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Flight Procedure Standards Branch
Flight Technologies and Procedures Division
Flight Standards Service

Analysis of Flight Simulator Tracks Into SFO RWY 28R

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

August 1998

Technical Report

U.S. Department of Transportation
Federal Aviation Administration

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Analysis of Flight Simulator Tracks Into SFO RWY 28R

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Technical Report

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11. Supplementary Notes

12. Abstract

Track data generated by a B747-400 flight simulator were analyzed and documented. These flight tracks were to Runway 28R at San Francisco International Airport (SFO) using a 3° offset localizer directional aide (LDA) with glideslope. The FAA's Airspace Simulation and Analysis for TERPS (ASAT) computer system was utilized to plot the track data. The track plots displayed information such as: ground track, bearing, runway, indicated airspeed, maximum bank angle, missed approach point, altitude above ground, wind direction and velocity, and overshoot data. Recommendations were also included.

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1.0 INTRODUCTION

The Flight Procedure Standards Branch received track data generated by a United Airline's B747-400 flight simulator based in Denver, Colorado. These flight tracks were to Runway 28R at San Francisco International Airport (SFO), utilizing a 3° offset localizer directional aide (LDA) with glideslope.

Various computer analysis tools were customized in order to display the approach data in a way that could help analyze several aspects of the proposed approach procedure. Tables 1 and 2 show summaries of the track data. Appendix I contains plots of all 29 tracks that were relevant to this evaluation, but excludes tracks used for calibration or overshoot experiments. The track plots in Appendix I displays information such as: ground track, bearing, runway, indicated airspeed, maximum bank angle, missed approach point, altitude above ground, wind direction and velocity, and overshoot data. Appendix II contains an Airline Pilots' Association (ALPA) report which describes the methodology used to generate the B747-400 flight track data.

2.0 METHODS

A total of 119 tracks (including 29 approaches) were logged during the 3 days of flight simulator tests. According to the ALPA methodology information contained in Appendix II, the simulator testing was conducted on October 23-24, 1997, and an additional day close to the first two days.

In addition to the "Approach Runs" (APP's), there were two other types identified as "Test Calibration Runs" (TCR's and "Overshoot Test Runs" (OTR's). Table 1 summarizes the number of runs per day and type.

	TCR	OTR	APP	TOTAL
DAY1	4	14	13	31
DAY2	3	3	16	22
DAY3	1	65	0	66
TOTAL	8	82	29	119

TABLE 1. FLIGHT SIMULATOR TRACKS CATEGORIES

The approach tracks were processed by the Federal Aviation Administration's Airspace Simulation and Analysis for TERPS (ASAT) computer system, making use of the flight simulator track display capabilities of the system. However, the system had to be modified in order to handle this specific data format.

The ASAT is capable of displaying various flight simulator data formats. The data furnished had a different structure in two aspects:

- the sequence of the parameters logged, and
- each run was logged on 2 files, containing different parts of the required data.

The data input section was modified to handle the new data format. In addition, information was added to the track display which showed the duration and distance of any runway centerline overshoot, as well as bearing (magnetic) for the relevant parts of the track.

Table 2 displays the SFO.OUT ASAT output data file which is a summary of parameters related to runs that resulted in runway centerline overshoots of 50 feet or higher.

Track File Name	Max Os Feet	Range Start Os50Ft	Range End Os50Ft	Time Start Os50Ft	Time End Os50Ft	Range At Os50Ft	Time At Os50Ft	Wind Deg@Kts
DAY1\B74R7404.RD1	265	11824	4169	5851.8	5879.0	7655	27.2	49@12
DAY1\B74R7410.RD1	75	8322	6522	13119.6	13126.0	1800	6.4	52@13
DAY1\B74R7511.RD1	116	9374	5490	12653.3	12666.9	3884	13.6	49@12
DAY1\B74R7613.RD1	84	8297	5466	14654.5	14664.9	2831	10.4	129@0
DAY1\B74R7614.RD1	150	9522	5906	14948.0	14960.8	3616	12.8	52@13
DAY2\B74R0103.RD1	85	8412	6160	12002.8	12010.8	2252	8.0	129@0
DAY2\B74R0104.RD1	195	11045	7424	12483.5	12496.3	3621	12.8	49@12
DAY2\B74R0105.RD1	187	11920	7427	13036.2	13052.2	4493	16.0	49@12
DAY2\B74R7701.RD1	53	6690	6240	2513.4	2515.0	450	1.6	0@0
DAY2\B74R7702.RD1	114	5813	-264	2980.5	3002.1	6077	21.6	52@13
DAY2\B74R7704.RD1	294	7961	126	4106.6	4133.8	7835	27.2	129@12
DAY2\B74R7714.RD1	454	11408	1740	6584.4	6618.8	9668	34.4	52@13

TABLE 2. SUMMARY OF OVERSHOOTS

The following is a description of the data presented in table 2:

Track File Name: The *BASE* file name at which the particular run was logged. Each track data set is contained in two files with the base name and extensions "RD1" and "RD2".

Max Os: The maximum runway centerline overshoot in feet.

Range-Start-Os50Ft: The distance from threshold in feet where the runway centerline overshoot was equal or greater than 50 feet.

Range-End-Os50Ft: The distance from threshold in feet where the runway centerline overshoot dropped to a value less than 50 feet.

Time-Start-Os50Ft: The time in seconds as logged by the simulator corresponds to the location of Range-Start-Os50Ft.

Time-End-Os50Ft: The time in seconds as logged by the simulator corresponds to the location of Range-End-Os50Ft.

Range-At-Os50Ft: The distance the aircraft flew while overshooting the runway centerline 50 feet or more.

Wind-Deg@Kts: Wind direction in degrees at a specified velocity in knots.

Time-At-Os50Ft: The elapsed time in seconds the aircraft was at a centerline overshoot of 50 feet or greater.

3.0 RESULTS

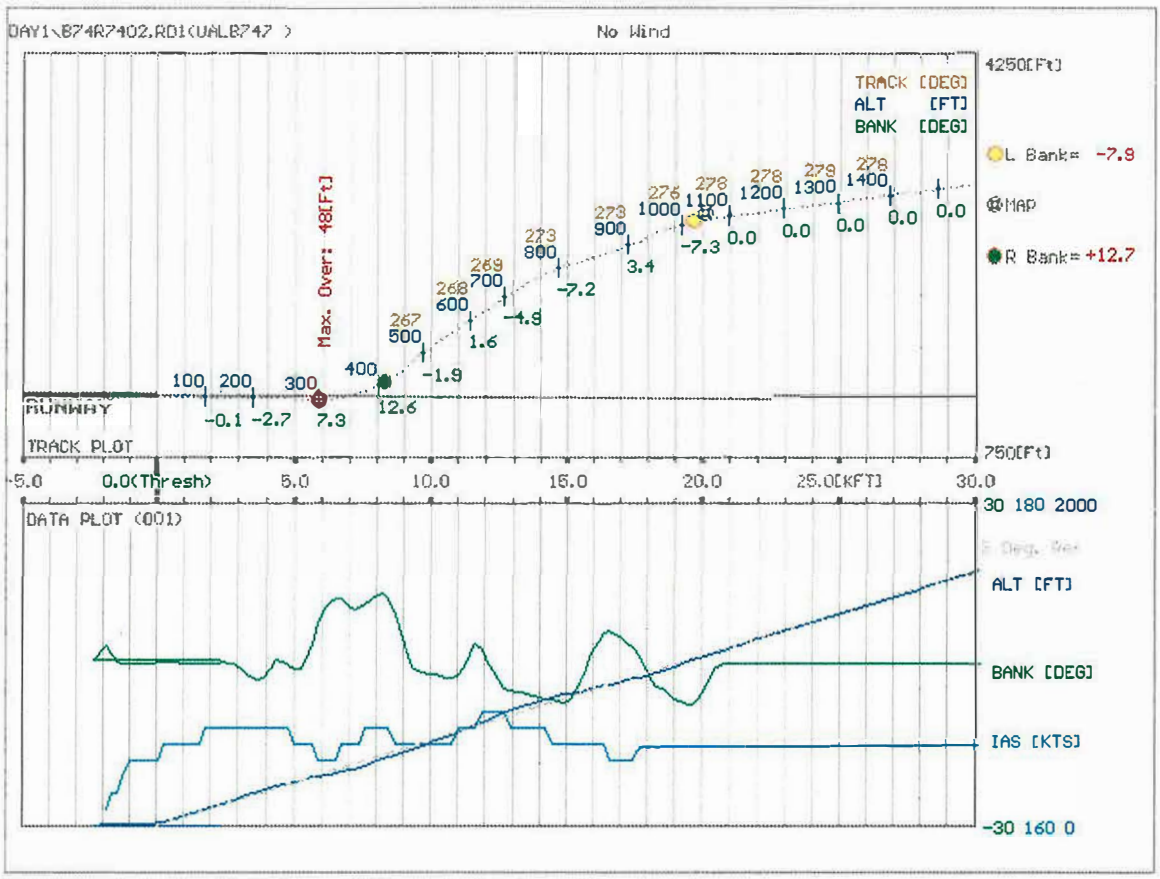
More than 30% of the flown tracks (12 out of 31) resulted in runway centerline overshoots of 50 feet or greater.

The percentage of significant overshoots indicate that this could not be an acceptable maneuver at SFO without a stagger, maintained and monitored by Air Traffic Control, relevant to aircraft on the adjacent runway.

4.0 RECOMMENDATION

This report contains a very limited set of data and therefore, it is recommended that a test plan be developed and additional B-747 test runs be completed. Future evaluations should include the effect of aircraft track dispersion from Runway 28L. Also, based on the track overshoot data as documented in this report, a computer aided stagger tool for air traffic control should be evaluated.

APPENDIX I

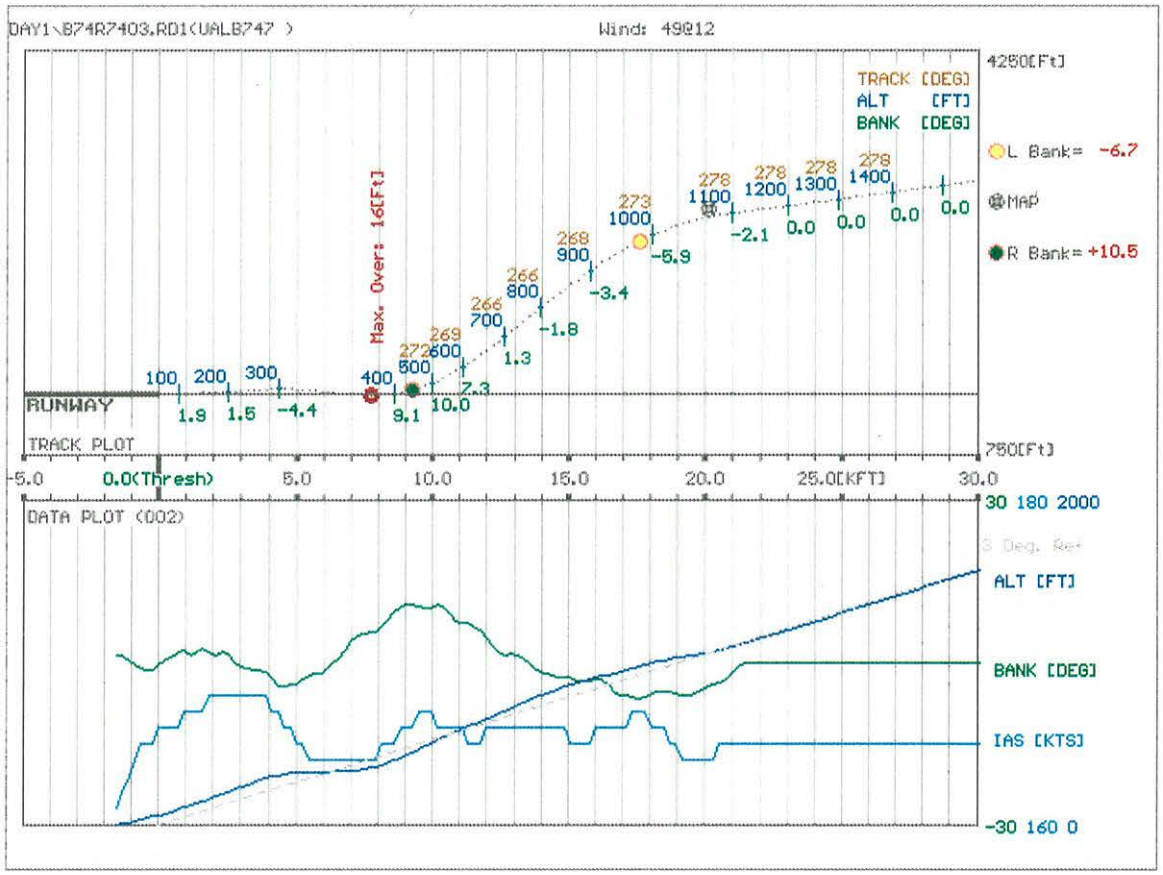


- Maximum Bank Angle Left
- Maximum Bank Angle Right
- Missed Approach Point (MAP)
- Maximum Runway Center-line Overshoot

IAS

Bank Angle

Altitude



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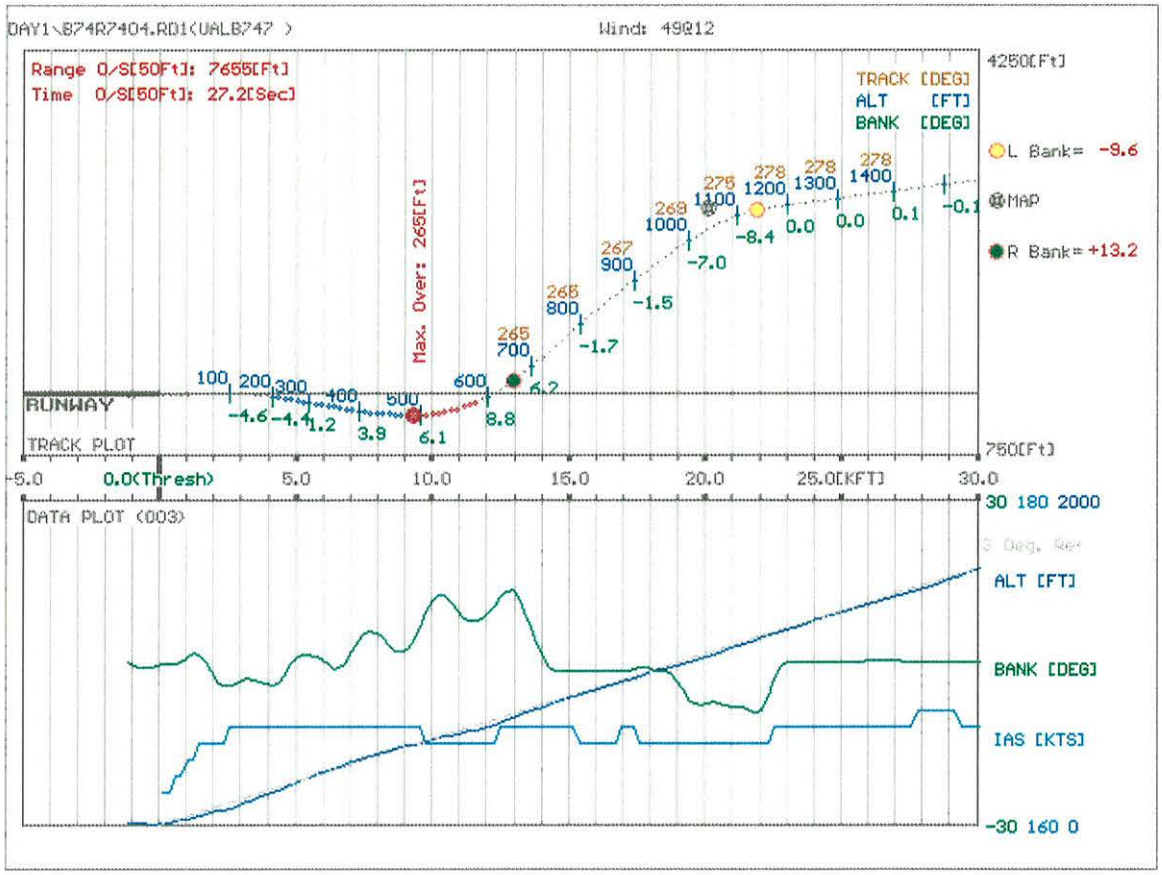

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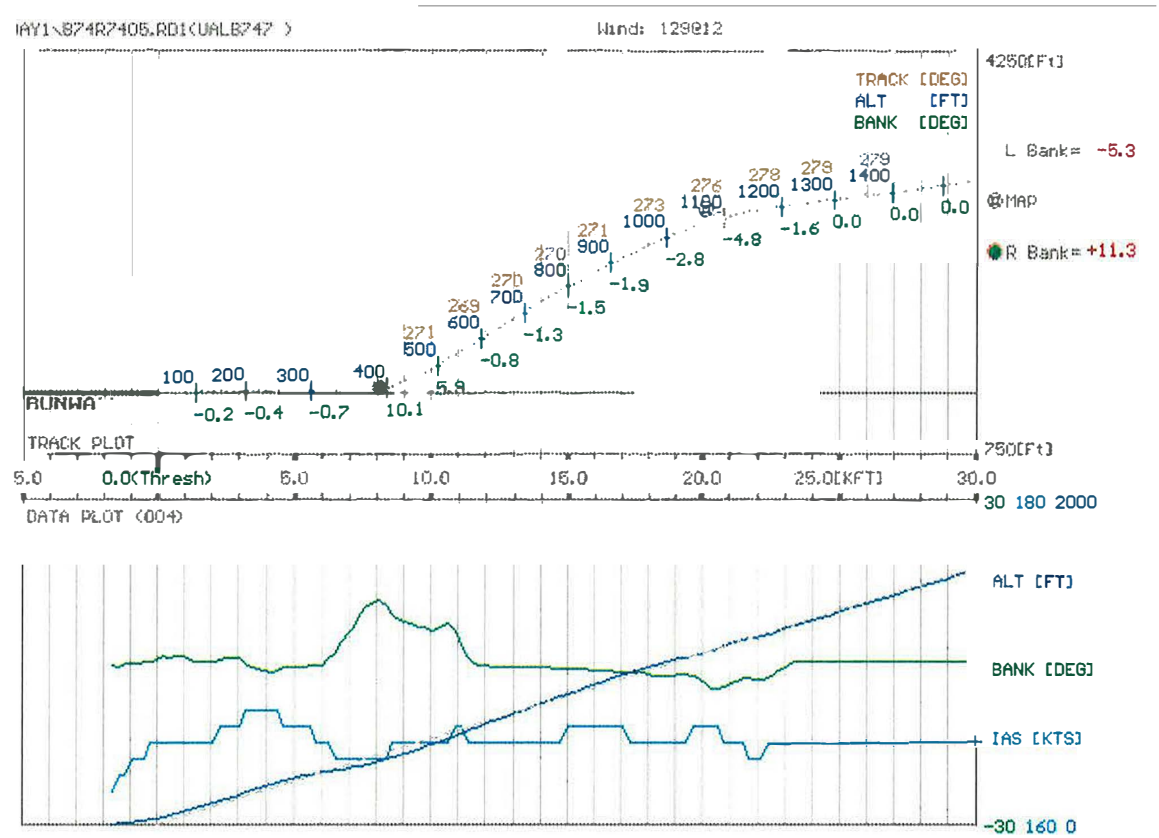

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———Bank Angle

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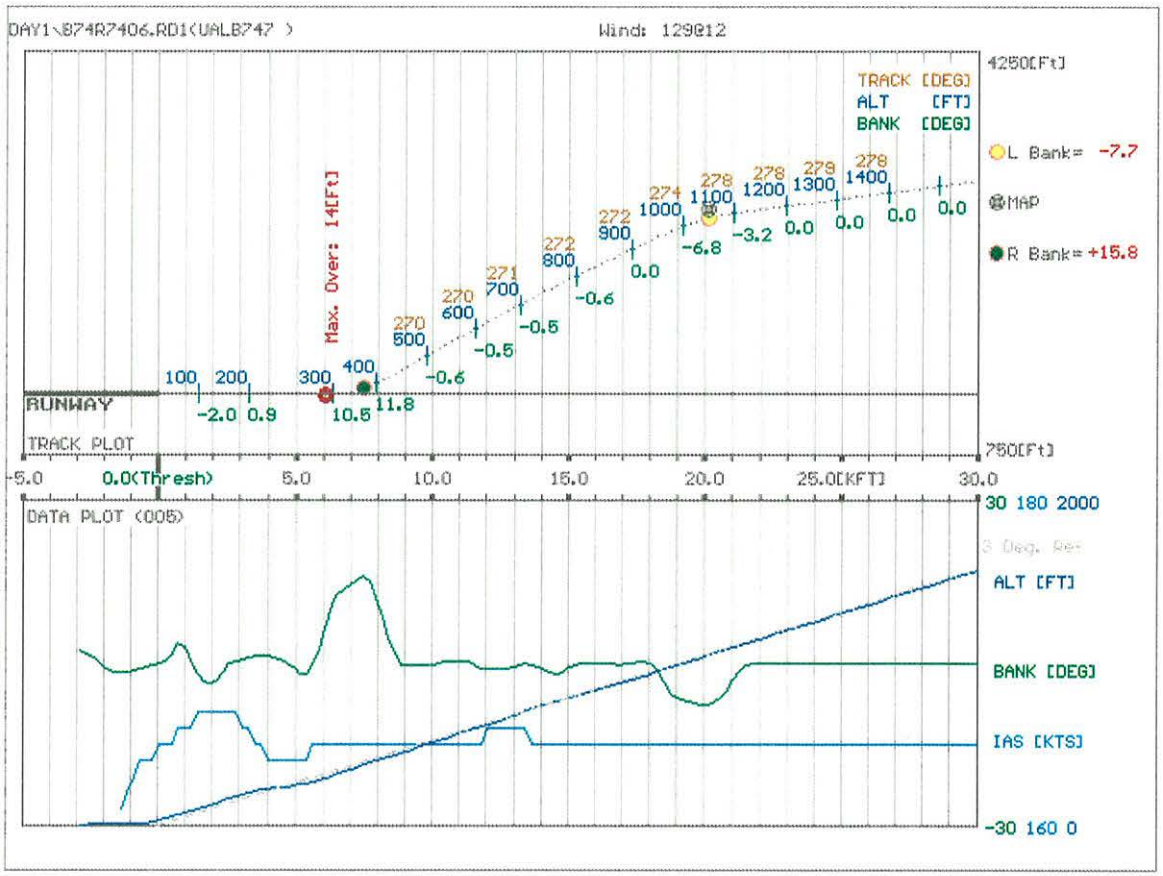

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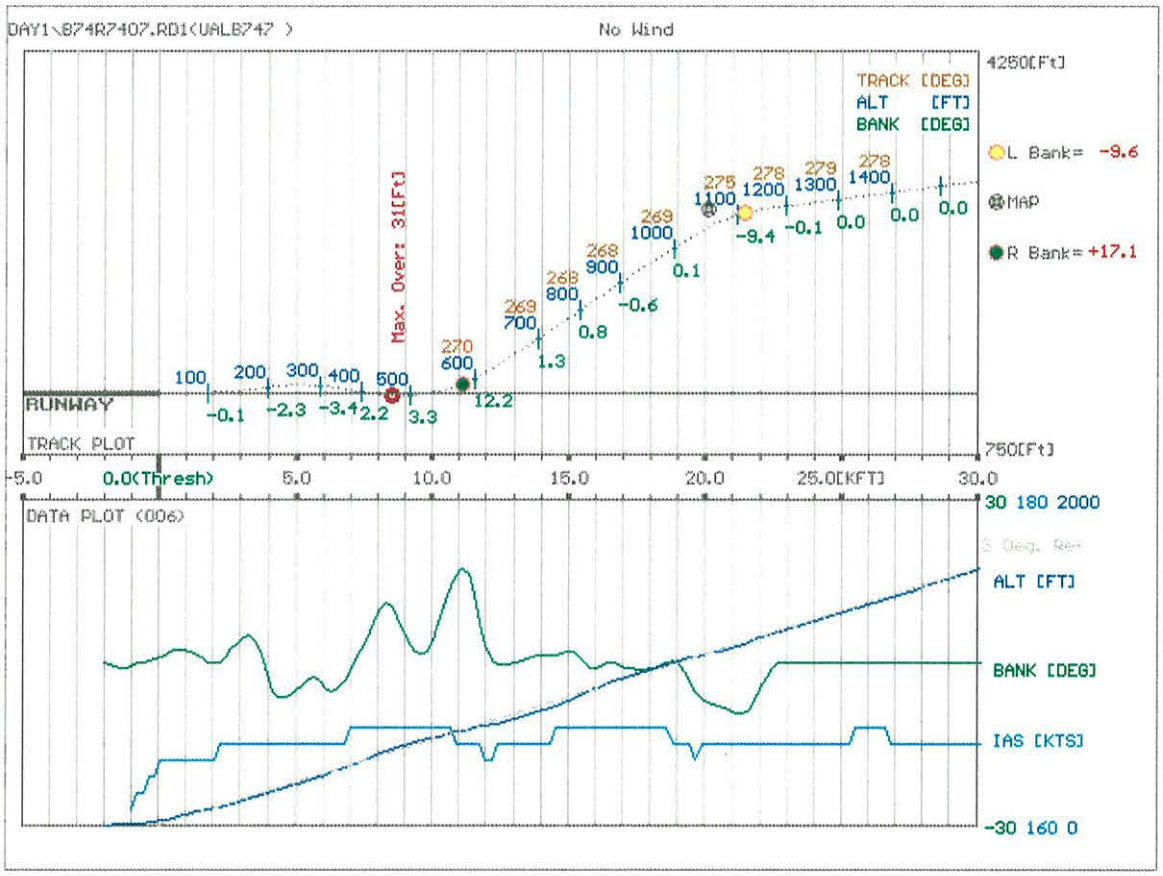

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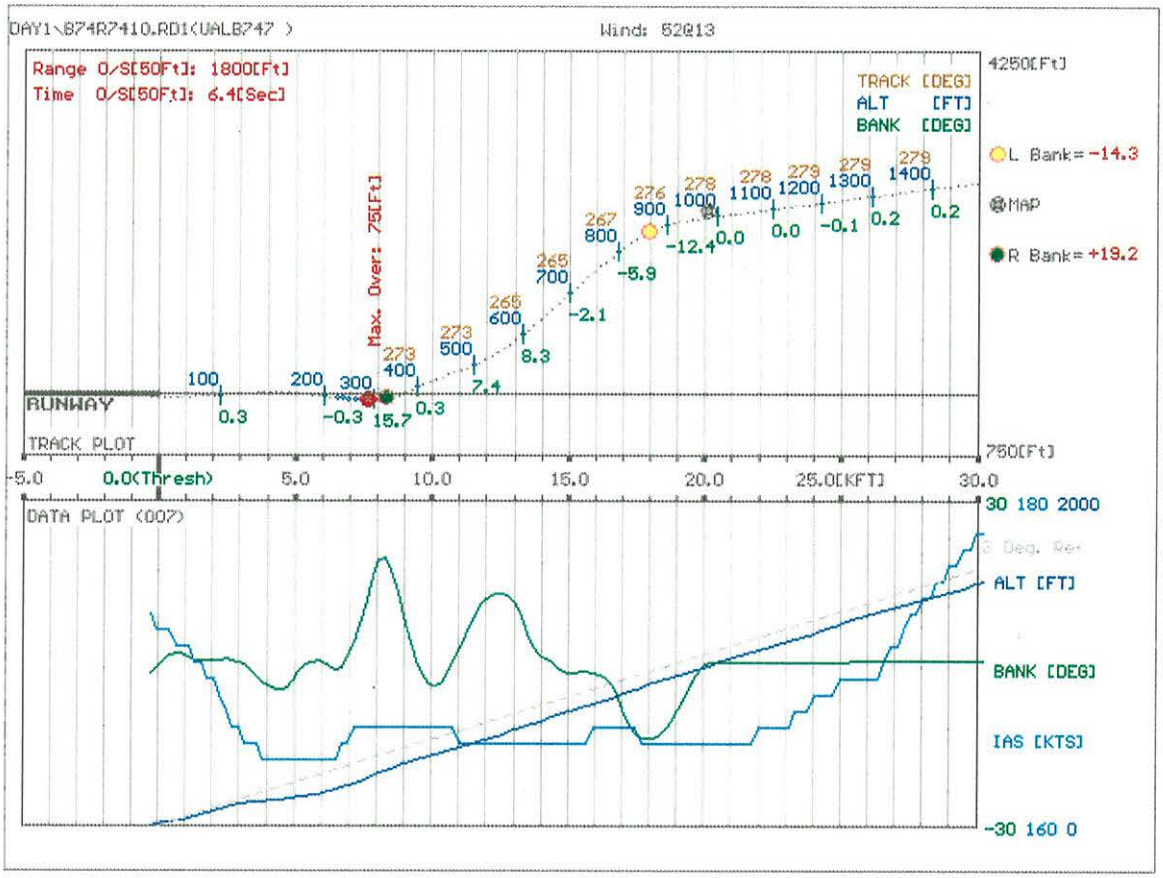

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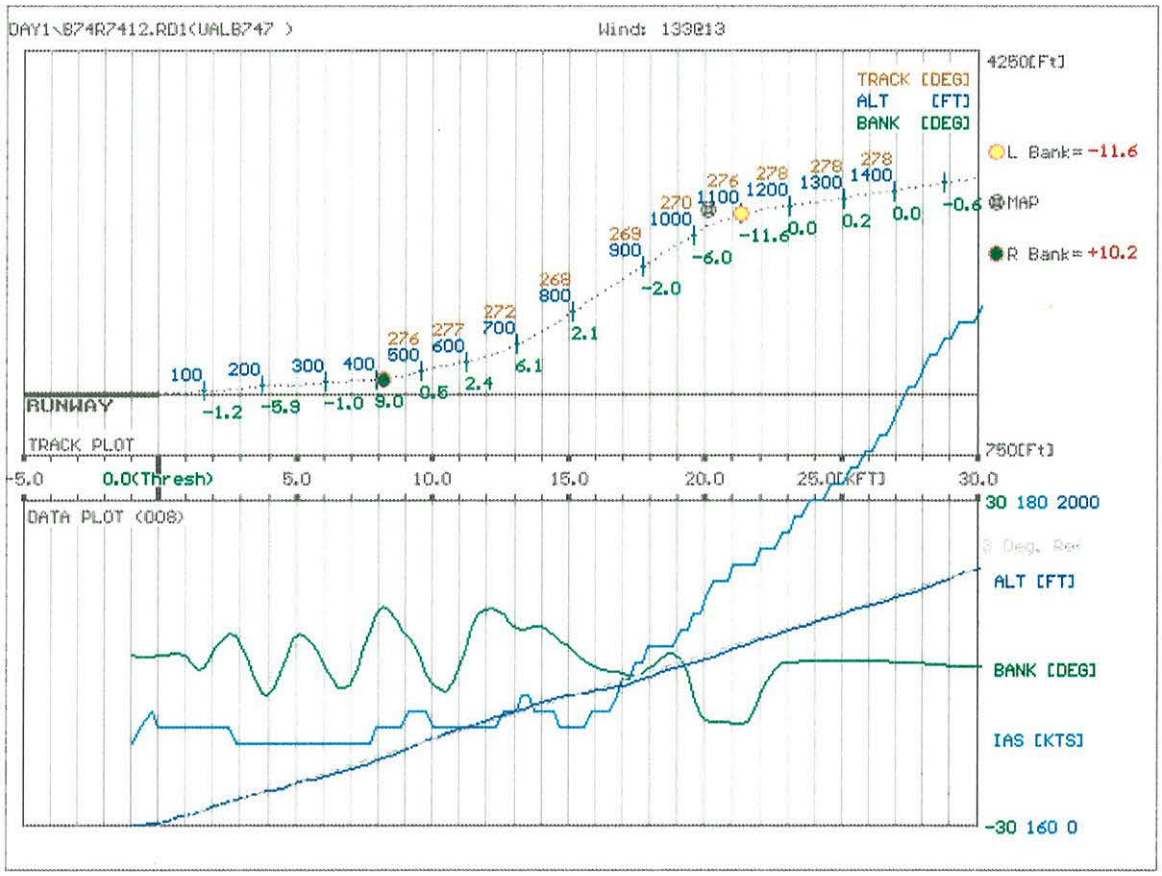

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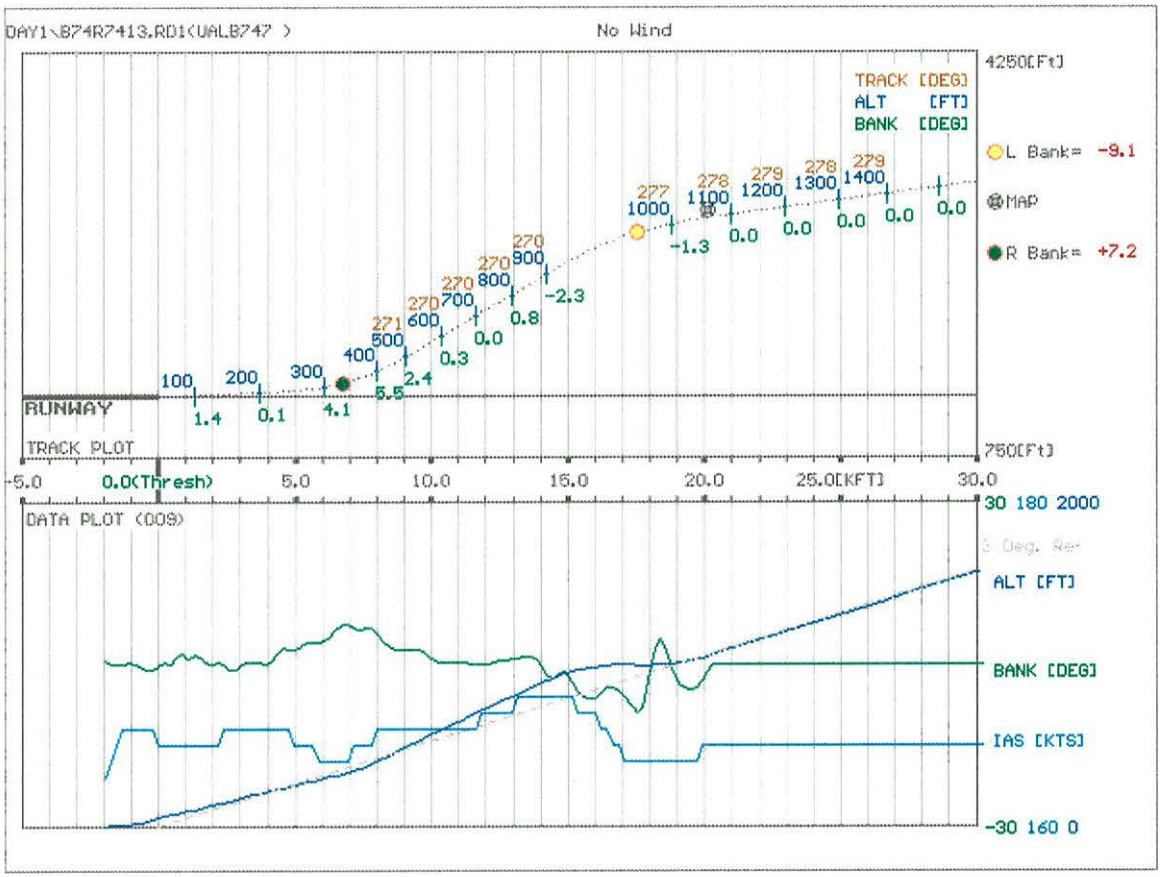

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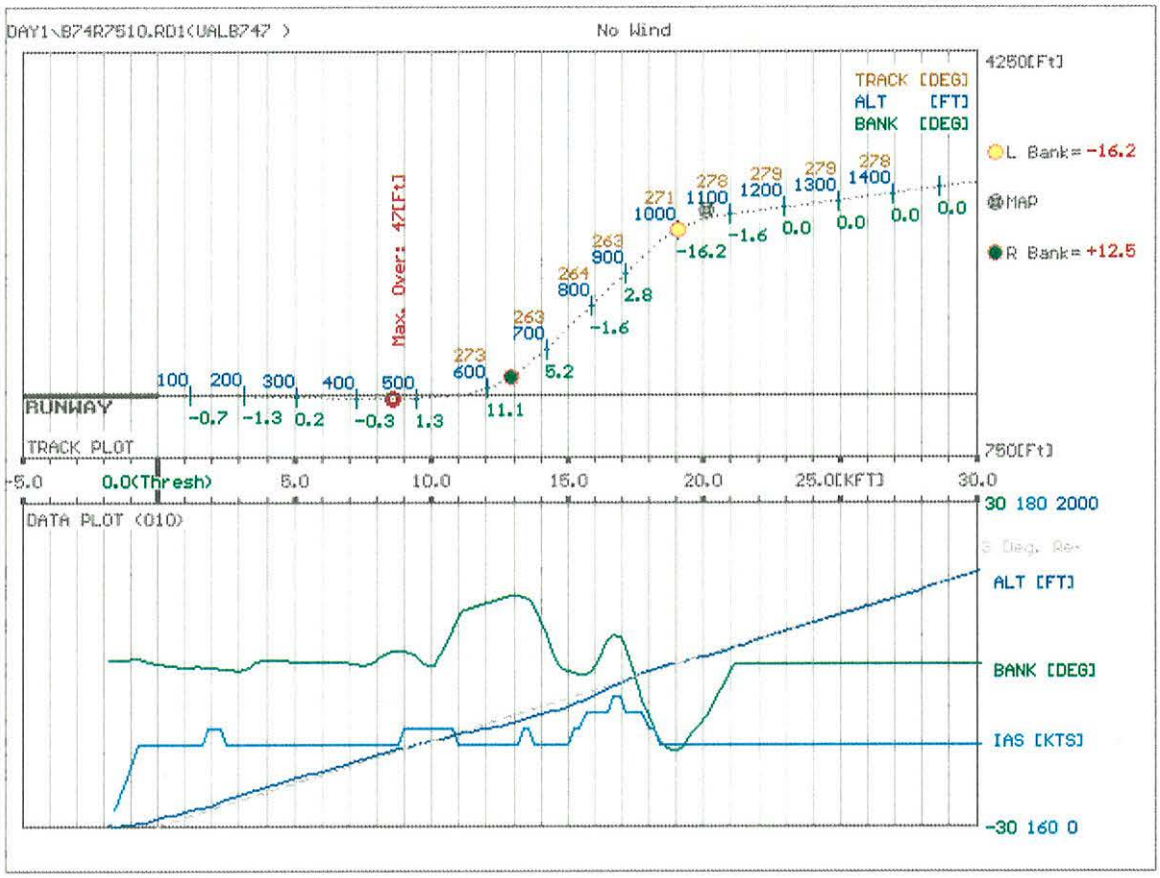

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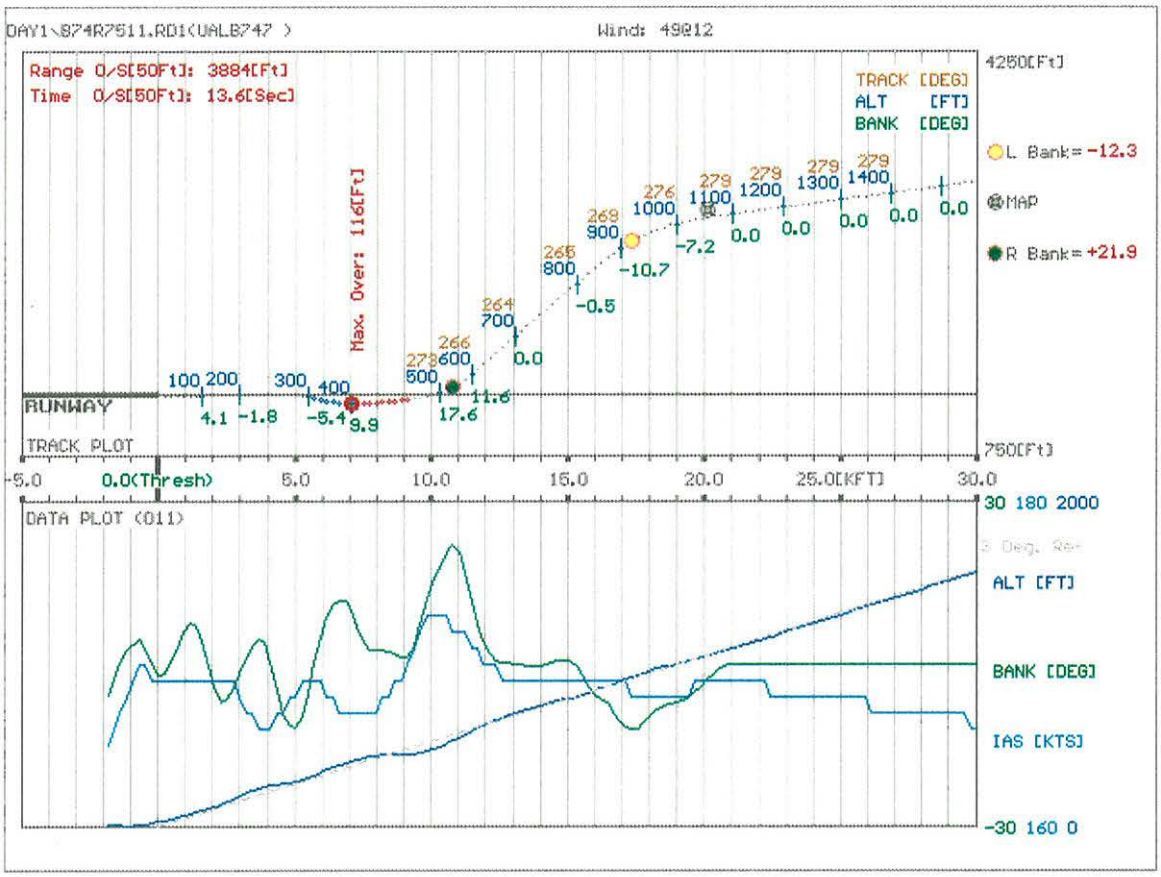

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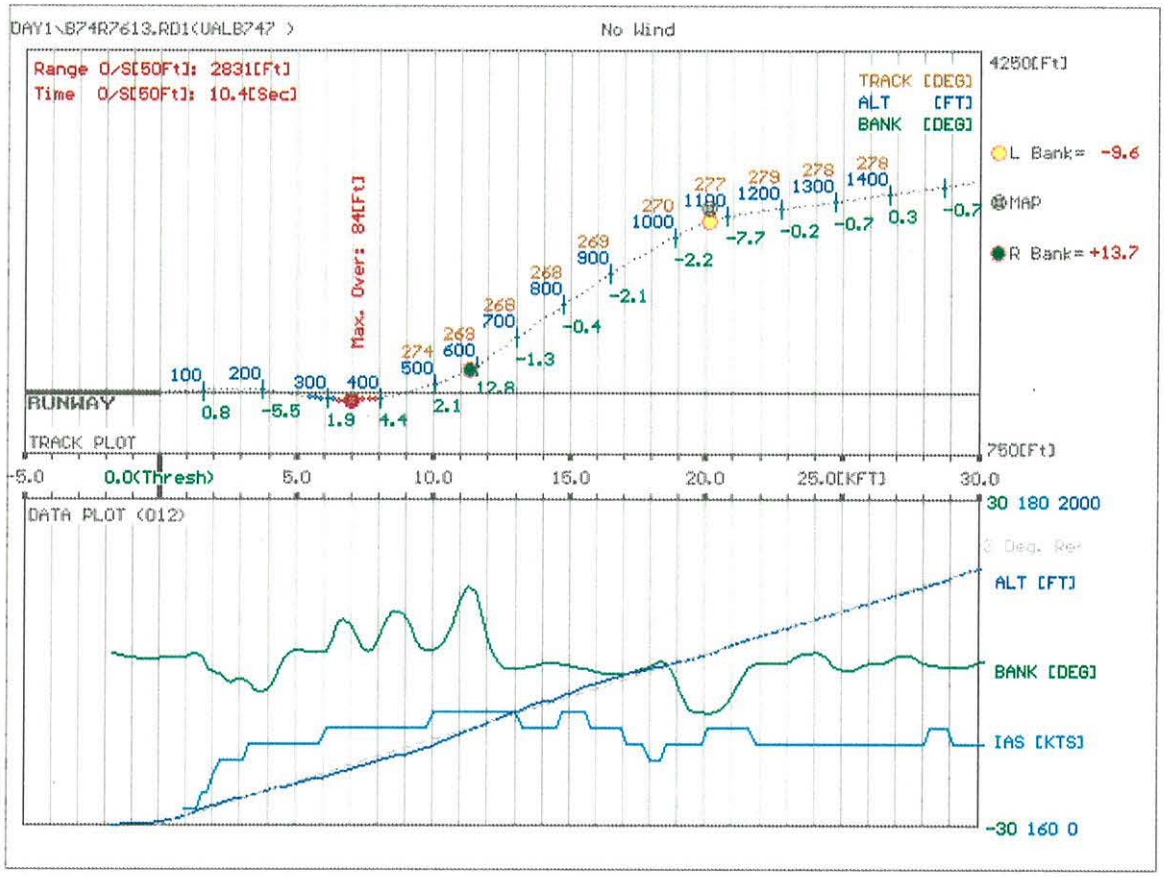

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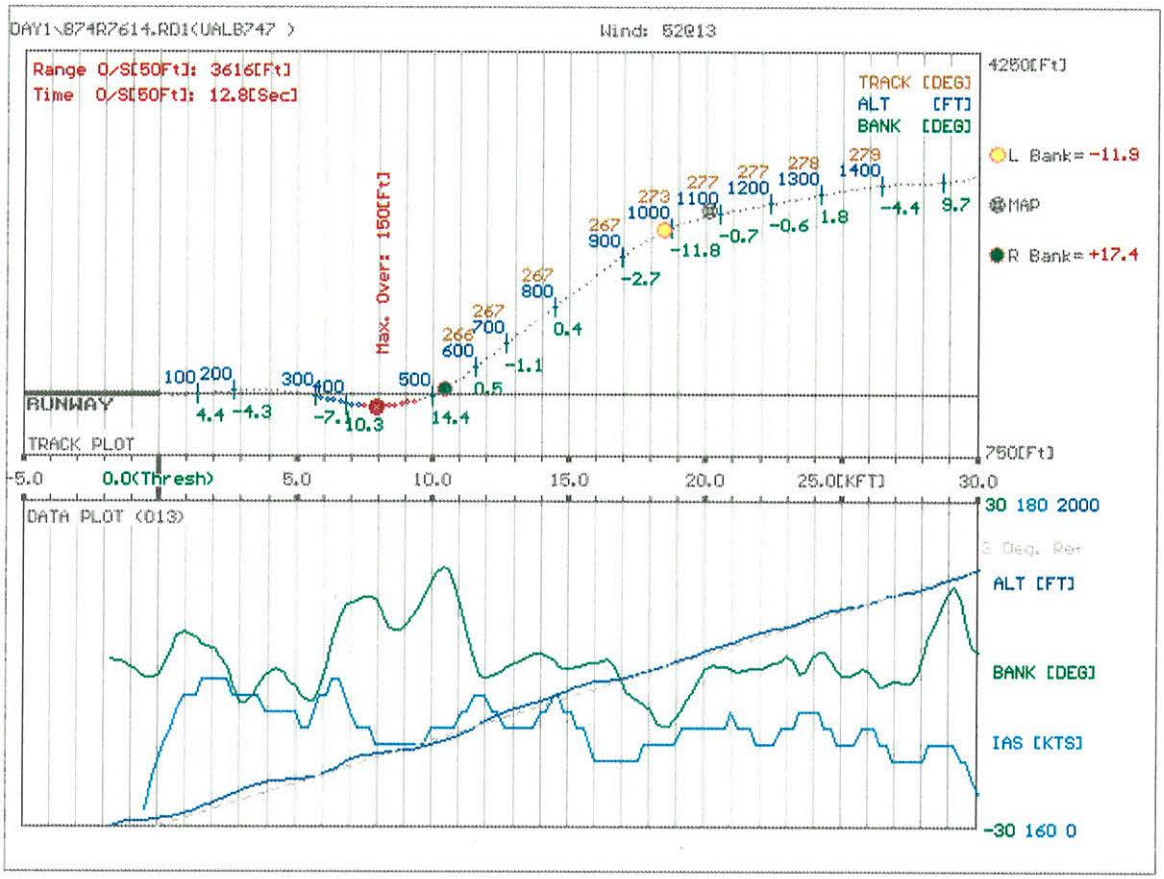

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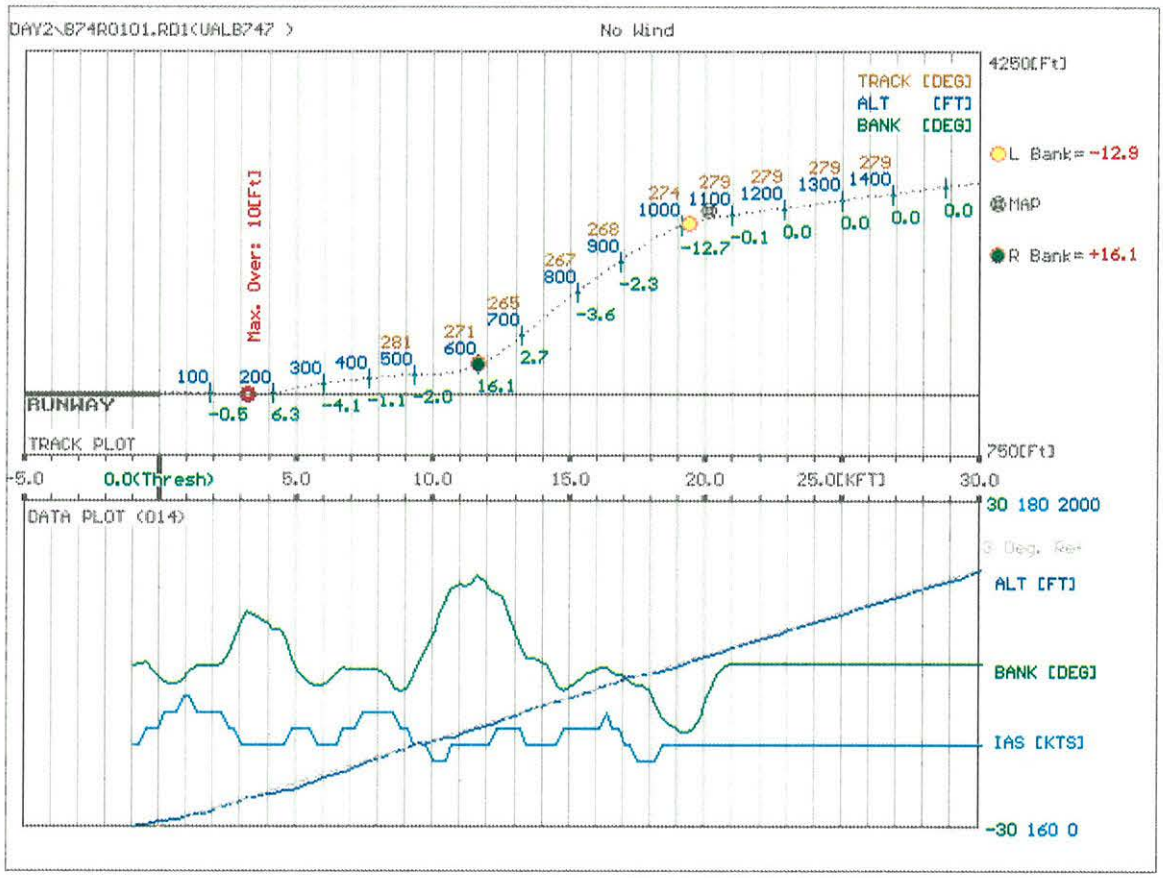

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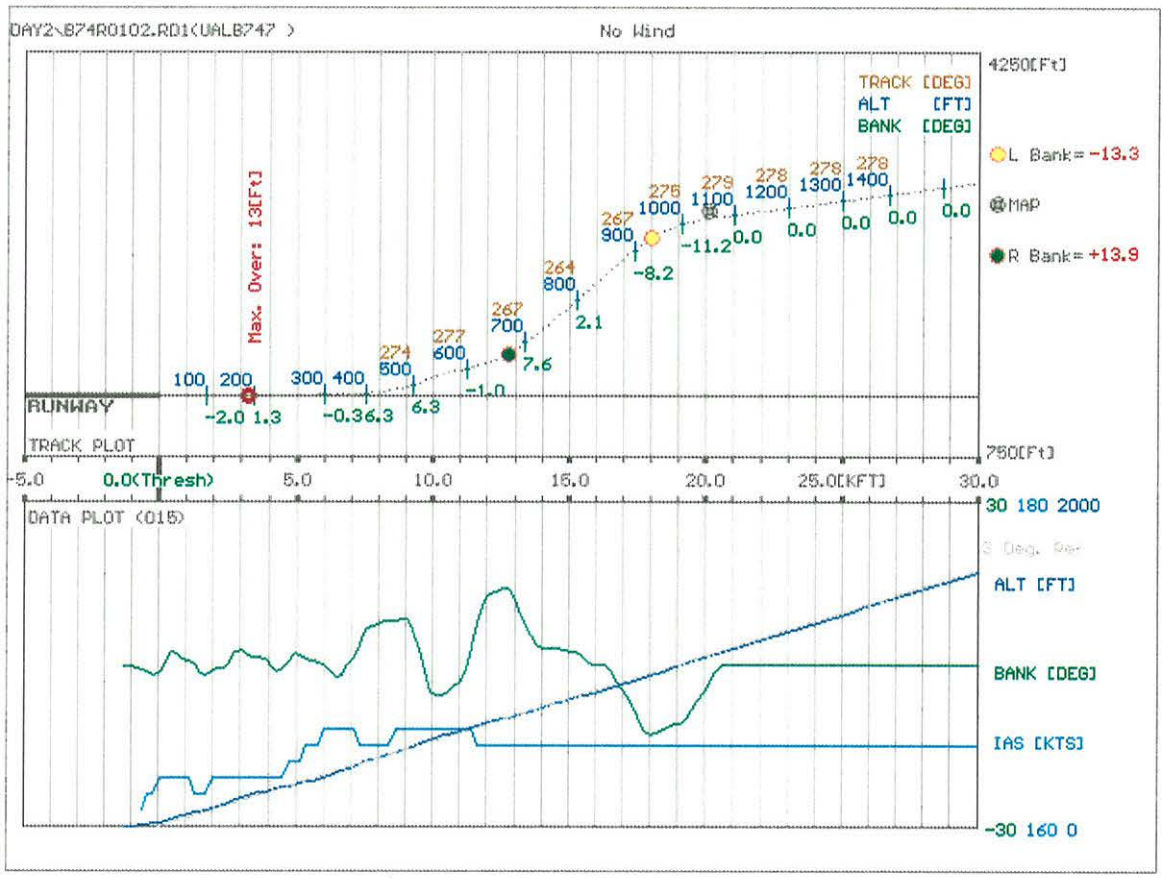

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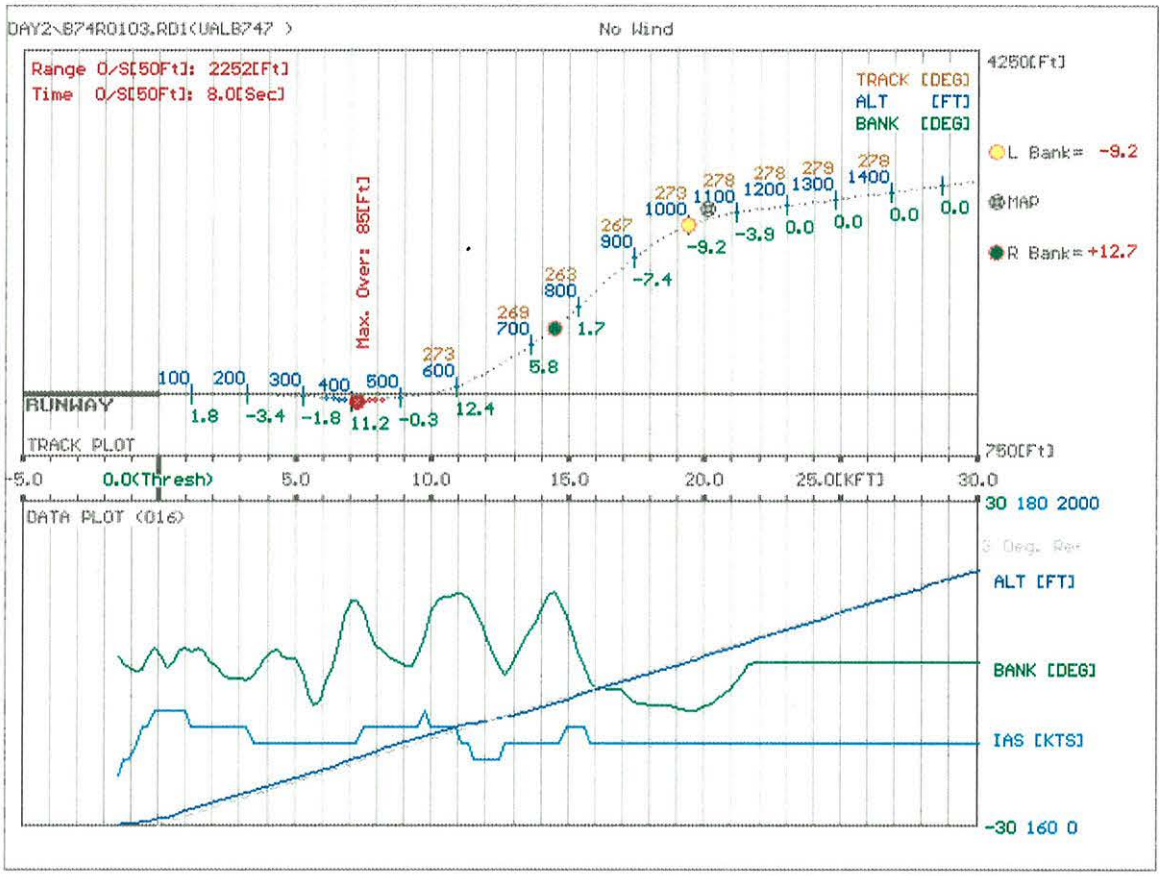

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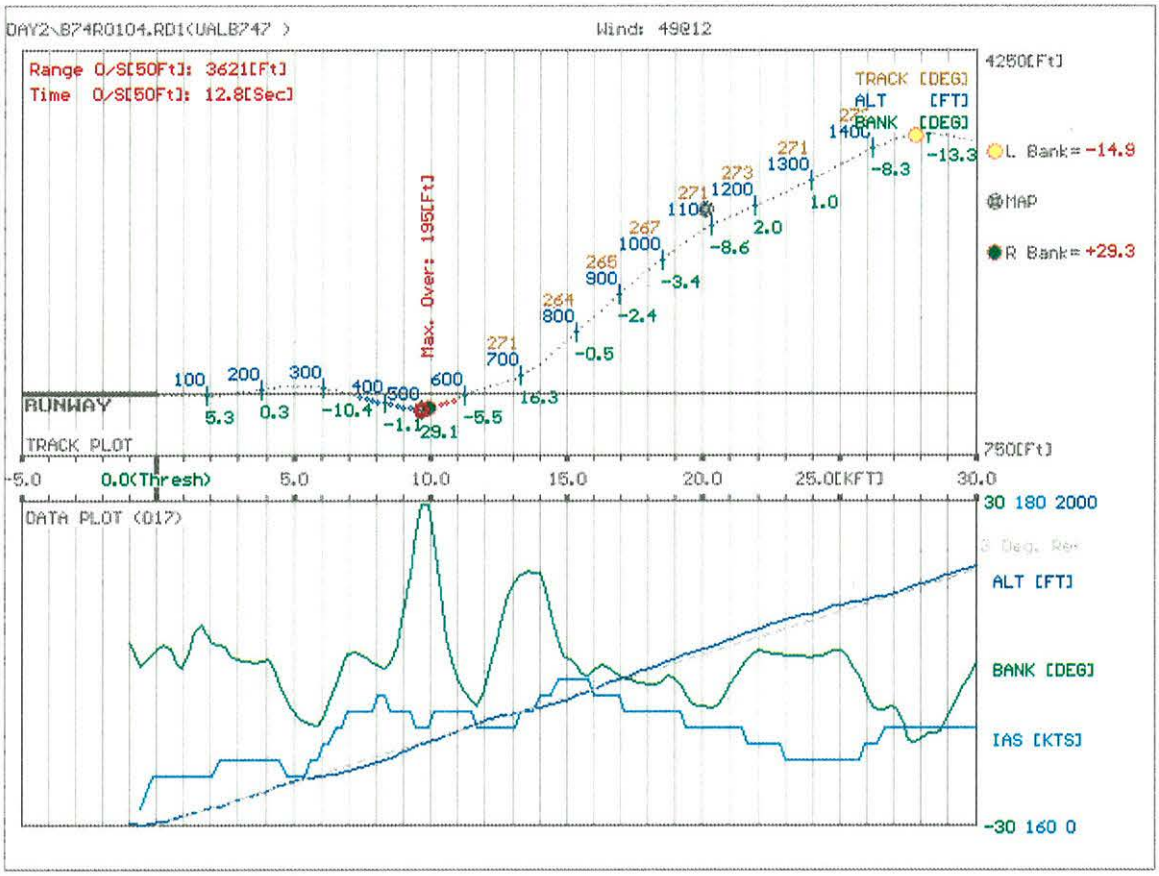

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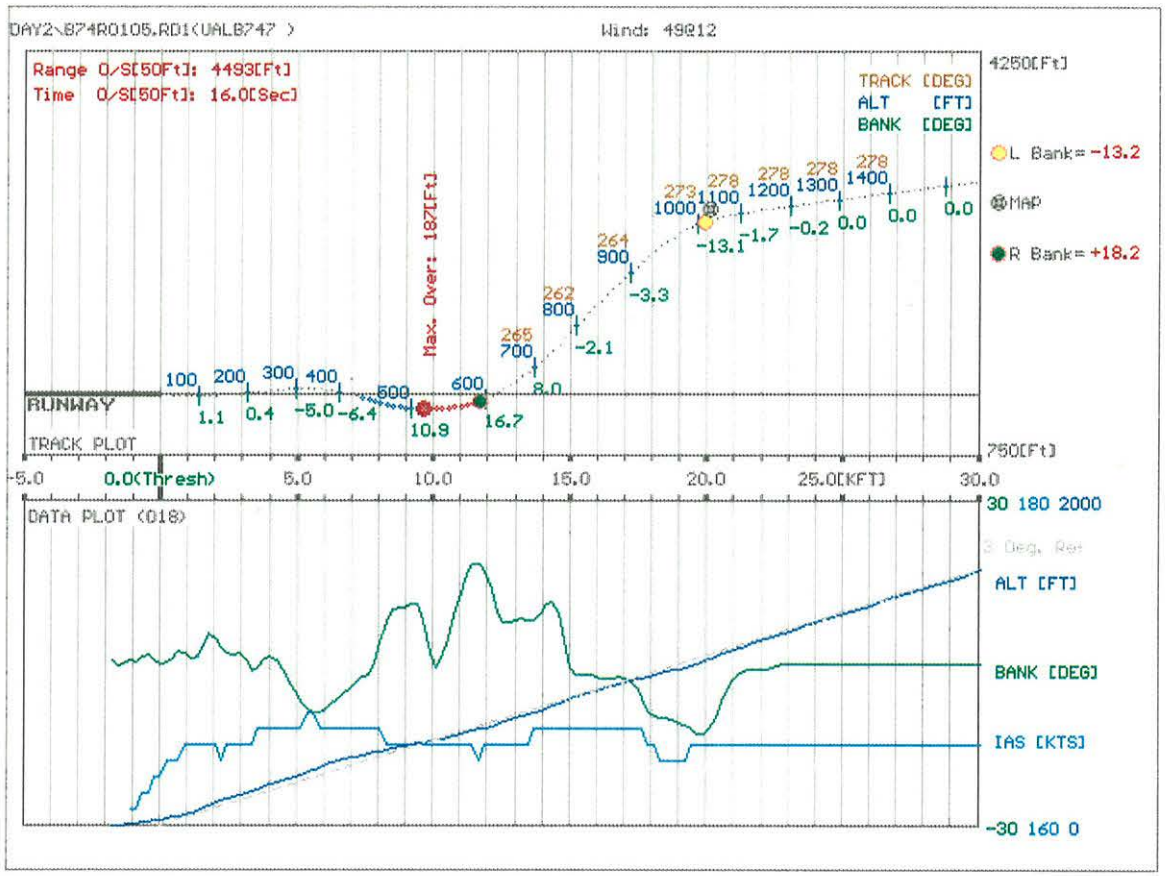

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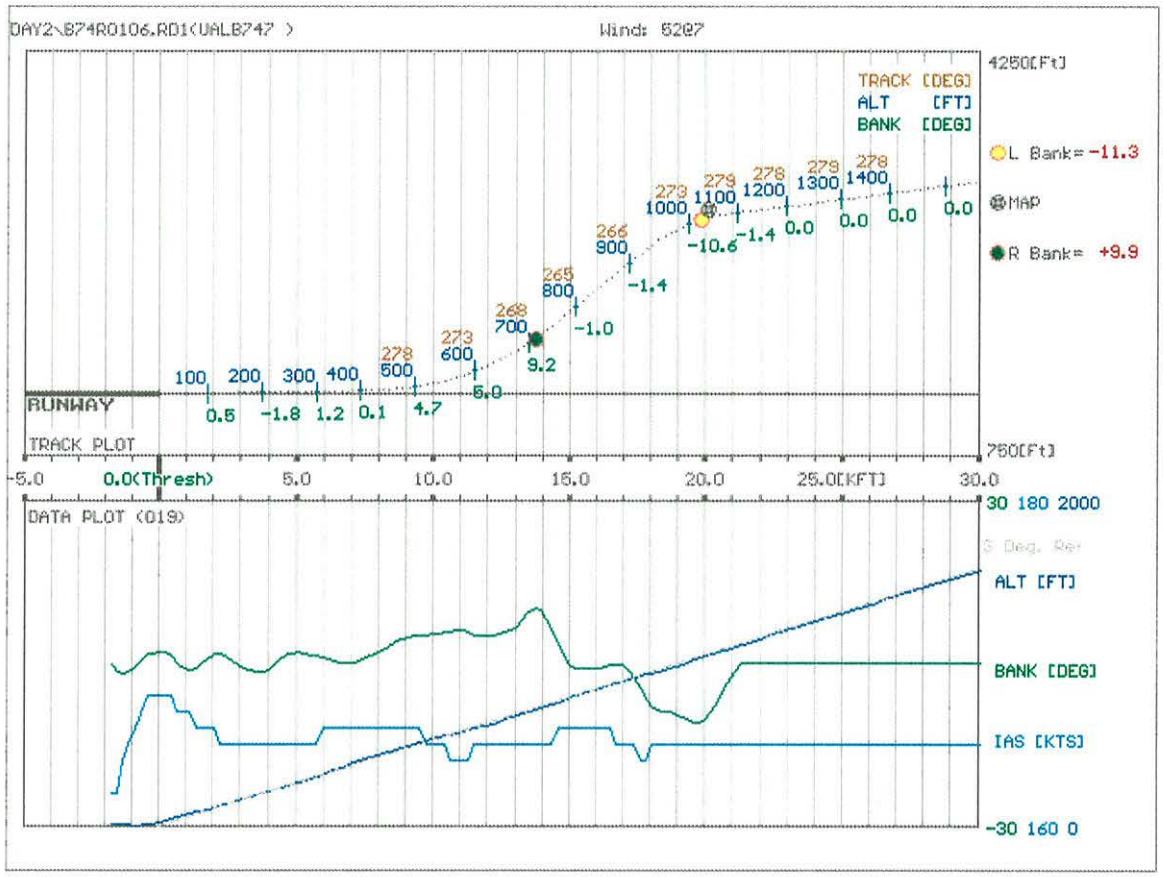

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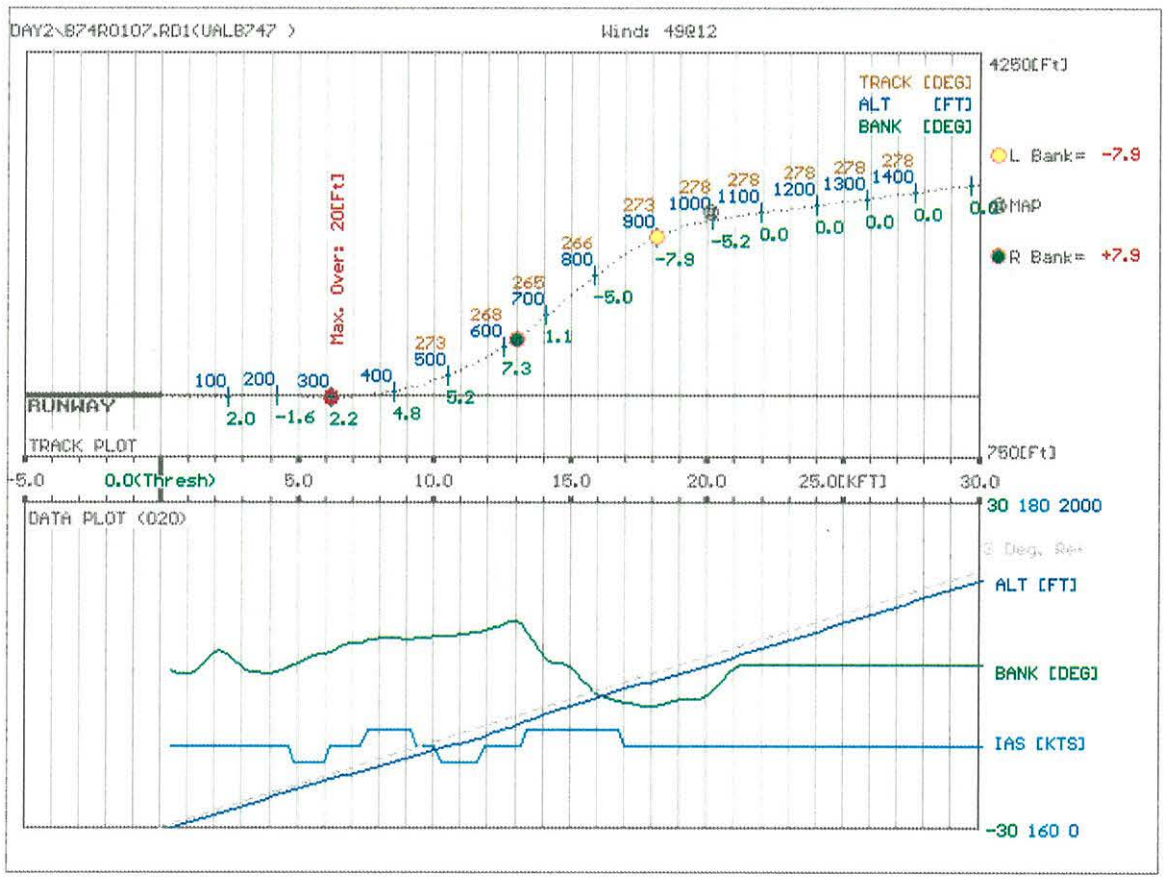

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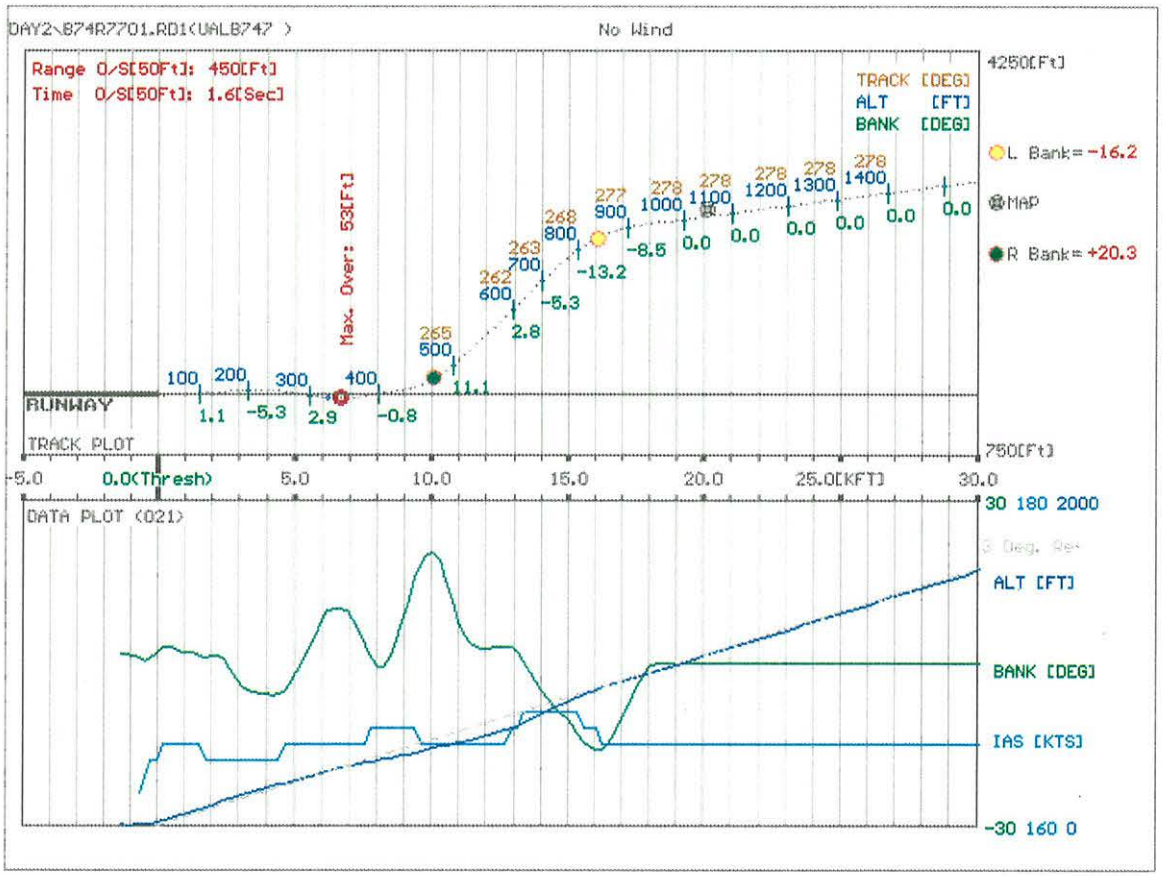

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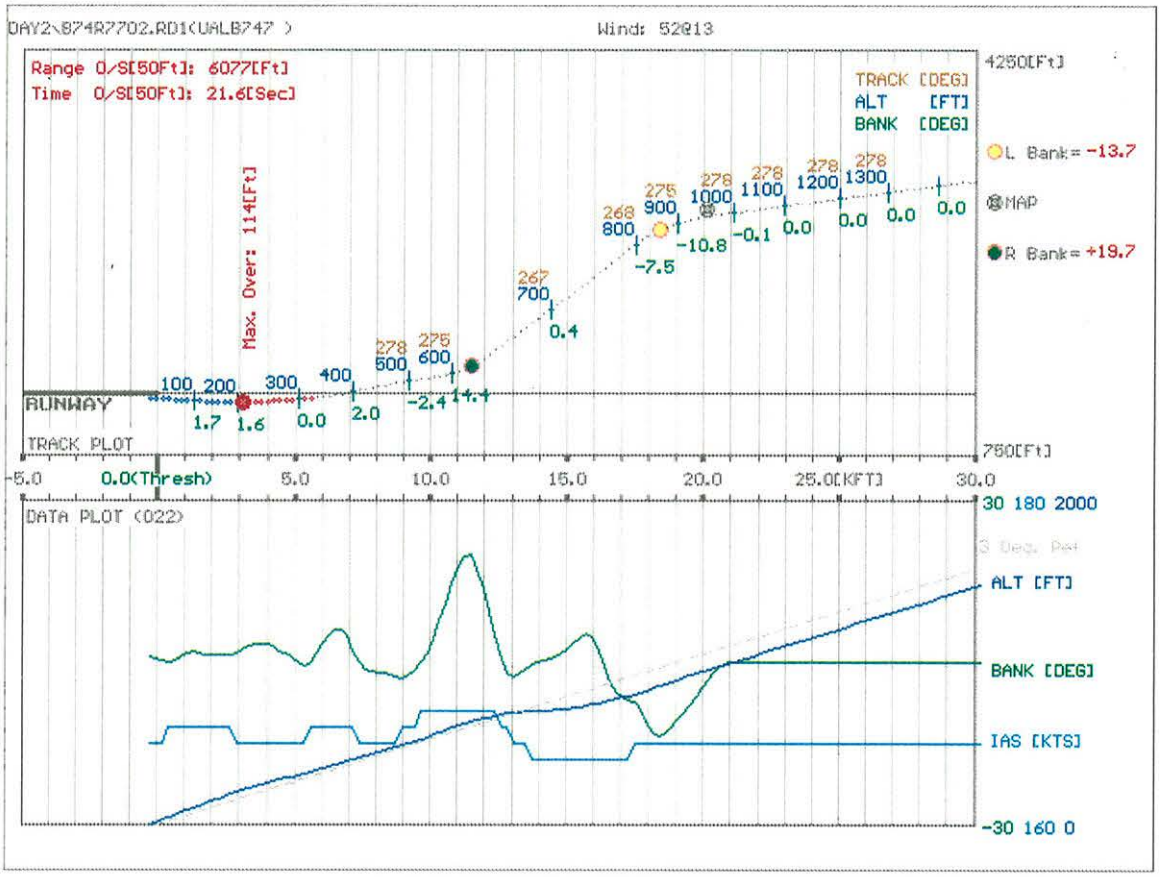

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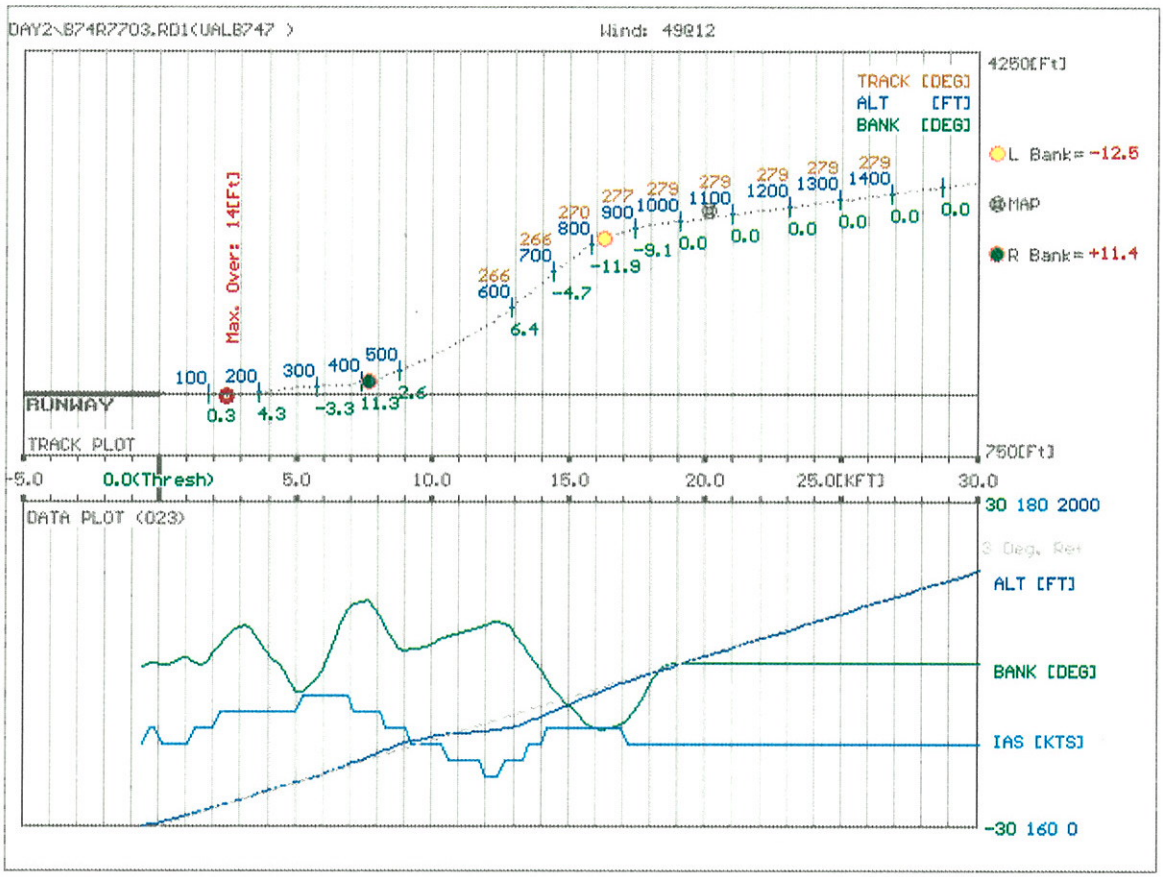

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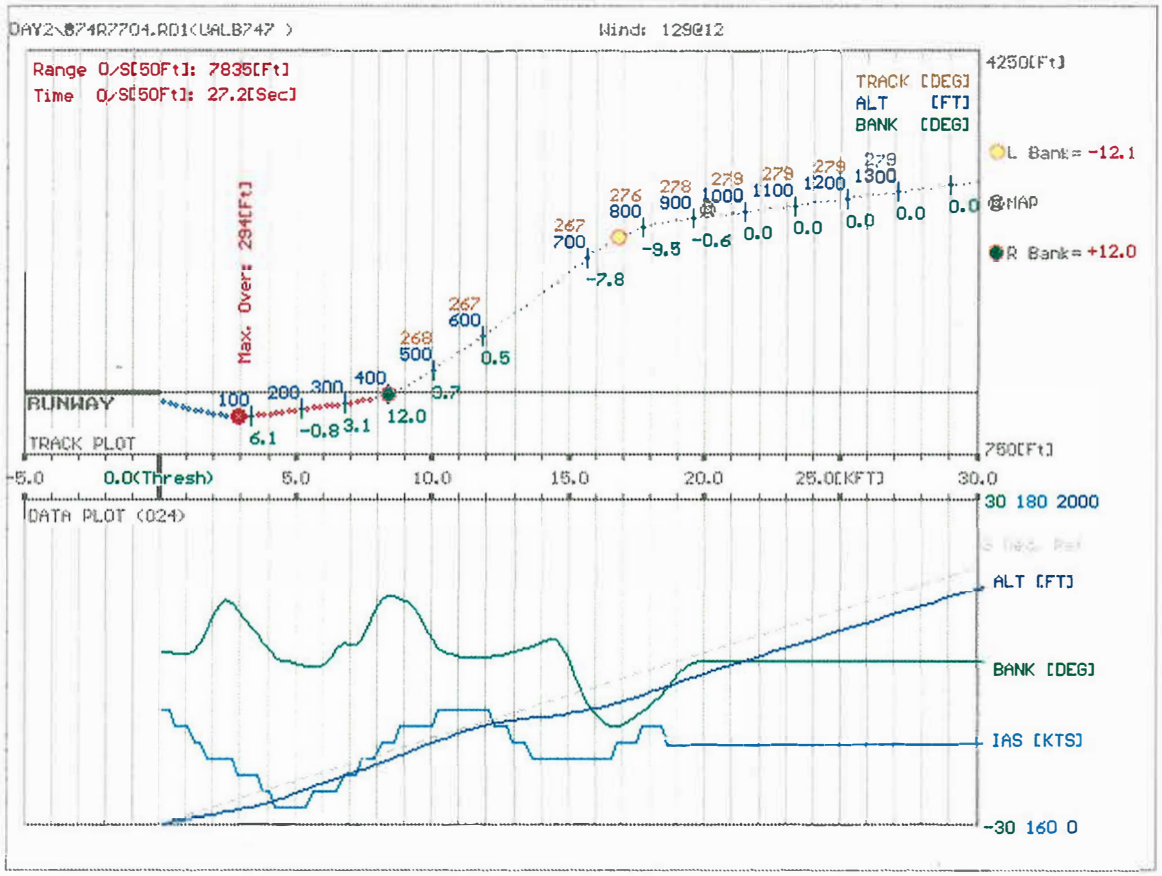

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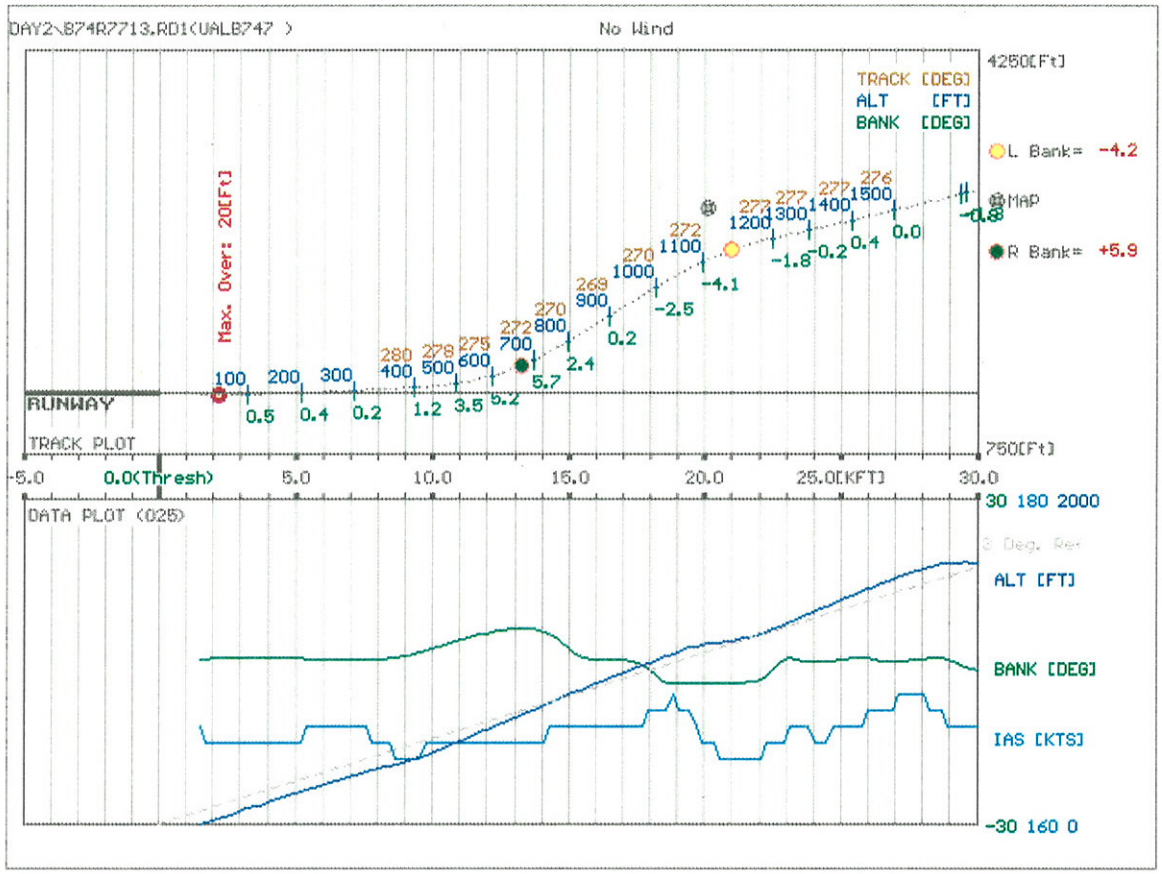

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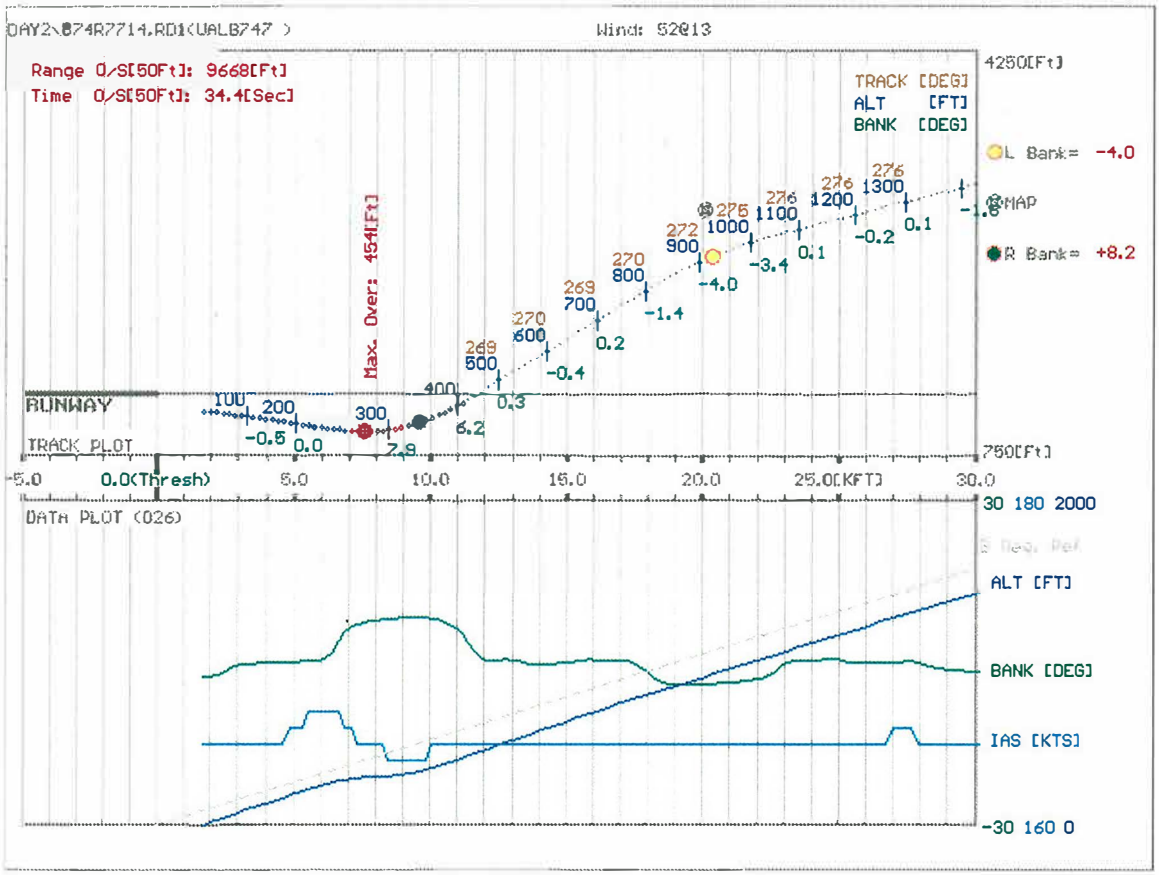

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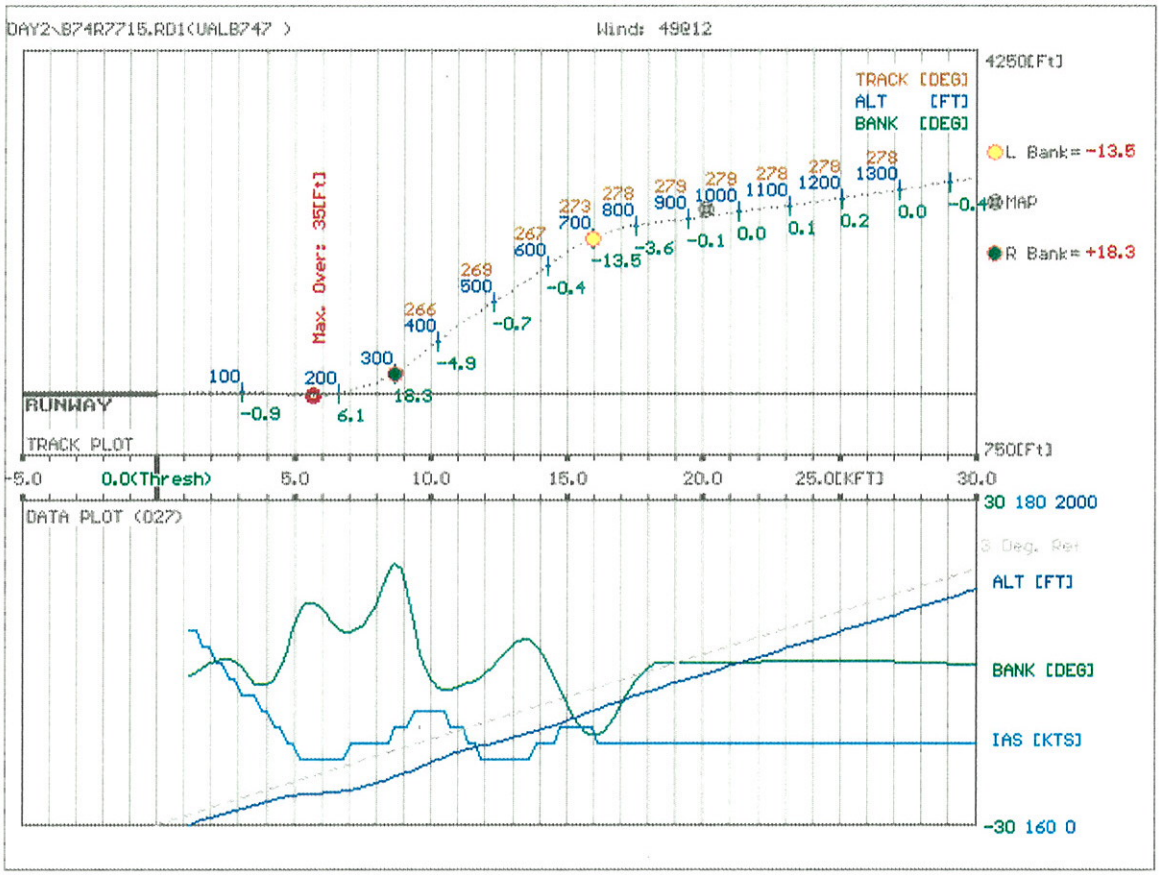

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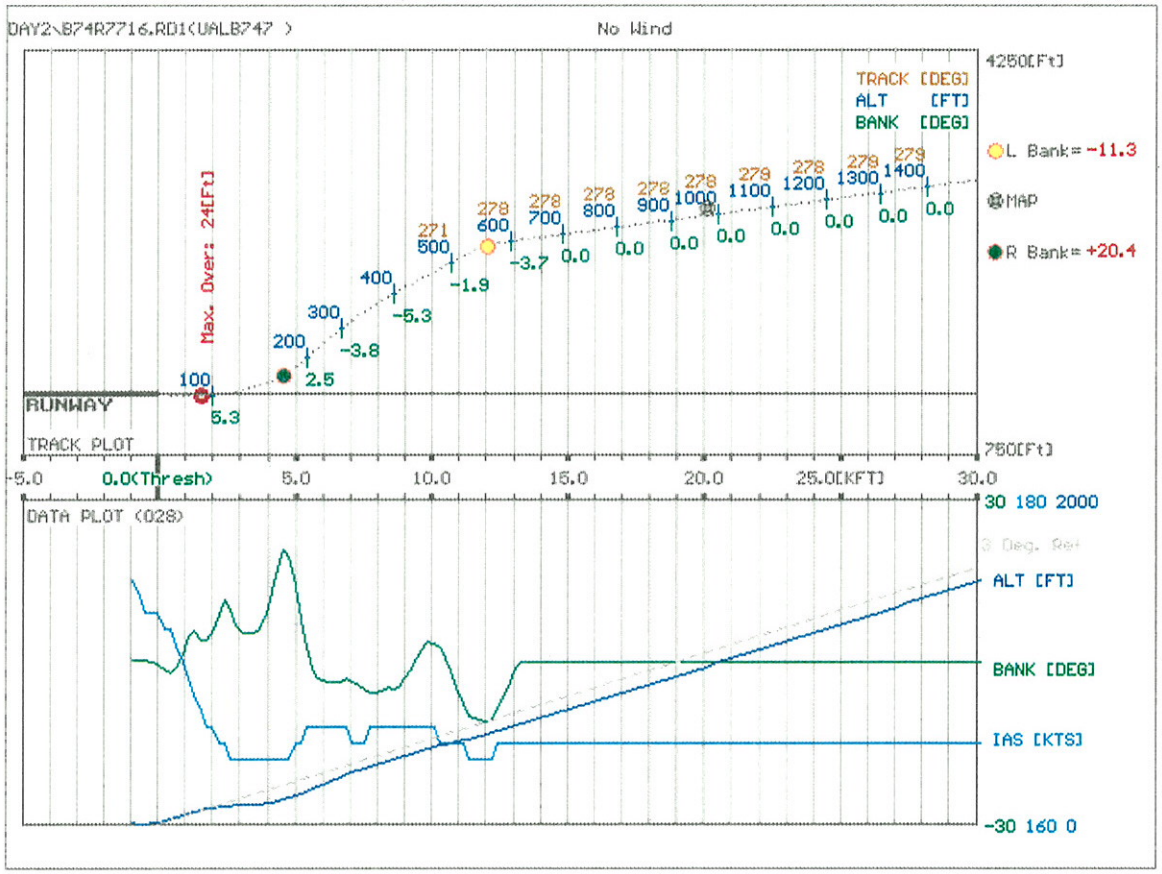

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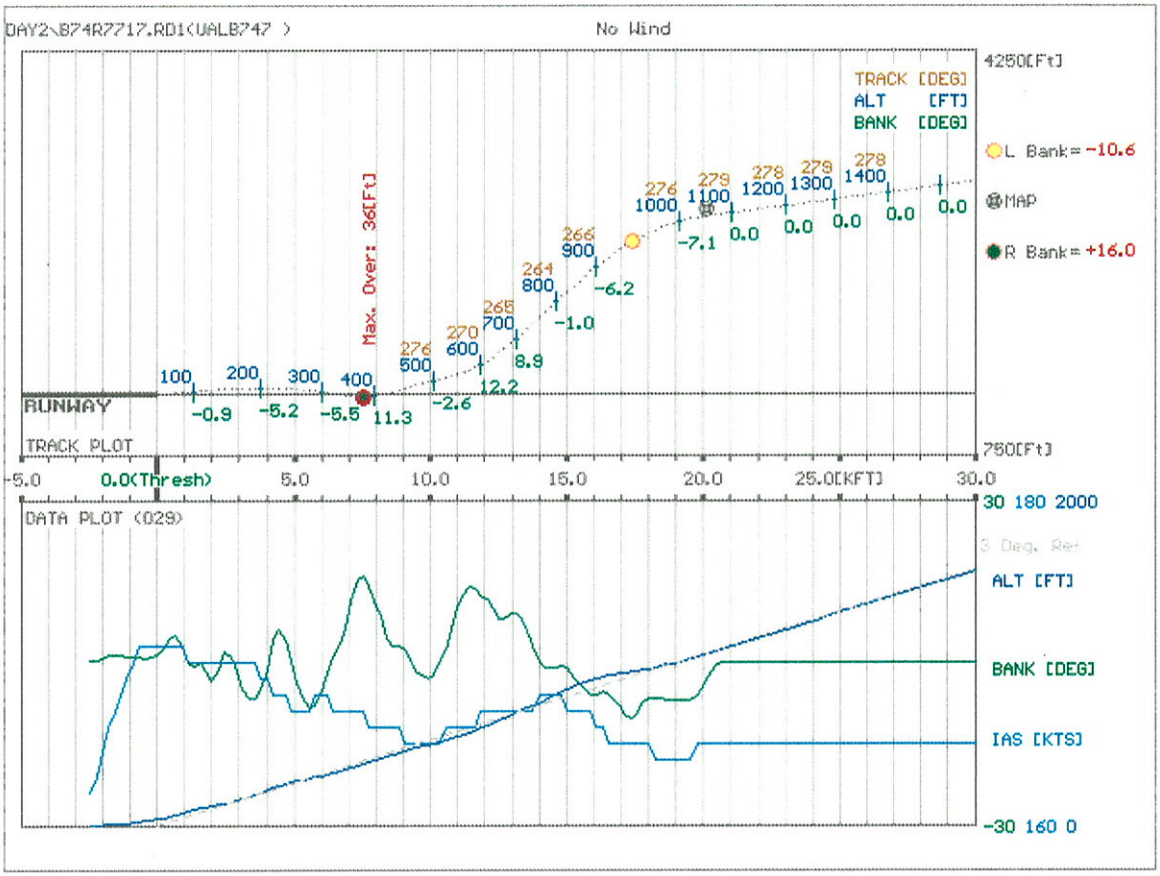

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APPENDIX II

AIR LINE PILOTS ASSOCIATION
535 HERNDON PARKWAY □ P.O. BOX 1169 □ HERNDON, VIRGINIA 20172 □ 703-689-2270
FAX 703-689-4370

February 2, 1998

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL

To Dave Lankford	From Spyder
Dept./Agency AFS	Phone #
Fax # 405 954 2528	Fax #

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

Mr. Robert Wright
Technical Programs Division Manager
Flight Standards Service, AFS-400
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Washington, DC 20591

Mr. Lee McGlamery
Manager, Strategic Operations/Procedures
Air Traffic Operations, ATO-100
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, DC 20591

Dear Sirs:

Enclosed is a report of a Precision Runway Monitor (PRM) Simultaneous Offset Instrument Approach (SOIA) procedure for San Francisco International Airport. The demonstration was conducted to determine if the concept is feasible and whether further testing is warranted. The conclusion by the participants of the demonstration is that the PRM/SOIA concept should be pursued but that considerable testing is needed as stated in the report.

Also enclosed are the Demonstration Plan, approach chart, Attention All Users Page, a list of pilot and controller training items, a list of modifications needed for the Bay ILS Rwy 28L approach, an equipment required list, and the unfinished draft FAA Order 8260.XX, SOIA. The draft order is the last work completed by the FAA/Industry SOIA Work Group in 1995 when it was decided that a SOIA approach would not be compatible with the Bay TRACON Airspace.

We posed some difficult questions in the report that must be answered before the SOIA concept can be pursued. We would like to hear the FAA's answers to these questions. Once these issues have been resolved, we stand ready to assist you, if you so desire, in finalizing criteria for PRM/SOIA type approaches.

Please feel free to contact me if you have questions.

We appreciate your prompt attention to this subject.

Sincerely,

Ross Sagun/dy

Captain Ross Sagun, Chairman
Air Traffic Control Committee

RS:dy

Attachments

List of Enclosures

1. SFO PRM/SOIA Demonstration
2. Demonstration Plan (SOIA)
3. PRM LDA DME Rwy 28R Approach Chart
4. Attention all users page
5. Training Information used in the Simulator
6. Operational Issues and/or Training Requirements
7. Modifications to the Bay ILS Rwy 28L Approach
8. ATC Equipment Required at SFO for SOIA Approach
9. Draft Order 8260.XX, SOIA

SFO PRM/SOIA Demonstration
United Airlines Flight Center
January 30, 1998

Background

Airports with parallel runway centerlines separated by less than 2500 ft must be treated as a single runway when weather conditions deteriorate to values below which simultaneous visual approaches can be conducted. Capacity is reduced during these periods. There are significant delay savings to be gained by developing techniques that would permit the use of both parallel runways when the weather is below parallel visual weather conditions.

A concept for achieving this is Simultaneous Offset Instrument Approaches (SOIA). ALPA safety representatives were asked by Flight Technology Incorporated (FTI) to participate in the simulation of SOIA/Precision Runway Monitor (PRM) approaches because of ALPA's experience with the SFO LDA 28R approach project. Captains Ross Sagun and Jim Arthur, representing ALPA, attended and assisted in the simulation. Captain Dick Deeds developed computer models and other data that are the basis for the approach design and analysis. Mr. Joe Lintzenich and Captain Bud Bensel were the FTI representatives and United Airlines (UAL) provided technical support and simulators for the evaluation.

Concept

A partially complete Draft SOIA Order developed by the FAA and industry is attached. Work on the draft was stopped in 1995 because the FAA said the approach would not fit into the San Francisco TRACON Airspace. The addition of a PRM system permits the missed approach points to be closer to each other and the airport and offers operational advantages. The Draft SOIA Order will require a thorough review to reflect the use of a PRM system.

- The SOIA/PRM operation requires an electronic glideslope with a 3 degree descent angle which aids in approach stabilization.
- Accurate localizer tracking is required; therefore, it is recommended that the autopilot should be utilized up to the Missed Approach Point (MAP) for aircraft flying the LDA.
- Precise monitoring of the approach would be provided by the high update Precision Runway Monitor (PRM) with aircraft prediction and controller alert algorithms. Closely spaced parallel approach criteria would applied.

- From an approach development viewpoint, the SOIA geometry requires the establishment of a Stabilized Approach Point (SAP) on the extended centerline of the landing runway at an altitude of 500 ft above the Runway Point of Intercept (RPI). The SOIA procedure design is intended to help the pilot establish the aircraft on the extended runway centerline at an altitude of 500 ft AGL.

- Aircraft approaching the parallel runways would navigate the ILS and Offset LDA/PRM courses outside of the MAP in the same manner as they conduct standard closely spaced parallel approaches.

- For runways spaced less than 1200 feet apart, no side-by-side operations or passing of the lead aircraft would be permitted.

- The in-trail aircraft would be obligated to execute a missed approach at the MAP unless, prior to reaching the MAP, the aircraft has the runway and (if applicable) the lead aircraft in sight and has accepted a clearance to maintain visual separation with that aircraft.

- All wake turbulence separation rules would be respected, including those dictating wake vortex separation for runway centerlines spaced less than 2500 feet apart.

- Aircraft entering the NTZ would be handled in accordance with 7110.65.

Objective

The objective of the demonstration was to determine the initial feasibility of the SOIA/PRM and to collect data to verify the SOIA computer overshoot (blunder) model. Further testing that includes, but is not limited to, simultaneous aircraft generation, ground proximity, communications and human factors is a mandatory requirement of the development process.

The Demonstration

The demonstration was conducted on October 23 and 24, 1997 at the United Airlines Training Center in Denver, Colorado using a B-747/400 simulator. The B-747/400 was chosen because it represented the largest aircraft contemplated to utilize the approach. The B-747/400 was operated at maximum landing weight with an approach speed of 165 knots, the upper limit of Category D. The combination of maximum speed for category D aircraft, largest possible aircraft, lowest proposed ceiling and visibility minimums, highest landing weight, icing conditions, maximum certified tailwinds generated by quartering tailwind, and delay of 20 seconds after descending below the overcast until acquiring the preceding aircraft were collectively considered.

An approach with geometry based on the draft SOIA criteria for category D aircraft was installed in the B-747/400 simulator for the San Francisco International Airport (SFO). SFO, at 750 ft runway centerline spacing, was chosen for a number of reasons: the airport has the minimum runway spacing applicable for the approach (750 ft), there was an LDA installed at SFO at one time, the airspace

around the airport is constrained due to terrain and traffic requirements of other airports, and there is a great need to reduce delays.

Approach Geometry

The same glideslope location for the 28R ILS was utilized for the 28R PRM/LDA. At the MAP (DICKI Int.), the LDA course was 3000 ft perpendicularly offset from the 28L ILS localizer. The LDA course was oriented 278 degrees inbound which provided a 3 degree offset with the runway 28L ILS localizer. A DME was located so that the DME reading at the MAP was 3.8 NM. The glide slope altitude at the DH was 1126' MSL. The Initial Fix was placed at a position that permitted a 21 NM leg from the initial fix to the MAP. This Initial Fix location permitted crossing the CEDES intersection at 11000 feet and 250 knots. NOT DH BUT MDA - NON PRECISION - LDA WITH G/S

Weather Minimums

Visibility: 4 statute miles.
Ceiling: 1600 ft
Surface OAT was set at 29 degrees F.

Surface wind speed was set at three different values; calm, right or left quartering tailwind of 14 Knots (a 10 knot tailwind component).

Day and night conditions were simulated.

Flight Crew

Flight crews included 8 pilots from United Airlines qualified in the B-747/400.

The flight crews were provided with a special approach chart (see attachment) developed for the demonstration. In addition, pilot briefing pages were provided which explained the various aspects of the approach, including procedures for closely spaced parallel approaches. Formalized training is expected for this type approach should the SOIA/PRM concept become operational.

Overshoot Data Collection

Aircraft were positioned at the LDA/PRM MAP, level at 1200 ft AGL in a landing configuration on a pre-determined heading. When the run began, the aircraft navigated on the specified intercept headings of 10, 15, 20, 25, and 30 degrees. The aircraft remained on the heading until crossing the runway 28R centerline as determined by zero localizer deviation. When the aircraft reached the centerline, a maximum roll rate turn to a 25 degree bank angle was initiated to return the aircraft to the runway 28R centerline.

A subsequent B-747/400 data collection was performed by United Airlines on December 5, 1997 to obtain additional overshoot data. In this collection, the beginning of the turn was based on control wheel movement, reasoned to be more accurate than the earlier visual crossing of the extended runway centerline. Ten runs were accomplished for each heading with a 13 knot quartering tailwind (10 knot crosswind). Ten runs were also done in no-wind conditions for the 30 degree case and overshoots were then calculated for the other intercept headings. More data needs to be collected in zero wind conditions. This data has not yet been analyzed using the same algorithms that were used in analyzing the original data. This analysis needs to be completed and will serve to enhance modeling data.

Demonstration Results

The demonstration showed that the approach presents a moderate to high workload for the pilot. Most of the pilots found the workload to be acceptable, except with regard to communications, which will be discussed later. The visual realignment and adjacent aircraft identification and acquisition, along with the requirement to stay north of the runway 28L approach course, presented the most difficulty.

NOTE: A simulated aircraft approaching runway 28L was provided through the use of an internally generated light signal. Since the target represented only the existence of the target, but provided no value in assessing pilots skills or workload in maintaining a safe separation distance or stagger, more research in this area must be accomplished before this approach concept could be deemed acceptable.

There appeared to be adequate time for the aircraft to cross CEDES intersection at 250 knots and descend to a point (approximately 20 NM) final where normal LDA interception below the glideslope was accomplished.

The demonstration revealed that a frequency change after the aircraft makes visual contact with the preceding aircraft increases the crew workload to an unacceptable level. In the simulation, the frequency changeover point was moved so that it occurred earlier in the approach and subsequent runs substantiated the value of this change.

The data was electronically collected for analysis. As a result of that analysis, it was determined that statistically significant overshoot of the runway 28R centerline was experienced, in the range of 15-20%. It was interesting to note that the most significant blunders occurred with a south wind. This is the third simulation to demonstrate this anomaly. MORE HEADING CHANGE TO PATTERN DUE TO MORE CRAB TO SOUTH.

For runways with less than 1200 ft centerline spacing, it is recommend that a stagger between the preceding and trailing aircraft be established to preclude the succeeding aircraft from penetrating the minimum protected area of 500 ft around the lead aircraft. To facilitate establishing this stagger, CRDA could be utilized. Both the PRM and the ARTS radar already have this capability. PRM also has the capability to provide predictive target separation information to ensure no passing or side-by-side flight takes place while extracting the minimum approved separation distances

ALPA requested some additional data to further verify the blunder model and such data was be taken in the B-747/400.

Issues to be resolved

There are several significant issues that must be resolved if the SOIA/PRM concept is to continue to be developed. They include:

1. How will controllers ensure that no passing or side-by-side operation will occur, and will the no-passing and no side-by-side rules be mandated?

2. Can ATC accommodate an approach in Bay TRACON airspace which requires that pilots intercept at or below the glideslope at a distance which will allow for a stabilized approach? This was a significant problem with the original SFO LDA approach and it eventually resulted in the cancellation of the LDA approach.

3. Can ATC change its procedures to allow for inbound aircraft to be switched to tower frequency well outside of the MAP and prior to being given a clearance to maintain visual separation? Current procedures present an unacceptably high workload for pilots.

4. Can the blunder model be verified to be correct? This must be accomplished so that maximum intercept angles can be determined.

5. How will the operation of TCAS be affected by this approach. The procedure used at MSP whereby TCAS is placed into the TA-only mode would be unacceptable. This, and future, PRM approaches must be TCAS compliant.

6. Many significant safety issues have surfaced with the MSP PRM procedure. They include frequency congestion, coasting targets, frequent intrusions into the NTZ well in excess of the rate predicted by the risk analysis, data collection, and lack of an immunity program for participants. These would have to be solved prior to development of enhanced PRM approaches such as the SOIA/PRM approach.

Future Work

Future work depends on these and other questions being addressed. The FAA in coordination with interested industry parties, including NATCA, should be asked to address these issues. Their specific recommendations should be considered for incorporation into the procedure. More initial simulator testing might be required to verify proof of concept. Additional simulations are required to collect blunder data in zero wind conditions. Finally, the FAA should develop the specifications for a real time simulation of the concept.

Attachment #2

Demonstration Plan

Simultaneous Offset Instrument Approaches

(SOIA)

Conducted at the
United Air Lines Training Center
Denver, Colorado
October 23/24, 1997

Demonstration Plan

Simultaneous Offset Instrument Approach

September 3, 1997

Background

Airports with parallel runway with centerlines separated by less than 2500 ft must be treated as a single runway when weather conditions deteriorate to values below which simultaneous visual approaches can be conducted. Capacity is reduced during these periods. There are significant delay savings to be gained by developing techniques that would permit the use of both parallel runways below parallel visual weather conditions.

The procedures have undergone numerous changes in the developmental stage. In order to capture the greatest benefits from SOIA and to bring the present SOIA approaches at St. Louis (STL) and SFO into compliance with the proposed SOIA geometry (without negatively impacting the present authorized minimums), it has been determined that closely spaced parallel approach criteria should be applied. This requires that the Precision Runway Monitor (PRM), complete with controller alert algorithms to be utilized to reduce the distance between the final approach courses at the Missed Approach Point (MAP) in order to achieve the lowest landing minimums consistent with SOIA criteria.

From an approach development viewpoint, the SOIA geometry permits the establishment of a Stabilized Approach Point (SAP) on the extended centerline of the landing runway at an altitude of 500 feet above the Runway Point of Intercept (RPI). The SOIA procedure design affords the pilot the best opportunity to establish the aircraft on the extended runway centerline at an altitude of 500 ft AGL.

In practice, aircraft will navigate the ILS and Offset PRM courses outside of the MAP in the same manner as they conduct standard closely spaced parallel approaches. When the Offset aircraft reaches the MAP, it must have the runway and (if applicable) the aircraft ahead conducting the ILS approach in sight or it is obligated to initiate a missed approach.

Objective

The objective of this effort is to determine the "flyability" of the Offset PRM approach with particular emphasis on altitudes and overshoots of the runway of intended landing. If the results are positive, an effort will be made to establish a SOIA team with the FAA so that further testing and definition of the approach may be made. Further testing that includes but is not limited to simultaneous aircraft generation, ground proximity, communications and human factors is a mandatory requirement of the approach.

The Demonstration

The demonstration will be conducted between the hours of 0600 and 1000 MDT on October 23/24, 1997 at United Air Lines Training Center in Denver, Colorado using a B747-400 simulator.

PRM SOIA APPROACH

Two different approaches will be provided. The first will permit a SOIA approach with a DH of 1126 ft. This approach is consistent with SOIA criteria which assumes that no blunders inside the MAP will violate a 400 ft No Transgression Zone between the two extended runway centerlines. Scenario 2 will permit a SOIA approach with a DH of 1455 ft. This approach is consistent with SOIA criteria which assumes that no blunders inside the MAP will violate a 500 ft No Transgression Zone between the two extended runway centerlines. If the first Scenario 1 appears to be meet demonstration criteria, it will not be necessary to evaluate Scenario 2.

Visibility: Scenario 1, 4 statute miles; Scenario 2, 5 statute miles.

Ceiling: Scenario 1, 1600 ft; Scenario 2, 1900 ft, ragged if possible.

Approaches will commence at CEDES Int. at 250 IAS (on MOD R245).

Surface OAT will be set at 29 degrees F.

Surface wind speed will be set to calm or a right or left quartering tailwind of 14 Knots.

Day and night conditions will be simulated.

Pilots will be asked to review the PRM LDA DME 28R Briefing Page prior to executing the approach.

OVERSHOOT

Aircraft will be positioned north of the runway 28R centerline, level at 1200 ft AGL on a heading of 278 degrees in a position approximating the runway 28R LDA MAP. When the run begins, the aircraft will commence a left turn to the heading specified in the chart below titled, "Overshoot Demonstration Runs". The aircraft will remain on the heading until crossing the runway 28R centerline. The ILS for runway 28R should be selected in order to facilitate an accurate determination of the crossing of runway 28R extended centerline. When the aircraft reaches the centerline, a maximum roll rate turn to 25 degree bank angle will be initiated to return the aircraft to the runway 28R centerline. The purpose of this demonstration is to validate the ALPA overshoot computer model.

Validation of the Approach Geometry

The same glideslope location for the 28R ILS will be utilized for the LDA.

At the DICKI Int., the LDA course will be 3000 ft perpendicularly offset from the 28L ILS localizer centerline in both scenarios.

The LDA course will be 278 degrees inbound in both scenarios adjusted to meet the criteria below in the Latitude/Longitude Approach table .

An LDA DME will be located so that the DME reading at the MAP is 3.8 nm in scenario one and 4.9 nm in scenario two.

The glide slope altitude at the DH for Scenario 1 will be 1126', for Scenario 2 it will be 1455'.

The Initial Fix will be placed at a position that allows for a 21 nm leg from the initial fix to the final fix. This fix position will permit crossing CEDES at 11000/250 (see table below).

Approach Latitude/Longitude information for the 400 foot buffer model

2.50°		Altitude	CEDES Heading/(TC)
Initial Fix	37 25.50.141N121 51 40.287W	11150	220/(337.1)
MAP	37 35 35.892N122 17 31.653W	20094.2 / 2274.3	
Antenna	37 37 13.457N122 21 51 772W		

2.75°		Altitude	CEDES Heading/(TC)
Initial Fix	37 25 55.481N121 51 36.972W	11120	220/(237.4)
MAP	37 35 35.942N122 17 31.772W	20083.4 / 2274.3	
Antenna	37 37 12.607N122 21 52.426W		

3.00°		Altitude	CEDES Heading/(TC)
Initial Fix	37 26 00.913N121 51 33.899W	11100	221/(237.6)
MAP	37 35 35.992N122 17 31.891W	20072.5 / 2274.3	
Antenna	37 37 11.755N122 21 53.074W		

Data Analysis

The purpose of the demonstration is to validate the operational approach geometry. Areas of special interest include:

1. Overshoots of the extended runway 28R centerline.

2. Maneuvering required to become established on the 28R LDA prior to glide slope interception.

3. Validation of the "blunder" model.

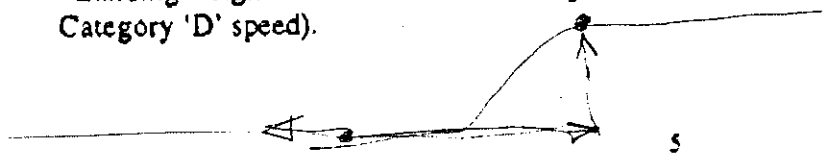
4. Ease of Maneuvering from the MAP to the runway threshold.

A pilot questionnaire will be filled out by each crew at the conclusion of each demonstration session.

Target Demonstration Criteria

Limitations	Initial	Inter.	FAF	MAP	SAP	Target Speed
Airspeed (kts)	10	10	10	10	10	747:165*
Altitude (ft)	100	100	100	100	100	
Vertical Speed (fpm)	1400	1400	1200	1200	1000	
Bank Angle (deg)	n/a	n/a	n/a	20	15	
g/p Deviation	n/a	n/a	...> 1 dot low			
Offset (ft)	n/a	n/a	n/a	n/a	200	

*Landing weight of the aircraft will be adjusted to a value that will produce a V_{ref} of 165 kts. (Max Category 'D' speed).



** If the 757/767 is utilized for category 'C' approaches the landing weight will be adjusted to a value that will produce a V_{ref} of 140 kts. If the 757/767 is utilized for Category 'D' approaches, its landing weight will be adjusted to a value that will produce a V_{ref} of 165 kts.

Data will be collected in digital form and supplied to the participating organizations. Distance parameters named x (distance from the touchdown point measured along the extended centerline of runway 28R), y (distance measured perpendicular to the extended centerline of runway 28R), and z (altitude) will be collected as well as airspeed, sink rate (vertical speed), bank angle and glidepath deviation. If at all possible, the data will be collected in the same form as the previous tests conducted at UAL.

Demonstration Runs

Approach Demonstration Runs

Run No.	Speed at CEDES/Initial fix	Scenario	Wind	Day/night	Pilot	Xponder Code
1	250/220	1	calm	d	1	01
2	250/220	1	calm	d	2	02
3	250/180	1	055/14	d	1	03
4	250/180	1	055/14	d	2	04
5	250/160	1	145/14	d	1	05
6	250/160	1	145/14	d	2	06
7	250/220	1	calm	n	1	07
8	250/220	1	calm	n	2	08
9	250/180	1	055/14	n	1	09
10	250/180	1	055/14	n	2	10
11	250/160	1	145/14	n	1	11
12	250/160	1	145/14	n	2	12

Scenario 2, if required, will be the same as Scenario 1

Simulation begins at CEDES on the Modesto (MOD) VOR 245 radial at 11,000 ft

	Scenario 1	Scenario 2
Ceiling	1600 ft	1900 ft
DH	1126 ft	1455 ft
Visibility	4 sm	5 sm
Temperature	29 F	29 F

Overshoot Demonstration Runs

Run No.	Intercept Angle	Heading	Pilot Code	Xponder
13	15 deg.	266 deg.	1	13
14	15 deg.	266 deg.	2	14
15	20 deg.	261 deg.	1	15
16	20 deg.	261 deg.	2	16
17	25 deg.	256 deg.	1	17
18	25 deg.	256 deg.	2	18
19	30 deg.	251 deg.	1	19
20	30 deg.	251 deg.	2	20

Pilot Questionnaire

Select more than one answer if necessary

1. How would you rate the difficulty of conducting this approach?
   -easy, -normal, -somewhat difficult, -difficult
   Comment:

2. If you have experience, how would you compare this approach to:
   a) the previous LDA approach at SFO?
   -easier, -about the same, -somewhat more difficult, -more difficult
   Comment:

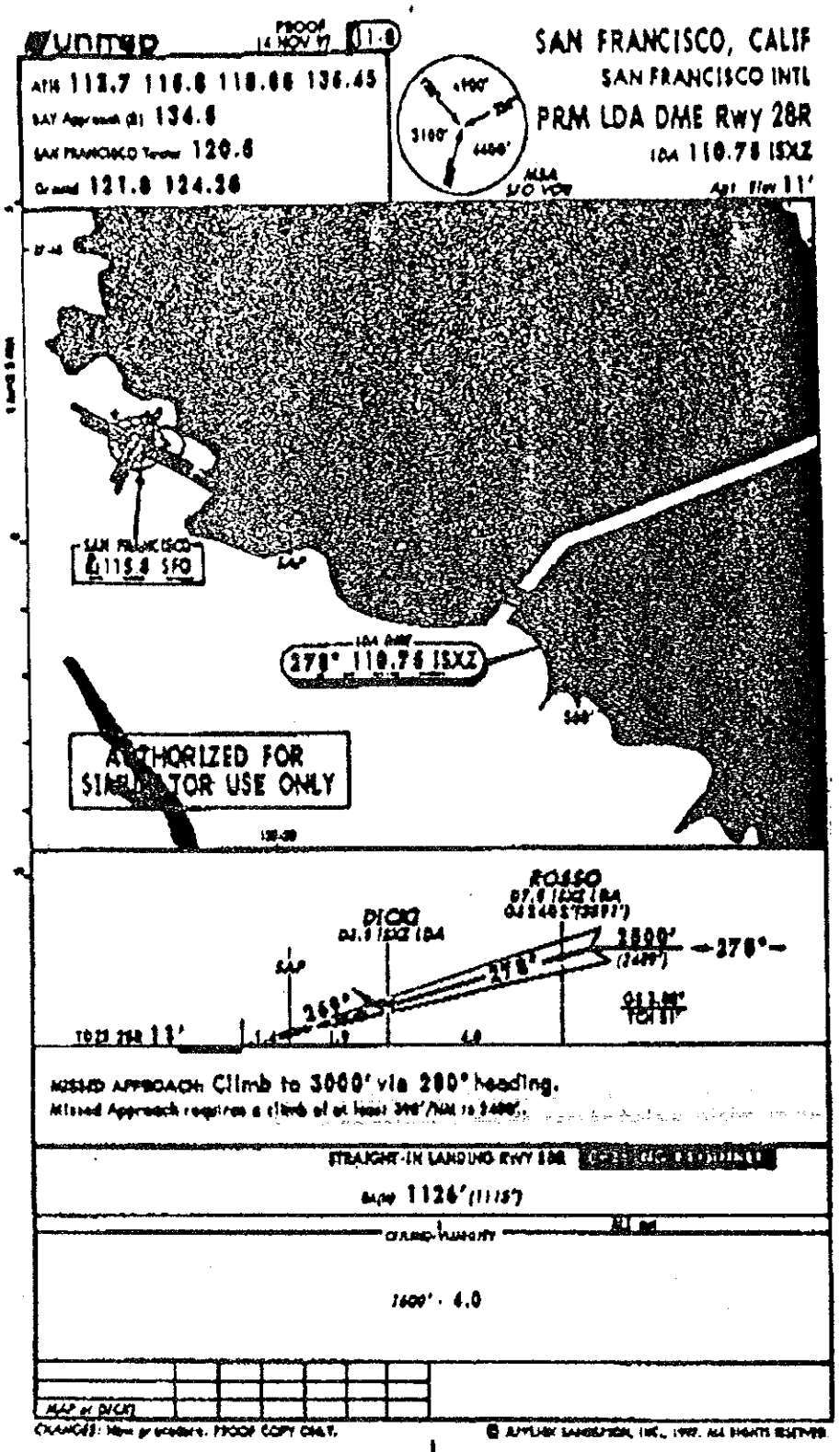
   b) the present LDA approach at STL?
   -easier, -about the same, -somewhat more difficult, -more difficult
   Comment:

3. How you rate the briefing and information pages?
   -informative, -required, -confusing, -unnecessary
   Comment:

4. How would you rate having a glide slope indication all the way to touchdown?
   -a definite help, -somewhat helpful, -not helpful
   Comment:

5. What could be added to make the approach easier to navigate?
   Comment:

6. Was there any aspect of the approach that you found difficult, confusing, etc.?
   Comment:


SAN FRANCISCO, CALIF
SAN FRANCISCO INTL
PRM LDA DME Rwy 28R
LDA 110.75 ISXZ
ATIS 113.7 116.8 118.65 136.45
SAN Approach (R) 134.6
SAN FRANCISCO Tower 120.6
Ground 121.8 124.35
SAN FRANCISCO
115.8 SFO
278° 110.75 ISXZ
AUTHORIZED FOR
SIMULATOR USE ONLY
ROSSO
DICIO
3000'
(2409')
278°
MISSED APPROACH: Climb to 3000' via 280° heading.
Missed Approach requires a climb of at least 300'/NM to 2400'.
STRAIGHT-IN LANDING RWY 28R
1126'(1115')
1600' - 4.0
CHANGES: None or minor. PROOF COPY ONLY.

DRAFT ATTENTION ALL USERS PAGE

Procedures for Precision Runway Monitor (PRM) Approach

Simultaneous PRM *LDA DME* RWY 28R, BAY ILS Rwy 28L Approaches SFO

Before initiating a simultaneous close parallel PRM *LDA DME* Rwy 28R or BAY ILS Rwy 28L approach, PILOTS ARE EXPECTED TO HAVE VIEWED THE VIDEO "RDU PRECISION RUNWAY MONITOR: A PILOT'S APPROACH" AT THEIR AIRLINE or at the FAA FLIGHT STANDARDS DISTRICT OFFICE and MEET THE FOLLOWING REQUIREMENTS (if unable notify ATC within 200 miles of the airport.)

1. **ATIS**: When the ATIS broadcast advises *simultaneous* PRM *LDA DME* Rwy 28R and BAY ILS Rwy 28L approaches are in progress, pilots will NOTIFY ATC on initial contact if they cannot meet all the requirements on this information page.

2. **Dual VHF Communications required:** To avoid blocked transmissions, each runway will have two frequencies, a primary and a monitor frequency. The tower controller and monitor controller will transmit on both frequencies. Pilots will ONLY transmit on the primary frequency, but will listen to both frequencies. It is important that the volume is set at about the same level on both radios so that the pilots well be able to hear transmissions on at least one frequency if the other is blocked.

3. **TCAS:** To avoid ATC giving instructions directly opposite to a TCAS RA, the TCAS will be placed in TA mode when entering the monitored PRM airspace just prior to intercepting the glide slope. If a pilot is broken out from the ILS, the TCAS should be reset to TA/RA mode as soon as practical.

4. **ALL ATC directed "breakouts" are to be HAND FLOWN:** Pilots, when directed to break off an approach, must assume that an aircraft is blundering toward their course and a breakout must be initiated immediately. The breakout must be hand flown to insure it is accomplished in the shortest amount of time.. Controllers may give a descending breakout but in no case will the descent be below minimum vectoring altitude (MVA) which provides at least 1,000 feet obstacle clearance. The MVA is 1,600 feet at San Francisco International *under the final approach course.*

5. **Phraseology - "TRAFFIC ALERT":** If an aircraft enters the "NO TRANSGRESSION ZONE" (NTZ), the controller will break out the threatened aircraft on the adjacent approach. The phraseology for the breakout will be:

   TRAFFIC ALERT, (aircraft call sign) TURN (left/right) IMMEDIATELY, HEADING (degrees), CLIMB / DESCEND AND MAINTAIN (altitude).

6. Avoid crossing over into the adjacent runway final approach course

7. The Runway 28R Precision Approach Path Indicator (PAPI) must be operational. The PAPI glide path is coincident with the PRM *LDA/DME* Rwy 28R glidepath.

TRAINING INFORMATION USED IN SIMULATION

Pilot

Operational Notes Simultaneous PRM-LDA/DME 28R at SFO
1600'/ 4 (DH 1126')

- The 269 degree heading between DICKI Int. and the SAP (500 ft AGL on the 28R extended centerline) is recommended to insure proper 28R centerline alignment with minimum heading change and centerline overshoot. Applying the same drift correction as was need to hold the LDA may be considered as a modification to the 269 degree heading.

- RADAR monitoring will be terminated when 'maintain visual separation" clearance is accepted by the pilot on either approach.

- The trailing aircraft on either approach will be instructed to "maintain visual separation" from the leading aircraft after that traffic has been reported in sight. A clearance to maintain visual separation requires the pilot to see and avoid the other aircraft, to keep that aircraft in sight at all times, and to provide wake turbulence separation. Promptly notify the controller if you lose sight of the other aircraft, are unable to maintain constant visual contact with it, or can not accept the responsibility for your own separation for any reason. Aircraft conducting these approaches SHOULD NOT pass each other, fly wingtip to wingtip or abeam, except in the landing phase of flight, i.e., at or below 50 feet AGL. If a passing situation becomes imminent, immediately notify the controller and consider executing a missed approach.

- Heavy jets/B757 will placed behind lighter aircraft and instructed not to overtake the lighter aircraft regardless of the approach being flown. Other aircraft will be sequenced on either approach to ensure that any aircraft, including another heavy jet/B757, is provided wake turbulence separation behind a heavy jet/B757 on the same or adjacent final approach course.

- The use of simultaneous approaches is TCAS sensitive.

- In the event of a go-around/balked landing inside the LDA MAP, a climb gradient of 390 feet per nautical miles has been established to ensure terrain clearance.

OPERATIONAL ISSUES AND/OR TRAINING ITEMS

Air Traffic

Operational Notes Simultaneous PRM-LDA/DME 28R, Bay ILS/DME 28L at SFO
1600'/4 (DH 1126')

- Simultaneous PRM *LDA/DME* Rwy 28R and BAY ILS/DME RWY 28L may be conducted during daylight hours only, when the weather is reported as follows:

    a. A ceiling of at least 1,600 feet and visibility of 4 miles is reported by the Automated Weather Observing System (AWOS) located near ROSSO Int., and a ceiling of at least 1,600 feet and visibility of at least 4 miles is reported at SFO, if the AWOS is inoperative.

    b. A ceiling of at least 1600 feet and visibility of 4 miles is reported by SFO Tower.

- Simultaneous approaches will not be used when the crosswind component at SFO is greater than 10 knots. RADAR monitoring will be terminated when visual separation is accepted by the pilot on either approach. The distance between the LDA course and the runway 28L localizer course is 3,000 feet at the *LDA/DME* MAP (DICKI Int.). The distance between the runway centerlines is 750 feet.

- ATC WILL NOT PROVIDE VISUAL SEPARATION. The trailing aircraft on either approach will be instructed to "maintain visual separation" from the leading aircraft after that traffic has been reported in sight. A clearance to "maintain visual separation" requires the pilot to see and avoid the other aircraft, to keep that aircraft in sight at all times, and to provide wake turbulence separation. Pilots will promptly notify the controller if they lose sight of the other aircraft, are unable to maintain constant visual contact with it, or can not accept the responsibility for their own separation for any reason. Aircraft conducting these approaches should be sequenced so that they DO NOT pass each other, fly wingtip to wingtip or abeam, except in the landing phase of flight, i.e., at or below 50 feet AGL. If a passing situation becomes imminent, the pilot will immediately notify the controller the initiation of a missed approach should be considered.

- ATC will provide speed information on the leading aircraft. ATC will sugger the trailing aircraft so that it does not pass the leading aircraft, at least ¾ NM entail spacing is suggested when the leading aircraft passes over or abeam the LDA MAP (DICKI Int. - 3.3 NM from the runway threshold), regardless of whether the 28R or 28L aircraft is in the lead. This distance does not represent a separation standard, but is used to prevent aircraft from passing.

- Heavy jets/B757 will placed behind lighter aircraft and instructed not to overtake the lighter aircraft regardless of the approach being flown. Other aircraft will be sequenced on either approach to ensure that any aircraft, including another heavy jet/B757, is provided wake turbulence separation behind a heavy jet/B757 on the same or adjacent final approach course (4 miles for a heavy behind a heavy, 5 miles for a large behind a heavy, 6 miles for a small behind a heavy, 4 miles for large behind a B/757, 5 miles for a small behind a B757).

- Controllers should be aware that the use of simultaneous approaches is TCAS sensitive.

- ATC will normally vector traffic to join the ILS 28L at an altitude of 4000 ft MSL.

- ATC will normally vector traffic to join the PRM/LDA 28R at altitudes between 5000 ft and 7000 ft MSL depending on the underlying traffic.

- When established on the respective localizers, aircraft will be assigned the tower frequency prior to the loss of 1000 ft relative altitude. (Approach monitoring override will be provided on the tower frequency).

Modifications to the BAY ILS 28L Approach for Compatibility with the SOIA/PRM 28R LDA Approach

- Lower the DH to 1126 ft so that it is the same minimums as the 28R PRM LDA approach. The present minimums on the BAY ILS 28L is a DH of 1180 ft. This change affords the pilot conducting the BAY ILS 28L approach the same amount of acquisition time as the 28R PRM LDA approach when the 28L aircraft is the trailing aircraft.
- Move the 28L MAP 0.2 nm closer to the runway (3.3 from the threshold instead of 3.5) to be compatible with the new DH of 1126 ft.
- Review obstacle clearance heights based on the new DH. If the obstacle heights remain the same, the minimum climb should be adjusted from 390 ft/min to 407 ft/min. (This translates, at 180 kts groundspeed, to an additional 51 ft/min rate of climb.)
- Change the BAY ILS visibility minimums from 6.0 miles as presently charted to 4.0 miles to agree with the minimums of the 28R PRM LDA approach

Also, since there can only be one coded missed approach procedure in the FMS (the normal 28L ILS approach in this case), add a note to the Bay ILS 28L approach plate cautioning the pilot that the BAY ILS 28L missed approach is not the missed approach procedure coded in the FMS data base.