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**GO AROUND RATES FOR
LAND AND HOLD SHORT
OPERATIONS**

Dr. David N. Lankford
Dr. Richard Greenhaw
Sally Bishop, Editor

U.S. Department of Transportation
Federal Aviation Administration
Mike Monroney Aeronautical Center
Oklahoma City, OK 73125

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Reviewed by:

 2/19/03

Donald P. Pate Date
Manager, Flight Procedure
Standards Branch

Released by:

 3/6/03

John McGraw Date
Manager, Flight Technologies and
Procedures Division

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<p>12. Abstract This report describes research conducted by FAA branch AFS-420 to find an accurate estimate of the Low-Altitude, Pilot-Initiated Go Around rate for Land and Hold Short Operations (LLAPIGA rate). A previous report by AFS-420 ("Risk Analysis of Rejected Landing Procedure for Land and Hold Short Operations at ORD, Runways 14R and 27L") required an estimate of the likelihood of LLAPIGAs on ORD runway 14R. Unfortunately, this likelihood – the LLAPIGA rate – was not known, and the two estimates available for this rate varied widely. The first estimate, provided by ALPA and APA representatives, and based on a commonly used missed approach rate, was one per hundred. The second rate, based on an ASY-1 study ("Land and Hold Short Operations Risk Assessment"), was 1.1 per million. Because of this extreme variance of estimates, this previous AFS-420 report used statistical methods to find a rough estimate the LLAPIGA rate. The rough estimate was 1 per 10,000. But the report cautioned that "the lack of a well-defined rate is clearly a troubling issue," and went on to state that AFS-420 was pursuing actual radar track data from ORD in order to provide a much more accurate estimate of the rate. The present study provides an independent estimate of this LLAPIGA rate based on different data (ORD radar track data) and a different methodology. The rate derived in the present study is about 1 per 10,000 LAHS operations, essentially the same as that of the previous study.</p>		
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Go Around Rates for Land and Hold Short Operations

Executive Summary

The purpose of this report is to describe research conducted by FAA branch AFS-420 to find an accurate estimate of the Go Around Rate for Land and Hold Short Operations (LAHSO) at Chicago O'Hare International Airport, and to report that estimate.

A previous report by AFS-420 ("Risk Analysis of Rejected Landing Procedure for Land and Hold Short Operations at ORD, Runways 14R and 27L" [2]) required an estimate of the likelihood of Low-Altitude, Pilot-Initiated Go Arouns during LAHSO operations (LLAPIGA's) on ORD runway 14R. Unfortunately, this likelihood – the LLAPIGA rate – was not known, and the two estimates available for this rate varied widely. The first estimate, provided by ALPA and APA representatives and based on a commonly used missed approach rate, was one per hundred (1×10^{-2}). The second rate, based on an ASY-1 study ("Land and Hold Short Operations Risk Assessment" [3]), was 1.1 per million (1.1×10^{-6}).

Because of this extreme variance of estimates, this previous AFS-420 report used statistical methods to find a rough estimate the LLAPIGA rate. The rough estimate was 1 per 10,000 (1×10^{-4}). But the report cautioned that "the lack of a well-defined LGA rate is clearly a troubling issue," and went on to state that AFS-420 was pursuing actual radar track data from ORD in order to provide a much more accurate estimate of the LLAPIGA rate.

The present study provides an independent estimate of this LLAPIGA rate based on different data (ORD radar track data) and a different methodology. The rate derived in the present study is about 1 per 10,000 LAHS operations (0.01% or 1×10^{-4}), essentially the same as that of the previous study [2].

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Go Around Rates for Land and Hold Short Operations

Chicago O'Hare International Airport, Runway 14R

1.0 Purpose

The purpose of this report is to describe research conducted by FAA branch AFS-420 to find an accurate estimate of the Go Around rate for Land and Hold Short Operations (LAHSO) at Chicago O'Hare International Airport, and to report that estimate.

2.0 Background

2.1 Definitions

Land and Hold Short Operations (LAHSO) are simultaneous independent operations to intersecting runways in which one runway is designated as the LAHSO runway with the special requirement that the pilot landing on this runway accepts responsibility for either stopping the aircraft prior to the intersection or safely missing the aircraft on the other runway if a rejected landing becomes necessary.

This study examines LAHS operations at Chicago O'Hare International Airport (ORD, Figure 1) on runways 14R (the LAHSO runway) and 27L (the intersecting runway) occurring between January 1998 and October 1999. During that period all 14R arrivals were LAHS operations as long as weather conditions were at least 1000-3 (1000 foot ceiling and at least 3 statute mile visibility) [1].

A Go Around is a flight operation in which the aircraft leaves an approach path, circles around, and then regains the approach path to complete the landing.

A Low-Altitude, Pilot-Initiated Go Around is a type of Go Around intended to safely transition an aircraft from a very low-altitude, pilot-initiated aborted landing (that may involve ground contact) back into terminal airspace.

This study examines both Go Arounds, and especially Low-Altitude, Pilot-Initiated Go Arounds on runway 14R between January 1998 and October 1999, focusing on those performed during LAHS operations. We will refer to a LAHSO Go Around as an LGA and a LAHSO Low-Altitude, Pilot-Initiated Go Around as an LLAPIGA. Since all LLAPIGAs are also LGAs, we first identify LGAs and then focus on LLAPIGAs.

2.2 Previous Report

A previous report by AFS-420 (“Risk Analysis of Rejected Landing Procedure for Land and Hold Short Operations at ORD, Runways 14R and 27L” [2]) described the risk associated with LLAPIGAs under two scenarios:

Scenario 1: the LAHSO runway (14R) aircraft executes an LLAPIGA and must clear an aircraft *on the ground* on the crossing runway (27L).

Scenario 2: the LAHSO runway (14R) aircraft executes an LLAPIGA and must avoid an *airborne aircraft* from the crossing runway (27L).

To describe this risk, the report first defined the *event at risk* to be a separation distance of less than 500 feet between the centers of gravity of the two aircraft in each scenario. Then the report set a target level of safety (TLS) of 10^{-8} . This meant that there should be no more than one event at risk for every 100,000,000 (10^8) LAHS operations on runway 14R.

Next, the report estimated the probability of the event at risk for each scenario. This probability was calculated using:

- (a) the likelihood the LAHSO runway aircraft executes an LLAPIGA
- (b) the likelihood there is an aircraft to avoid on (or above) the crossing runway
- (c) the likelihood that the centers of gravity of the approaching aircraft come within 500 feet of each other

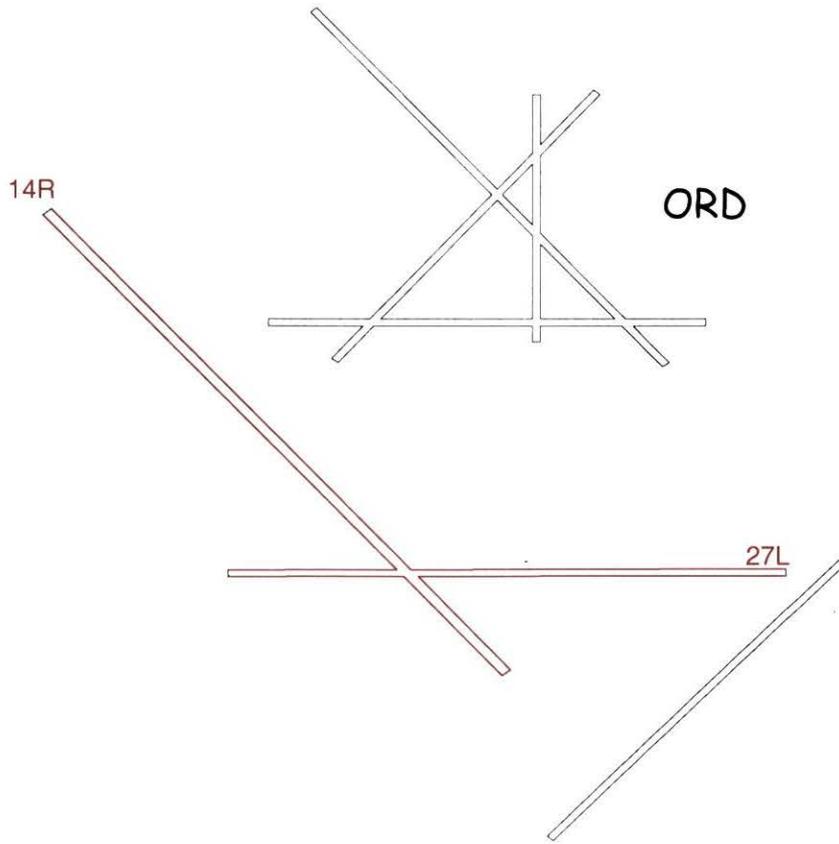
Therefore, the likelihood of (a) the LAHSO runway aircraft executing an LLAPIGA, was a significant factor in the evaluation of the risk. Unfortunately, this likelihood – the LLAPIGA rate – is not known, and the two estimates available for this rate vary widely.

The first estimate, provided by ALPA and APA representatives and based on a commonly used missed approach rate, was 1 per hundred. The second rate, based on an ASY-1 study (“Land and Hold Short Operations Risk Assessment” [3]), was 1.1 per million.

As a result of this extreme variance of estimates, the AFS-420 report used flight simulator data and data supplied by the ORD Air Traffic Operations Program to estimate the LLAPIGA rate to be roughly 1 per 10,000, but cautioned, “the lack of a well-defined rate is clearly a troubling issue.” The report went on to state that AFS-420 was pursuing actual radar track data from ORD in order to provide a much more accurate estimate of the LLAPIGA rate.

The purpose of the present study is to provide an independent estimate of this LLAPIGA rate from ORD radar track data.

Figure 1: Chicago O'Hare Runway Diagram



3.0 Procedure

3.1 Procedure Overview

Since the LLAPIGA rate for a runway is the runway's number of LLAPIGAs divided by the number of LAHSO approaches to the runway, we count the number of LAHSO approaches and the number of LLAPIGAs to ORD runway 14R over a period of time. The number of approaches and the nature of each approach (LLAPIGA or not) can be determined from radar track data and an operational definition of LLAPIGA. Whether or not the approach is a LAHSO approach can be determined from weather data and information associating weather conditions with the use of LAHSO [1].

3.2 Objective Nature of the Procedure

The radar track data and the weather data were collected independently of the analysis procedure. The method of data collection was not biased by any predetermined outcome. In addition, we (AFS-420) established the criteria for determining whether an operation was a LLAPIGA before we examined the data. These steps led to an objective procedure and result.

3.3 Data Acquisition

We acquired Continuous Data Recording (CDR) radar track data for ORD runways 14R and 27L for the years 1998, 1999, and 2000 from the Noise Abatement Office, Chicago O'Hare International Airport. These data provide 3-dimensional (x, y, z) snapshots of aircraft position at 4.8-second intervals (duration) for each approach to runway 14R and each departure from runway 27L for the three-year period (Table 1).

We acquired specific ORD weather data for the same three-year period from the National Climatic Data Center, ORD Weather Station. These data provide visibility and sky conditions by the hour and at the time of weather change for ORD (Table 2).

Table 1: ORD Radar Track Data Extract

Operation	Date	Time	Airport	Type	Flight	Carrier	Aircraft	Runway	Duration	X	Y	Z
5059182	04/02/98	5:10:49	ORD	A	UAL085	UAL	B747	14R	0	-4350	6990	236
5059182	04/02/98	5:10:49	ORD	A	UAL085	UAL	B747	14R	4	-4254	6876	231
5059182	04/02/98	5:10:49	ORD	A	UAL085	UAL	B747	14R	13	-4159	6768	220
5059182	04/02/98	5:10:49	ORD	A	UAL085	UAL	B747	14R	18	-4073	6666	214

Table 2: ORD Weather Data Extract

Date/Time	Sky Condition Type	Sky Condition Value	Visibility
04/02/1998 4:56:00 AM	OVC	16	10SM
04/02/1998 5:38:00 AM	BKN	14	10SM
04/02/1998 5:56:00 AM	BKN	14	10SM
04/02/1998 6:03:00 AM	SCT	14	10SM

3.4 Analysis Procedure

We analyzed the data to develop an estimate of the LLAPIGA rate using these eight steps:

- Step 1. Determine LAHSO weather conditions
- Step 2. Categorize radar track data by LAHS operation type
- Step 3. Screen 14R radar track approach operations for *possible* LGA's
- Step 4. Plot *possible* LGA's from screened 14R radar track approach operations
- Step 5. Screen plotted *possible* LGA operation tracks to determine *actual* LGA's
- Step 6. Categorize LGA's by distance from leading aircraft
- Step 7. Categorize LGA's by distance initiated from threshold
- Step 8. Estimate LLAPIGA rates based on the LGA categories

Step 1. Determine LAHSO weather conditions

We determined that ORD ran LAHS operations on runways 14R and 27L from January 1998 until October 1999 when weather conditions were 1000-3 (at least 1000 foot ceiling and at least 3 statute mile visibility) [1]. We retained the (non-LAHSO) November and December 1999 data and the 2000 data to compare LAHSO and non-LAHSO Go Around rates.

Step 2. Categorize radar track data by LAHS operation type

We determined the date and time a 14R approach radar track began and what the weather conditions were then. If the date was between January 1, 1998 and October 1, 1999, and the weather conditions were 1000-3, we classified the track as a LAHS operation; otherwise the track was classified as non-LAHSO. There were 58,140 radar track approaches to 14R from the 1998-2000 data. Of those, 43,960 occurred between January 1, 1998 and October 1, 1999. Of those 43,960 there were 33,809 LAHS operations and 10,151 non-LAHS operations (See table 3).

Table 3: ORD 14R LAHSO and non-LAHSO Approach Operations

1/1/98-12/31/00 All Approaches	1/1/98-10/1/99 All Approaches	1/1/98-10/1/99 LAHSO Approaches	1/1/98-10/1/99 Non-LAHSO Approaches
58,140	43,960	33,809	10,151

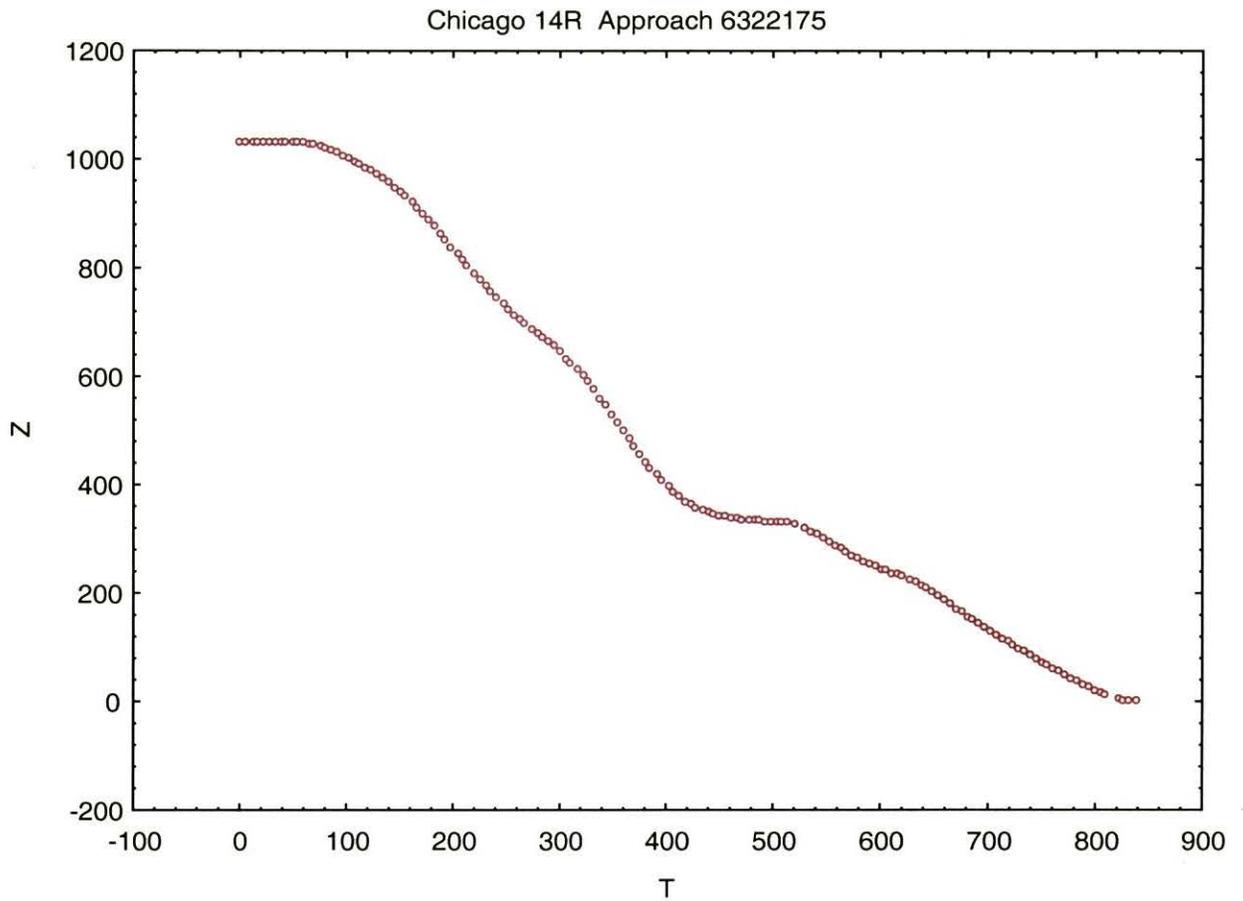
Step 3. Screen 14R radar track approach operations for *possible LGA's*

We screened all 33,809 LAHSO approach tracks to 14R for *possible LGA's* by algorithmically detecting any snapshot whose height (z value) was greater than the previous snapshot height for the same track. For a normal approach, the aircraft is not climbing. Therefore, for a normal approach track, later snapshot heights should be less than previous ones. For an LGA there will be at least one point at which the aircraft ceases to descend and begins to climb. Therefore, for an LGA there should be at least one snapshot whose height is greater than the previous snapshot height.

We used this as a first-level method because it could screen out the bulk of normal approaches. It could detect any *possible LGA* operations, but it might not screen out some of the normal approaches. We treated normal approaches not screened out in this first-level method (because of data anomalies or actual brief flight track climbs) in a later step (Step 5).

Figure 2 depicts a typical normal 14R approach that was screened out in this step. Figure 3 shows a normal approach that was not screened out in this step (due to data anomalies). And Figure 4 shows a *possible LGA* not screened out in this step. These graphs present each snapshot as a 2-dimensional point by plotting only the snapshot time (T, horizontally in seconds since track initiation) and height (Z, vertically in 10-foot units).

Figure 2: Normal ORD 14R Approach, Screened Out in Step 3



Step 4. Plot possible LGA's from screened 14R radar track approach operations

We plotted all 14R approach operation tracks that passed the algorithmic screen in Step 3. There were 1,523 of these tracks not screened out in Step 3. We created the plots by transferring the data directly from the database to the statistical analysis application *Statistica*.

Figures 3 and 4 are plots of two of these 1,523 *possible* LGA tracks not screened out in Step 3.

Figure 3: Normal ORD 14R Approach, Not Screened Out Due to Data Anomalies

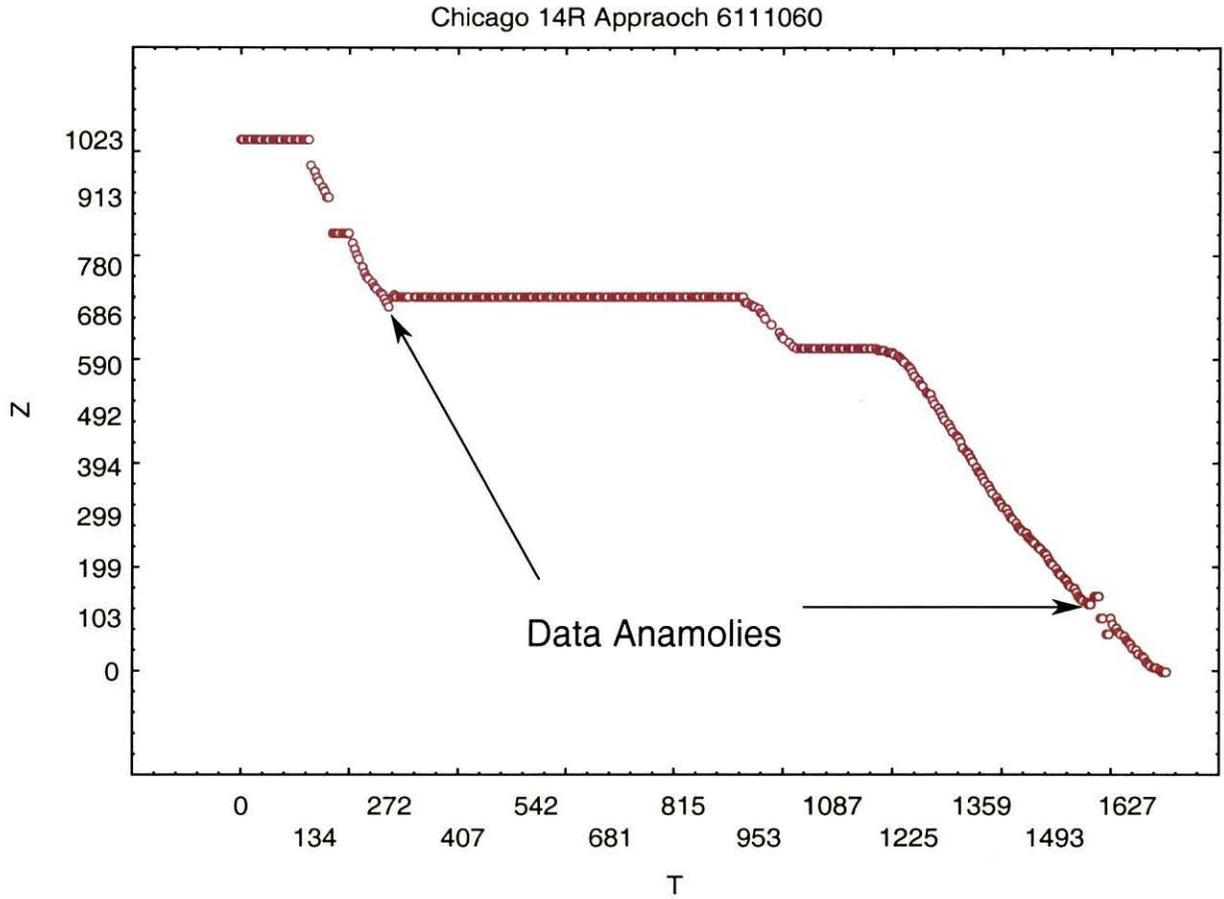
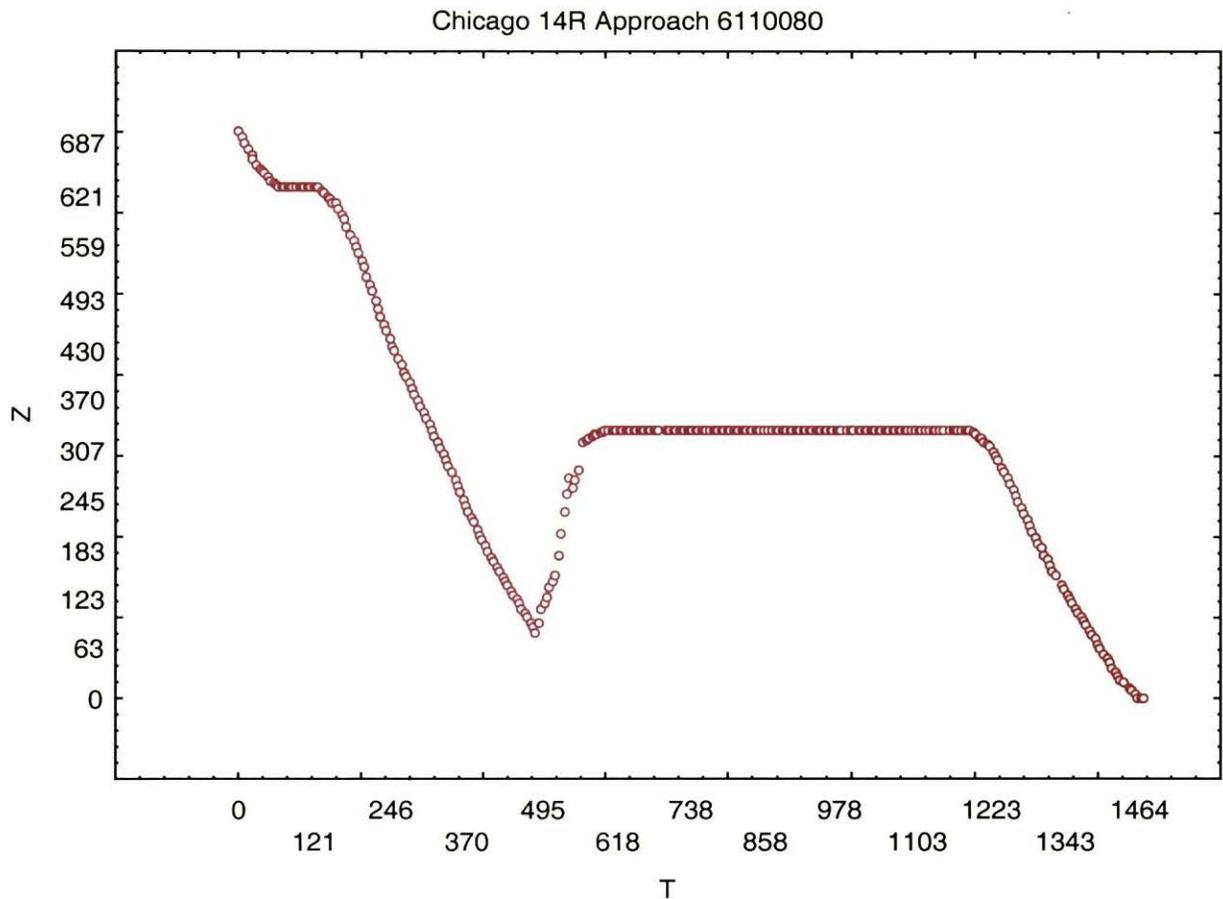


Figure 4: Possible LGA ORD 14R Approach



Step 5. Screen plotted possible LGA operation tracks to determine actual LGAs

We visually examined the 1,523 possible LGA tracks plotted in Step 4 to eliminate those normal approaches with data anomalies and other track patterns, which allowed them to pass the Step 3 algorithmic screen. We examined both 2-dimensional graphs as in Figures 2-4 and 3-dimensional graphs as in Figure 5. (In Figure 5 the XT, YT, and ZT units are feet. The 14R runway is along the XT axis.)

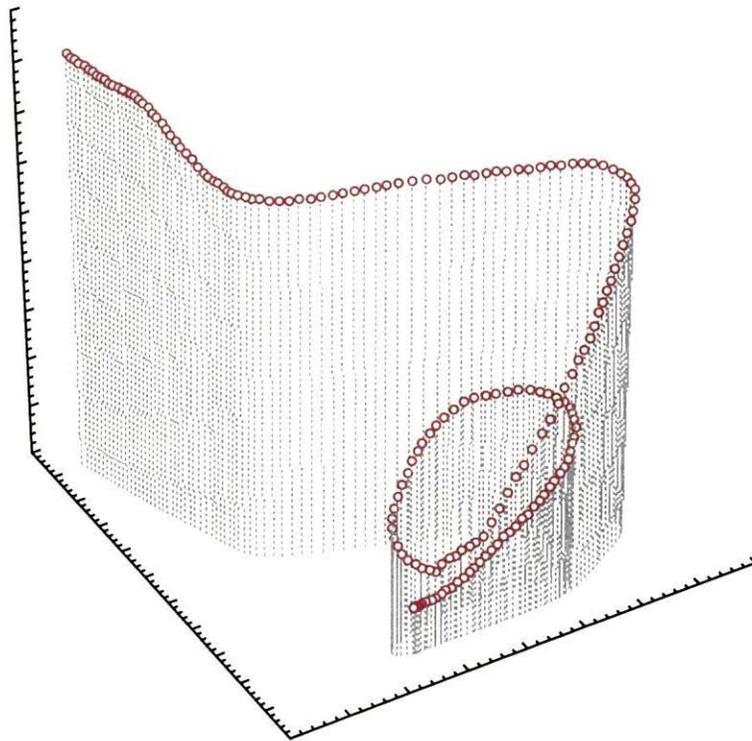
By this means, we eliminated over 95% of these 1,523 possible LGA tracks, leaving 59 actual LGA operations in which the aircraft actually aborted the approach and moved back into terminal airspace. That is, we found 59 LGAs out of 33,809 LAHS operations, giving a LGA rate of 1.7 per 1000 (0.17% or $1.7 \cdot 10^{-3}$)

However, to find the LLAPIGA rate we did not count all of these 59 actual LGA's as LLAPIGA's for the following reason. We defined an LLAPIGA as an operation intended to safely transition an aircraft from a very low-altitude pilot-initiated aborted landing back into terminal airspace.

It is probable that not all of these 59 *actual LGA's* were aborted by the pilot at very low altitudes. Therefore, we used the following two steps (steps 6 and 7) to eliminate LAHSO Go Arouns that were not very low-altitude and pilot-initiated.

Figure 5: Possible LGA ORD 14R Approach – 3-Dimensional Graph

Chicago 14R Approach 8859857



Step 6. Categorize LGA's by distance from leading aircraft

Most aborted landings at busy airports are due to the presence of leading aircraft on the runway ahead of the aircraft aborting its landing. These types of aborted landings are typically controller-initiated rather than pilot-initiated [4]. In order to eliminate these types of aborted landings we categorized *LGA's* by the distance from the aircraft aborting its landing to the aircraft immediately ahead (the leading aircraft). If the distance to the leading aircraft was less than 2.5 NM (when the leading aircraft crossed the threshold) we assumed that the landing was aborted because of the presence of the leading aircraft on or near the runway. (Because the radar track data was continuous and included actual dates and times, we had track data for leading aircraft.)

Of the 59 *LGA*'s, there were 27 tracks in which the leading aircraft was less than 2.5 NM ahead when it crossed the threshold. The leading aircraft was not less than 2.5 NM ahead in 32 tracks.

Step 7. Categorize *LGA*'s by distance initiated from threshold

To ensure that we included only very low-altitude aborted landings, we categorized the remaining 32 *LGA*'s by the distance of the aircraft from the threshold when its aborted landing was initiated. The landings aborted after 0.25 NM of the threshold were categorized as low-altitude and very likely pilot-initiated [5].

Of the remaining 32 *LGA*'s, 30 had landing aborted at 0.25 NM or greater and two had landings aborted after 0.25 NM of the threshold and therefore could be categorized as very low-altitude and pilot-initiated.

Step 8. Estimate LLAPIGA rates based on *LGA* categories

Therefore, of the 33,809 LAHS operations tracked for ORD runway 14R, our analysis showed that two appear to fit the definition of actual LLAPIGA. This represents a rate of 6 per 100,000 (0.006% or 6×10^{-5}) LLAPIGA's per LAHSO approach.

4.0 Results

The rate of 6 per 100,000 (0.006% or 6×10^{-5}) LLAPIGA's per LAHSO approach is the estimate of the Low-Altitude, Pilot-Initiated Go Around rate for Land and Hold Short Operations at ORD we were to find. Also, the larger LASHO Go Around rate (*LGA* rate) estimate is 1.7 per 1000 (0.17% or 1.7×10^{-3}).

Table 4 provides a summary of the data this rate is based on. Table 5 provides a summary of the actual derivation of the rate.

Table 4: Summary of *LGA* and non-*LGA* Operations

	Distance from Leading Aircraft		
	< 2.5 NM	>=2.5 NM	All
LGA's			
Initiated < 0.25 NM	5	2	7
Initiated >= 0.25 NM	22	30	52
<i>Total LGA's</i>	27	32	59
All Other (non-<i>LGA</i>) LAHSO			
<i>Total Other (non-<i>LGA</i>) LAHSO</i>	14613	19137	33750
Total LAHSO (<i>LGA</i> and non-<i>LGA</i>)	14640	19169	33809

Table 5: Summary of Rate Derivation

Step1	Weather Data (1998-2000)	
Step 2	All LAHSO Approach Tracks from Data	33,809
Step 3	Possible LGA Tracks (after algorithmic screening)	1523
Step 4	Plot Possible LGA Tracks	
Step 5	Actual LGA Tracks (after visual screening)	59
	LGA Rate (59 per 33,809 LAHS operations)	0.17%
Step 6	LGA's with Leading Aircraft ≥ 2.5 NM	32
Step 7	LGA's (Leading ≥ 2.5 NM & Initiated < 0.25 NM)	2
Step 8	LLAPIGA Rate (2 per 33,809 LAHS operations)	0.006%

5.0 Conclusion

Reasonableness

The results give the estimate based on analysis of the ORD 14R approach track data. Can we conclude that this estimate is reasonable?

There are five arguments which, taken together, support the reasonableness of this estimate.

1. Its value lies between the two estimates provided by other sources.

The report [2] presented two LLAPIGA rate estimates. The first estimate, provided by ALPA and APA representatives and based on a commonly used missed approach rate, was 1 per hundred (1% or 1×10^{-2}). The second rate, based on report [3] was 1.1 per million (0.00011% or 1.1×10^{-6}). The current study's estimate (0.006% or 6×10^{-5}) lies between these two values.

The original report [3], containing the smallest estimated value, describes this number as "subject to considerable bias" and warns that it is not an "accurate measure of risk" [3, p.46]. The report explains that its estimate is based on *reported* numbers of pilot initiated go-arounds in 1998 rather than objective measures of those numbers.

2. It is close to the stochastically derived estimate in the previous study.

The previous study [2] estimated the LLAPIGA rate to be 1 per 10,000 (0.01% or 1×10^{-4}). The current study's estimate (0.006% or 6×10^{-5}), although derived independently and from different data, is quite close to this value.

3. It is derived independently and from objective data.

The rate estimated in the current study was derived without recourse data or estimates from the previous studies. It was derived from objective radar track data as opposed to reported results, results from other sources, or estimated results.

4. It is based on parameters supplied by subject matter experts.

Other than the objective radar track data, the only other information or assumptions used were parameters supplied by subject matter experts. There were only three such parameters. First, the information about when LASH operations were in effect at ORD was supplied by ATT-5 [1]. Second, the 2.5 NM cut-off for distance to leading aircraft was supplied by ATP-106 [4]. Third, the 0.25 NM distance from threshold to use to provide a Low-Altitude Pilot-Initiated Go Around was supplied by ORD Tower management [5].

5. A detailed analysis of the two LLAPIGA's (those two whose leading aircraft distance was greater than 2.5 NM and whose rejected landing was initiated after 0.25 NM of the threshold) shows they are the kind of Go Arounds that pose significantly increased risk in a LAHS operation (based upon high-risk Go Arounds previously studied, that is those which are initiated within 0.75 NM of threshold).

As Table 6 shows, the aircraft in these two operations descended to an average of 310 feet above threshold height before aborting their landings. These aircraft initiated their aborted landings at an average of 0.15 NM before the threshold. They averaged following their leading aircraft by 6.4 NM.

Table 6: Summary of Two LLAPIGA Operations

Operation ID	Distance Initiated from Threshold	Minimum Height above Threshold Achieved	Distance from Leading Aircraft
5888756	0.21 NM	220	8.9 NM
6323781	0.08 NM	400	3.9 NM
Average	0.15 NM	310	6.4 NM

The appendices contain detailed analyses of the tracks of these two ORD 14R LLAPIGAs along with their relationships to departing aircraft on runway 27L.

Caveat 1

There may have been LLAPIGA operations we did not count because Step 6 excluded from the LLAPIGA count *all* aircraft less than 2.5 NM from their leading aircraft. We assumed that all of these operations were controller-initiated rather than pilot-initiated. However, we had no reason to know that these were not pilot-initiated. It may be that some were pilot initiated and should have been counted.

This would be even more likely if one were to assume that the LAHSO operations on the intersecting runways were independent from a controller perspective.

The data in Table 4 shows that, in addition to the two likely LLAPIGA's we counted, (those initiated after 0.25 NM of the threshold with leading aircraft 2.5 NM or more ahead) there were five likely LLAPIGA's not counted. Those five were operations initiated after 0.25 NM of the threshold but with leading aircraft less than 2.5 NM ahead.

If we were to include half of those, or 2.5, the LLAPIGA rate would increase from 2 per 33,809 LAHS operations (0.006% or 6×10^{-5}) to 4.5 per 33,809 LAHS operations (0.013% or 1.3×10^{-4}). If we were to include all five, the rate would increase to 7 per 33,809 LAHS operations (0.021% or 2.1×10^{-4}).

Therefore, a conservative estimate of the LLAPIGA rate is one on the order of 1 per 10,000 LAHS operations (0.01% or 1×10^{-4}). It may be slightly lower (0.006% or 6×10^{-5}), but it may be slightly higher (as much as 0.021% or 2.1×10^{-4}). This range is very close to the rate of 1 per 10,000 (0.01% or 1×10^{-4}) estimated independently in the previous study [2].

Caveat 2

The 14R approach data we used likely does not include all ORD approaches to 14R during the time period studied (January 1998 through September 1999). The data we used was all of the data provided by the Noise Abatement Office, Chicago O'Hare International Airport. However, the Noise Abatement Office, at the direction of the Chicago Air Traffic Tactical Operations Office, provided data for all 14R approaches for the 3 days each month during the periods that were most likely to include a high number of LAHSO operations (based on weather conditions).

Since this data selection was made without regard to any variable that would influence LLAPIGA rates, and since the selection was made by members of the Noise Abatement Office staff (at the direction of the Chicago Air Traffic Tactical Operations Office) independently of the analysis process, it is very unlikely that this selection process introduced bias into the results. However, it is possible, though unlikely, that the data that was actually selected for analysis differs from the data not selected with respect to LLAPIGA rates. To address this possibility, we can determine a smallest possible LLAPIGA rate based on all ORD 14R approaches in the years 1998 to 2000.

The Noise Abatement Office selected the 33,809 LAHS operations on ORD 14R from 60 days (approximately three per month for the period 1998 and January through September 1999). Based on weather conditions, we have determined that there were as many as 412 days during that period in which it might have been possible to run LAHSO on ORD 14R. The ratio of 412 to 60 is about 6.87. Therefore, there may have been, as an extreme upper limit, as many as 33,809 times 6.87, or 232,268 LAHS operations during the period.

Assuming that none of these operations included any additional LLAPIGA's, the LLAPIGA rate for ORD 14R could be no lower than 2 out of 232,268, or 0.86×10^{-5} .

This value is very unlikely given the extremely conservative nature of the assumptions used to derive it (no additional LLAPIGA's in about 200,000 additional operations). But it does represent a lowest possible value for LLAPIGA's on ORD 14R during the period studied. The best estimate is still the one described in the results above: on the order of 1 LLAPIGA in 10,000 LAHSO operations (1×10^{-4}).

Sources

[1] Personal communication, Jim Krieger, Air Traffic Tactical Operations Office Position, Great Lakes Region Headquarters, ATT-5 FAA

[2] "Risk Analysis of Rejected Landing Procedure for Land and Hold Short Operations at ORD, Runways 14R and 27L," FAA AFS-420, October 2000

[3] "Land and Hold Short Operations Risk Assessment," FAA ASY-1, September 1999

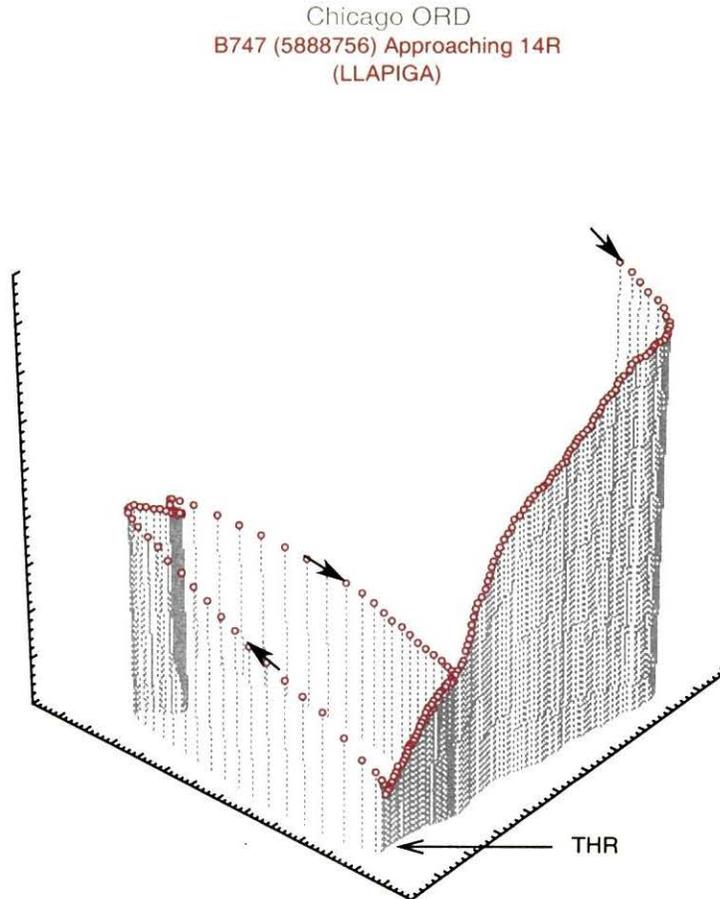
[4] Personal communication, Larry Ramirez, Air Traffic Control Specialist, AT Planning and Procedures Program, Terminal and Enroute Procedures Division, ATP-106 FAA

[5] Personal communication, Michelle Behm, Manager, Airport Traffic Control Tower, O'Hare International Airport, ATC FAA

Appendix A. Operation 5888756, a B747 approaching ORD runway 14R

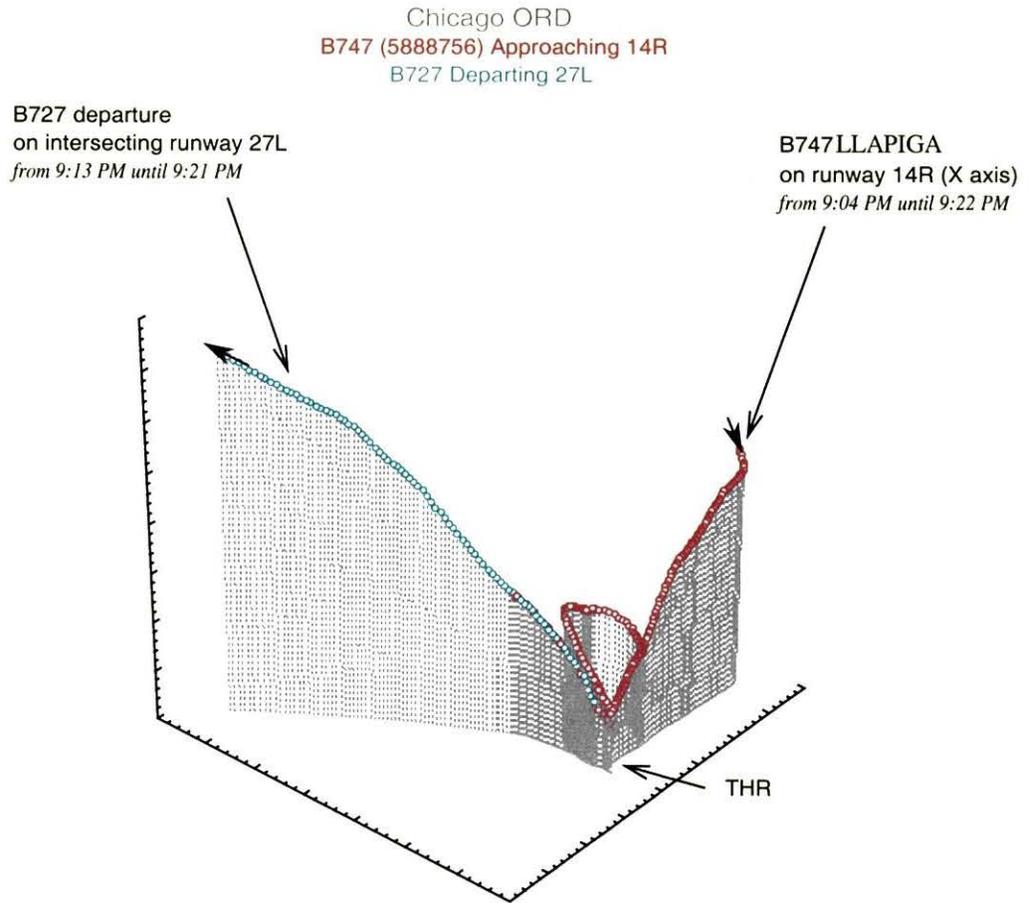
As Figure 6 shows, the B747 aircraft approached runway 14R and rejected the landing, turning sharply right at a height of about 220 feet above threshold height and approximately 1200 feet (0.21 NM) before the threshold.

Figure 6: Operation 5888756, ORD 14R LLAPIGA – the First LLAPIGA



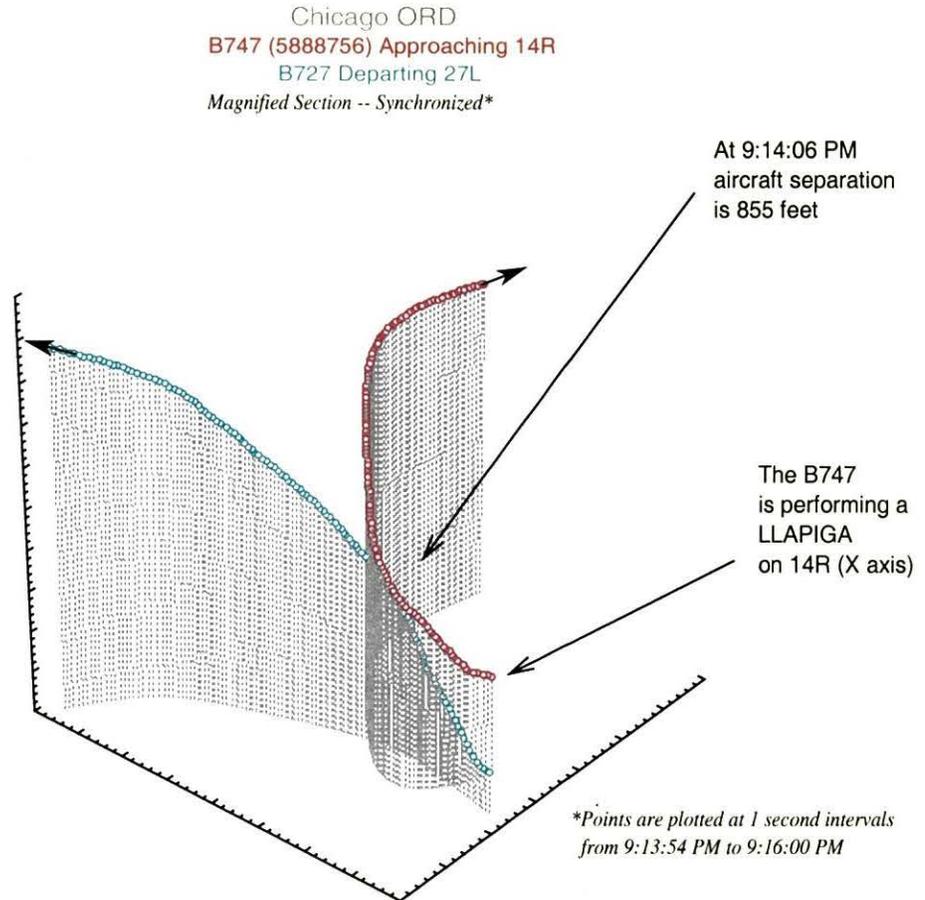
As Figure 7 shows, a B727 aircraft began takeoff from runway 27L as the B747 approached runway 14R. The 27L departing aircraft passed under the 14R aircraft as the latter performed a rejected landing.

Figure 7: Operation 5888756, ORD 14R LLAPIGA along with a 27L Departure



As Figure 8 shows, the 27L departing aircraft began takeoff from runway 27L as the B747 approached runway 14R. The 27L departing aircraft passed under the 14R aircraft as the latter performed a LLAPIGA landing. At 9:14:06 PM, the two aircraft were separated by 855 feet according to radar track data.

Figure 8: Operation 5888756, ORD 14R LLAPIGA with 27L Departure -- Magnified

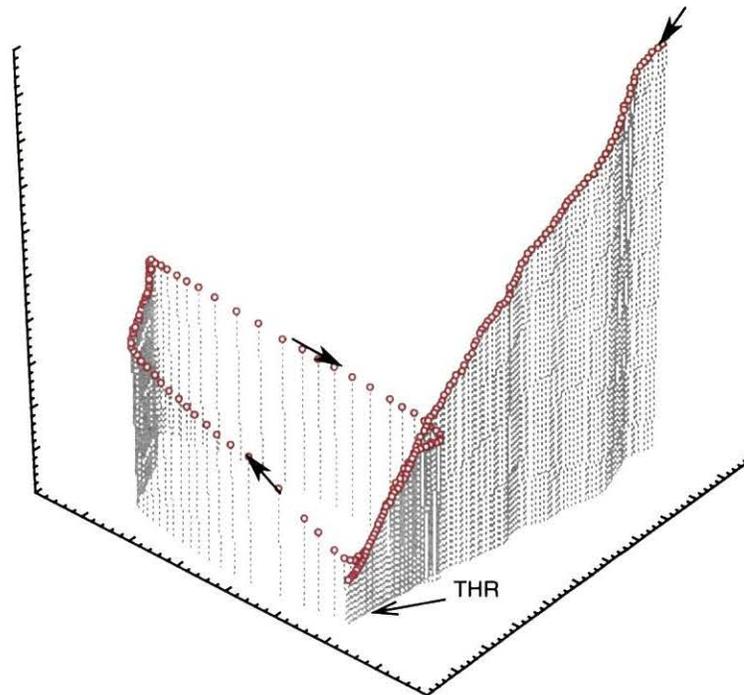


Appendix B. Operation 6323781, a B747 approaching ORD runway 14R

As Figure 9 shows, the B747 aircraft approached runway 14R and going around (as in operation 5888756), turning sharply right at a height of about 400 feet above threshold and approximately 480 feet (0.08 NM) before the threshold.

Figure 9: Operation 6323781, ORD 14R LLAPIGA – the Second LAHSO LLAPIGA

Chicago ORD
B747 (6323781) Approaching 14R



As Figure 10 shows, the 27L departing aircraft began takeoff from runway 27L as the B747 approached runway 14R. The 27L departing aircraft crossed the 14R's trajectory a few seconds ahead of the 14R aircraft.

Figure 10: Operation 6323781, ORD 14R LLAPIGA along with a 27L Departure

