

# Boeing 777

## **EICAS & ECL, Non Normal Checklist Handling**

EICAS (*Engine Indicating and Crew Alerting System*) is the centralised system for monitoring the normal (NM) and non-normal (NNM) status of modern Boeing aircraft. It is a one stop shop for engine indications and crew alerting and in combination with the Electronic Checklist (ECL), providing a human centric set of problem solving tools for modern aircraft.

This document does not seek to explain the basic mechanics of EICAS or ECL and assumes that you already have the relevant systems and procedural knowledge from the Boeing FCOM, QRH, FCTM and some practical experience. Instead here I explain the philosophy behind EICAS and ECL, providing a consistent framework for all crew to use as a basis for handling EICAS messages, ECL NM and NNM checklists and NNM events in a consistent manner, using the best practice CRM/NTS principles of the modern multi crew cockpit. You will also find some handling tips that have come from experience with the aircraft.

You may find some of the procedures and techniques documented here somewhat pedantic and stilted, but they are intended to produce a level playing field in the handling of NNM events across crew of varied language skills, company cultures, experience levels and degrees of fatigue – these procedures become second nature with repetition.

Note that nothing in this document should be considered authoritative over any procedures found in the Boeing Normal Procedures (NP's). The NP's and your airline Flight Operations Manual document are overriding.

Finally, note that while most of the contents is applicable to all 777 models, a few items (*such as 5.9 Engine In Flight Start Envelope*) are specific to the B777-300ER with GE90 Engines.

### ***Disclaimer.***

*This document is based on extensive research and operational experience of the Boeing EICAS/ECL found in the 777, in conjunction with documented procedures in the Boeing 777 QRH, FCTM and FCOM. Material incorporated in this guide is taken from all three of the relevant Boeing documents, as well as Boeing publications from issues of Airliner magazine and other sources.*

*As such this document is to be regarded as secondary in precedence to all these reference texts and should not be actively referred to with respect to operation of the aircraft.*

*Additionally this document incorporates techniques that have been developed and tested in conjunction with Simulator Training but not validated in operation of the aircraft, and must be read with caution.*

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## 1. Document Summary

This section provides a summary as a reference point list for each paragraph included in the rest of this SOP Amplification on EICAS/ECL. This table will tell you what to do – the detail sections tell you why you’re doing it. Note that anywhere you see a purple, italic link – this text can be clicked to jump that section.

### 1.1. Checklists and Checklist Memory Items

In the last few years, Boeing removed the use of the word “**Recalls**” when referring to the memory items on NNM checklists – possibly because of confusion with the Recall/Cancel switch. Instead these items are referred to as “**Checklist Memory Items**”. Hence when a NNM event occurs that requires the actioning of a checklist with memory items, crew no longer call for “**Fire Engine Right Recalls**” but “**Fire Engine Right Memory Items**”. As much as a tongue twister as this is on the flight deck when you’re under pressure, it’s even more difficult to refer to clearly in print. As such in this document:

- When you read “**Checklist/Memory Items**” this means Checklists OR Checklist Memory Items (in other words, Checklists or Recalls).
- When you read “**Checklist Memory Items**” this means just that (i.e. “Recalls”).

| Para       | Ref/pp        | SOP Amplification  | Sounds Like ...   |
|------------|---------------|--|---|
| <b>2</b>   | <b>6</b>      | <b>General ECL Usage</b>   |   |
| <b>2.1</b> |               | When you start a checklist, read the Checklist Title and Condition Statement.  | <b>“ Dual Engine Fail/Stall Checklist. ... Engine speed for both engines is below idle. ”</b>     |
| <b>2.2</b> | QRH<br>CI.1.2 | When you’ve finished a checklist, read the Checklist Title and Completing Statement.   | <b>“ Engine Failure Left ... Checklist Overridden. ”</b>  |
| <b>2.3</b> | QRH<br>CI.1.2 | <b>Before Take Off &amp; Before Landing Checklists</b> – read back “ <b>Checklist Complete</b> ”. Note this is the only time the PF is <i>required</i> to do this. | PM : <b>“ Before Takeoff ... Checklist Complete. ”</b><br>PF : <b>“ ... Checklist Complete. ”</b> |
| <b>2.4</b> |               | Any incomplete checklist should remain displayed on the MFD. The MFD may be temporarily used for another purpose – but return it to the checklist when finished.   |   |
| <b>2.5</b> |               | Overriding a checklist is unusual and should make you stop and think.  |   |
| <b>2.6</b> |               | The operation of the Normal Checklist requires <b>both</b> pilots to verify the completion of each checklist item.   |   |

| Para       | Ref/pp   | SOP Amplification  | Sounds Like ...   |
|------------|----------|--|---|
| <b>3</b>   | <b>8</b> | <b>General EICAS, Lower MFD and Synoptic Usage</b>   |   |
| <b>3.1</b> |          | EICAS Pre-flight: Review all messages, check for exceedences, leave EICAS clear and check for Status messages.   |   |
| <b>3.2</b> |          | When the Master Warning/Caution switch activates – Cancel it to reset the system, and call the failure.  |   |
| <b>3.3</b> |          | Keep the EICAS Clear. Once a NNM is over – Review ( <b>3.7</b> ) and Cancel the EICAS.   |   |
| <b>3.4</b> |          | Keep the lower MFD clear unless it’s actively in use.  |   |
| <b>3.5</b> |          | Non-Normal Checklists are to be completed before the Normal Checklists.  |   |
| <b>3.6</b> |          | <b>EICAS Recall:</b> <ul style="list-style-type: none"> <li>▫ PM presses Cancel/Recall switch, calls “<b>Recall</b>” and reads messages.</li> <li>▫ PF considers messages and calls “<b>Cancel EICAS</b>”.</li> <li>PM presses Cancel/Recall switch and clears EICAS.</li> </ul> |   |
| <b>3.7</b> |          | <b>EICAS Review:</b> At the completion of the NNM, PM reviews (reads out) the messages; PF calls “ <b>Cancel EICAS</b> ”.  | PM : <b>“ (NNM C/List) ...Checklist Complete. ”</b><br>PF : <b>“ EICAS Review ”</b><br>PM : <b>“ (Reads all displayed EICAS Messages)”</b><br>PF : <b>“ Cancel EICAS. ”</b> |
| <b>3.8</b> |          | Synoptic Displays are there to be used, but EICAS is the primary reference and situational awareness, Aviate, Navigate and Communicate must have priority.   |   |

| Para                     | Ref/pp          | SOP Amplification  | Sounds Like ...   |
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| <b>4</b>                 |                 | <b>Non Normal EICAS Message and ECL Usage</b>  |   |
| <b>4.1</b>               |                 | When a NNM event occurs, PM will call <b>"EICAS"</b> and identify the problem (read the message)   | <b>"EICAS ... Thrust Asymmetry Compensation"</b>  |
| <b>4.2</b>               | QRH<br>CI.2.4   | Checklist Memory Items should only be called for once Flight Path and Navigation are stabilised, and will remain so.   |   |
| <b>4.3</b>               | QRH<br>CI.2.4   | Checklists should only be called for once Flight Path and Navigation are stabilised, Memory Items are complete and the aircraft is not at a Critical Stage of Flight.  |   |
| <b>4.4</b>               | QRH<br>CI 2.5   | Checklist items that are not normally Memory Items may be called for from memory by the CA/PF when doing so is deemed both non-hazardous and desirable, or if reference to a checklist is not available.   |   |
| <b>4.5</b><br><b>4.6</b> | FCOM<br>15.20.2 | EICAS prioritises <b>Warning/Caution/_Advisory</b> messages and checklists, but not within these categories. It is within the PF's authority to select the order of Checklist/Memory Item action, guided by EICAS & airmanship.  |   |
| <b>4.7</b>               | QRH<br>CI 2.6   | Read all the White Checklist items (except for the <b>"Inhibited Checklist"</b> items).  |   |
| <b>4.8</b>               |                 | Certain Engine Controls that require confirmation can be guarded by the PF if the control is in the PM's area of responsibility.   |   |
| <b>4.9</b>               | QRH<br>CI 2.5   | Checklist actions that require confirmation are : <ul style="list-style-type: none"> <li>• Auto Throttle Arm Switches, Thrust Levers, Fuel Control Switches, Engine Fire Switches, APU Fire Switch, Cargo Fire Arm Switch, Generator Drive Disconnect Switches.</li> </ul> This excludes the Fuel Control Switches during Dual Engine Fail/Stall Memory Items; and Memory Items on the Ground. |   |
| <b>4.10</b>              |                 | Initiating and actioning Checklist Memory Items is a facsimile of initiating and actioning a NNM checklist.  | PM : <b>"EICAS ... Fire Engine Left"</b><br>PF : <b>" Fire Engine Left Memory Items"</b>  |
| <b>4.11</b>              | QRH<br>CI 2.5   | Checklist items should be read aloud in entirety, the Item Action performed, the Action re-stated and the checklist reference item clicked off (where necessary).  |   |
| <b>4.12</b>              |                 | Yes/No decision branches in the checklist require the agreement of both crew and should not be pre-empted by PM.   | PM : <b>"Fuel to remain must be changed – YES or NO?"</b><br>PF : <b>"Hmmm ... NO"</b><br>PM : <b>"I agree " ... (clicks NO) ... "NO"</b> |
| <b>4.13</b>              |                 | Checklist notes are collected through the completion of NNM checklists – unless a checklist is Overridden (2.5) rather than completed. Notes are used to review the implication of a failure long after the NNM checklists have been completed. See the detailed section for the dispatch with TAC inoperative example.  |   |
| <b>4.14</b>              |                 | Crew should consider Un-Annunciated checklist titles and condition statements as memory items. PF could consider prefacing a call for such a checklist with <b>"Un-Annunciated"</b> as an aid to the PM.   |   |
| <b>4.15</b>              | QRH<br>CI.2.2   | The checklist statement <b>"Plan To Land At The Nearest Suitable Airport"</b> does <b>not</b> require you to begin preparing for landing during the NNM checklist. By implication, this statement is an indication of the urgency of the NNM situation. Protect your current task – finish the checklist.  |   |
| <b>4.16</b>              |                 | Entering ECL NNM adjusted approach speeds needs to be done carefully. Select the Flap Line first, then modify the indicated speed based on the ECL Note. Consider confirming the result with the PF.   |   |
| <b>4.17</b>              |                 | When a Checklist is Complete Except for Deferred Items, it is acceptable to review these items before continuing through the NNM checklist cycle.  |   |
| <b>4.18</b>              |                 | The quickest way to locate an Un-Annunciated checklist is through the ECL Non Normal Menu – Un-Annunciated Checklists ... prompt.  |   |
| <b>4.19</b>              |                 | When a NNM checklist is complete and another exists – PM can click on the <b>NON-NORMAL</b> to display either the next NNM checklist, or the NNM checklist queue.  |   |
| <b>4.20</b>              |                 | When multiple NNM checklist exist, they are handled in a cycle. The loopback process commences at <b>"Checklist Complete"</b> with the PM prompting <b>"More NNM Checklists"</b> .   |   |

| Para       | Ref/pp    | SOP Amplification   | Sounds Like ... |
|------------|-----------|---|-----------------|
| <b>5</b>   | <b>18</b> | <b>Miscellaneous EICAS/ECL Notes</b>  |                 |
| <b>5.1</b> |           | The Autostart event during a ground engine start results in a hidden Autostart checklist – Call for it when appropriate once the Checklist Memory Items are complete.   |                 |
| <b>5.2</b> |           | The <b>HYD PRESS SYS R+C</b> system failure, which brings with it the <b>STABILIZER</b> Checklist/Memory Items, is one area where the EICAS/ECL philosophy seems not to apply – until you try it.   |                 |
| <b>5.3</b> |           | There is a general profile to handle NNM's during Takeoff – Memory Items after 400 ft, Checklists when clean – but for every rule ...   |                 |
| <b>5.4</b> |           | Non Normal calls during takeoff need careful consideration. Safe Flight of the aircraft must not be affected.   |                 |
| <b>5.5</b> |           | EICAS/ECL handling for a Packs Off Takeoff requires cancelling the EICAS PACK L/R messages and not running the NNM checklists. After takeoff restore the Packs and the EICAS messages and associated NNM checklists will clear.   |                 |
| <b>5.6</b> |           | EICAS/ECL Engine Failure handling follows the basic rules of EICAS/ECL, with some minor differences.  |                 |
| <b>5.8</b> |           | The Captain may decide that time is insufficient to complete (or call for) a checklist, in which case<br>(a) any incomplete checklist should remain on the lower MFD; or<br>(b) the EICAS message should remain displayed.<br>Choosing not to action a checklist is within the Captain's authority, but the implications should be mitigated.   |                 |
| <b>5.7</b> |           | Any failure that happens during a critical phase of flight, includes an engine malfunction or involves a combination of malfunctions may cause the PF to prompt the PF to " <b>Identify The Failure</b> ". This process begins with the EICAS Messages (either all or just the critical ones) and possibly leads to an Engine Failure Analysis. |                 |
| <b>5.9</b> |           | Boeing/GE publish an Engine In Flight Start Envelope in the AFM (not on board the aircraft). A comparison of this diagram as against the EICAS re-start envelope indications (X-BLD / FL-IAS) provides useful background information to the likely result of engine re-lights at various altitudes/speeds.                                      |                 |

## 2. General ECL Usage

### 2.1. Read the Title and Condition Statement

Reading the **Title** and **Condition Statement** of all checklists enables the Pilot Flying (PF) & Pilot Monitoring (PM) to confirm that the correct checklist has been displayed. In essence this reading is a challenge from the PM to the PF to confirm that the correct checklist has been selected – ideally the PF should respond. Note that technically the QRH only requires as much of the condition statement read as confirms the correct checklist selection.

Some NNM's will result in multiple EICAS messages and checklists. EICAS performs only a basic prioritisation of multiple messages and checklists ([4.5 EICAS Message Prioritisation](#)) and it is the responsibility of the Captain to choose the order in which the NNM checklists are actioned. Thus when the workload is high and the flight path must be positively maintained, reading the title and conditions clearly ensures the PF's requests are being met correctly.

Additionally, some NNM's require the manual selection of an un-annunciated NNM checklist ([4.18 Locating an Un-Annunciated Checklist](#)) in which case this confirming step becomes crucial.

Note this technique is also used when initiating Checklist Memory Item actions ([4.10 Initiating & Actioning Checklist Memory Items](#)).

### 2.2. When a checklist is over ...

All checklists should finish with the PM reading in full "*Checklist Title ... Checklist Complete.*", "*Checklist Title ... Checklist Complete Except For Deferred Items.*", or "*Checklist Title ... Checklist Overridden.*" At this point in the NNM event handling cycle ([5.8 How NOT to do a Checklist](#)), the PF is required to initiate the next step in the process – whether this is calling for the next NNM checklist, an EICAS Review ([3.7 EICAS Review](#)) or a NM checklist. These phrases should be a prompt to the PF that input is required once again to direct the flow of problem solving.

### 2.3. Before Take Off and Before Landing Checklists

Boeing QRH requires the PF to echo the "**Checklist Complete**" statement after the PM at the completion of these checklists. This implies that the PF will visually confirm that the **correct** checklist was completed – and is complete.

|   |
|---|
| PM : " <b>Before Takeoff Checklist Complete ...</b> "<br>PF : " <b>.. Checklist Complete.</b> " |
|---|

### 2.4. Interrupting a Checklist ...

Some checklists incorporate pauses. These can be timed, or they can require waiting for an internal event (Fuel Jettison Complete) or external event (Level at 10,000 ft). Checklists may also be halted at the direction of the PF/CA for achieving a more pressing need. Examples include the Fuel Jettison Checklist, or the Fuel Imbalance Checklist.

If a checklist execution is paused or interrupted for some reason, it should remain open on the lower MFD. It is acceptable to use the lower MFD for another (higher) purpose while an ECL checklist is halted (or in use). When the lower MFD is no longer required, it should then be returned to the incomplete checklist.

### 2.5. Overriding a checklist

The PF's confirmation is required before any checklist item or any checklist is overridden. Note that the overriding of a checklist means any deferred items ([4.17 Deferred Checklist Items](#)) will not be deferred and any Notes ([4.13 Checklist Notes](#)) generated by the checklist will not be copied to the ECL Notes page.

Crew new to the aircraft (but experienced in the simulator) should note that there are very few instances where a checklist is overridden – the regular exception to this being the Engine Failure checklist when an alternative Engine Failure Checklist (Engine Severe Damage/Separation, Engine Limit/Surge/Stall or Fire Engine) has already been actioned.

One result of continuous simulator training with repeated cycles of NNM's and the associated NNM checklists is a tendency to override any outstanding checklist that gets in your way. If you find yourself overriding any checklist – stop ask yourself why, stop and ask yourself are you sure.



## 2.6. It Takes Two Pilots to do a Checklist

The Boeing QRH Checklist Instruction section specifies for each of the NM checklists which pilot is to call, read, verify and respond to a checklist item. Perhaps the most important point of this paragraph is that **both pilots are to visually verify that each item is in the needed configuration** irrespective of respondent.

Note that the inclusion of CM1, CM2, PF, PM, BOTH and ALL beside the NM checklist items is company specific and may not necessarily conform to either area of responsibility or the Boeing QRH CI table Respond column, but are selected to assist in the ease of use of the paper checklist when ECL is unserviceable – with ECL serviceable the items are closed loop.

| Checklist      | Call         | Read             | Verify | Respond                |
|----------------|--------------|------------------|--------|------------------------|
| PREFLIGHT      | Captain      | First officer    | Both   | Area of responsibility |
| BEFORE START   | Captain      | First officer    | Both   | Area of responsibility |
| BEFORE TAXI    | Captain      | First officer    | Both   | Area of responsibility |
| BEFORE TAKEOFF | Pilot flying | Pilot monitoring | Both   | Pilot flying           |
| AFTER TAKEOFF  | Pilot flying | Pilot monitoring | Both   | Pilot monitoring       |
| DESCENT        | Pilot flying | Pilot monitoring | Both   | Area of responsibility |
| APPROACH       | Pilot flying | Pilot monitoring | Both   | Area of responsibility |
| LANDING        | Pilot flying | Pilot monitoring | Both   | Pilot flying           |
| SHUTDOWN       | Captain      | First officer    | Both   | Area of responsibility |
| SECURE         | Captain      | First officer    | Both   | Area of responsibility |

Finally, it's worth noting that when a checklist address multiple crew ("All") the first reply should come from the other Primary crew member (PF/CM1) followed by CM3, CM4 and then the PM. The only place this occurs is the Pre-Flight Checklist item "Oxygen ... Tested 100% ... All".

### 3. General EICAS, Lower MFD and Synoptic Usage

#### 3.1. EICAS during pre-flight

The Boeing pre-flight setup requires the crew member to:

- Review the EICAS messages
- Review the Status messages
- Look for engine indication exceedences

Coupled with the Tech Log and the external inspection, the following procedure facilitates the CM1's complete knowledge of aircraft status. A good technique is for the CM1 to do this on entering the flight deck:

- Display the Secondary Engine Indications on the lower MFD.
- If the EICAS is not clear – press the Cancel/Recall switch until it is.
- Now press the Cancel/Recall switch once and look for any exceedence indications on both Upper and Lower MFD's.
- Review (think about) the EICAS messages, including those on any subsequent pages, pressing the Cancel/Recall switch until the EICAS is clear.
- Press the STAT button and review any Status messages on the lower MFD – and consider their impact on dispatch.
- Leave the MFD clear (**3.4 Keep the Lower MFD Clear**) if not required for another purpose (Doors, Fuel, etc)

Subsequent EICAS messages during pre-flight should be dealt with as at any other time (**4.1 Responding to EICAS Messages**) – called, analysed, cleared.

#### 3.2. Cancel the Master Warning/Caution Switch

Nothing is more disturbing when things are going wrong that having lights and sirens going off when you're trying to think. The first instinctive action of a crew member should be to cancel the warning. In the case of the Master Warning/Caution light/switch – when it illuminates, press the switch to cancel (**and therefore reset**) the light/switch, and call the failure (**4.1 Responding to EICAS Messages**)



Note that the Autopilot Disconnect aural cannot be cancelled by the Master Warning/Caution switch – a second activation of the autopilot disconnect switch is required. The recommended method for autopilot disconnection is the silent disconnect, see **Infinidim B777 Document : Standard Calls, Autopilot and Control Handover Calls**.

#### 3.3. Keep the EICAS Clear

Once a NNM has been dealt with, **Review** the EICAS (**3.7 EICAS Review**) and **Cancel**. Keeping the EICAS clear enables further messages associated with subsequent systems failures to be noticed quickly and actioned by the crew.

**Do not cancel messages without an EICAS Review.**

Note that you cannot cancel a **Warning** message on the EICAS – these remain until the displayed condition no longer exists.

#### 3.4. Keep the Lower MFD Clear

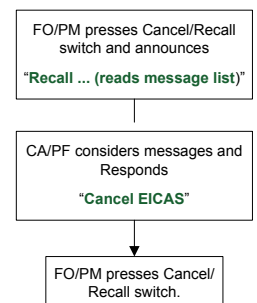
When not in use, the lower MFD should be kept clear. This allows the crew to easily recognise when an engine limit exceedence popup is displayed by EICAS. Note that if a NNM checklist is in play, it should be kept displayed on the lower MFD until complete (**2.4 Interrupting a Checklist**).

#### 3.5. Non-Normal *before* the Normal

NNM checklists are to be completed before NM checklists. A useful tip to remember is that when the final EICAS Review (**3.7 EICAS Review**) is complete and you tell the PM "**Cancel EICAS**" – consider there and then whether it's appropriate to call for the next NM Checklist (typically forgotten at this point is the **After Take Off Checklist**).

#### 3.6. EICAS Recall

During several of the NM ops flows, the FO/PM presses the Cancel/Recall switch and reads the displayed messages to the CA/PF. It is the CA/PF's job at this point to consider the message list and the stage of flight being contemplated. This primary reason for the EICAS Recall is to build crew situational awareness and encourage thought about the aircraft technical status into the conscious decision making process. Note the CA/PF would only respond "**Cancel EICAS**" if the messages involved were expected and no NNM checklists were outstanding. As always, multiple pages of messages may need to be reviewed. If there are no EICAS messages as the result of a Recall, CA/PF should respond with simply "**Check.**"





### 3.7. EICAS Review

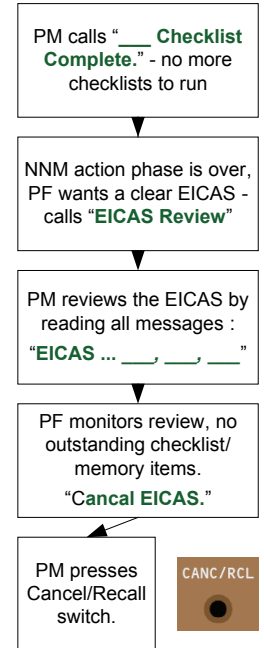
An EICAS Review is different. At the completion of all outstanding NNM checklists, the PF should call for an **"EICAS Review"** or **"Review the EICAS"**. The intent of this procedure is to allow the PM to clear the EICAS without clearing any messages the PF has not considered/dealt with – whether or not those messages have checklists associated. The Review also allows the clearing of EICAS without having to read the messages associated with previous failures already dealt with.

So – PF calls for **"EICAS Review"**. PM then reads the currently displayed messages from the EICAS. PF considers the messages, ensuring there are no outstanding checklists and that an appreciation of the technical status of the aircraft and the impact on the rest of the flight has been reached. PF then responds **"Cancel EICAS"**.

It should be noted that this is **not** an **EICAS Recall**. A complete EICAS Recall is not procedurally required at this point. Any messages not currently displayed on EICAS at the end of a NNM checklist do not need to be recalled and re-read at this point. That's not to say that the PF can't call for an **"EICAS Recall"** at any time if desired for situational awareness.

#### Calling for EICAS Review during Multiple Failures

When a significant failure is in progress that involves multiple EICAS messages and associated Checklist/Memory Items, the PF can call for an **"EICAS Review"** at the end of the completion of any NNM Checklist/Memory Items to assist in deciding what the next action should be. Normally however, the PF uses the EICAS and checklist icons to decide on the next Checklist/Memory Items to be actioned, without the need for an EICAS Review.



### 3.8. Synoptic Display Usage

Synoptics displays are always available for crew use. This includes during NNM events and while NNM checklists are in progress. However any use of synoptics should not interfere with the requirement to focus on task completion – don't let your curiosity about a synoptic display interfere with completing a NNM checklist. The need to see the synoptic should be genuine – not curiosity.

The synoptics can provide an important visual snapshot of the status of the various systems of the aircraft, particularly at the completion of the NNM checklist after a NNM event. For example, sometimes the EFIS Flight Controls page can provide a visual representation of a series of failed spoilers with greater clarity than a generic ECL Notes statement.

Note that it is acceptable to use a Synoptic display on the left or right MFD's, for example during ECL use. However good airmanship dictates that the display of a synoptic should not impede the PF's navigational situation awareness, nor the PM's ability to monitor the PF.

Recent incidents have highlighted the usefulness of the Synoptics to provide flight crew with a non-specific snapshot of the damage done to an aircraft (or more correctly, what's left working on the aircraft) after severe NNM's such as significant damage to electrical sub-systems or significant engine damage events.

Finally, note that Boeing cautions against Synoptics being used to diagnose problems and that in some specific instances synoptic displays can be misleading as to the true state of a system. EICAS is always the primary source for NNM handling.

## 4. Non Normal EICAS Message and ECL Usage

### 4.1. Responding to EICAS Messages

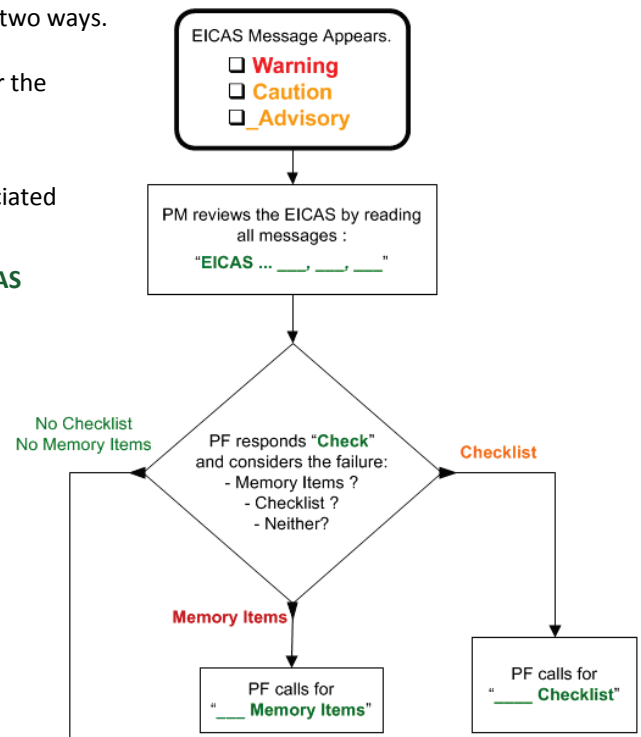
From the point of view of EICAS, a NNM event starts in one of two ways. Either EICAS detects a problem and generates an associated **Warning/Caution/\_Advisory** or abnormal engine indication, or the problem is identified by the crew alone and un-announced Checklist/Memory Items are called for.

The technique for handling EICAS messages and possible associated actions is as follows.

- PM (or PF) sees the message and announces it clearly **“EICAS – Message”**
- PF calls **“Check – Message Checklist/Memory Items”**.

If the EICAS message has a checklist icon (☐), the PF calls for either the **“Message Checklist”** – or if that checklist includes Memory Items, then PF first calls for the relevant memory items **“Message Memory Items”**.

Note that the radio should remain the responsibility of the PM. The exchange of responsibilities is not encouraged by Boeing as it divides the crew, especially during a critical time such as a NNM Checklist/Memory Items. Flight path remains the primary responsibility of the PF; Communication is to remain the responsibility of the PM. The PM is strongly encouraged not to make radio calls during Checklist Memory Items.



### 4.2. When to do Memory Items

Checklist Memory Items are those items at the beginning of a checklist that must be committed to memory and actioned from memory as a response to a NNM event. Boeing has two statements regarding when to call for NNM Checklists.

***“Non-normal checklist use commences when the airplane flight path and configuration are correctly established”***

***“Flight path control must never be compromised”***

By implication, Memory Items should be called for and completed expeditiously. However it is suggested that Memory Items should not be called for until:

- The **Flight Path** is under control.
- It is established that this control will be maintained whilst the Memory Items are being carried out – that is, the PF is able to handle other tasks such as:
  - a) Monitoring an engine shutdown.
  - b) Manipulate the MCP.

It is strongly suggested the Autopilot (AP) be engaged prior to calling for Memory Items.

### 4.3. When to do NNM Checklists

A NNM checklist should only be called for when:

- The **Flight Path** is under control.
- The **Navigation** is under control.
- The aircraft is not at a **Critical Stage** of Flight.
- All **Checklist Memory Items** are complete.

Prior to commencing a lengthy (or series of) NNM checklists, the PF could give consideration to a mini-plan that will take care of the Navigation and Communication operation of the aircraft. Heading towards an airport, taking up a hold, advising ATC – all could be considered appropriate actions prior to the commencement of NNM Checklists.

#### 4.4. Checklist Items by Memory

The PF may direct that a checklist action be completed from memory when the action is not a memory item. PF should only do so if “no hazard is created by such an action, or if the situation does not allow reference to the checklist.”

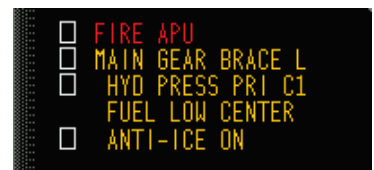
In practice this option is seldom exercised by the PF, for obvious reasons. Generally it is used to justify continuing the Engine Limit/Surge Stall Checklist from memory to shut a misbehaving engine down, or to pre-empt damage in the event of an engine oil loss. Note this paragraph is not an encouragement to use checklist items from memory in either of these situations.

#### 4.5. EICAS Message Prioritisation

Significant failures or failures in combination can result in multiple EICAS messages of varying levels, as well as multiple NNM checklists. The ECL queues multiple NNM checklists (**4.6 Prioritisation of NNM Checklists**) pending checklist completion

EICAS prioritises multiple messages on the basis of **Warning/Caution/\_Advisory** and that is all. It is the responsibility of the CA/PF to select which message is the next to be actioned. This decision process should follow the following priority list:

- Checklist Memory Items
- **Warnings**
- Checklists with Memory Items
- **Cautions** with a Checklist
- **\_Advisories** with a Checklist



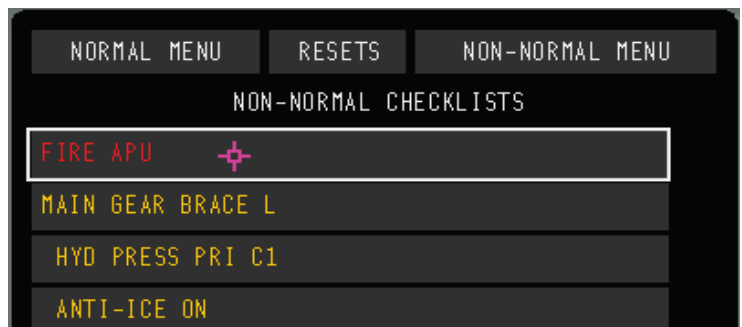
However it is well within the authority of the CA/PF to decide which message is to be dealt with first. Consider some of the following EICAS Messages/Checklists/Memory Items and the possible prioritisation in comparison to others of a similar level of EICAS priority.

- Memory Items for **CABIN ALTITUDE** (Oxygen is good for you).
- Memory Items for **STABILIZER** (Control of the aircraft is important too).
- Memory Items for **Engine Severe Damage/Separation**.
- Checklists for **CABIN ALTITUDE / STABILIZER / Engine Severe Damage/Separation** (all checklists with Memory Items).
- Checklists for **FWD CARGO DOOR** and **SLATS DRIVE** (both cautions).
- Checklist for **\_THRUST ASYM COMP** (Advisory) over **ENG FAIL** (Caution, to be overridden after Engine Damage)

By implication, the ability of the CA/PF to prioritise between checklists of similar levels of EICAS prioritisation is enabled by familiarity with the messages and checklists contained within the QRH. Keep studying.

#### 4.6. Prioritisation of NNM Checklists

After an EICAS event that results in multiple NNM checklists, the PM & PF will be confronted with an ECL that provides a list of NNM checklists to be completed. Note that the ECL prioritises these checklists at the same basic level of **Warning/Caution/\_Advisory** that EICAS does (**4.5 EICAS Message Prioritisation**) and it is up to the CA/PF to determine which checklist is done next.



#### 4.7. If it's in White – read it (except ...)

A good rule of thumb is that everything in white on the ECL **must** be read aloud. Neither **completed** (green) nor **not applicable** (cyan/blue) checklist items are read. The white list includes:

- Checklist Titles.
- Conditions Statements.
- Checklist Items.
- Information Notes.
- Yes/No Branches.

The item missing from this list is **Inhibited Checklists** (which appear in the paper **QRH** as “*Do not accomplish the following checklists :*”) Reading the Inhibited Checklist list from the ECL is acceptable, but not necessary. Any checklist title that appears in the “**Inhibited Checklists:**” list will be displayed on the EICAS without the associated checklist icon (☐) and will be evaluated during the subsequent EICAS Review (**3.7 EICAS Review**). Thus reading them during the NNM checklist, then reading them as part of the EICAS Review doubles up, and is not required.

#### 4.8. Guarding Critical Controls

Some airlines do not require guarding critical engine controls when actioned during NNM checklist/memory items by the PM. Good airmanship suggests that when critical engine controls are being confirmed and actioned - the PF can guard the functional control. Specifically this should include the following checklist actions.

- FUEL CONTROL Switch .....CUTOFF
- Engine Fire Switch .....Pull

Guarding is only relevant when the control is actioned by the PM. While the PF must confirm with the PM the correct identification of the A/T ARM switch and Thrust Lever prior to actioning a recall or checklist, it is not considered necessary for the PM to guard the relevant functional control in this case. Note that the PF should not guard the control in such a way as to permit the accidental selection of the control by either pilot – the intent is to preclude the control be actioned – not facilitating the accidental selection of the control by the PF.

#### 4.9. Actions Requiring Confirmation

Good CRM dictates that the PF monitors the actioning of all checklist items to ensure it is being done correctly. That said, the plane must be flown and navigated, communications dealt with and situational awareness maintained as well. It is not required that the PM confirm with the PF the correct actioning of all checklist items. However the following actions **must** be confirmed by both crew before the action is completed by either pilot.

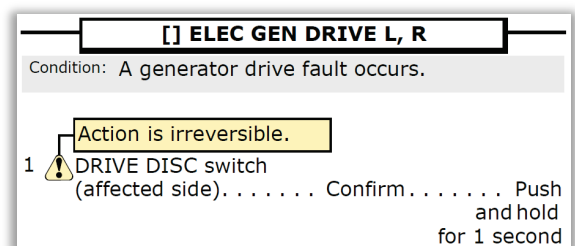
- Auto Throttle (A/T) Arm Switch.
- Thrust Lever.
- Fuel Control switch.
- Engine Fire switch.
- APU Fire switch.
- Cargo Fire Arm switch (guarded).
- Generator Drive Disconnect switch (guarded).

The exceptions to this requirement include:

- The Dual Engine Fail/Stall Checklist Memory Items where the PM is expected to cycle both Fuel Control Switches without confirmation.
- Any Checklist/Memory Item actioned on the ground.

Some checklist items include the statement **Action is irreversible**. Good airmanship dictates the PM should seek the confirmation of the PF prior to such actions.

Other controls often considered for confirmation are guarded switches. However when you consider that this would include the RAT deployment during a Dual Engine Fail/Stall, the Passenger Oxygen switch during Cabin Altitude Memory Items, and other guarded but reversible switches such as the GPWS Flap Override – it becomes clear why guarded switches are not part of Boeing’s list. That said, if you’re about to action a guarded switch, stop, think and be sure (doesn’t that apply to all switching?)



**4.10. Initiating & Actioning Checklist Memory Items**

Some checklists begin with Items that are to be completed from memory. As such the technique employed when calling for, actioning and completing Checklist Memory Items follows the same methodology as a non-normal checklist ([4.11 Performing Checklist Actions](#))

With NNM checklists - PF calls for a NNM checklist, PM finds the checklist in the ECL and reads the checklist title, then reads the checklist action items, and the actions themselves are completed by the pilot who has the area of responsibility over the control, accounting for confirmation ([4.9 Actions Requiring Confirmation](#)) and control guarding ([4.8 Guarding Critical Controls](#)). Once the action is complete, the actioning pilot restates the action. When the checklist is complete, PM will re-state the checklist title, and **“Checklist Complete”**.

Memory Items are done in much the same way. PF calls for the \_\_\_ Checklist Memory Items, PM re-states (agrees), PM reads the items (from memory), they’re actioned (area of responsibility/confirmation/guarding) and when complete, the PM announces **“\_\_\_ Memory Items Complete.”**

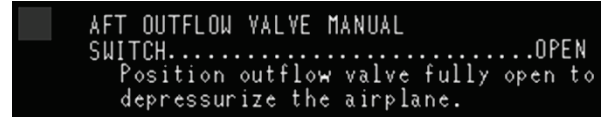
| NNM Event Stage.  | PF/PM Calls & Actions.   | Details & Background.  |
|---|--|--|
| <input type="checkbox"/> <b>FIRE ENG L</b><br>(someone reset the Master Warning/Caution switch)             | PM : <b>“EICAS – Fire Engine Left.”</b>                            | The PM (ideally) calls the failure from EICAS.   |
|   | PF : <b>“Check.”</b> ...<br><b>“Fire Engine Left Memory Items”</b> | PF responds, verifies, and selects the next action to be taken.  |
| <b>Recall/Checklist reads :</b><br>A/T ARM switch..... Confirm OFF<br>(PF Area of responsibility)           | PM : <b>“Fire Engine Left Memory Items”</b>                        | PM re-states the Memory Checklist to be actioned, (agreement) then begins the memory actions.  |
|   | PM : <b>“Left AUTOTHROTTLE ARM switch ... OFF”</b>                 | PM calls the Checklist Items from memory. Note that QRH text <b>“Confirm”</b> is not called out.                                       |
|   | PF : <b>“Confirm ?”</b>  | PF touches the A/T Arm Switch and seeks confirmation from the PM.  |
|   | PM : <b>“Confirmed”</b>  | PM confirms the correct control selection.   |
| <b>Recall/Checklist reads :</b><br>Thrust Lever ..... Confirm... Idle<br>(PF Area of responsibility)        | PF : <b>“Off”</b>  | PF Selects left A/T Arm switch to Off and restates the action ( <b>“Off”</b> ) now completed.  |
|   | PM : <b>“Left Thrust Lever ... Idle”</b>                           | PM calls the next Checklist Memory Items (Skip <b>“Confirm”</b> )  |
|   | PF : <b>“Confirm ?”</b>  | PF identifies (touches) the control and seeks confirmation.  |
|   | PM : <b>“Confirmed”</b>  | PM confirms the correct control selection.   |
| <b>Recall/Checklist reads :</b><br>FUEL CONTROL switch.... Confirm... CUTOFF<br>(PM Area of responsibility) | PF : <b>“Idle”</b>   | PF actions the Memory Item and re-states the completing Action.  |
|   | PM : <b>“Left Fuel Control Switch ... Cutoff”</b>                  | This control is in the PM’s area of responsibility. PM calls the Checklist Items from memory.  |
|   | PM : <b>“Confirm ?”</b>  | PM identifies the control seeks confirmation.  |
|   | PF : <b>“Confirmed”</b>  | PF can guard the functional engine control and confirm the correct control selection by the PM.  |
|   | PM : <b>“Cutoff”</b>   | PF actions the Memory Item and re-states the completing Action.  |
| ... And so on ... until ...   |  |  |
| <b>Checklist Memory Items Complete.</b>   | PM : <b>“Fire Engine Left ... Memory Items Complete”</b>           | The crew now moves on to an EICAS Review (3.7) for the next step:<br>(a) Another Checklist with Memory Items; or<br>(b) NNM Checklist. |

- It doesn’t matter who resets the Master Warning/Caution switch, nor does this require confirmation. It should be reset as soon as it is noticed ([3.2 Cancel the Master Warning/Caution Switch](#)) so the system is ready for the next activation.
- Although it looks here like the call **“Fire Engine Left Memory Items”** is repeated by both PF and PM, in fact this procedural terminology is based on the use of NNM checklists (see [2.1 Read the Title and Condition Statement](#)) and is procedurally correct as well as being the PM’s concurrence with the PF’s decision.
- When the PF/PM confirms that the control referenced verbally by the PM/PF has been identified (touched) correctly – this should include checking the EICAS to ensure that the **affected** control has been referenced. **There’s no point confirming that the PM has his hand on the Right Fuel Control Switch, when it was the Left Engine that was damaged and needs to be shut down.**



#### 4.11. Performing Checklist Actions

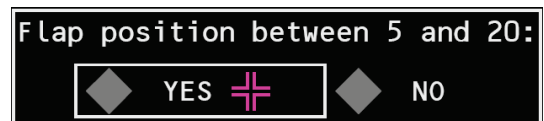
Checklist actions are performed in a deliberate, unhurried manner. While the PF's agreement is not required for most checklist actions (**4.9 Actions Requiring Confirmation**) the actions should be performed with a verbalisation that allows the PF to fly the aircraft, navigate and follow the checklist. Checklist actions are performed generically in much the same way that a Checklist Memory item is actioned.



| Recall/Checklist Actions & Flow  | Verbalisation and Control Actions.  |
|--|---|
| PM reads each Reference line and the <b>Response</b> and any <b>Amplifying Information</b> . | <b>"AFT OUTFLOW VALVE MANUAL SWITCH ... OPEN<br/>Position outflow valve fully open to depressurize the airplane."</b> |
| PM Performs the <b>Action</b> .  | Position the Outflow Valve to full Open.  |
| PM Re-States the <b>Action</b> .   | <b>"Open."</b>  |
| PM <b>Clicks Off</b> the checklist item if required.   |   |

#### 4.12. Yes / No Decision Branches

Occasionally the ECL will require the answer to a Yes/No question. **These questions require the input/confirmation of the PF.** PM should avoid pre-empting the PF's decision by highlighting either of the answers in the checklist (*such as is shown here*).



PM : **"Fuel to remain must be changed – YES or NO?"**  
PF : **"Hmmm ... NO"**  
PM : **"I agree ... "** (clicks NO) **"... NO"**

PM : **"Flap position between 5 and 20 – YES or NO?"**  
PF : **"Uhhh ... No."** (or more typically) **"Uh ... Check"**  
... ..  
PM : **"Capt ... Flap position between 5 and 20 – YES or NO?"**  
PF : **"Oh ... YES."**  
PM : **"I agree ... "** (clicks YES) **"...YES."**

#### 4.13. Checklist Notes

Many checklists incorporate **Notes** to crew. These notes often affect the subsequent operation of the aircraft and are collected by the ECL for later display using the **NOTES** prompt at the bottom of the MFD ECL display.



The philosophy here anticipates a non-normal event occurring significantly prior to approach and landing, or during the Relief Crew operation. While preparing for the approach briefing, PF will consult the ECL Notes to assess the impact of the flight's NNM's on the approach and landing.

Note however that in the event a checklist with notes is overridden (**2.5 Overriding a checklist**) – the associated notes will not be collected by the ECL. It should also be noted that the action of **RESETS ... RESET NON NORMALS** clears any accumulated notes in the ECL.

An example of this is dispatch with TAC inoperative. After pushback, the EICAS **THRUST ASYM COMP** message will display, with the associated checklist icon. The checklist specifies resetting the TAC switch, which is of course switched off in accordance with the MEL. The crew elects to override the checklist – in this event the note regarding manual control inputs for asymmetric thrust conditions will not appear in the ECL notes for later referral. Oops.

**A refresh of the Notes (along with an EICAS Recall) should be completed as part of your Preparation/Arrival Brief – as is stipulated in the Descent Checklist.**

#### 4.14. Un-Annunciated Checklist Titles/Conditions are Memory Items

Some failures require the PF to call for an un-annunciated checklist from memory – some of them with Memory Items. Knowing which checklist to call for can be a challenge. **Crew are well advised to consider the Titles and Condition Statements of Un-annunciated checklists as memory items.** It can be quite difficult to call for a checklist when you don't know which checklist is appropriate for the fault you've detected – or you don't know the correct title of the checklist. For example – the left engine does not respond to thrust lever movement – which Checklist/Memory Items? In this situation, PF should, by recall and using the correct wording, call for the **"Engine Limit/Surge/Stall Left Memory Items."**

When it comes to calling for the checklist, the PF could consider prefacing a call for an un-annunciated checklist with **"Un-Annunciated"**. In times of adrenalin and stress – a PM might find it easier locating the **"Un-Annunciated Engine Limit/Surge/Stall Left Checklist."**



#### 4.15. Plan to land at the nearest suitable airport

When this statement appears in the checklist, crew are often tempted to begin the management phase of a NNM – seeking the information necessary to choose a suitable airport for an immediate landing - weather, NOTAMS, runway in use, approach, etc. That is not the intent of this checklist statement. The “Land ASAP” checklist statement is establishing the need for a “landing at the nearest suitable airport” – it is not requiring you to choose it during the checklist. At this point your immediate task is the completion of the checklist – protect this task and finish it.

PF should acknowledge the statement, *perhaps* state a brief intention “**Ok, we’ll look at a return to Sydney shortly.**” and the checklist should go on. Implicitly, this statement is an indication of the urgency of the NNM event.

Some situations require landing at the nearest suitable airport. They include, but are not limited to:

- The Non-Normal checklist says so “Plan to land at the nearest suitable airport.”
- Cabin Smoke or Fire, (technically uncontained Fire, or un-determined smoke source).
- 1 AC power source remaining (Engine Generator OR APU Generator OR Backup Electrical System).
- Any other situation determined by the crew to present a significant adverse effect on safety if flight is continued.
- For persistent smoke, or fire that cannot be positively confirmed to be extinguished, the **earliest possible descent, landing and passenger evacuation** should be accomplished.

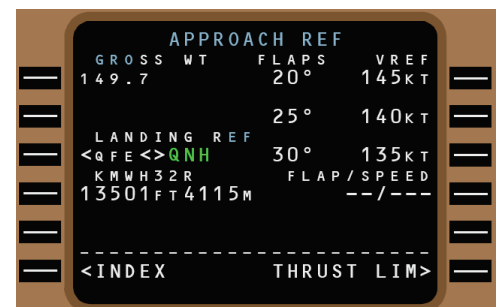
Note that the two backup generators that constitute Backup Electrical System are considered a single power source. The RAT is **not** considered a source for this determination.

#### 4.16. Approach Speeds

One common error during NNM ops is the entering of a modified Flap and  $V_{REF}$  setting into the FMC as the result of a NNM. The clue here to realise you are being given two separate pieces of information – the flap setting to enter into the FMS, and the reference speed used for the approach. In the example given here – **Flaps 20** and a reference speed of  $V_{REF}$  **30+20**.

**Notes:** Use flaps 20 and  $V_{REF}$  30 + 20 for landing. This allows higher approach speeds to improve airplane maneuvering characteristics.

- Select the line appropriate to the Flap Setting. (LSK 1R : 20° / 145KT)
- CLR the speed in the scratchpad and replace with a calculated replacement – which in this case is  $V_{REF}$  30 (135 knots) + 20 = 155 knots.
- Line Select 20/155 the scratchpad into the FLAP/SPEED line (LSK 4R).



PM should consider cross-checking the setting with the PF, although PF should check this value separately as part of preparing for the approach.

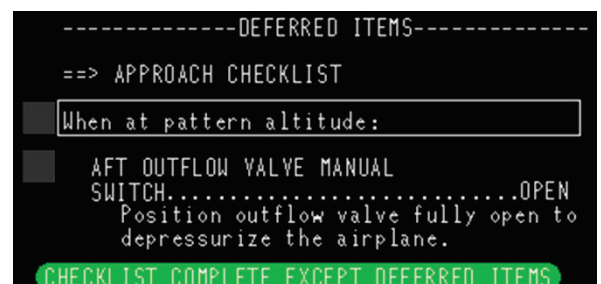
It’s not a bad technique to pause the NNM checklist and enter this speed into the FMC when the Note appears in the checklist. Beware however of significant changes subsequent to setting  $V_{REF}$  owing to Fuel Jettison etc. If you don’t set the  $V_{REF}$  in the checklist – you’ll pick it up when you review the ECL Notes as part of your Preparation/Arrival Briefing (won’t you ...)

Another good technique any time you are selecting an approach speed is to cross check your weight with the Maximum Landing Weight of the aircraft. **Anytime the Flap 30 Approach Speed is above 148 Knots – check!**

#### 4.17. Deferred Checklist Items

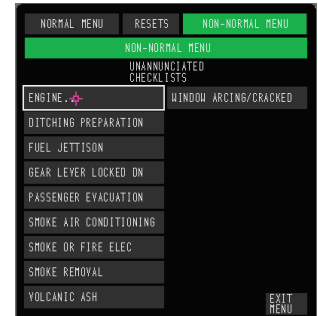
Some checklists gather together items which must be completed as part of the Descent, Approach or Landing Checklists. These items will be collected together at the bottom of the NNM checklist and will appear later on as part of the relevant NM checklist.

Note that it is permissible (even encouraged) for the PF/PM to review these items once **CHECKLIST COMPLETE EXCEPT FOR DEFERRED ITEMS** stage is reached. Just don’t tick any of them off by mistake.



#### 4.18. Locating an Un-Annunciated Checklist

There are two ways of locating an un-annunciated checklist in the ECL. The easiest way is to use the **UNANNUNCIATED CHECKLISTS...** prompt, which is the focus of the cursor when you open the **NON-NORMAL MENU** of the ECL (there's a hint). At this point the available un-annunciated checklists are either grouped under the **ENGINE...** prompt, which is the focus of the ECL cursor (another hint) or directly available. In essence – open the ECL NNM Checklist Menu, click, click and you're immediately looking at a complete list of the un-annunciated engine failure checklists. You'd almost think it was designed that way ...



An alternative method is to look within the system (such as **FUEL...** for the Fuel Jettison Checklist). This requires several more clicks and is not the recommended method.

#### 4.19. NNM Checklist(s) Complete ... What's next?

When a NNM checklist is complete, crew focus should return to the EICAS message display to determine what action should be taken next. If there are outstanding NNM checklists to complete (override, etc) then apart from checklist icons (☐) in the EICAS message display, the ECL focus (the cursor) jumps to the bottom right hand corner **NON-NORMAL** prompt. At this point, the PM can select the **NON-NORMAL** prompt and display either the remaining checklist, or the NNM outstanding checklist queue.

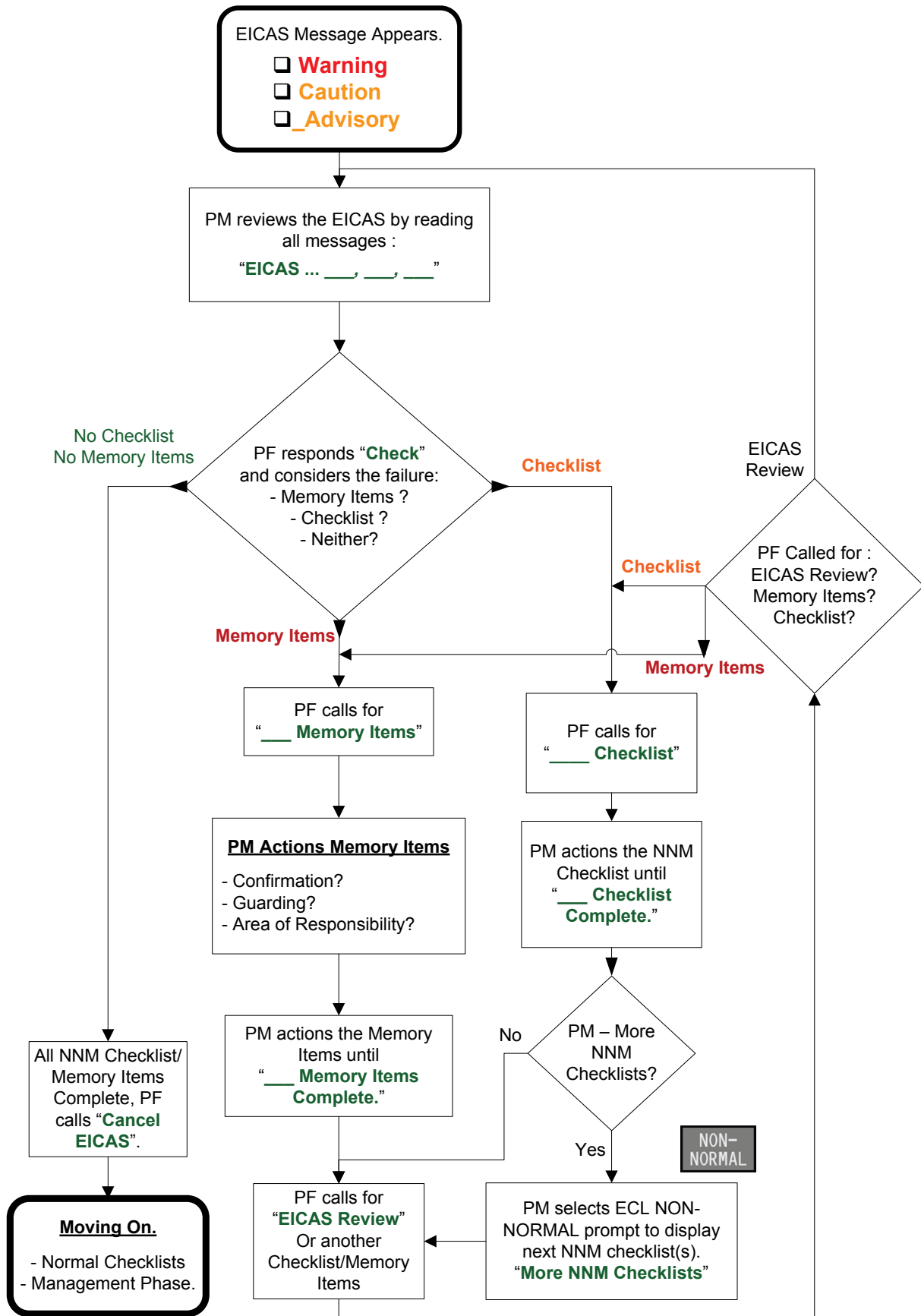
Note that it is possible for there to be incomplete checklists in the NNM queue without icons showing on the EICAS message display.

It's good practice for the PM to prompt the PF with the fact that more NNM checklists remain to be completed ("**More NNM Checklists**") if the **NON-NORMAL** prompt is showing on the bottom RHS ECL. PF can then decide to simply call for one of the outstanding NNM checklists (as shown on EICAS) or call for another EICAS review.

Otherwise the cursor will jump to the bottom left hand corner and the **NORMAL MENU** prompt. At this point, it is advisable for the PM to leave the cursor there while the EICAS is Reviewed and Cancelled, prior to calling for any NM checklist applicable.

#### 4.20. EICAS/ECL NNM Checklist Cycle

This completes the discussion of the EICAS/ECL NNM checklist handling cycle. Using the tools above, a crew will be able to handle any significant system failure or failures that generate multiple NNM EICAS Checklist/Memory Items. An overview diagram is shown below to provide a big picture overview of the cycle – please note that not all of the included training points above are in this diagram.



## 5. Miscellaneous EICAS/ECL Notes

### 5.1. AUTOSTART Checklist – where did the message go?

The Autostart NNM is one area where the EICAS does not appear to work as advertised – but where applying the philosophy of EICAS/ECL usage brings about the correct result.

In the event of an EICAS **AUTOSTART L/R** during engine start, PF will action the Memory Items associated with the associated NNM checklist (**Fuel Control Switch ... Cutoff**). Because the engine is now in Cutoff (and on the ground) most associated non-normal engine messages are inhibited – include **AUTOSTART**. But the PF who has read his Boeing documentation will know that once NNM Checklist Memory Items are called for, the next action is to call for the associated checklist. When the EFIS Checklist button is pressed – the **AUTOSTART** Checklist is in the ECL NNM Queue – ready to action.

### 5.2. Dual (R+C) Hydraulic Failure & The Stabilizer Memory Items

Another system failure with a catch is the **Hydraulic Pressure System R+C** failure. This results in no hydraulic pressure to the Stabilizer which is therefore inoperative, and so **HYD PRESS SYS R+C** checklist incorporates all the items of the Stabilizer checklist, and in fact inhibits the Stabilizer checklist.

However if the Stabilizer should attempt to move (change in airspeed, altitude, configuration, etc) before you get to the Stabilizer Cutout switches in the Hydraulic failure checklist, then the **STABILIZER** warning will be raised by the EICAS. The **STABILIZER** checklist has Memory Items - but you are in the middle of a Caution level NNM checklist – what do you do?

Airmanship (and your Boeing QRH) requires you to action the higher priority item – Stabilizer Checklist Memory Items (**STAB Cutout Switches (both) ... CUTOUT**, and **Do not exceed the current airspeed**) ... Memory Items Complete.

The question is – what do you do now? Boeing advises that a checklist with Memory Items has higher priority than a checklist associated with a Caution (**4.6 Prioritisation of NNM Checklists**) and so technically you should action the **STABILIZER** checklist.

Before continuing this discussion, let it be said that if the Stabilizer Checklist is called for and actioned – in accordance with EICAS/ECL philosophy – there is no negative flight safety impact.

However – because the Hydraulic Pressure System R+C checklist has begun – the checklist for **STABILIZER** is inhibited. **STABILIZER** appears on EICAS without the checklist icon (☐), it will not be in the ECL NNM queue and therefore you would have to hunt through the ECL **NON-NORMAL MENU**. From these indicators it could be said that the Hydraulic Pressure System R+C checklist can be continued instead.

Again note that if you haven't taken the hint and doggedly bring up and complete the **STABILIZER** checklist – there is no negative flight safety impact. The design of the EICAS/ECL integration protects the conscientious as well as the casual.

### 5.3. Takeoff Non-Normals – Memory Items, Accelerate, Checklists

When non-normals occur during takeoff, common errors include the early commencement of a non-normal checklist prior to acceleration, or inappropriate delaying of checklist memory items.

Non-normals during takeoff differ not at all to other regimes of flight in that **flying the aircraft must take priority over checklist/memory items**. Typically this is implemented in the following way:

- Checklist Memory Items are delayed until the aircraft is at least 400 ft, flight path and navigation are stabilised and (ideally) the autopilot is engaged. Memory items are then commenced and (ideally) completed prior to acceleration and flap retraction.
- Non Normal checklists (whether associated with Checklist Memory Items or not) are delayed until the aircraft is clean, CLB/CON thrust is selected and terrain clearance is assured (if not necessarily achieved). All non-normal checklists should be complete, the EICAS reviewed and cancelled prior to calling for the After Take Off Checklist.

There are always exceptions to common sense guidelines – an APU Fire on takeoff may be one of these. Despite not including any Memory Items to fight the fire, delaying the checklist until the aircraft is clean would seem a significant risk. One option would be to commence the checklist at 400 ft (much like a Recall), halting it to accelerate and clean up once the fire bottle is discharged.

The QRH allows the Captain to call for any checklist by memory (whether or not it contains memory items), so another option would be to do the immediate actions of the APU Fire Checklist from memory at 400 ft, prior to acceleration.

#### 5.4. Takeoff Non Normal Calls

The issue of calling Non Normals during takeoff is potentially a CRM discussion paper. There is no definitive industry viewpoint on the correct handling of this issue - policies tend to diverge along company lines, rather than manufacturer. Welcome to Aviation.

The following should be taken into account by the CM2 when calling failures during the takeoff roll.

- EICAS inhibits the Master Caution/Warning light and aural indications for various messages at various stages during the Takeoff. Essentially, if there's no light and sound, it could be said that Boeing has already decided the failure should not affect the safety of the flight.
- EICAS does **not** inhibit any caution or warning failure **messages** during takeoff. If a failure occurs during the takeoff roll such that the associated Master Warning/Caution light and associated Aural is inhibited – the message still displays on EICAS. The QRH & FCTM indicates that these messages should be called.
- New Captains using the occurrence of Aural alerts during takeoff as their Stop/Go decision should note that the **Cabin Alert** message and **High Low Chime** is **not** inhibited at all during takeoff. The CM2 may be quite guarded in the calls made during takeoff, but a crew member down the rear trying to speak to a friend in the mid galley and dialling carelessly will generate a tone at any time during the takeoff roll ...
- The crew should **not** initially identify an engine when calling an engine fire/failure, **unless calling the specific EICAS message**. It may be quite acceptable at various phases of takeoff to call "**EICAS ENGINE FAIL LEFT**" – it is not acceptable to look at engine parameters at low level and advise the PF "**I think the LEFT engine has a problem ...**" This is to avoid prejudicing any failure assessment that is performed at 400 ft after takeoff.
- It is not unusual for the CM1 to fail to detect a TAC non-failure during a catastrophic engine failure on takeoff, and trim the aircraft prior to AP engagement. On the other hand, calling the EICAS message "**EICAS THRUST ASSYMETRY COMPENSATION**" when the inhibit ends after takeoff can be quite useful to the PF, especially if trimming is not taking place.
- For the aircraft to suffer a catastrophic engine failure at or after V<sub>1</sub> and the crew to work successfully to get the aircraft to 400 feet **without any calls regarding the failure** is probably not a case encouraging situational awareness or CRM.

Confused? As long as the PM calls a failure in a calm and reasoned voice, there should be no reason to believe the CM1 will act precipitously during the critical high speed phase of the takeoff. EICAS messages called by the PM during takeoff or airborne should be prefaced with the standard call "**EICAS**". Additionally there's value once the Landing Gear is retracted in calling "**EICAS Engine Fail Left/Right**" and referring to TAC status (such as "**EICAS THRUST ASSYMETRY COMPENSATION**" - or even "**TAC is working**" if the PF is observed trimming the aircraft), to provide some confirmation to the PF that the PM is in the loop and to promote the awareness and flow into the NNM process. Problems without EICAS messages such as EGT exceedences should be brought to the PF's attention, again without causing excitement.

When calling failures that may or may not affect the safe continuation of the flight, the following two principles should be taken into consideration:

- Close to V<sub>1</sub>, nothing should prejudice the CM1's ability to decide the fate of the takeoff.
- The period between V<sub>1</sub> and Gear Retraction is crucial with Engine Out and the crew should concentrate on protecting the task of rotation and when appropriate confirming positive climb and raising the landing gear. The aircraft may well get airborne engine out with the gear down, but it won't fly very well.

Finally note that in the event of a call regarding the status of the aircraft from the CM2 anytime during the takeoff roll, the correct response from the CM1 is either "**STOP**" or "**GO**", which puts the discussion in context, don't you think?

#### 5.5. Packs Off Takeoff

Packs Off Takeoff is one of those anomalies that requires slightly unusual handling with respect to EICAS/ECL. The Packs are turned off at least 30 seconds before takeoff thrust is applied. EICAS will display  **PACK L** and  **PACK R**. The crew are not expected to action these checklists – quite apart from the 4 minute delay, leaving the checklists outstanding serves as a reminder after takeoff should their re-instatement be forgotten. The PACK L/R messages should be acknowledged and cancelled to keep EICAS clear during takeoff.

Overriding the checklists is not correct - if selecting Packs ON with Flaps Selected Up is missed after takeoff, they may well go un-noticed until the 8400 cabin altitude popup and EICAS **CABIN ALTITUDE** shortly after that.

Once the Packs are turned back on after takeoff, the PACKS L/R messages are removed from the EICAS queue – along with the associated NNM checklists.

#### QRH MAN 1.2 : Rejected Takeoff

*During the takeoff, the crew member observing the non-normal situation will immediately call it out as clearly as possible.*

#### FCTM 3.5 : Initiating Takeoff Roll

*The PM should monitor engine instruments and airspeed indications during the takeoff roll and announce any abnormalities.*

## 5.6. Engine Failures - Overview

The basic EICAS/ECL techniques for handling engine failures at all stages of flight (or on the ground) stem from the procedures used when the engine failures after  $V_1$  on takeoff.

From the previous discussion on (*5.4 Takeoff Non Normal Calls*) while the PM may call the EICAS and specifically identify the engine/malfunction ("**EICAS Engine Fail Left/Right**") it is important **not to commence the assessment phase until call for by the PF once the aircraft is at a safe height.**

- PF's primary responsibility is to **fly the plane.**
- PM may call the EICAS failure or "**Engine Problem**", but this call should not prejudice the safe flight of the aircraft ("**Rotate**", "**Positive Rate**", "**Gear Up**", etc)
- At a safe height (>400 ft RA), flight path stabilised and navigation established, PF calls "**Identify the Failure**" (*5.7 Failure Assessment*)
- PM conducts the assessment, which should result in the identification of the failed Engine and Failure Type (Engine Failure, Engine Limit Surge Stall, Engine Severe Damage/Separation)
- PF verifies the assessment and calls for the appropriate checklist Memory Items "**\_\_\_ Memory Items**"
- PM will action the Memory Items and when they are complete, advise the PF "**\_\_\_ Memory Items Complete**"
- PF then continues with the takeoff, including acceleration, cleanup and a mini plan, before moving to the NNM Checklist phase. Note that the checklist that should be called for (first) is the one associated with the completed Memory Items.

Refer to the **Infinidim B777 Documents : Practices and Techniques, Engine Failure** section for a discussion on Acceleration, Configuration and Memory Items. Refer also to the P&T for details of **AICC – Announce, Identify, Confirm, Commence.**

An engine failure at altitude or on the ground, runs substantially the same way. Fly the aircraft, call the failure, analyse the failure, Memory/Checklist Items when appropriate.

## 5.7. Failure Assessment

For simple failures that result in a single or small selection of EICAS messages, the failure will be called by the PM (EICS read) and the PF will review and call for the appropriate Checklist/Memory Items.

During critical phases of flight such as takeoff, the PM may choose not to call the EICAS until PF has achieved flight stabilisation and navigation, along with a "safe" height (such as 400 ft AGL). Once ready, the PF can prompt "**Identify the Failure**" to prompt the PM to commence the analysis of the malfunction.

For more complex failures, such as those involving multiple system failures or any malfunction involving an engine problem – again the PF may call for the PM to "**Identify The Failure**".

In both cases, PM will commence any malfunction assessment by reviewing the EICAS messages generated. If there are a significant number of messages, this review can be restricted to the relevant Warnings/Cautions as appropriate.

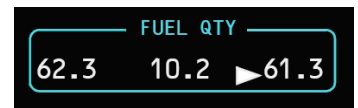
***For Engine Malfunctions, the procedures documented in the Practices and Techniques (Engine Failure After Takeoff / Engine Failure Analysis) provide a clear, simple diagnosis of engine malfunctions that lead to one of the 5 applicable engine fire/failure checklists. Crew are advised to review the P&T document for this technique.***



## 5.8. How NOT to do a Checklist

There are times when the CM1 may elect NOT to perform a checklist. This is usually associated with a perceived lack of time to complete the checklist and the increased workload associated, during a critical phase of the flight, such as commencing an approach. This issue most often arises in connection with the Fuel Imbalance Checklist.

During an Engine Failure After Takeoff event followed by return to the departure airport, the need to do the **FUEL IMBALANCE** checklist usually arises. Often this occurs in the approach phase of flight, when it may be inappropriate to commence a NNM checklist, and the question arises - how to **not** do (or how to delay) a checklist.



There are three basic requirements that should be considered in this situation.

- The Captain may elect to halt or not to perform a checklist, **but the effect on flight safety of that action must be considered and ideally, mitigated.**
- A checklist, if started but incomplete, should remain displayed on the lower MFD.
- An EICAS message should not be cleared (cancelled) from the EICAS until any associated NNM checklist has been completed.

With respect to **FUEL IMBALANCE** – generally the answer to this question depends on the time remaining in flight – it's the responsibility of the Captain as to which of the following options is exercised. It is poor airmanship to dismiss this checklist based on the assumption that the imbalance is not aerodynamically significant. This is only part of the checklist – the first thing the **FUEL IMBALANCE** checklist does is ensure the imbalance is not the result of a Fuel Leak.

- a) Enough time to complete the checklist to "**When Fuel Balancing Is Complete**" – Downwind?
- b) Enough time to open the checklist and ensure there is no leak, then hold the checklist – Base?
- c) Not enough time to open the checklist. Leave the EICAS message displayed.

When the CM1 feels insufficient time exists to commence the checklist, but seeks to confirm (or preclude) a Fuel Leak prior to landing, a basic comparison between the following three L/R values should ensure there is no leak. These values should be looked at critically to ensure they add up, and that the imbalance is justified by the asymmetric fuel usage associated with the operative engine.

- L/R Fuel Tank Quantities
- FMC Progress Page 2 L/R/Ttl Fuel Use; Calculated vs Totalizer quantities.
- L-R Failed/Operative Engine

The issue of NOT running a NNM checklist also arises when Fuel Jettison is underway during asymmetric flight. Understandably crew may choose not to balance fuel during jettison – but the implications of not running the NNM checklist must be considered.

### 5.9. Engine In Flight Start Envelope

Boeing/GE publish an assured in flight start envelope in the aircraft AFM. Outside of this envelope, a successful engine re-light is not assured. The AFM is not available on board to the crew, so re-light envelope guidance is provided through the EICAS.

The following discussion is background information only.

EICAS display of the assured restart envelope comprises of an Altitude/Airspeed range display and an **X-BLD XB** **FL 300 270-330 KTS** indication.

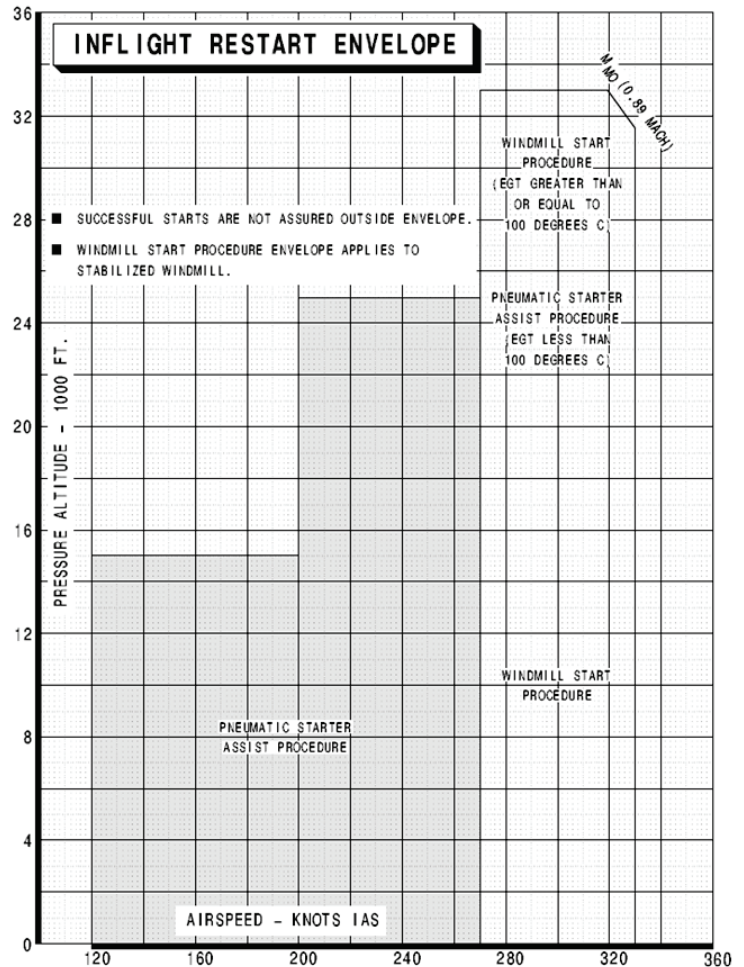
The altitude/airspeed display is relatively straight forward. Altitude is either current altitude or the maximum attitude for an assured re-light (FL330). Airspeed displays the envelope for an assured start – whether windmill or starter assist.

The X-Bleed (or compacted XB) indication is displayed when the aircraft is either

- not in the windmill envelope; or
- in the windmill envelope but EGT is below 100°C

The cross bleed start indication will displayed when the aircraft is above the altitude where use of starter assist assures a start (FL250).

This combination of indicators can occasionally be misleading. The following scenarios are outside the assured start envelope.



| ALT  | IAS | Alt/Speed Display   | X-Bld |
|------|-----|---------------------|-------|
| F170 | 180 | F170 : 200-330 Kts  | XB    |
| F280 | 240 | F280 : 270-330 Kts  | XB    |
| F350 | 240 | FL330 : 270-330 Kts | XB    |
| F350 | 290 | FL330 : 270-330 Kts | XB*   |

\* XB displayed if EGT is < 100°C