THE STUDY OF ACCIDENTS & SERIOUS INCIDENTS INVOLVING A GO-AROUND

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1. The Data

1.1 A non-random selection of published Accident and Serious Incident Reports into events involving transport category aircraft where a go around took place between 2000 and 2012 were subjected to a detailed review.

1.2 A total of 66 go around events were included, as listed in the Annex to this Paper. They were a mixture of those in which the safety of the go around was central to the investigation carried out and others where it was simply the safely flown aftermath of similar circumstances to the ones that went wrong. The majority of events involved single aisle jets (64%), with twin turboprops (21%) and Twin Aisle Jets (15%) making up the remainder.

1.3 The nature of the sample - independently investigated events where an approach was followed at some point by a go around - meant that it contained both safe and unsafe go arounds. The reason for these investigations was sometimes the circumstances which led to the go around, sometimes the go around itself and sometimes both. Remarks contrasting the 'safe' go arounds with risk-bearing ones are therefore subject to the qualification that the 'safe' ones were just a non random subset of many more similar go arounds which are carried out because of both crew decisions and ATC instructions.

2. The Methodology

2.1 The context, safety aspects and overall level of risk of each event were characterised by creating a spreadsheet and appending as many of a selection of 185 'tags' as were applicable to each one. Not all these tags were mutually exclusive and not all reports allowed the applicability of all tags to be established. The extent to which many characteristics could be identified is therefore understated.

2.2 On the basis of the degree of risk to a safe outcome posed by a go around, each one was assigned to one of three categories - High Risk (19 events) Moderate Risk (25 events) and Non risk-bearing (22 events). The latter followed circumstances, some not dissimilar to those where a risk-bearing go around followed, that were the main concern of the investigation report.

2.3 For the two risk-bearing categories, six 'headline' Go Around Safety Issues (GASIs) were defined in respect of the initiation and execution of each go around. Most of the 44 risk bearing events attracted a single GASI but five events had two. The definitions used were:

- AO1- Initiation of go around ineffective (LOC)
- AO2- control of aircraft not maintained once successfully initiated (LOC/CFIT)
- AO3- Go around not flown on required track (CFIT)
- AT1- Traffic separation not maintained (MAC)
- AT2- Go around traffic wake turbulence hazard (LOC)
- EN1- significant low level wind shear (LOC)

2.4 All risk-bearing events were assigned one of three 'Outcome Risks' - LOC, CFIT or MAC.

3. Primary Analysis - risk-bearing go arounds

3.1 The overwhelming contribution of crew performance issues to go around safety - 89% in High Risk cases and 72% in Moderate risk cases is shown below:

GASI	HIGH RISK	MOD RISK	BOTH
AO1/2/3	17	18	35
AT1/2	1	7	8
EN1	1		1
ALL EVENTS	**19**	**25**	**44**

3.2 The Outcome Risk - LOC, CFIT or MAC - associated with each of the two risk-bearing categories shows LOC as significant in both but relatively more dominant in the High risk category (73% of all events) compared to the Moderate risk category (52% of all events):

OUTCOME RISK	LOC	CFIT	MAC	ALL EVENTS
HIGH	14	4	1	19
MOD	13	5	7	25
BOTH	**27**	**9**	**8**	**44**

3.3 The connection between GASI and Outcome Risk below shows the expected association between the risk of LOC and CFIT and crew performance and the similarly expected association of the risk of MAC and controller performance:

GASI	OUTCOME RISK			
	LOC	CFIT	MAC	ALL
AO1/2/3	26	9	2	37
AT1/2			6	6
EN1	1			1
ALL	**27**	**9**	**8**	**44**

4. Detailed Findings

4.1 <u>The prelude to unsafe go arounds</u>
The relationship between unstabilised approaches and risk bearing go arounds was examined:

- Just over 60% of all go arounds in the sample, both risk bearing and non risk-bearing - 40 events, followed either unstabilised flight due to approach mismanagement (30 events) or mishandling during landing[1] (10 events). 73% of these 40 events were followed by a risk-bearing go around.

- The proportion of each type of approach being flown prior to a go around, whether risk bearing or not, was very similar. The risk bearing go around figures (44 events) were as follows:

[1] Defined as below 50 feet agl and after touchdown

- ILS Cat 3 5%
- ILS Cat 1 50%
- Non precision 23%
- Visual 16%
- Circling 5%
- RNP 2%

For fatal accident outcomes, the ILS Cat 1 proportion rose to 56% with ILS Cat 3 and Circling not involved in any of these events.

- Only three of the 30 go around decisions attributable to unstabilised approaches were triggered at the formal challenges set by Stabilised Approach Gates or Approach Minima. Over half of the 27 ad hoc decisions were made below 500 ft agl (excluding the three made at DA/MDA below this height).

- Of the 26 go arounds in the complete sample of 66 which did **not** follow an unstablised approach or a mishandled landing, 64% were risk-bearing:

GA CAUSE	HIGH RISK	MOD RISK	Non Risk Bearing	ALL
No Vis Ref	5		2	7
Loss of Vis Ref	1	2	1	4
ATC Inst due RI			3	3
ATC Inst due WX	1			1
ATC Inst due TFC		3		3
A/c Technical	1	1	1	3
Weather	1	1		2
Pilot observes RI			2	2
RI Other pilot call			1	1
ALL EVENTS	**9**	**7**	**10**	**26**

4.2 <u>The source of the risk in risk-bearing go arounds</u>

- In the 80% (35) of risk-bearing go arounds where the risk was attributable to the mismanagement and/or mishandling of the go around by pilots, failure to initiate a go around effectively was twice as prevalent as failure to both 'aviate and navigate' it properly once initially established.
- In the 18% (8) risk-bearing go arounds where the risk was attributable to controllers:
  - One followed controller failure to apply clearly established procedure in respect of a late go around which led directly to an unrecognised mid air collision risk resolved by TCAS RA.
  - Five involved controller misjudgements in dealing with the proximity of take offs to unexpected go arounds - a significant loss of separation in four cases and an unrecognised wake turbulence hazard in the other. Two events involved controllers talking to different aircraft on the same frequency in different languages (English and French). In both cases, pilots seeking to understand the developing situation both before and after the go around was commenced were deprived of valuable situational awareness.

- Two involved a single event of conflict between two arriving aircraft, one of which made a pilot-declared go around and the other which was then given a controller-instructed one. A trainee controller under supervision working in a non radar environment was faced with an aircraft transitioning to a conventional go around and the need to instruct the potentially conflicting aircraft on an RNP approach to fly an RNP go around. The effect of this was that the situational awareness of both aircraft on go around in IMC of the potential proximity of the other was compromised by lack of appreciation of the procedure being flown.

➢ In the one other risk-bearing go around, an 'environmental' event, an encounter with a dry microburst, undetectable even on predictive onboard wind shear detection systems, almost eliminated positive climb during a go around proactively initiated because of general concerns about convective weather.

4.3 Low experience pilots featured disproportionately in unsafe go arounds

➢ Go around decisions by pilots which were followed by poor initiation/execution and which led to hull loss accidents due to either LOC or CFIT were particularly likely to involve a crew where either the PIC or the Co Pilot were lacking in experience. For the PIC, this means experience of the aircraft type or the role of PIC[2]. For the Co Pilot, this means experience of the aircraft type or multi crew operations generally[3].

➢ Taking all events where the experience of both pilots was fully documented and the go around safety issue arose from pilot performance, one or both pilots was low experience on the above definition in:

- 82% of fatal/hull loss go around accidents
- 73% of all risk bearing go arounds

➢ Out of the 15 High Risk events with fully documented pilot experience and where the go around safety issue arose from pilot performance, 80% involved at least one of the pilots being low experience. Two (including one fatal accident outcome) involved only the PIC being low experience, five (including three fatal accident outcomes) involved just the Co Pilot being low experience and four (three with fatal accident outcomes) involved both crew members being low experience.

4.4 The limited effectiveness of the PM role during both approach and go around

➢ Excessive confidence by the PIC PM that the PF Co Pilot would achieve a timely stabilisation appeared to not infrequently lead to a delayed take over as PF by which time the circumstances had frequently become more 'complex' and the chances of not initiating the go around properly thereby increased. In some cases a near or on-ground take over of control occurred in order to make one.

➢ Excessive confidence by the Co Pilot PM that the PIC PF would achieve a timely stabilisation appeared to not infrequently lead - especially in operating cultures which may not have adequately addressed the effect of a significant relative experience gap between a Co Pilot and their PIC - to a delayed or absent go around call.

[2] Defined in this analysis as one or both of <500 hours on type or <500 hours in command
[3] Defined in this analysis as one or both of <2000 hours multi-crew experience or <500 hours on type

4.5 Some other precursors for a risk-bearing go around

- The more unsafe go arounds are, the more likely they were to have been preceded by one or more of:
  - significant procedural non compliance(s) - identified in 74% of High Risk events but in only 28% of Moderate Risk events, a rate similar to that for non risk bearing events.
  - a delay in making the decision to go around beyond the point where the majority of pilots would (on a subjective assessment) probably have taken it - recorded in 42% of High Risk events but only 8% of Medium Risk events, an even lower proportion than for non risk-bearing events.
  - A 'complex situation'[4] at the time of the go around decision – recorded in 53% of High Risk Events but only 8% of Medium Risk events, about the same as for non risk-bearing events.
- Significant violation of landing minima followed by a go around decision was a notable precursor to five of the ten fatal accident outcomes during attempted go arounds. Violation of landing minima only occurred elsewhere in the data in the case of two additional go arounds which preceded one of these fatal accident outcomes.
- 14% of risk bearing go around decisions were made above 1000 feet, half of which were made because of an unstabilised approach condition.

4.6 Runway Incursions as a cause of go arounds

- None of the six go arounds which arose because of runway incursions were risk-bearing.

4.7 Limits to the analysis

There was insufficient available data to look adequately at some aspects of potential interest including differences in the availability and use of automation during go arounds and the relationship between this and its use just prior to the go around decision. There was also insufficient data to make any meaningful review of the overall effect of the opportunity for dual inputs to occur at critical junctures on aircraft where pitch and roll are controlled by (unseen) inputs made via side sticks rather than (fully visible) inputs made via conventional control columns.

5. A summary of some findings on go around risk versus precursors

5.1 High Risk go arounds compared to Moderate Risk go arounds are:

- **more** likely to:
  - involve low experience pilots
  - involve a go around decision made below DA/MDA
  - be flown by the PIC as PF
  - be at risk of LOC

[4] For example, after selecting reverse on the runway, being unstable in more than one respect, persisting with a circling or visual approach despite marginal in flight visibility, being confused about aircraft system status or because of an incomplete appreciation of aircraft energy state and its implications

- follow a violation of DA/MDA
- involve crew surprise that they have become necessary

➢ **less** likely to:

- follow an unstabilised approach
- involve a change of PF at initiation of or during the go around

5.2 Non risk-bearing go arounds compared to Moderate Risk go arounds are:

➢ **more** likely to:

- follow go around decisions that were foreseen as possibilities rather than occurred unexpectedly
- likely to be made on ATC instructions

➢ **less** likely to:

- take place at night
- involve low experience pilots
- have the Co Pilot as PF
- involve surprise that they have become necessary

➢ **just as** likely to:

- be preceded by significant procedural non compliance
- involve a change of PF at the initiation of or during the go around

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ANNEX

THE LIST OF REVIEWED GO AROUND EVENTS

NOTE: Event designation uses the year of occurrence (in the range 2000-2012) followed by a letter in alphabetic sequence with no other significance.

00A **Bahrain A320**
http://www.bea.aero/docspa/2000/a40-ek000823a/htm/a40-ek000823a.html

01A **Brisbane Australia B734**
http://www.atsb.gov.au/publications/investigation_reports/2001/AAIR/pdf/aair200100213_001.pdf

01B **Zurich Switzerland RJ1H**
http://www.sust.admin.ch/pdfs/AV-berichte//1793_e.pdf

02A **Oslo Norway B752**
http://www.aibn.no/tf_fio_eng-pdf?lcid=1033&pid=Native-ContentFile-*File&attach=1

03A **Brest France CRJ1**
http://www.bea-fr.org/docspa/2003/f-js030622a/pdf/f-js030622a.pdf

03B **Geneva Switzerland A319**
http://www.bfu.admin.ch/common/pdf/airprox/1866_e.pdf

04A **Nantes France MD83**
http://www.bea.aero/docspa/2004/su-f040321a/pdf/su-f040321a.pdf

04B **Los Angeles USA B744**
http://www.ntsb.gov/aviationquery/brief2.aspx?ev_id=20040830X01323&ntsbno=LAX04IA302&akey=1

04C **Pristina Kosovo MD83**
http://www.bfu.admin.ch/common/pdf/1858_e.pdf

04D **Oshawa Canada SH36**
http://tsb.gc.ca/eng/rapports-reports/aviation/2004/a04o0336/a04o0336.pdf

04E **Amsterdam Netherlands B733**
http://tele2.onderzoeksraad.nl/docs/rapporten/2004006_088_D4-CBG_PH-BDC_EN.pdf

05A **Port Harcourt Nigeria DC93**
http://aib.gov.ng/fmaaipb424.pdf

05B **London Heathrow UK 2005 A320**
http://www.aaib.gov.uk/cms_resources.cfm?file=/Airbus%20A320-200,%20I-BIKE%2006-06.pdf

06A **Gibraltar B752**
http://www.aaib.gov.uk/cms_resources/Boeing%20757-2T7,%20G-MONE%2008-06.pdf

06B **Sochi Russia A320**
http://www.bea.aero/docspa/2006/ek-9060502/pdf/ek-9060502.pdf

06C **Geneva Switzerland F100**
http://www.bfu.admin.ch/common/pdf/airprox/1983_e.pdf

06D **Manchester UK D328**
http://www.aaib.gov.uk/cms_resources.cfm?file=/Dornier%20328-11%200,%20D-CPRW%2010-06.pdf

06E **East Midlands UK B733**
http://www.aaib.gov.uk/publications/formal_reports/5_2008_oo_tnd/oo_tnd_report_sections.cfm

06F **Geneva Switzerland B737**
http://www.bfu.admin.ch/common/pdf/airprox/1977_e.pdf

06G **Bristol UK B737**
http://www.aaib.gov.uk/cms_resources.cfm?file=/Boeing%20737-76N,%20G-STRH%2011-06.pdf

06H **La Ronge Canada CVLT**
http://tsb.gc.ca/eng/rapports-reports/aviation/2006/a06c0062/a06c0062.pdf

06I **Fairbanks USA MD83**
http://www.ntsb.gov/aviationquery/brief2.aspx?ev_id=20060522X00596&ntsbno=ANC06IA054&akey=1

07A **Bournemouth UK B733**
http://www.aaib.gov.uk/cms_resources/3-2009%20G-THOF.pdf

07B **Dublin Ireland MD83**
http://www.aaiu.ie/sites/default/files/upload/general/11469-0.PDF

07C **St Louis USA MD82**
http://www.ntsb.gov/doclib/reports/2009/AAR0903.pdf

07D **Sydney Australia B744**
http://www.atsb.gov.au/media/1290037/ao2007001.pdf

07E **Kansai Japan B763**
http://www.mlit.go.jp/jtsb/eng-air_report/CFMWPJA8236.pdf

07F **Seinajoki Finland AT45**
http://www.turvallisuustutkinta.fi/Satellite?blobtable=MungoBlobs&blobcol=urldata&SSURIapptype=BlobServer&SSURIcontainer=Default&SSURIsession=false&blobkey=id&blobheadervalue1=inline;filename=9v6kk7h4.pdf&SSURIsscontext=Satellite Server&blobwhere=1330439894487&blobheadername1=Content-Disposition&ssbinary=true&blobheader=application/pdf

07G **Seinajoki Finland AT45**
[as above – second go around in sequence]

07H **Amsterdam Netherlands A318**
http://tele2.onderzoeksraad.nl/docs/rapporten/2007112_EN.pdf

07I **Phuket Thailand MD82**
http://www.investigateudom.com/files/ThaiReport.pdf

08A **London Gatwick UK B752**
http://www.aaib.gov.uk/cms_resources.cfm?file=/Boeing%20757-2T7,%20G-MONK%2011-09.pdf

08B **Sydney Australia DH8C**
http://www.atsb.gov.au/media/1566648/ao2009001.pdf

08C **Nairobi Kenya A343**
http://www.aaib.gov.uk/cms_resources.cfm?file=/Airbus%20A340-313,%20G-VAIR%2011-09.pdf

08D **Geneva Switzerland A321**
http://www.bfu.admin.ch/common/pdf/airprox/2092_e.pdf

08E **Hamburg Germany A320**
http://www.bfu-web.de/EN/Publications/Investigation%20Report/2008/Report_08_5X003_A320_Hamburg-Crosswindlanding.pdf?__blob=publicationFile

08F **Hamilton Canada B727**
http://tsb.gc.ca/eng/rapports-reports/aviation/2008/a08o0189/a08o0189.pdf

09A **Kansai Japan A321**
http://www.mlit.go.jp/jtsb/eng-air_report/HL7763.pdf

09B **Paris Orly France B738**
http://www.bea.aero/docspa/2009/cn-k090704/pdf/cn-k090704.pdf

10A **Kalgoorlie Australia B712**
http://www.atsb.gov.au/media/3543522/ao2010081.pdf

10B **Kalgoorlie Australia B712**
[as above - second go around in sequence]

10C **Chambery France B733**
http://www.aaib.gov.uk/cms_resources/Boeing%20737-33A,%20G-CELC%2012-10.pdf

10D **Queenstown New Zealand B738**
http://www.taic.org.nz/ReportsandSafetyRecs/AviationReports/tabid/78/ctl/Detail/mid/482/InvNumber/2010-007/Page/0/language/en-US/Default.aspx?SkinSrc=[G]skins%2ftaicAviation%2fskin_aviation

10E **Queenstown New Zealand B738**
[as above - 2 simultaneous go arounds in conflict]

10F **London Heathrow UK A319**
http://www.aaib.gov.uk/cms_resources.cfm?file=/Airbus%20A319-131%20G-EUPO%2004-12.pdf

10G **Fukuoka Japan DH8C**
http://www.mlit.go.jp/jtsb/eng-air_report/JA844C_JA602A.pdf

10H **Dublin Ireland A319**
http://www.aaiu.ie/sites/default/files/upload/general/13379-REPORT_2011_019-0.PDF

10I **Tripoli Libya A332**
http://caa.ly/finalReport/FINAL_5A-ONG-1.pdf (Report)
http://caa.ly/finalReport/FINAL_5A-ONG-4.pdf (Apps 5-12)

10J **Tripoli Libya A332**
[as above - details of previous incident earlier in same year included]

11A **East Midlands UK A306**
http://www.aaib.gov.uk/cms_resources/Airbus%20A300-B4-622R%20TF-ELK%2005-12.pdf

11B **Cork Ireland SW4**
http://www.aaiu.ie/sites/default/files/upload/general/13067-PRELIMINARY_REPORT_2011_005-0.PDF and
http://www.aaiu.ie/sites/default/files/upload/general/Interim_Statement_2012_003.pdf

11C **Cork Ireland SW4**
[as above – second go around in sequence]

11D **Cork Ireland SW4**
[as above – third go around in sequence]

11E **Stockholm Sweden CRJ2**
http://www.havkom.se/virtupload/reports/RL%202012_03e.pdf

11F **Kaimana Indonesia MA60**
http://www.dephub.go.id/knkt/ntsc_aviation/baru/Final%20Report%20PK-MZK%20Release.pdf

11G **Manchester UK DH4D**
http://www.aaib.gov.uk/cms_resources.cfm?file=/DHC-8-402%20Dash%208%20G-ECOK%2004-12.pdf

11H **Manchester UK A321**
http://www.aaib.gov.uk/cms_resources/Airbus%20Industries%20A321-211%20OE-LBF%2009-12.pdf

11I **Frankfurt Germany A388**
http://www.bfu-web.de/EN/Publications/Investigation%20Report/2011/Report_11_5X013_A380A320_FRA.pdf?__blob=publicationFile

11J **Paris CDG France B772**
http://www.bea.aero/docspa/2011/f-pp111116/pdf/f-pp111116.pdf

11K **Abidjan Ivory Coast A332**
http://www.bea.aero/docspa/2011/od-a110821/pdf/od-a110821.pdf

11L **Shannon Ireland AT72**
http://www.aaiu.ie/sites/default/files/report-attachments/REPORT%202013-008_0.pdf

12A **Norwich UK D328**
http://www.aaib.gov.uk/cms_resources.cfm?file=/Dornier%20328-100%20DO328%20G-BWWT%2012-12.pdf

12B **Memmingen Germany B738**
http://www.bfu-web.de/EN/Publications/Interim_Reports/IR2012/I1_Report_12_EX002_B737_Memmingen.pdf?__blob=publicationFile

12C **Luton UK A319**
http://www.aaib.gov.uk/cms_resources.cfm?file=/Airbus%20A319-111%20G-EZFV%2001-13.pdf

12D **Paris CDG France A343**
http://www.bea.aero/docspa/2012/f-zu120313/pdf/f-zu120313.pdf

12E **London Gatwick UK A320**
http://www.skybrary.aero/bookshelf/books/2217.pdf