

BIG DATA ANALYSIS OF IRREGULAR OPERATIONS: ABORTED APPROACHES AND THEIR UNDERLYING FACTORS

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Abstract

Procedures such as Missed Approaches and Holding Patterns are designed into Air Traffic Control procedures to provide a safe manner for flights to temporarily exit the airspace or the traffic flow when irregular operations occur. These procedures serve as “pressure release valves” and in this way are symptoms of the occurrence of infrequent phenomena that impact efficiency and safety margins. The occurrence of these procedures is not currently tracked by airlines or Air Navigation Service Providers (ANSP) due to the inability to identify these situations using the existing time-stamped event data (i.e. OOOI data) that is the basis for NAS performance analysis today.

This paper describes a Big Data analysis of surveillance track data to establish the frequency of occurrence of Aborted Approaches, and an analysis of voluntary pilot/air traffic controller reports to establish factors leading to Aborted Approaches. Aborted Approaches include a Go Around for a Missed Approach as well as a turn off the final approach segment prior to the Missed Approach Point (MAP).

Analysis of 21 days of surveillance track data for approaches at ORD identified a 7.4 in 1000 frequency of approaches resulting in an Aborted Approach. Daily Aborted Approaches ranged from 0 per day to 21 per 1000 approaches per day. Eighty percent of the Aborted Approaches involved a turn off the final approach segment prior to the MAP.

An analysis of 467 voluntary pilot/air traffic controller reports from all U.S. airports identified factors leading to aborted approaches: (1) 48% airplane issues (e.g. onboard failure, unstable approach), (2) 27% traffic separation issues, (3) 16% weather (e.g. ceiling, visibility, crosswind), (4) 5% runway issues, and (5) 4% flightcrew-ATC interaction issues. These results suggest mitigation strategies to reduce the high variance in daily

occurrences through procedure modification, training and equipment design.

INTRODUCTION

Infrequent irregular operations, such as Missed Approaches and Holding Patterns, are designed into Approach and Standard Arrival procedures as “pressure release valves.” When traffic flow is not proceeding in orderly or safe manner, when the airspace/runway resource is temporarily unavailable, or when a procedure (e.g. approach and landing) cannot be completed, these procedures provide a safe manner for flights to exit the flow, and resolve any issues before continuing.

In this manner these non-normal trajectories or maneuvers are symptoms of irregular operations in the NAS leading to reduced efficiency and safety margins.

State-of-the-art National Airspace System (NAS) performance metrics are based on time-stamped events of Gate-out, Wheels-off, Wheels-on, and Gate-In [1]. These performance metrics, responsible for the significant innovations in traffic flow management that have led to increases in effective-capacity and productivity over the last three decades, do not capture these trajectories/maneuvers. The recent availability of track data and voluntary pilot reporting data has significantly changed the environment. It is now possible to count the frequency of occurrence of these trajectory/maneuver-based events, and to identify the factors that lead to these events.

This paper describes the analysis of detailed surveillance track data from the National Offload Program [2] in the TRACON to determine the frequency of Aborted Approaches and to identify the causes of the Aborted Approaches. An Aborted Approach includes a Go Around for a Missed Approach from the Missed Approach Point (i.e. Decision Height or Minimum Descent Altitude), as

well as trajectories that turn off the approach path prior to the Missed Approach Point (MAP).

The main results of the study are as follows:

- Aborted Approaches at ORD for 21 days studied occurred on average 7.4 times for every 1000 approaches
- Daily Aborted Approaches at ORD ranged from zero per day to 21 per 1000 approaches per day. The daily probability for Aborted Approaches fits a Normal Distribution with a mean of 7/1000 and standard deviation of 5/1000.
- 20% of the aborted approaches at ORD followed a traditional missed approach path trajectory overflying the runway. Eighty percent involved an early turn off the approach path prior to the “decision height.”

In addition, an analysis voluntary pilot/air traffic controller report (ASRS) from all U.S. airports identified the factors that lead to Aborted Approaches.

- Twenty three (23) factors were identified from voluntary pilot/air traffic controller reports as the causes of Aborted Approaches. The 5 main categories of factors:
 - (1) 48% airplane issues (e.g. onboard failure, unstable approach)
 - (2) 27% separation violation issues (e.g. wake vortex, simultaneous runway occupancy)
 - (3) 16% weather (e.g. ceiling, visibility, crosswind)
 - (4) 5% runway issues (e.g. Navaid failure, runway closed)
 - (5) 4% flightcrew-ATC interaction (e.g. ambiguous clearance, no clearance).

The distribution for daily counts of Aborted Approaches exhibits a non-Gaussian form with a large right tail. The variability of the process is 1.4 times the mean (i.e. $\mu/\sigma = 1.4$) indicating opportunities for productivity improvement by reducing the variance (i.e. days with high Aborted Approach counts).

Forty seven percent of the issues are related to airplane operation or airplane equipment issues that may be addressed though improved flightdeck procedures and improved equipment reliability.

Thirty percent of the factors were related to flightcrew-ATC interaction in sequencing and spacing of flights (26%) and clearance issues (4%) that may be addressed through improved procedures.

This paper is organized as follows: the next section describes the methods and results of the track data analysis of Aborted Approach frequency. The following section describes the methods and analysis of voluntary pilot/air traffic controller report data to determine the factors resulting in Aborted Approaches. The final section provides a discussion of the implications of these results and future work.

FREQUENCY OF OCCURRENCE OF ABORTED APPROACHES

This section describes the method of analysis and the results of track data analysis of Aborted Approaches.

Track Data and Algorithm

The National Offload Program (NOP) data provides short duration updates of the three dimensional position of each individual flight. Position updates vary with distance to runway and can be as short at 2 seconds and as long at 60 seconds. The data used for this analysis included: track index, time, longitude and latitude. The track index is a unique number for each track. Sample NOP tracks are shown in Figure 1

The process of identifying Aborted Approaches is summarized as follows. First, the geographic latitude and longitude in the PDARS data are converted to Universal Transverse Mercator coordinate system (UTM). The WGS84 ellipsoid is applied.

The center location of the airport is estimated (e.g. ORD at latitude 41.98 and longitude -87.90). From this center, a 3 nautical mile radius is defined to identify arrival and departure flights at the airport. All flights starting outside the circle and ending within this circle are considered to be arrivals from other airports and are candidate tracks.

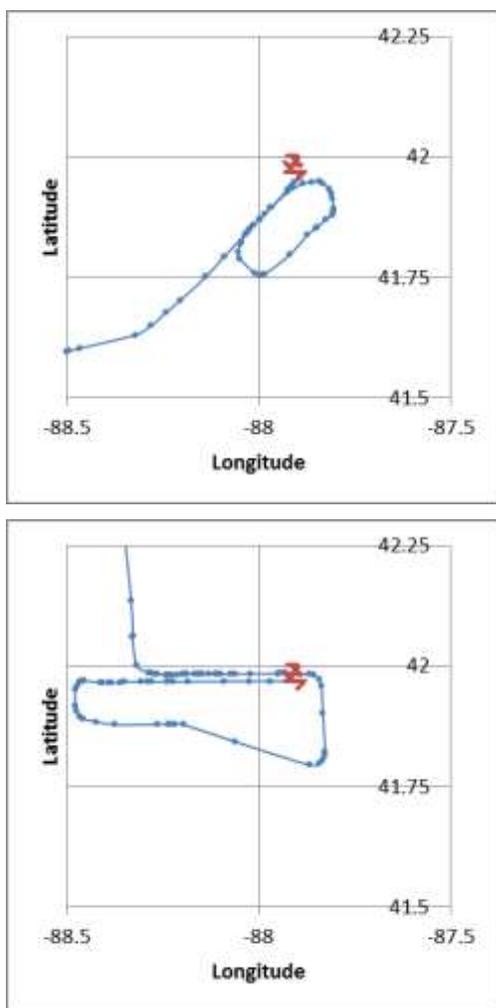


Figure 1. Sample NOP track data

Next, a 6 nautical mile radius is defined for these filtered tracks. Once a track enters the circle, the calculation of its turn angle begins. Figure 3 shows the method to calculate the turn angle at one point. To determine the turn angle at current point (x_1, y_1) , the coordinates of two previous points (x_2, y_2) and (x_3, y_3) are needed (see Figure 2).

The calculation continues to the final data point of each track. A final cumulative turn angle is calculated for each track by adding up all the turn angles calculated at each data point within 6 nautical miles from the estimated center location of the airport. With all final cumulative turn angles of all qualified tracks calculated, their

absolute values are sorted from largest to smallest. A threshold of final cumulative turn angle to distinguish an Aborted Approach from an ordinary landing is set to be 330 degrees. All flights with absolute values of final cumulative turn angles greater than this threshold are considered to be candidates for Aborted Approaches.

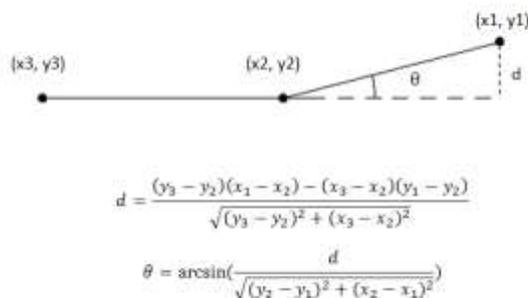


Figure 2. Calculation of turn angles

To verify that these candidate tracks are real Aborted Approach, their paths are plotted and visually examined relative to the location of runways at the airport. Although most of the candidate tracks are real Aborted Approaches, a small number of these filtered tracks include procedure turns or other maneuvers that meet the quantitative criteria described above, but are not Aborted Approaches.

Results

Approaches into ORD for 21 days of NOP data in /11 were analyzed for Aborted Approaches (see Table 1). An average of 7.4 flights in every 1000 flights experienced an Aborted Approach.

On a per day basis, the rate of Aborted Approaches varied from zero per day to 21 in 1000 per day. The average daily rate of Aborted Approaches was 0.0074 with Standard Deviation 0.0053. The Median was 0.0069 indicating slight right tail. A fit for a Normal Distribution yielded a mean of 0.007 and standard deviation of 0.005 but failed to capture the long right tail (Figure 3).

Table 1. Aborted Approach statistics for 21 days at ORD

Date	Apps	Aborted Apps	Likelihood Aborted Approach	Missed Approach	Aborted Approach Prior to MAP
01/17/11	683	7	0.0102	2	5
01/18/11	1101	9	0.0082	3	6
01/24/11	1174	10	0.0085	1	9
01/25/11	1160	8	0.0069	3	5
01/26/11	1147	6	0.0052	1	5
01/27/11	1129	3	0.0027	0	3
02/15/11	1101	3	0.0027	0	3
03/22/11	1124	23	0.0205	1	22
03/23/11	1109	9	0.0081	0	9
04/26/11	947	8	0.0084	2	6
05/09/11	1156	3	0.0026	2	1
05/10/11	999	2	0.0020	1	1
05/29/11	630	5	0.0079	0	5
06/10/11	1171	15	0.0128	3	12
06/11/11	1108	15	0.0135	10	5
06/15/11	711	2	0.0028	0	2
06/20/11	678	3	0.0044	0	3
07/01/11	964	0	0.0000	0	0
12/14/11	1055	7	0.0066	2	5
01/22/12	1132	19	0.0168	0	19
01/23/12	1348	2	0.0015	1	1
TOTAL	21627	159	0.0074	32	127

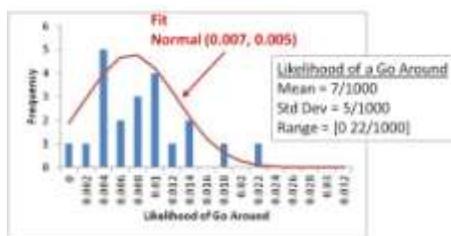


Figure 3. Distribution of daily Aborted Approach likelihood for 21 days at ORD. Non-gaussian right tail suggests opportunity for improvement

The track data showed that there are two types of Aborted Approach trajectories: (1) overfly of the runway maintaining runway heading to perform a

traditional Missed Approach, and (2) turn off the approach path prior to the Missed Approach Point (see Figure 1). Only 20% of the aborted approaches followed a traditional missed approach path trajectory overflying the runway. Eighty percent involved an early turn prior to a “decision height.”

FACTORS LEADING TO ABORTED APPROACHES

This section describes an analysis of factors leading to Aborted Approaches using voluntarily reported data in the Aviation Safety Reporting System (ASRS) [3].

Data

The ASRS, operated by the Federal Aviation Administration (FAA) and the National Aeronautics and Space Administration (NASA), collects and organizes qualitative descriptions of events in the National Airspace System. The system is based on voluntary submission of reports by pilots, air traffic controllers, flight attendants, maintenance staff, and others. The reports may describe both unsafe occurrences and hazardous situations that otherwise may not be reported.

The purpose of the ASRS is to improve safety by providing a reliable, factual source of information to the aviation industry. After report collection, the ASRS improves the current aviation system through an attempt to prevent future violations: (1) identifies system deficiencies, analyzes them, and disseminates alerts to the appropriate aviation industry stakeholders, (2) provides educational material via its associated publications such as the *CALLBACK* newsletter and the *ASRS Directline* journal, and (3) offers a public database of aviation incident reports. As well, the ASRS system allows (4) quick responses from FAA and the National Safety Board (NTSB).

To encourage reporting, the ASRS provides a voluntary, confidential and non-punitive environment to the reporter. A reasonable protection from a professional penalty for a truthful report is defined by the criteria in FAA Advisory Circular No. 00-46D. For example, a pilot involved in an incident would not have their license revoked or suspended for reporting the incident. Instead,

Query

The search criteria used: (i) Text contains “Go Around, Missed Approach,” (ii) include the Narrative and the Synopsis, (iii) search limited to Part 121 of federal aviation regulations, and (iv) the search item Mission is limited to “passengers”.

Process

Each ASRS report was visually inspected by a researcher with Certified Flight Instructor credentials with over 2,000 flight hours. An assignment was made into the appropriate category. Each ASRS report and assignment was reviewed by a Subject Matter Expert with over 26 years experience in airline operations. Discrepancies were discussed and resolved. Each ASRS report was reviewed at least twice.

Categories for Aborted Approaches

The query was performed on November 11th, 2012 and resulted in 1702 reports. A total of 467 ASRS reports were analyzed for this study. Two hundred and eighty four (284) reports included descriptions of Aborted Approaches. One hundred and eighty three reports did not describe an Aborted Approach and were discarded. For example, the report may mention the “missed approach” in the description of another incident. Some reports included descriptions of more than one Aborted Approach, yielding a total of 301 Missed Approaches categorized.

As the reports were analyzed a running list of factors was developed. This list evolved as the analysis was conducted. Special care was taken to identify the *direct* event or phenomenon that resulted in the Aborted Approach. Ancillary issues, or indirect causes were not included.

The factors leading to Aborted Approaches are listed in Table 2. Five categories of factors were identified based on the direct event or phenomenon that resulted in the Aborted Approach. Airplane issues were the result of unstable approach, alerts or onboard failures. Traffic Separation issues were the result of traffic on the runway, on the approach, or adjacent airspace.

Weather issues include storm cells, or wind conditions. Runway availability issues are related to

the availability of the runway concrete or the navigation equipment.

Flightcrew-ATC interaction issues related to ambiguous communication or understanding between ground and air.

Example ASRS reports for each factor/sub-factor/sub-sub factor are included in Appendix A.

Frequency of Factors

The likelihood of each of these factors in the ASRS data were found to be in order of frequency of occurrence:

1. airplane issues (48%)
2. traffic separation issues (27%)
3. weather (16%)
4. runway issues (5%)
5. flightcrew - ATC interaction (4%).

Airplane issues exhibited the highest occurrence. One out of every two Aborted Approaches is due airplane issues. Within this category: onboard-equipment failures (35%), unstable approaches contributed (7%), flightdeck alerts (other than equipment failures) (5%).

Traffic separation issues accounted for approximately 1 in every 4 Aborted Approaches. Issues with departing flights on the runway ranked highest with 9%, followed by separation violations with the lead flight on the approach at 7%. Arriving flights not clearing the runway (SRO), TCAS alerts from flights on parallel runway approaches, and runway incursion by taxiing flights all occurred 3% of the time each. Flights intruding on the approach airspace (e.g. lack of coordination with training flights at a nearby regional airports) occurred 2% of the time.

Weather related issues were the next factor. Issues with windshear-like conditions occurred 10% of the time. Unexpected IMC conditions on the approach, excessive tailwind, excessive crosswind, and a storm cell on the approach or missed approach occurred 3% of less of the time.

Runway availability issues, either the actual runway or failures in runway navigation equipment

Table 2: Analysis of 284 ASRS reports resulted in 301 Aborted Approaches. The factors directly leading to the Aborted Approach along with the frequency of occurrence of the factors reported are listed

Factor	Sub-factor	Sub-sub-factor
1. Airplane Issues (48%)	1.1 Unstable Approaches (7%)	1.1.1 High and fast (4%)
		1.1.2 Low-speed and other approach issues (3%)
	1.2 Alerts (not including failure) (5%)	
	1.3 Onboard Failures (35%)	
2. Traffic Separation Issues (27%)	2.1 Departing flight (9%)	
	2.2 Arriving flight simultaneous runway occupancy (3%)	
	2.3 Arriving flight wake vortex separation violation (7%)	
	2.4 Taxing aircraft/runway incursion (3%)	
	2.5 Approach space intrusion (2%)	
	2.6 Approach space intrusion from parallel approach (3%)	
3. Weather (16%)	3.1 Storm cell on approach/runway/missed approach (<1%)	
	3.2 Windshear encounter (10%)	
	3.3 Unexpected IMC conditions occur on approach(3%)	
	3.4 Excessive Tailwind (2%)	
	3.5 Excessive Crosswind (<1%)	
4. Runway Availability Issues (5%)	4.1 Runway Comm/Nav/Surveillance Equipment failure (3%)	4.1.1 Inappropriate runway alignment (1%)
		4.1.2 CNS equipment failure (2%)
	4.2 Construction/Runway no longer in use (1%)	
	4.3 Emergency (1%)	
5. Flightcrew – ATC Interaction (4%)	5.1 Vague/No ATC clearance (3%)	5.1.1 Landing Clearance 1%
		5.1.1 Clearance other than Landing 2%
	5.2 Clearance VMC, but IMC conditions (<1%)	
	5.3 Inappropriate/Infeasible instructions (1%)	
	5.4 Misunderstanding (<1%)	

were cited 5% of the time. Flightcrew-ATC interaction issues, such as a vague clearance, no clearance, or infeasible instructions occurred with frequency of 5%.

When airports were included in the report information, Aborted Approaches were reported at

SFO and ORD at twice the rate of the next tier of airports (LGA, CLT, DCA, JFK, LAX).

When the type of approach was included in the report, Aborted Approaches were reported on ILS and VFR at three times that rate of other approaches (e.g. RNAV, RNAV/GPS, VOR, LDA).

CONCLUSIONS AND FUTURE WORK

This paper identified the frequency of occurrence of aborted approaches for approaches to ORD - average of 7.4 in 1000. Further daily aborted approaches ranged from 0 per day to 21 per 1000 per day. At the higher end, 21 aborted approaches per 1000 flights, is 3 times the average.

Actions to investigate the conditions under which the higher frequency aborted approaches occur, and if possible, to mitigate any controllable causes would yield reductions in the average.

Final Segment Turn-off Procedures?

One of the surprising findings was that only 20% of the aborted approaches followed a missed approach trajectory overflying the runway while maintaining runway heading. The remaining 80% of the aborted approaches involved a turn off the final approach segment prior to the Missed Approach Point. To the author's knowledge, there is no standard procedure for air traffic control or airlines for this event. This raises an interesting question of whether these *ad-hoc* procedures for handling the early turn-off the final approach segment are as efficient as they could be.

Onboard Equipment Failures?

The analysis of voluntary pilot/air traffic control reports from across the NAS, of factors that contributed to aborted approaches identified airplane issues at the cause of half of all aborted approaches. Within this category onboard equipment failures were cited as the highest contributing factor (35%). Unstable approaches, an issue that has been improved dramatically over the last decade, accounted for only 7% of the occurrences. A detailed analysis of the onboard issues could yield some opportunities to address this issue.

Traffic Issues?

The next biggest factor, separation issues, maybe worth a closer examination as well, although these factors are distributed among several issues. For example, actions could be taken to address merging and spacing for a specific geometric configuration of flights in staggered approach

onto parallel runways that result in TCAS RA. Likewise coordination with ground control for taxiing operations could also be investigated. These issues are likely to be airport/runway configuration specific.

Analysis of the details of the runway issues and flightcrew-ATC interaction issues could yield some low level reductions in the number of aborted approaches.

Future Work

There are two threads of future work. First, an extension of the existing analysis by using the data to identify some the factors identified in the voluntary pilot reports. For example, by joining track data analysis with METAR, runway configuration, and airport acceptance rates, correlations may be established between ceiling/visibility, crosswinds, etc and the occurrence of an aborted approach. Second, these aborted approach statistics could be used in a formal model the approach and landing process to better understand the interactions between the parameters that contribute to runway throughput efficiency. For example, reduction in the variance of separation buffers (through ADS-B) will increase throughput, but might lead to increased aborted approaches. Likewise, decreased runway occupancy times (or relaxation of the SRO rule) may reduce the number of aborted approaches.

References

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Email Addresses

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Appendix A

Example ASRS Reports for each Factor/Sub-factor/Sub-sub-factor

ASRS reports for a sample of categories are shown below:

- (1) **Airplane Issue** is composed of (1.1) Unstable Approach split into (1.1.1) High and Fast, and (1.1.2) Low Speed and other Approach Issue. The remaining sub-categories in the Airplane Issue category are (1.2) Alert (no Failure), and (1.3) Onboard Failure.

Category 1 Examples:

- (1.1.1) High and Fast (Unstable Approach):

B737 flight crew reports descending below the FAF altitude during a night visual approach to Runway 34L at RNO, generating a low altitude warning from ATC. Confusion results in the aircraft getting too high to complete the approach and a go around ensues. The second approach is successful.

- (1.1.2) Low-speed and other approach Issue (Unstable Approach):

An Airbus pilot on a DCA Runway 19 River visual approach executed a go-around after the airspeed dropped below Vls during turbulence and the autothrust unexpectedly transitioned to TOGA LOCK.

- (1.2) Alerts (other than Onboard Failures):

When they extended the landing gear on final approach the flight crew of an A320 received multiple ECAM brake and autobrake warnings. After going around and following associated checklists the warnings

extinguished when the gear was extended for the subsequent normal landing.

- (1.3) Onboard Failure:

An A320 Flight Crew was unable to lower their landing gear, initiated a go around, successfully conducted a gravity extension procedure and returned for a safe landing. Their fuel remaining could have compromised more extensive trouble shooting had the gravity extension not proven successful. A previous identical failure some 11 days before was not annotated in the AML or in the flight crew's maintenance briefing message provided for flight planning.

- (2) **Traffic Separation Issues** expands into (2.1) Departing Flight, (2.2) Arriving Flight/Simultaneous Runway Occupancy, (2.3) Arriving Flight Wake Vortex, (2.4) Taxiing Aircraft Runway Incursion, (2.5) Approach Space Intrusion, and (2.6) Approach Space Intrusion from Parallel Approach.

Category 2 examples:

- (2.1) Departing Flight on Runway:

B737 First Officer landing Runway 28L at SFO describes a conflict with traffic departing Runway 1R that results in a go around.

- (2.2) Arriving Flight/Simultaneous Runway Occupancy:

Despite using all available resources to save fuel enroute, delays due to runway changes and a spacing problem with preceding aircraft, which forced a go-around, resulted in a B737-800 flight crew arriving with only 3,600 LBS of fuel. Tower called go-around due to the Airbus delay in exiting the runway.

- (2.3) Arriving Flight Wake Vortex:

*The Tower Controller issued a **go around** to a B737-300 flight crew who lost separation with the aircraft they were following.*

- (2.4) Taxiing Aircraft Runway Incursion:

Following a low speed rejected takeoff due to asymmetrical spooling of the engines, the flight crew of a B737-800 exited the runway at an exit other than that by which they were cleared, presenting the possibility of conflict with an inbound jet to an adjacent runway. The Tower directed the landing aircraft to execute a precautionary go-around.

- (2.5) Approach Space Intrusion:

SEA Tower Controller described go around event involving traffic on final for Runway 16C, indicating the go around may have been prompted by traffic in the BFI traffic pattern, suggesting additional coordination requirements be included in local LOA's.

- (2.6) Approach Space Intrusion from Parallel Approach:

SFO Controller described a go around event when traffic on visual approach to Runway 28R initiated a go around

resulting from a TCAS RA involving traffic on parallel Runway 28L.

- (3) **Weather** is composed of (3.1) Storm Cell on the Approach/Runway/ Missed Approach, (3.2) Windshear Encounter, (3.3) Unexpected IMC Conditions Occur on Approach, (3.4) Excessive Tailwind, and (3.5) Excessive Crosswind.

Category 3 Examples:

- (3.1) Storm Cell on the Approach/Runway/ Missed Approach:

An air carrier Captain took umbrage at an Approach Controller's refusal to facilitate avoidance of a thunderstorm cell in the arrival routing to PHL. A windshear warning and escape maneuver from within the cell resulted. "We asked for a vector to final to avoid the cell, but were told "not if you want to land at Philly". The Controller advised everyone else was going through the cell. We followed her vector into the cell, against my better judgment. While in the cell we received a windshear alert with loss in excess of 40 KTS of airspeed and initiated a go around. "

- (3.2) Windshear Encounter:

Air carrier on approach to MIA Runway 8L executed a wind shear go around and experienced a TCAS RA with traffic departing Runway 8R.

- (3.3) IMC Conditions Occur on Approach:

An Air Carrier crew executed an IMC go around after failing to remain VMC on the DCA River Visual and, because no missed approach procedure was specified, were extremely task saturated keeping up with the aircraft and ATC's instructions.

- (3.4) Excessive Tailwind:

B737 flight crew experiences strong tailwinds during approach and is unable to configure completely during a CAT III approach. A go around is initiated at 200 FT but the TOGA switches are not pushed initially resulting in further descent before selecting TOGA.

- (3.5) Excessive Crosswind:

ATC issued a CRJ200 on approach to CLT 18C a go around because it was drifting toward another aircraft in winds 70 degrees right at over 60 KTS. Three aircraft were on approaches to the three 18 runways simultaneously.

- (4) **Runway Availability Issue** is split into (4.1) Runway and Communication or Navigation, or Surveillance Failure which is further split into (4.1.1) Inappropriate Runway Alignment, and (4.1.2) CNS Equipment Failure. (4.2) is Construction/Runway no longer in Use, and (4.3) is Emergency

Category 4 examples:

- (4.1.1) Inappropriate Runway Alignment

An air carrier Captain executed a go-around approaching BDL on a night visual approach to Runway 6 because the airport was not detected in the surrounding lights until the aircraft was on short final and not in a position to land.

- (4.1.2) CNS Equipment Failure:

An Air Carrier crew reported an unstabilized approach and go around after a fluctuating glideslope caused them to be high on final to MSP Runway 12L. The subsequent approach was normal and stable.

- (4.2) Construction/Runway no longer in Use:

CLE TRACON Controller receiving training described a loss of separation event when the landing runway was closed because of braking issues, the Reporter indicating the Instructor failed to hear an incorrect vector instruction because of coordination involvement/s. "There were 3 planes on the final when a second poor braking action was received and the city shut down the runway. Air Carrier X was sent around by the Tower"

- (4.3) Emergency:

MD88 flight crew landing in heavy rain with the First Officer flying reports departing the runway momentarily before returning to the center line and discovering both engines have flamed out. Emergency power is selected to communicate with the Tower and have approaching aircraft go around. Engines are restarted to clear the runway.

- (5) **Flightcrew-ATC Interaction** is composed of (5.1) Vague/No ATC Clearance which is further decomposed into (5.1.1) Landing, and (5.1.2) Other Clearance. The remaining sub-categories under Flightcrew-ATC Interaction are (5.2) Clearance VMC, but IMC, (5.3) Inappropriate/Infeasible Instructions, and (5.4) Misunderstanding.

Category 5 Examples:

- (5.1.1) Landing (Vague/No ATC Clearance):

Air Carrier on final for Runway 21L at DTW failed to receive landing clearance even though several tower contact attempts were made, the report listing controller workload as a probable causal factor.

- (5.1.2) Other Clearance (Vague/No ATC Clearance):

An Air Carrier on approach to ORD Runway 4R was issued a go around after receiving several conflicting headings. The reporter suspects training may have been a factor.

- (5.2) Clearance VMC, but IMC:

Unanticipated IMC, no available ILS and fatigue combined to cause a breakdown in CRM on the flight deck, an eventual poorly managed go around for a B757-200 flight crew.

- (5.3) Inappropriate/Infeasible Instructions:

*Limited experienced Controller described a complex traffic event that eventually resulted in a go around, the reporter indicated the need for training on unusual traffic situations.
Need for training on unusual traffic situations.*

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