Departure From Controlled Flight
Trans-Pacific Air Charter, LLC
Learjet 35A, N452DA
Teterboro, New Jersey
May 15, 2017

Accident Report

NTSB/AAR-19/02
PB2019-100271

National
Transportation
Safety Board

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Adopted March 12, 2019

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490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

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Abstract: This report discusses the May 15, 2017, accident involving a Learjet 35A, N452DA, operated by Trans-Pacific Air Charter, LLC, that departed controlled flight while on a circling approach to runway 1 at Teterboro Airport, Teterboro, New Jersey, and impacted a commercial building and parking lot. The pilot-in-command (PIC) and the second-in-command died; no one on the ground was injured. The airplane was destroyed by impact forces and postcrash fire. Safety issues identified in this report include the need for flight data monitoring programs (and supporting recording devices) for 14 *Code of Federal Regulations* Part 135 operators; the need for safety management systems for Part 135 operators; the need for the Federal Aviation Administration (FAA) to develop and implement procedures to identify Part 135 operators whose pilots do not comply with standard operating procedures (SOP); the need for Part 135 operators to monitor pilots with performance deficiencies; inadequate FAA guidance for Part 135 crew resource management training; the need for leadership training for Part 135 PICs; and the lack of approach speed wind additive guidance in Trans-Pacific SOPs. As a result of this investigation, the National Transportation Safety Board makes three new safety recommendations to the FAA, reiterates six safety recommendations, and reclassifies one recommendation.

For more detailed background information on this report, visit http://www.ntsb.gov/investigations/dms.html and search for NTSB accident ID CEN17MA183. Recent publications are available in their entirety on the Internet at http://www.ntsb.gov. Other information about available publications also may be obtained from the website or by contacting:

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Abbreviations

AC advisory circular

AFCS automatic flight control system

AFM airplane flight manual

agl above ground level

AOA angle of attack

ASAP aviation safety action program

ATC air traffic control

ATIS automatic terminal information service

BED Laurence G. Hanscom Field

CFR *Code of Federal Regulations*

CDU control display unit

CRM crew resource management

CVR cockpit voice recorder

DME distance measuring equipment

DUATS Direct User Access Terminal Service

EGPWS enhanced ground proximity warning system

EWR Newark Liberty International Airport

FAA Federal Aviation Administration

FDM flight data monitoring

FedEx Federal Express Corporation

FMS flight management system

FSDO flight standards district office

GOM general operations manual

HAA helicopter air ambulance

HSI horizontal situation indicator

IFR instrument flight rules

ILS instrument landing system

JFK John F. Kennedy International Airport

kts knots (nautical miles per hour)

LGA LaGuardia Airport

LOC localizer

LOFT line-oriented flight training

LOM locator outer marker

MDA minimum descent altitude

msl mean sea level

nm nautical miles

NCU navigation computer unit

NPRM notice of proposed rulemaking

NTSB National Transportation Safety Board

PF pilot flying

PHL Philadelphia International Airport

PIC pilot-in-command

PM pilot monitoring

PNF pilot not flying

POI principal operations inspector

PRIA Pilot Records Improvement Act of 1996

SAS safety assurance system

SIC second-in-command

SMS safety management system

SOP standard operating procedure

TEB Teterboro Airport

VMC visual meteorological conditions

VOR very-high-frequency omnidirectional radio range

Executive Summary

On May 15, 2017, about 1529 eastern daylight time, a Learjet 35A, N452DA, departed controlled flight while on a circling approach to runway 1 at Teterboro Airport (TEB), Teterboro, New Jersey, and impacted a commercial building and parking lot. The pilot-in-command (PIC) and the second-in-command (SIC) died; no one on the ground was injured. The airplane was destroyed by impact forces and postcrash fire. The airplane was registered to A&C Big Sky Aviation, LLC, and was operated by Trans-Pacific Air Charter, LLC, under the provisions of Title 14 *Code of Federal Regulations* (*CFR*) Part 91 as a positioning flight. Visual meteorological conditions prevailed, and an instrument flight rules flight plan was filed. The flight departed from Philadelphia International Airport (PHL), Philadelphia, Pennsylvania, about 1504 and was destined for TEB.

The accident occurred on the flight crew's third and final scheduled flight of the day; the crew had previously flown from TEB to Laurence G. Hanscom Field (BED), Bedford, Massachusetts, and then from BED to PHL. The PIC checked the weather before departing TEB about 0732; however, he did not check the weather again before the flight from PHL to TEB despite a company policy requiring that weather information be obtained within 3 hours of departure. Further, the crew filed a flight plan for the accident flight that included altitude (27,000 ft) and time en route (28 minutes) entries that were incompatible with each other, which suggests that the crew devoted little attention to preflight planning. The crew also had limited time in flight to plan and brief the approach, as required by company policy, and did not conduct an approach briefing before attempting to land at TEB.

Cockpit voice recorder data indicated that the SIC was the pilot flying (PF) from PHL to TEB, despite a company policy prohibiting the SIC from acting as PF based on his level of experience. Although the accident flight was likely not the first time that the SIC acted as PF (based on comments made during the flight), the PIC regularly coached the SIC (primarily on checklist initiation and airplane control) from before takeoff to the final seconds of the flight. The extensive coaching likely distracted the PIC from his duties as PIC and pilot monitoring, such as executing checklists and entering approach waypoints into the flight management system.

Collectively, procedural deviations and errors resulted in the flight crew's lack of situational awareness throughout the flight and approach to TEB. Because neither pilot realized that the airplane's navigation equipment had not been properly set for the instrument approach clearance that the flight crew received, the crew improperly executed the vertical profile of the approach, crossing an intermediate fix and the final approach fix hundreds of feet above the altitudes specified by the approach procedure.

The controller had vectored the flight for the instrument landing system runway 6 approach, circle to runway 1. When the crew initiated the circle-to-land maneuver, the airplane was 2.8 nautical miles (nm) beyond the final approach fix (about 1 mile from the runway 6 threshold) and could not be maneuvered to line up with the landing runway, which should have prompted the crew to execute a go-around because the flight did not meet the company's stabilized approach criteria. However, neither pilot called for a go-around, and the PIC (who had assumed control of the airplane at this point in the flight) continued the approach by initiating a turn to align with the landing runway. Radar data indicated that the airplane's airspeed was below the approach

speed required by company standard operating procedures (SOPs). During the turn, the airplane stalled and crashed about 1/2 nm south of the runway 1 threshold.

The National Transportation Safety Board (NTSB) identified the following safety issues as a result of this accident investigation:

- **Need for flight data monitoring (FDM) programs (and supporting recording devices) for 14 *CFR* Part 135 operators.** If this flight hadn't ended in an accident, Trans-Pacific (a Part 135 operator) would not have had a way to identify the flight crew's deviations from policy and procedures just as it had no way to determine whether this (or any) crew's previous operations were conducted in accordance with company policies and SOPs. The NTSB has long recognized the value of FDM programs for Part 135 operators, having first issued a safety recommendation for data recording devices and monitoring programs for helicopter emergency medical service operators in 2009. More recently, as a result of our investigation of a 2015 fatal accident in Akron, Ohio, involving a Part 135 operator, the NTSB recommended that the Federal Aviation Administration (FAA) require all Part 135 operators to install data recording devices capable of supporting an FDM program and then to establish structured FDM programs (Safety Recommendations A-16-34 and -35, respectively). The Trans-Pacific accident further highlights the need for such programs and recording devices to be required for Part 135 operators.

- **Need for safety management systems (SMS) for Part 135 operators.** Although a safety officer position was included in Trans-Pacific's organizational chart and the company was pursuing an SMS, no formal safety programs were in place at the time of the accident. Therefore, the company did not identify or mitigate the hazards that contributed to this accident (such as an unauthorized SIC acting as PF and pairing two pilots who had both exhibited difficulties in training). The NTSB has investigated several other Part 135 accidents that highlighted operational safety issues that could have been identified and mitigated by an SMS. As a result of our investigation of the Akron accident, the NTSB also recommended that the FAA require all Part 135 operators to establish an SMS (Safety Recommendation A-16-36).

- **Need for the FAA to develop and implement procedures to identify Part 135 operators whose pilots do not comply with SOPs.** FAA guidance states that cockpit en route inspections are one of the "most effective methods of accomplishing [the FAA's] air transportation surveillance objectives." Despite this statement, the FAA's principal operations inspector for Trans-Pacific at the time of the accident stated that he had never conducted an en route inspection for a Part 135 operator and had no way of knowing if pilots were following SOPs during flights based on the line checks that he performed. Similar to this accident, the NTSB found multiple instances of a flight crew's failure to comply with SOPs during the Akron accident investigation and noted that the FAA had never conducted an en route inspection of any pilots at that company. As part of the Akron investigation, we recommended that the FAA review its Safety Assurance System (SAS) and develop and implement procedures needed to identify Part 135 operators whose pilots do not comply with SOPs (Safety Recommendation A-16-41), but the FAA has not yet taken the requested action, even though the circumstances of the TEB accident demonstrate that noncompliance with SOPs remains a pervasive issue for Part 135 operations.

- **Need for Part 135 operators to monitor pilots with performance deficiencies.** Trans-Pacific was aware that both accident pilots required additional simulator training sessions to complete initial company training. However, after completing the simulator training, both pilots began line operations without any further monitoring or evaluation. During the accident flight, both pilots exhibited performance problems that mirrored some of those noted during their simulator training courses (for example, the PIC did not properly execute the circling approach, and the SIC struggled with aircraft control).

  As a result of our investigation of a 2003 accident in Memphis, Tennessee, the NTSB recommended that the FAA require Part 121 air carriers to establish programs to review the performance history of crewmembers who had performance deficiencies or had experienced failures in training and administer additional oversight and training to ensure that performance deficiencies are addressed and corrected (Safety Recommendation A-05-14, classified "Closed—Acceptable Action"). Part 135 operators would benefit from similar required programs.

- **Inadequate FAA guidance for Part 135 crew resource management (CRM) training.** Beginning in 2013, the FAA required all Part 135 operators to provide CRM training to flight crews. Title 14 *CFR* 135.330 requires operators to cover eight specific topics in CRM training; however, the FAA does not provide clear guidance on how operators can implement required CRM training, even though such guidance is available for Part 121 CRM programs. Both accident pilots participated in Trans-Pacific's CRM training program, which had been approved by the FAA and covered all required topics. However, the training did not seem to influence the crew's actions during the accident flight. FAA-funded scientific research has identified factors that influence the effectiveness of CRM training. These findings could be used to develop guidance for CRM training programs tailored to the specific characteristics of Part 135 operations.

- **Need for leadership training for Part 135 PICs.** The absence of adequate preflight planning and the omission of required checklists, callouts, and briefings during the accident flight were indications of the PIC's inadequate leadership. Title 14 *CFR* 135.330 requires operators, as part of CRM training, to provide training that addresses the authority of the PIC but does not contain additional details. Trans-Pacific's CRM training did not adequately describe core leadership functions necessary for ensuring effective crew performance. The NTSB has found deficiencies in PIC leadership in previous accident investigations, most notably in the investigation of the 2009 accident in Clarence Center, New York. As a result of that investigation, we recommended that the FAA issue an advisory circular on leadership training for upgrading captains and require all Part 121, 135, and 91K operators to provide such training (Safety Recommendations A-10-13 and -14, respectively). In October 2016, the FAA issued a notice of proposed rulemaking modifying leadership training requirements for Part 121 operators but not Part 135 or 91K operators.

  The NTSB notes that the PIC in this accident had never been employed as a Part 135 PIC before being hired by Trans-Pacific and had never received formal specific leadership training to prepare him for the leadership duties associated with the upgrade to PIC. Specific leadership training for Part 135 and 91K PICs provided during the upgrade process would help standardize and reinforce the critical command authority skills that PICs need.

- **Lack of approach speed wind additive guidance in Trans-Pacific SOPs.** The Learjet 35A airplane flight manual recommends increasing approach speed in gusting wind conditions. However, the approach speeds listed in Trans-Pacific's SOPs did not include these wind additives. Gusting wind conditions were present during the accident flight. Although the accident airplane was flown significantly slower than directed by the SOPs during the approach, the airplane remained above the manufacturer-published stall speed. However, the strong, gusting wind might have momentarily reduced the airplane's airspeed below the stall speed. Adding guidance to Learjet 35A operations manuals to include a wind additive (if appropriate) when calculating approach speeds would provide additional stall margin and reduce the risk of a stall.

The NTSB determines that the probable cause of this accident was the PIC's attempt to salvage an unstabilized visual approach, which resulted in an aerodynamic stall at low altitude. Contributing to the accident was the PIC's decision to allow an unapproved SIC to act as PF, the PIC's inadequate and incomplete preflight planning, and the flight crew's lack of an approach briefing. Also contributing to the accident were Trans-Pacific's lack of safety programs that would have enabled the company to identify and correct patterns of poor performance and procedural noncompliance and the FAA's ineffective SAS procedures, which failed to identify these company oversight deficiencies.

As a result of this investigation, the NTSB makes three new safety recommendations and reiterates six previously issued safety recommendations to the FAA.

1. Factual Information

1.1 History of Flight

On May 15, 2017, about 1529 eastern daylight time, a Learjet 35A, N452DA, departed controlled flight while on a circling approach to runway 1 at Teterboro Airport (TEB), Teterboro, New Jersey, and impacted a commercial building and parking lot.[1] The pilot-in-command (PIC) and the second-in-command (SIC) died; no one on the ground was injured. The airplane was destroyed by impact forces and postcrash fire. The airplane was registered to A&C Big Sky Aviation, LLC, and was operated by Trans-Pacific Air Charter, LLC, under the provisions of Title 14 *Code of Federal Regulations* (*CFR*) Part 91 as a positioning flight.[2] Visual meteorological conditions (VMC) prevailed, and an instrument flight rules (IFR) flight plan was filed. The flight departed from Philadelphia International Airport (PHL), Philadelphia, Pennsylvania, about 1504 and was destined for TEB.[3]

The accident occurred on the flight crew's third and final scheduled flight of the day. The PIC checked the weather before the first flight, which departed TEB about 0732 and arrived at Laurence G. Hanscom Field (BED), Bedford, Massachusetts, about 0815. The second flight was scheduled to pick up one passenger at BED and depart about 0915; however, three passengers were waiting for the airplane. The flight was delayed until the pilots were able to address the discrepancy and complete passenger documentation. The airplane departed BED about 1009 and landed at PHL about 1104. Passenger interviews indicated that the PIC was the pilot flying (PF) on that flight.

Records obtained from the Direct User Access Terminal Service (DUATS) indicated that the PIC's account was used about 1415 to file an IFR flight plan from PHL to TEB.[4] The flight plan listed an en route time of 28 minutes and requested an altitude of 27,000 ft mean sea level (msl).[5] The PIC generated the flight plan using FltPlan.com, an online planning application.[6] No

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[1] All times in this report are expressed in eastern daylight time.

[2] Trans-Pacific Air Charter did business as Trans-Pacific Jets. This report uses the company names interchangeably and refers to the company as "Trans-Pacific." Trans-Pacific also conducted operations under Part 135.

[3] Supporting documentation referenced in this report can be found in the public docket for this accident accessible from the National Transportation Safety Board's (NTSB) Accident Dockets web page by searching CEN17MA183. Other NTSB documents referenced in this report, including other reports and summarized safety recommendation correspondence, are accessible from the NTSB's Aviation Information Resources web page (www.ntsb.gov/air).

[4] DUATS was a free online Federal Aviation Administration (FAA)-sponsored weather and flight-planning service that was available to pilots until May 2018.

[5] All altitudes are expressed in msl unless otherwise noted.

[6] To generate a flight plan, a pilot enters the requested route of flight and an altitude request, if desired. The application calculates estimated time en route and selects an en route altitude (if the pilot does not enter one). For the accident flight, the PIC entered a requested altitude of 27,000 ft.

record was found of the pilot checking the weather before departure from PHL, as required by company policy (see section 1.10.1.1 for additional information).

Air traffic control (ATC) audio recordings indicated that the crew contacted the PHL clearance delivery controller about 1433. The clearance delivery controller cleared the flight to TEB via the Philadelphia One standard instrument departure and instructed the crew to climb to 3,000 ft after departure and to expect clearance to 4,000 ft 10 minutes after departure.[7] The crew read back the clearance, contacted PHL ground control, and received instructions to taxi to runway 35.

At 1500:51, the cockpit voice recorder (CVR) recorded the PIC's statement to the SIC, "okay I think we're next man. hand on your yoke," while the flight crew was holding short of the runway.[8] The PIC continued to make statements directing the SIC's control inputs during the takeoff roll.

Just after takeoff, at 1504:18, the PIC stated, "gear up. yaw dampener engaged. ya gotta tell me to do that." About 20 seconds after takeoff, the PIC stated, "after takeoff checks." The SIC acknowledged the statement. The PIC then contacted PHL departure control and stated that the airplane was climbing to 2,000 ft. The controller then cleared the airplane to 4,000 ft and instructed the pilot to contact PHL approach control.[9]

About 1506, while leveling off the airplane at 4,000 ft, the PIC directed the SIC in the use of the trim wheel; shortly thereafter, he reminded the SIC to "watch the altitude." At 1507:03, the PIC told the SIC that he (the PIC) selected the altitude hold mode of the autopilot and reminded the SIC to keep the airplane's speed below 250 knots (kts); about 24 seconds later, the PIC prompted the SIC to check airspeed. The PIC then stated that the SIC was doing much better, had been paying attention, and was understanding what to do.

At 1508:39, the PIC stated to the SIC, "two fifty on the speed," which was followed by the sound of increased engine thrust. At 1508:54, the SIC stated, "keep us below two fifty." At 1509:35, the controller asked for the airplane's speed. The CVR captured sound similar to a decrease in engine thrust about 1 second before the PIC reported an airspeed of 260 kts. Between 1510:33 and 1510:37, the PIC stated, "#. give it a little power [along with a sound similar to a sigh]" and "keep it within ten."[10]

About 1512, the PIC asked the controller if the flight could be cleared to fly at a higher altitude (the PIC had requested an altitude of 27,000 ft when he filed the flight plan). The controller replied "unable higher" and explained that a higher altitude would require resequencing the airplane for arrival at TEB. Speaking to the PIC, the SIC exclaimed, "ha. it's like she [the

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[7] A standard instrument departure is an FAA departure procedure developed to meet environmental, capacity, and ATC requirements for a specific airport.

[8] See appendix C for the full CVR transcript.

[9] Philadelphia approach control provided en route handling for the flight from 1505:40 to the handoff to New York approach control at 1513:31.

[10] The "#" symbol in the CVR transcript indicates an expletive.

controller] doesn't like us." At 1512:32, the SIC said, "it's holdin' the speed," and the PIC replied, "no it's a # tail wind so yeah you have to pull back the power juuust a little." The PIC made additional comments about the controller and concluded by exclaiming in a high-pitched voice, "she's a # idiot. get us someone else if she can't do it."

About 1514, after changing frequencies to New York approach control as instructed, the flight crew was given the altimeter setting for Newark Liberty International Airport (EWR), Newark, New Jersey, and the controller vectored the flight for the instrument landing system (ILS) runway 6 approach, circle to runway 1 at TEB.[11] The PIC asked the controller to repeat the altimeter setting. After the controller repeated the altimeter setting and the vector for the ILS runway 6 approach, circle to runway 1, the PIC read back the assigned heading. Speaking to the SIC, the PIC stated, "he was saying circling # six or something. I don't know what the # they thinkin' we're doin'. we're # hundreds of miles away man." Radar data showed that the airplane was 48 nm from TEB at that time.[12] The crewmembers then discussed their arrival time at TEB; the SIC stated that they would arrive in "like # an hour." At 1515:08, the PIC corrected the SIC's estimate by stating that they would arrive in 20 minutes.

At 1515:13, the controller instructed the flight crew to descend to and maintain 3,000 ft. After acknowledging the clearance, the PIC stated to the SIC, at 1515:22, "we're # gonna be there in ten minutes. I gotta get the # ATIS [automatic terminal information service] #. I didn't realize we're that # close." At 1515:30, the PIC stated, "of course I don't have # G-P-S that's why." The SIC replied, "you wanna use my ipad?" and the PIC responded, "naw that's okay." At 1515:46, while the SIC flew the descent to 3,000 ft, the PIC tuned the TEB ATIS broadcast. While the PIC was listening to the ATIS broadcast, the controller instructed the crew to turn the airplane to a heading of 120°, which the SIC acknowledged. The PIC questioned the vector as the ATIS broadcast continued to play. He stated the altimeter setting that was broadcast over the ATIS and told the SIC to "watch the altitude." The PIC then tuned the radio off the ATIS frequency, stating that he did not have time to listen to it, and repeated the altimeter setting.[13]

Radar data indicated that the airplane was southwest of TEB about 1517; at that time, the PIC asked the SIC if he could see New York, and the SIC responded, "negative. we're so # far from it. like—…we're (in) the boonies." Shortly thereafter, the PIC stated, "well it's less than fifty miles man. that's why. two five zero on the speed sir," which was followed by the sound of increased engine thrust. The PIC continued to talk about the airplane's location and altitude and then stated in a high-pitched loud voice, "but they got us at # three thousand. really?… and we're goin' # south we're not goin' # north," followed by, "I don't know what. (well it) must be a flow

[11] An ILS transmits course and glideslope signals from collocated transmitters. The two signals are received by tuning a navigation receiver to the published ILS frequency. The ILS approach procedure for runway 6 is described in section 1.5 of this report.

[12] The NTSB completed a radar performance study to determine the airplane's position, airspeed, altitude, pitch angle, and bank angle at various times in the flight. The study is discussed in section 1.9 of this report.

[13] ATIS information Zulu indicated an automated observation of wind from 340° at 18 kts gusting to 29 kts, visibility 10 miles with light rain, scattered clouds at 5,500 ft above ground level, temperature 18°C, dew point 6°C, and altimeter 29.74 inches of mercury.

issue." At 1517:59, the PIC said to the SIC, "let's do the checklist," but the PIC did not identify which checklist he was referring to. At 1518:24, the PIC stated, "approach is one twenty-six. V-ref is one-nineteen."[14]

About 1519:17, the controller instructed the flight crew to fly a heading of 90° to intercept the runway 6 localizer. Between 1519:40 and 1519:45, the PIC told the SIC to "set this up on your side" and "one oh eight point nine," which was the frequency used to set the pilots' navigation equipment for the TEB ILS. At 1520:09, the PIC stated that he was also setting his navigation equipment for the ILS. Radar data indicated the airplane flew through the localizer course at 1520:20. At 1520:29, the SIC announced to the PIC, "runway in sight"; radar data showed that the airplane was about 30 nm from TEB at the time. At 1520:32, the controller stated, "make sure you intercept the localizer," which the PIC acknowledged. At 1520:42, the controller stated, "Learjet two delta alpha left turn twenty heading (if) you (need it) to join," which the PIC acknowledged. At 1520:38, the PIC stated to the SIC, "why aren't you not—intercepting it. I guess it's # left," followed by, "we're makin' the left." The SIC then stated, "you want me to hit nav?" to which the PIC replied, "#. that's why." The PIC redirected the SIC's attention to the runway; afterward, between 1521:01 and 1521:05, the SIC stated, "that was Newark" twice and "I thought that was Teterboro."

At 1521:09, the PIC stated to the SIC, "alright your localizer is captured. and we've got nav mode selected on the F-M-S [flight management system]."[15] At 1521:42, the PIC stated, "you got two forty on your speed. two four zero," which was followed by the sound of a decrease in engine thrust.

At 1521:52, the controller stated, "can you go to VINGS? can you do that? VINGS? and then just localizer six?" and the PIC stated, "copy."[16] He then spelled out VINGS ("V-I…N-G-S"); provided the heading; and stated, "gonna go in nav mode." At 1522:29, the SIC stated, "go ahead and take over." CVR information indicated that the SIC continued to fly the airplane. The PIC stated, "on the F-M-S…we're there we're going direct VINGS at this time. twelve miles away to VINGS." Radar data confirmed that the airplane was 12 miles from VINGS at the time. The PIC added, "you still got the localizer on your side so we're doin' good." The SIC replied, "alright. I don't wanna # up."

At 1522:46, the controller instructed the crew to descend to and maintain 2,000 ft. As the descent to that altitude began, the PIC continued to coach the SIC. At 1523:04, the PIC stated, "try to keep the speed at about one er two forty," which was followed by the sound of an increase in engine thrust. The PIC continued to coach the SIC, stating, "let me help you out we're trimming it forward a little."

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[14] V_{REF} is commonly defined as stall speed with full landing flaps or selected landing flaps multiplied by 1.3.

[15] An FMS, or flight management system, is an onboard computer system that integrates inputs from various subsystems to aid the pilot in controlling the airplane's lateral and vertical paths.

[16] VINGS, DANDY, and TORBY are fixes on the ILS runway 6 instrument approach procedure, which is discussed in detail in section 1.5 of this report.

At 1523:23, the controller advised the flight crew that the airplane was 8 nm from VINGS, instructed the flight to cross VINGS at 2,000 ft, and cleared the flight for the ILS runway 6 instrument approach to TEB with an instruction to circle to land on runway 1. The crew read back the clearance. The controller then asked for the airplane's airspeed; the PIC replied that the airspeed was 240 kts. The controller instructed the flight crew to maintain 240 kts until the airplane reached VINGS and then to slow to 180 kts until reaching TORBY, the final approach fix. The PIC read back the instruction. Figure 1 shows the distance from PHL to TEB (about 80 nm) along with the airplane's position, heading, and ground track before ATC directed the flight to the VINGS navigational fix.

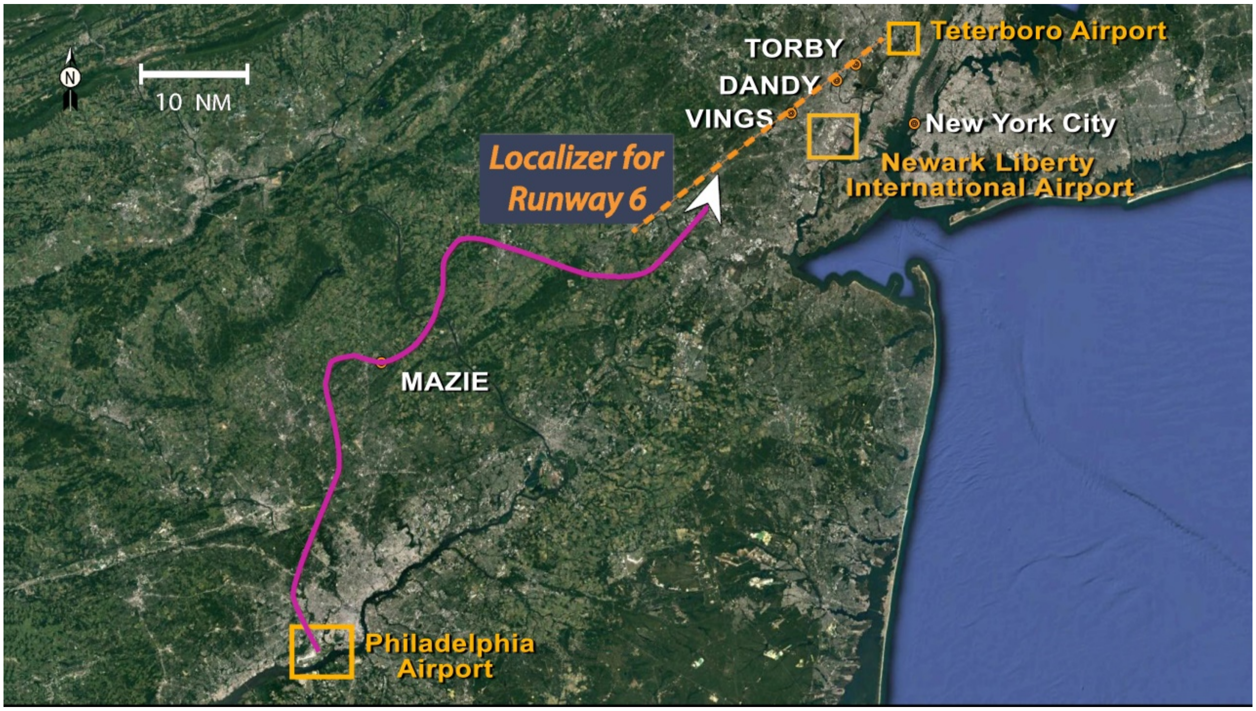

Figure 1. Accident airplane's ground track en route to TEB.

At 1524:01, the PIC told the SIC, "you are nav mode selected. we're on F-M-S still." The PIC added that it was 6 miles to VINGS and told the SIC to maintain 240 kts at 2,000 ft. The PIC reminded the SIC that they were circling to runway 1 and stated, "so circling minimums…is seven hundred and sixty [ft]." The SIC replied with an expletive.

At 1524:34, the PIC told the SIC that he was changing the autopilot mode to heading select and that he was setting his navigation equipment for the ILS approach. At 1525:08, the SIC stated, "you're gonna have to get on with it—with me when we uh start this #." The PIC then stated, "hey we're tracking the V-O-R inbound now."[17] The SIC stated, "there's the airport," and the PIC responded, "yes sir. we're tracking—we're tracking the localizer excuse me."

At 1525:17, the PIC stated to the SIC, "two forty on the speed sir," which the SIC acknowledged, and a sound similar to decreasing engine thrust was heard on the CVR. At 1525:25,

[17] VOR is the abbreviation for very-high-frequency omnidirectional radio range.

the PIC announced that the airplane was over VINGS and, at 1525:31, told the SIC to "go ahead and pull all the way to idle" to slow the airplane. Radar data indicated that the airplane began to descend and slow. The PIC then stated, "down to one eighty on the airspeed. no. no. no. no. don't # do that yet. we haven't captured the glideslope." At 1526:02, the PIC stated the tower frequency; he then told the SIC to maintain between 180 and 190 kts. At 1526:21, the PIC stated, "before landing checks."

At 1526:32, the controller instructed the flight crew to contact TEB tower and added, "be sure (you) cross DANDY (fitch) hundred feet circle at TORBY."[18] The PIC read back the instruction, stating "DANDY at two hundred feet. circle at TORBY." The controller repeated DANDY at 1,500 ft, and the PIC stated, "DANDY at fifteen." The PIC then twice told the SIC to be at 1,500 ft at DANDY. At 1527:07, the PIC asked the SIC, "you got any indication on uh distance for DANDY?" The SIC replied, "nope. I got nothing." The PIC then stated "six point four [nm to] Teterboro…okay we're fine." When the SIC asked if he should descend, the PIC replied, "not yet." The airplane continued to follow the approach course and crossed DANDY at 2,050 ft.

While crossing DANDY, the airplane reached but flew through the glideslope without descending. At 1527:19, the PIC stated, "glideslope's come'n in you gotta' look at my side." About 17 seconds later, the PIC stated, "it did not capture. trim the nose over," and, "you're gonna have to fly on—you gotta' glideslope on your side?" When the SIC replied, "yes sir," the PIC stated, with emphasis, "follow the glideslope. do not go below fifteen." At 1527:54, the CVR recorded increased background noise consistent with the sound of air drag on landing gear during extension. The PIC then told the SIC (for the second time) to slow to 180 kts so that the PIC could extend the flaps to 20°. CVR and radar data indicated that the SIC slowed the airplane and stopped its descent at 1,600 ft.

The airplane crossed TORBY at 1528:08 at an altitude of 1,550 ft. At 1528:10, the PIC told the SIC, with emphasis, to "follow the # glideslope." The SIC replied, "alright you said don't go below one—," and the PIC replied, "yeah don't go below fifteen 'til I call TORBY." At 1528:17, the controller again instructed the crew to contact TEB tower, which the PIC acknowledged. At 1528:22, before checking in with the tower, the PIC stated to the SIC, "now you can bring it on down." At 1528:27, the PIC added, with emphasis, "seven sixty," which is the published minimum descent altitude (MDA) for the circling approach; the SIC repeated the altitude.

At 1528:30, the TEB tower controller made initial contact with the flight crew, and the PIC responded with "yeah we're up uh for the circling" to runway 1. The controller stated that the wind was from 360° at 16 kts gusting to 32 kts, instructed the flight crew to continue toward runway 1, and stated that traffic was holding in position; the PIC acknowledged this transmission. Following this exchange with the tower controller, the PIC told the SIC, "eight—eight hundred. right there. hold eight hundred." The SIC stated, "(yeah) I am," and the PIC then added, "watch your airspeed. hand on the # throttle." Radar data indicated the airplane was about 2.5 nm from runway 6.

According to radar data, the airplane leveled off at an altitude of about 800 ft while continuing inbound. At 1528:51, the TEB controller asked the pilots where the airplane would be

[18] Questionable words in a CVR transcript are enclosed in parentheses.

parking, and the PIC responded with the parking location. Between 1528:58 and 1529:05, the PIC told the SIC that they would circle for runway 1; stated, "so we're kinda on a downwind" and "so. go'head"; and told the SIC to disengage the autopilot. At 1529:07, the TEB controller asked the pilots if they were going to start their turn, and the PIC replied, "we're doin' it right now." Radar data indicated that the airplane began a right turn after the transmission, when the airplane was about 1 nm from runway 6.

The PIC then directed the SIC through a right turn. Radar data indicated that the airplane descended from about 650 to 350 ft as it turned. At 1529:15, the PIC stated to the SIC, "watch the airspeed"; the SIC then stated, "your flight controls," with emphasis. The PIC did not verbally respond to the SIC's statement. At 1529:18, the enhanced ground proximity warning system (EGPWS) issued an aural "five hundred" feet alert, which the PIC told the SIC to disregard. The 500-ft alert was followed 3 seconds later by an aural alert indicating "sink rate. pull up." Radar data indicated the airplane then rolled wings level and climbed 100 ft. At 1529:26, the SIC said to the PIC, in a strained voice, "I'm gonna give ya your controls, okay?" The PIC replied, "alright. my controls," and the SIC responded, "your flight controls." The PIC stated, "# eh," in an angry tone. He then told the SIC to watch the airspeed.

Radar data indicated that the airplane then began to turn left and that the speed slowed. At 1529:35, the SIC announced, "V-ref" as the airplane slowed; 3 seconds later, he emphasized "add airspeed" and exclaimed "airspeed" three times. Radar data indicated that the airplane reached a left bank angle of 35^{o} and slowed to about 111 kts at 1529:39. At 1529:40, the PIC said, "stall" in a strained voice, and the SIC replied, "yup." At 1529:43, the SIC again exclaimed, "airspeed. airspeed." The PIC stated an expletive, and the EGPWS annunciated "sink rate" and "pull up." At 1529:43.9, the PIC yelled an expletive over the radio, which was the last communication recorded by the CVR and ATC audio recordings.

One witness reported seeing the airplane make two "hard" turns, the last of which was to line up for runway 1. Witnesses reported seeing the airplane nearly inverted in a nose-low attitude just before impact. A security camera recorded the airplane's impact in a parking lot about 0.5 mile south of runway 1 at TEB. Three buildings and 16 vehicles were damaged or destroyed by the impact forces and postcrash fire.

1.2 Flight Crew Information

1.2.1 The Pilot-In-Command

The 53-year-old PIC held a Federal Aviation Administration (FAA) airline transport pilot certificate with a multiengine land airplane rating and Learjet, Beechjet 400 (SIC only), and Mitsubishi MU-300 (SIC only) type ratings, issued on November 26, 2014. The PIC completed his Learjet line check on October 7, 2016 (the date he received his PIC upgrade), and completed a proficiency check on March 20, 2017. The PIC's most recent first-class medical certificate, issued on February 28, 2017, required him to wear corrective lenses. The PIC was current and qualified under FAA and Trans-Pacific requirements.

A review of Trans-Pacific records indicated that the PIC had about 6,898 hours total flight experience, of which 353 flight hours were as a Learjet PIC. In the 90, 30, and 7 days before the accident, the PIC flew about 96, 33, and 8.4 hours, respectively. FAA records of certificate and rating checkrides indicated that the PIC had been issued notices of disapproval for three different certificates but obtained each of the certificates on subsequent attempts.[19]

The PIC was hired as a Learjet PIC by Sunquest Executive Air Charter, LLC (later Trans-Pacific), on July 15, 2016, which was his first job as a PIC for a Part 135 operator.[20] Before being hired by Sunquest (Trans-Pacific), the PIC's most recent aviation employment was with D&D Aviation in Salt Lake City, Utah, as a Learjet and Beechjet SIC. He was a Learjet SIC from May 2006 to February 2009 but was laid off due to a "lack of work." In November 2014, D&D Aviation rehired him as a Beechjet SIC; his employment ended in December 2015 because his contract was not renewed. The PIC's employment status between the D&D Aviation positions is unknown. On an application for an FAA medical certificate dated June 24, 2016, the PIC noted that his occupation was "pilot" and that his employment status was "unemployed." He also reported that he had 6,599 total flight hours, with no hours in the last 6 months.

According to company records and interviews with the Trans-Pacific director of operations, the company requested Pilot Records Improvement Act of 1996 (PRIA) records for the PIC from D&D Aviation on July 10, 2016, but never received a response to the initial request or follow-up telephone calls.[21] FAA Advisory Circular (AC) 120-68G, which addresses PRIA requirements, describes a "good faith exception" to the regulation. Specifically, section 3.5.2 indicates that, if PRIA records are not received from a previous employer, the hiring employer can allow an individual to begin service as a pilot 30 days after submitting the request for PRIA records as long as the hiring employer made "a documented attempt" to obtain that information. Trans-Pacific's director of operations stated that he had hired the PIC based on a recommendation from a friend (the former director of operations for D&D Aviation).

The PIC was enrolled in a 4-day recurrent Learjet training program at CAE Simuflite that began on July 15, 2016.[22] The training plan included 2 days of ground school, 1 day of simulator

[19] On December 18, 1996, the PIC was disapproved for a flight instructor airplane certificate; he was approved on February 3, 1997. On November 29, 1997, the PIC was disapproved for commercial pilot–airplane multiengine land and instrument airplane type ratings; he was approved later that day. On February 7, 2001, the PIC was disapproved for an airline transport pilot–multiengine land type rating; he was approved the next day.

[20] Sunquest Executive Air Charter, LLC, changed its name to Trans-Pacific Air Charter, LLC, in January 2017. Company information is discussed in section 1.10 of this report.

[21] PRIA, as amended, was enacted to ensure that air carriers and air operators adequately investigate a pilot's background "before allowing that individual to begin service as a pilot with their company." Under PRIA, a hiring employer cannot place a pilot into service until that employer obtains and reviews the last 5 years of the pilot's background and other safety-related records. PRIA requirements are codified at Title 49 *United States Code* 44703(h), (i), and (j).

[22] Trans-Pacific used the CAE Simuflite training center in Dallas, Texas, as part of its approved training program. CAE Simuflite is an FAA-certified training center operating under the provisions of 14 *CFR* Part 142. Both the PIC and SIC received training from CAE Simuflite.

training, and a checkride. CAE Simuflite records from July 17, 2016, indicated that, during his first simulator training session, the PIC was graded “Not Yet Proficient - Additional Training Required” for engine failure, circling approach, and landing from a circling approach maneuver. CAE Simuflite used the VOR 4L Circle Runway 31R approach to John F. Kennedy International Airport (JFK), Queens, New York, to both train and evaluate students on circle-to-land approaches. The instructor for that session sent an e-mail to CAE Simuflite’s Learjet manager stating that the PIC had not flown a Learjet for more than 7 years and that the instructor could not recommend him for a checkride due to a lack of proficiency.

On July 18, 2016, the PIC received additional simulator training. His instructor that day sent an e-mail to CAE Simuflite’s Learjet manager stating that the PIC was not recommended for a checkride and that he needed additional training on circling approaches. The instructor also asked the manager to make Trans-Pacific aware of the PIC’s training difficulties. On July 20, 2016, Trans-Pacific received notification that the PIC needed additional training and approved it. During his training course, the PIC accumulated 17.5 hours of simulator flight time: 9.2 hours as PF and 8.3 hours as pilot monitoring (PM).[23] He conducted eight ILS approaches, nine nonprecision approaches, two visual approaches, and five circle-to-land approaches. The PIC completed his simulator checkride on July 24, 2016. The Trans-Pacific chief pilot stated, during a postaccident interview, that he was aware of the PIC’s training difficulties and that he attributed them to the PIC having flown a different airplane model (the Beechjet) during his previous employment.

The National Transportation Safety Board (NTSB) interviewed D&D Aviation and Trans-Pacific pilots who had flown with the accident PIC. Some of his former colleagues at D&D Aviation described the PIC as not proactive with checklists and ineffective in his role as PM. One pilot stated that he and another D&D Aviation PIC had agreed that the accident pilot was not ready to be a PIC. A Trans-Pacific pilot who was qualified on both the Learjet and the Dassault Falcon stated that he had flown with the accident PIC when both were designated as PICs. He stated that the accident PIC had overbanked the Learjet once on approach to landing. The pilot stated that he thought that the accident PIC would need a competent SIC in the right seat.

1.2.2 The Second-in-Command

The 33-year-old SIC held an FAA commercial pilot certificate with single- and multiengine land airplane and instrument ratings and a Learjet type rating (SIC privileges only), issued on October 19, 2015. The SIC completed his Learjet proficiency check on September 29, 2016, and he completed proficiency training on November 1, 2016. The SIC’s most recent first-class medical certificate, issued on October 13, 2016, required him to wear corrective lenses. The SIC was current and qualified under FAA requirements; per Trans-Pacific policy, he was authorized to perform PM duties only (see section 1.10.1.8).

A review of Trans-Pacific records indicated that the SIC had about 1,167 hours total flight experience, of which 407 hours were as an SIC. In the 90, 30, and 7 days before the accident, the SIC flew about 81, 33, and 8.4 hours, respectively. The SIC had been issued notices of disapproval

[23] The term “pilot monitoring” has mostly replaced the term “pilot not flying” (PNF) (FAA 2015). The term PM is used in this report except when directly quoting Trans-Pacific policy documents, which used the term PNF.

for a private pilot single-engine land airplane certificate on April 10 and 13, 2009. He was issued the certificate on April 28, 2009.

Before being employed at Trans-Pacific, the SIC was employed as a Learjet 35A SIC by MedFlight Air Ambulance and was based in Albuquerque, New Mexico. Trans-Pacific hired the SIC on September 1, 2016. Trans-Pacific requested and received the SIC's PRIA records documenting his training and flight check history from MedFlight Air Ambulance.

The SIC was enrolled in a 5-day recurrent Learjet training program at CAE Simuflite that began on September 16, 2016. The training plan included 2 days of ground school, 2 days of simulator training, and a checkride. After the SIC's simulator training session on September 18, 2016, the instructor noted the following:

- Struggled with normal procedures
- Did not perform takeoff checks correctly or know what to look for during the checks
- Did not know how to start the engines
- Crashed on first takeoff due to incorrect flight director settings
- Unable to control speed and altitude during the stall series
- Flew inverted on unusual attitude module
- Crashed on landing during an ILS approach

During circle-to-land training on September 22 and 26, 2016, the SIC was graded "Not Yet Proficient – Additional Training Required." CAE Simuflite e-mail records showed that the SIC's instructor informed the CAE Simuflite Learjet manager and the Trans-Pacific director of operations that the SIC was not ready for his scheduled checkride. The director of operations approved additional simulator training. The SIC completed four additional simulator training sessions and was graded proficient on circle-to-land training on September 28, 2016. The SIC's proficiency checkride on September 29, 2016, did not include (and was not required to include) evaluation of a circle-to-land approach. During his training program, the SIC accumulated 24.7 hours of simulator flight time: 18.6 hours as PF and 6.1 hours as PM. He conducted 17 ILS approaches, 12 nonprecision approaches, 2 visual approaches, and 5 circle-to-land approaches.

The NTSB interviewed MedFlight Air Ambulance pilots and Trans-Pacific pilots who had flown with the accident SIC. The chief pilot of MedFlight Air Ambulance described the SIC's performance as "hit or miss." The chief pilot stated that the SIC was not as proficient as some SICs who had less experience. The chief pilot added that the company had not documented the SIC's weak performance and was considering such documentation, but the SIC voluntarily left the company. A Trans-Pacific PIC who had flown with the accident SIC stated that the SIC was progressing but that he was prone to errors. That PIC also stated that the SIC was not ready for a higher SIC level at the time they last flew together.

The SIC was hired by Short Hills Aviation Services, Inc., in Morristown, New Jersey, as a Dassault Falcon 50/900 SIC. His employment would have been effective on May 23, 2017, and he was scheduled to begin simulator training at CAE Simuflite that same day. Trans-Pacific managers were not aware that the SIC intended to leave the company.

1.2.3 Preaccident Activities and Crew Rest

Trans-Pacific records indicated that the pilots had been scheduled together as a crew during April and May 2017. On May 12 and 13, 2017, the crew completed four flights, accumulating 1.8 flight hours and 7.8 duty hours. The crew was not scheduled to fly for the company on May 14, 2017.

Limited information was available regarding the pilots' 72-hour histories. During a postaccident interview, the PIC's wife stated that she last spoke to him via telephone about 2300 on May 14. She recalled that he was in his hotel room near TEB and was about to go to sleep. The SIC stayed at his mother's home in New Jersey on the night of May 14. During a postaccident interview, the SIC's mother stated that he wanted to go to sleep early because he had an early flight the next morning. Company records indicated that the pilots' rest opportunities in the 72 hours before the accident met FAA requirements.

1.3 Airplane Information

1.3.1 General

The accident airplane, shown in figure 2, was a Learjet 35A manufactured in 1981. The airplane was powered by two Honeywell TFE-731-series engines. Postaccident examination of the airplane and engines did not reveal any preaccident anomalies that would have precluded normal operation.

Source: Rainer Bexten, www.airliners.net.

Figure 2. Accident airplane: N452DA, a Learjet 35A.

1.3.2 Stall Warning System

The accident airplane was equipped with a dual stall warning system that provided both tactile and visual indications of an impending stall. System components included angle-of-attack (AOA) indicators (on the instrument panel at both pilot positions), a stick shaker and stick pusher that could be felt through both sets of controls, and stall warning lights (on the glareshield annunciator panel).

The stall warning system activates based on flap position and stall vane signals.[24] The system produces tactile indications of a stall via the stick shaker, which causes the control column to vibrate, and visual indications of a stall via the AOA indicators, which provide information about the airplane's potential stall hazard with a set of bands that are green, yellow, and red, as described below and shown in figure 3.

- The green band on the AOA indicators represents safe operation; when the airplane is operating in the green band, no stall warning tactile or visual indicators will activate.
- When the stall warning system determines that the airspeed has decreased to about 7% above the system-derived stall speed, the AOA indicators will move into the yellow band, and the stick shaker will activate and remain active until the airspeed increases above that margin. The frequency of stick shaker vibration increases as the airplane's speed approaches stall speed. The stall warning lights illuminate when the stick shaker activates and pulses at the same frequency as the stick shaker.
- When the airplane's airspeed has decayed to just above the system-derived stall speed, the AOA indicators will be in the red band. Within 1 kt of the stall speed, the stall computer sends a signal directly to the elevator servo to initiate nose-down elevator movement via the stick pusher. The stall warning lights remain illuminated when the stick pusher activates.

[24] The left and right stall vanes, located on the forward fuselage, aligned with airflow to provide AOA information to the system. Flap position switches provide information to a computer amplifier, which will decrease stall indication speeds as the flaps move from 0° to 40°.

Figure 3. AOA indicator on the left side of the Learjet 35A cockpit.

1.3.3 Navigation Equipment

The installed navigation equipment relevant to this accident is described below.[25]

1.3.3.1 Navigation Receivers

Two identically functioning navigation receivers, designated NAV-1 and NAV-2, were installed in the airplane to process VOR, ILS, and distance measuring equipment (DME) signals.[26] Tuning a VOR or an ILS frequency in either receiver configured it to process the course signal and, for an ILS frequency, the glideslope signal.[27] Navigation information from the NAV-1 and NAV-2 receivers is displayed on horizontal situation indicators (HSI) on the left and right sides of

[25] Navigation equipment installed on the accident airplane also included an automatic direction finder receiver and a marker beacon receiver.

[26] The NAV-1 receiver provided information to the left side of the instrument panel and the autopilot. The NAV-2 receiver provided information to the right side of the instrument panel.

[27] If a DME transmitter is collocated with the VOR or ILS transmitter, DME information can be received on that channel.

the instrument panel in front of each of the control columns. The HSIs depict course information via a deviation bar that indicates whether the airplane is on, to the left, or to the right of the selected course. Glideslope pointers in each HSI indicate whether the airplane is on, below, or above the glideslope. DME information is also displayed in a digital readout.

1.3.3.2 Flight Management System

The accident airplane was equipped with a Universal Avionics UNS-1K+ FMS that included a navigation computer unit (NCU), GPS receiver, and control display unit (CDU) mounted in the console between the pilot seats.[28] The CDU included an alphanumeric keypad for data entry, a display screen, and various function keys. According to the UNS-1K+ *Operator's Training Manual*, pilots use the FMS for navigation by entering route data in the NCU via the CDU keypad (Universal Avionics Systems Corporation 2009).[29] The NCU uses GPS information and other navigation data to generate course, distance, time, speed, and other navigation information related to the flight plan and displays the information in pilot-selectable formats on the CDU display.

1.3.4 Autopilot

The accident airplane was equipped with a J.E.T. FC-200 automatic flight control system (AFCS) that performed autopilot functions when coupled to the flight controls (autopilot engaged) and flight director functions when not coupled to the flight controls (autopilot disengaged); the autopilot was controlled by the ENG button in the center of the AFCS control panel.[30] The buttons on the AFCS panel that control the roll modes include heading (HDG) and navigation (NAV). Pressing the HDG button engages the heading mode in which the autopilot provides roll inputs to maintain a pilot-selected heading. Pressing the NAV button engages the navigation mode in which the airplane follows the previously engaged roll mode or pilot control inputs until the airplane nears a pilot-selected course from the NAV-1/DME receiver or FMS. As the airplane nears the course, the navigation mode engages, and any previous roll mode disengages. After the navigation mode engages, the autopilot adjusts roll to track the selected course.

The buttons on the AFCS panel that control the pitch modes include speed (SPD), altitude (ALT), and glideslope (G/S). Pressing the SPD or ALT mode button on the AFCS control panel engages the corresponding mode, which then adjusts pitch to maintain the current value for the selected parameter. Pressing the G/S button on the AFCS control panel arms the glideslope mode,

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[28] Although an FMS performs many functions, this report discusses only the navigation functions of the FMS installed on the accident airplane.

[29] Entries used to create a flight plan include, but are not limited to, identifiers for departure procedures, VORs, airways, navigation fixes, arrival procedures, and airports.

[30] (a) The autopilot controlled the airplane in the roll and pitch axes by adjusting the aileron (roll) and elevator (pitch) servos. Yaw control was provided by a separate yaw damper system. (b) The AFCS control panel was mounted in the center of the glareshield on the accident airplane and could be reached from either pilot position.

which is used during ILS approaches.[31] When the airplane approaches the glideslope signal from an ILS transmitter with the glideslope mode armed, the autopilot glideslope mode engages and adjusts pitch to intercept and track the glideslope. If the G/S button is pressed when another pitch mode is engaged, the glideslope mode would arm, but the autopilot would remain in the previous mode until the airplane neared the glideslope. The glideslope mode would then engage to intercept and track the glideslope signal.

1.4 Meteorological Information

The TEB forecast that the PIC obtained about 0637 forecasted wind from 320° at 20 kts with gusts to 32 kts, visibility greater than 6 statute miles, and scattered clouds at 6,000 ft above ground level (agl). At that time, there were limited pilot reports for the area and no in-flight weather advisories. There was no record indicating that the accident pilots obtained any weather information after that obtained about 0831 for the BED-to-PHL flight leg.

The National Weather Service Surface Analysis charts for 1400 on the day of the accident depicted a deep low-pressure system and an associated occluded front located off the northeastern US coast and a strong high-pressure system located over Michigan and Ohio. These conditions resulted in strong, gusting northwesterly winds over the New Jersey/New York area.

A High Resolution Rapid Refresh numerical model sounding noted a moderate and greater potential for low-level windshear below 100 ft agl and a high probability of moderate turbulence between 3,500 and 4,500 ft. Several aircraft in-situ reports also noted strong wind at low altitude and potential turbulence below 5,000 ft.

One-minute wind data from the TEB automated surface observing system, collected from 1509 through 1539, indicated wind from 310° to 340° sustained at 16 to 20 kts gusting to 32 kts.[32] No significant wind shifts were noted, and only slight changes in direction and speed were recorded during the period.

About 1525, the TEB tower controller reported wind from 330° at 19 kts gusting to 29 kts, visibility of 10 statute miles or more, and scattered clouds at 5,500 ft agl. At 1528:36, the TEB tower controller reported wind from 360° at 16 kts gusting to 32 kts. At 1528:45, the TEB tower controller reported that the wind was 18 kts gusting to 32 kts before clearing another airplane for takeoff.

Pilot reports from airplanes within 20 nm of TEB included severe turbulence and/or low-level windshear encounters before and after the accident. About 16 minutes before the accident, a regional jet over LaGuardia Airport (LGA), New York, New York, which was about 10 nm from TEB, issued an urgent pilot report of severe low-level windshear at 700 ft with a 20-kt

[31] When any mode is engaged, a green light above the mode button illuminates to indicate system status. The NAV and G/S buttons also have an amber light above them to indicate that the mode is armed. When either of these modes is engaged after arming, the amber light extinguishes, and the green light above the button illuminates.

[32] The automated surface observing system reported wind relative to true north, whereas ATIS and ATC reported magnetic wind; the variation was 12° west.

loss of airspeed. About 10 minutes after the accident, the flight crew of a corporate jet over Morristown, New Jersey, about 16 nm from TEB, reported severe windshear at 200 ft with a 20-kt airspeed loss.

1.5 Teterboro Airport and Approach Procedures

TEB is a general aviation airport owned and operated by the Port Authority of New York and New Jersey and is located about 1 nm southwest of Teterboro, New Jersey. TEB has two intersecting runways, runway 1/19, which is 7,000 ft long, and runway 6/24, which is 6,013 ft long. As shown in figure 4, TEB is located near three high-volume, commercial airports: LGA, JFK, and EWR. When TEB uses runway 1 (as on the day of the accident due to a strong northwest wind), inbound aircraft are commonly routed to the airport from the southwest via the ILS to runway 6 to limit conflicts with traffic at the other three airports.

Figure 4. Locations of TEB, LGA, JFK, and EWR.

Note: Airplanes flying the ILS runway 6, circle to runway 1 approach typically circle at TORBY; afterward, the airplanes turn right, fly toward MetLife Stadium, and turn left to line up with runway 1. Additional information about the navigational fixes shown in this figure appears in this section.

Vectoring aircraft for an instrument approach procedure to runway 6 followed by a circle-to-land maneuver to runway 1 is a common method of landing aircraft to the north at TEB.[33] The FAA's *Pilot/Controller Glossary* defines a circle-to-land maneuver as follows:

[33] The instrument approach for runway 6 could be flown as either an ILS approach (using course and glideslope guidance) or a localizer approach (using course guidance only). Both procedures are based on navigation information from the ILS.

> A maneuver initiated by the pilot to align the aircraft with a runway for landing when a straight-in landing from an instrument approach is not possible or is not desirable. At tower controlled airports, the maneuver is made only after ATC authorization has been obtained and the pilot has established visual reference to the airport. (FAA 2018)

Because the circling maneuver is a visual maneuver, the pilot is responsible for determining the appropriate point at which to begin to circle to the landing runway.

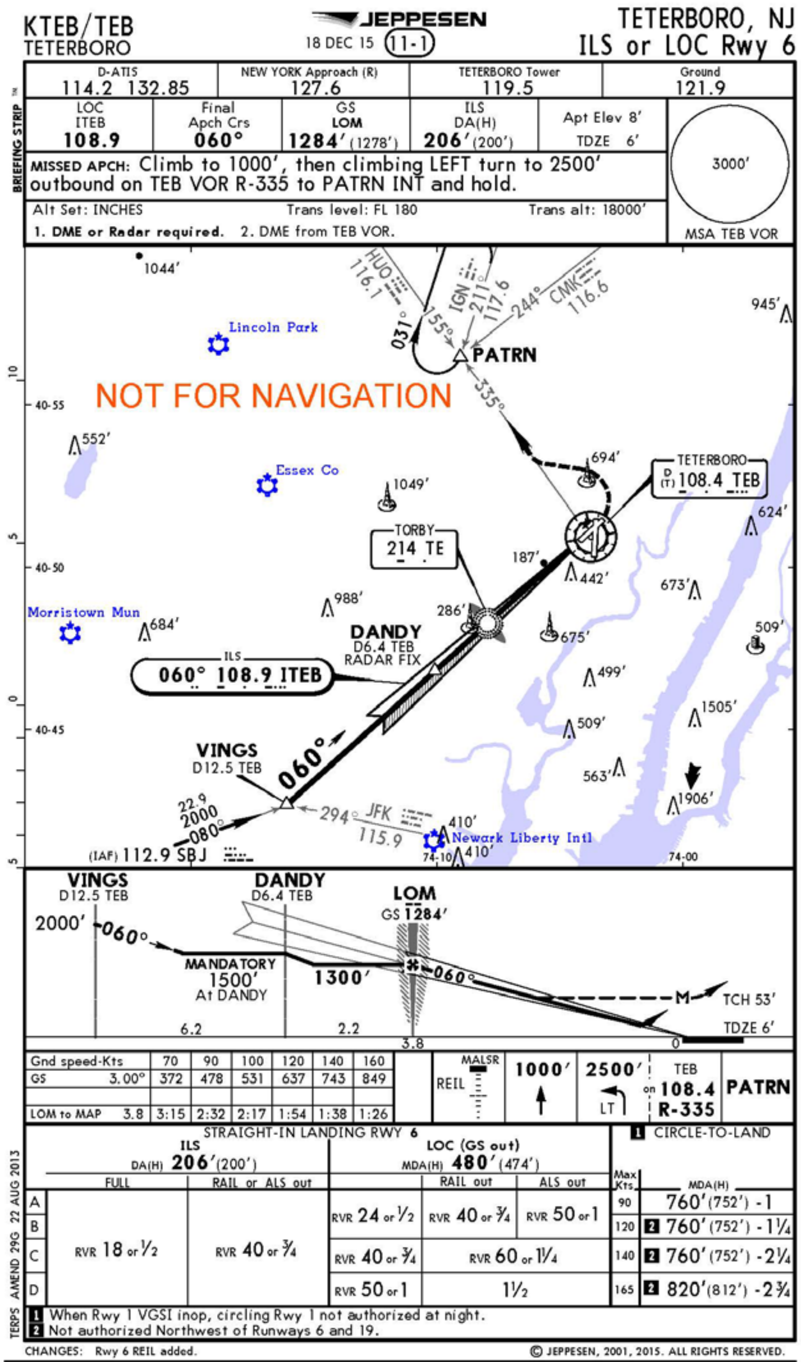
The runway 6 ILS approach procedure, shown in figure 5, includes four navigation fixes (two of which were identified by DME) and the missed approach point; to receive a DME signal, an aircraft on an ILS or localizer (LOC) approach to TEB would have one navigation receiver tuned to the ILS to receive course and glideslope signals and a second navigation receiver tuned to the TEB VOR to receive a DME signal.[34] Information about the fixes and missed approach point appears below.

- The SOLBERG VOR, which is not depicted on the printed instrument approach procedure, is the initial approach fix (as referenced by SBJ in figure 5).
- VINGS is the second approach fix and is 12.5 DME from the TEB VOR. Aircraft are required to be at or above 2,000 ft until they pass VINGS.
- DANDY is the third approach fix and is 6.4 DME from the TEB VOR; this fix can also be identified by ATC, upon pilot request, using radar. Aircraft are required to be at 1,500 ft when passing over DANDY. After passing DANDY, aircraft are permitted to descend to 1,300 ft until reaching the final approach fix (or, if on the ILS approach, intercepting the glideslope).
- TORBY is the final approach fix and is identified by passing the locator outer marker (LOM) or by reaching 1,284 ft while on the glideslope.[35]
- The missed approach point for the ILS procedure is reached when an aircraft following the glideslope signal descends to the decision height or, in the case of a circling approach, descends to the MDA and flies to the missed approach point depicted on the instrument approach procedure.

The MDA is 760 ft for a circling approach. If an aircraft is not in position to land on runway 1, a pilot should execute the missed approach procedure indicated on the approach chart (turn toward the airport, climb to an altitude of 1,000 ft, and intercept the TEB 335° radial).

[34] The fixes use a DME signal from the TEB VOR transmitter rather than the ILS transmitter.

[35] The TEB ILS/LOC approach also includes a LOM, which consists of a nondirectional beacon transmitter collocated with a marker beacon transmitter. The LOM is normally positioned where an aircraft is expected to intercept the glideslope on an ILS approach. The LOM broadcasts a signal that activates visual and audio marker beacon annunciations in aircraft passing overhead.



Source: Jeppesen.

Figure 5. TEB ILS runway 6 instrument approach procedure.

On December 28, 2018, the FAA issued the following notice to airmen: “when circling to [TEB runway] 01, begin maneuver as soon as practical to establish a stabilized approach.” The FAA estimated that the notice would be in effect until December 28, 2020.

1.6 Flight Recorders

The airplane was equipped with a Universal CVR-30 voice recorder, which stored a minimum of 30 minutes of digital audio on solid-state memory modules. Four channels were recorded: one channel for each pilot, one channel for a cockpit observer, and one channel for the cockpit area microphone. The recording began at 1459:44 when the airplane was holding short of runway 35 at PHL. A transcript of the entire recording is provided in appendix C.

The airplane was not equipped with a flight data recorder and was not required by federal regulations to be so equipped.[36]

1.7 Wreckage and Impact Information

Examination of the accident site revealed that the access panel to the right wing tip tank and a fragment that appeared to be from the right (green) navigation light were found on the roof of an office building that was 30 ft tall; this location was consistent with the initial impact point. Fragments of the right wing tip tank were located below the initial impact point. The remainder of the wreckage was found in a debris path that was 315 ft in length and was oriented on a heading of about 135°. The airframe was fragmented by impact forces and damaged by fire. Both aileron quadrants and the rudder quadrant were found with broken cables attached. The cable breaks were consistent with impact damage. The elevator cable was found with continuity through the tail cone. Both flap tracks were found intact. Measurements taken at the crash site indicated the flaps and landing gear were fully extended at impact. Figures 6 through 8 depict the airplane’s initial impact point, ground impact area, and the debris field, respectively.

[36] According to 14 *CFR* 135.152(a), an approved flight recorder is required for multiengine, turbine-powered airplanes and rotorcraft that have a passenger seating configuration of 10 to 19 seats. The accident airplane was configured with eight passenger seats.

Source: Carlstadt, New Jersey, Police Department.

Figure 6. Security video image of N452DA at ground impact.

Note: The NTSB enhanced the image in the red square to emphasize pertinent information.

Figure 7. Photograph of the initial impact point and start of the debris path.

Figure 8. Photograph of the continuation of the debris path.

Both engines were found separated from the main wreckage near the farthest point of the debris path. The left engine traveled about 25 ft farther than the right engine. Compressor blades from both engines were bent opposite the direction of rotation; the blades also exhibited tearing and battering damage, indicating that the engines were operating at the time of impact. The oil caps from each engine were found in place, and oil drained from both engines when they were moved. The thrust reversers from both engines were found in the stowed position.

1.8 Medical and Pathological Information

The Bergen County Medical Examiner's Office, Paramus, New Jersey, performed autopsies on the pilots. The cause of death for each pilot was multiple blunt trauma injuries. The FAA's Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma, performed toxicology testing on specimens from each pilot; results for both pilots were negative for ethanol and commonly abused drugs.[37]

[37] Only the pilots' muscle tissue was available for toxicological testing.

1.9 Tests and Research

The NTSB completed radar, CVR sound spectrum, and surveillance video studies to better understand the airplane's performance during the accident flight. Airplane performance parameters were derived primarily from radar data; limited data from the airplane's EGPWS were used to supplement the radar data.

Figure 9 shows the airplane's approach to the airport starting just before TORBY, the final approach fix. Radar data indicated that the airplane began the circle-to-land maneuver about 2.8 nm beyond TORBY (1 nm from the TEB runway 6 threshold). During the airplane's first turn to the right, the bank angle reached 28°, and the airspeed decreased from 127 to about 123 kts starting at 1529:16. The airplane's altitude also decreased from 650 to 350 ft during the right turn. After the EGPWS 500-ft callout at 1529:18, the airplane returned to wings level and climbed 100 ft. About 1529:36, the airplane began a left turn toward the runway at an altitude of 450 ft and an airspeed of 120 kts. At 1529:39, the airplane reached a left bank angle of 35°, and the airspeed decreased to about 111 kts.

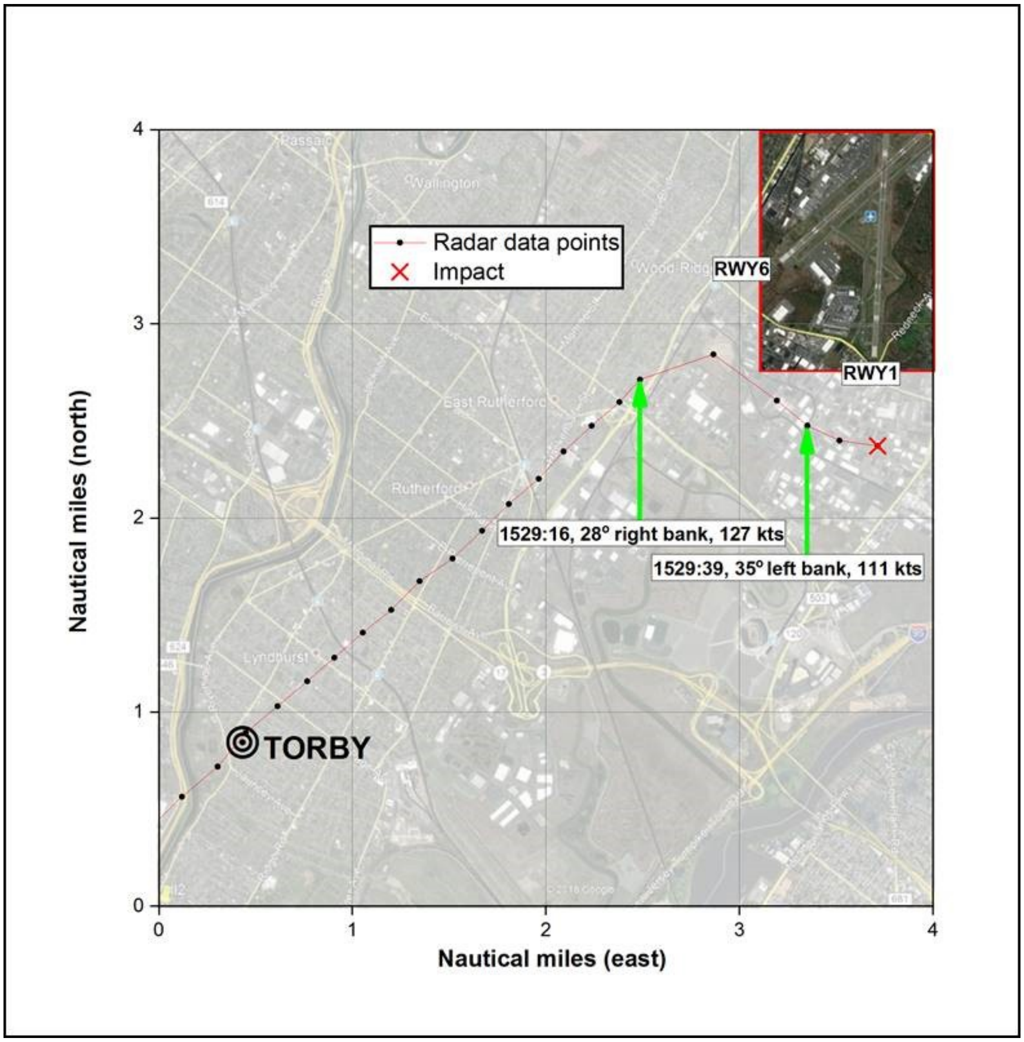


Figure 9. Radar data depicting the airplane's track during the approach.

Manufacturer-provided data indicated that the stall speed for the accident airplane in a 35° level turn was 102 kts. Although radar data indicated that the airplane remained 9 kts above the stall speed during the final left turn, the margin does not account for the effect of wind gusts or flight control inputs that could reduce the airplane's airspeed below the stall speed. The left-wing-down aileron input required to make the turn to final and to counter the strong left crosswind would have increased the AOA of the right wing and potentially led that wing to stall first, inducing a roll to the right. Radar data and the security video showed that the airplane rolled to the right (away from the runway) before impact.

A sound spectrum study of the CVR was conducted to determine the airplane's engine speed, particularly at the end of the flight after the landing gear was extended. However, after the landing gear extended, the signal-to-noise ratio was insufficient to definitively extract engine speed information.

1.10 Organizational and Management Information

At the time of the accident, Trans-Pacific was a privately held company based in Honolulu, Hawaii, and was certificated to operate under 14 *CFR* Part 135.[38] At the time of the accident, Trans-Pacific operated six airplanes and had nine pilots.[39] Company management included a director of operations (who also acted as safety officer and charter coordinator), a chief pilot, and a director of maintenance.

1.10.1 Trans-Pacific Operational Policies and Procedures

Trans-Pacific's policies and procedures were published in two manuals: the *Trans-Pacific Jets General Operations Manual* (GOM) and the *Standard Operating Procedures* (SOPs) manual.

1.10.1.1 Preflight

Among preflight activities, Trans-Pacific SOPs listed performing the mission briefing, obtaining weather information, and completing flight planning. The SOPs stated that "the mission briefing is a general overview of all assigned flight legs, any layover periods and other factors pertinent to the mission." The SOPs stated that the mission briefing should include the following items:

1. Duty position assigned to each crewmember.

2. Aircraft (by registration number) and the status of that aircraft, making note of deferred items or repeat discrepancies.

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[38] Trans-Pacific moved its principal base of operations from Van Nuys, California, to Honolulu, Hawaii, in May 2016. The company's principal maintenance base moved to Honolulu in March 2017.

[39] The operator's six airplanes comprised two Dassault Falcon AMD-50-50s (Falcon 50), one Learjet 31A, and three Learjet 35As. The operator employed three PICs and one SIC for the Falcon airplanes and three PICs and two SICs for the Learjet airplanes. The company did not employ a Learjet-qualified check airman.

3. Assigned flight legs [to] include departure airport, destination airport, departure times, estimated arrival and flight times.

4. Planned routing for each flight leg, including pertinent navigation aids, en route weather, winds aloft, altitudes, turbulence, SIGMETS [significant meteorological information], etc.

5. Departure and arrival airport information including NOTAMS [notices to airmen], runway lengths, instrument approach procedures, terrain, special considerations and taxi route from the runway of expected landing to the FBO [fixed-based operator].

The SOPs also stated that the mission briefing "may include other items…as necessitated by the nature of the mission," In addition, the SOPs required flight crews to obtain weather information from an approved source (listed in the GOM) and complete flight planning no earlier than 3 hours before their scheduled departure time.

1.10.1.2 Checklists

According to the Trans-Pacific GOM, pilots were to conduct checklists using one of three FAA-accepted methods. The GOM described the types of checklists as follows:

> **Do List:** The do list is a checklist that must be completed as written, but may be done silently by a single pilot crewmember. It is standard practice that when a 'do list' checklist is completed by a single pilot crewmember, that the other pilot crewmember conduct a second check to assure that all items are completed. In the event that an item is found to have not been completed as required by the 'do list' checklist, the checklist is to be completed in its entirety again.
>
> **Challenge and Response:** Challenge and response checklists require the presence and participation of both flight crew members. This method of checklist completion is typically utilized when the aircraft is not in motion. During the use of this checklist completion method, the PNF [pilot not flying] will read the checklist items and elicit a response from the PF. Any movement of controls or switches or operational checks will be verbalized and conducted by the PF. The PF may command the PNF to complete all or some of an operational check or control movement, but only if ordered should the PNF do so. Additionally, if ordered to manipulate any controls or switches, the PNF must verbalize all actions as they occur.
>
> **Challenge and Self-Response:** When an aircraft is in motion checklists are usually conducted as a challenge and self-response checklist. While completing a checklist using this method, the PF will focus on control of the aircraft and monitoring the surrounding ramp, taxiways, or airspace. The PNF will read the checklist aloud while responding aloud with the action taken with regards to the checklist items. This is done so that the PF can monitor the actions are being taken as required without distracting him or her from flying the aircraft.

Trans-Pacific Learjet 35A pilots used checklists in the CAE *Learjet 35/36 Operating Handbook*, dated May 2012. Section 12.4.3 of the GOM stated the following about checklist use:

> It is Trans-Pacific Air Charter's policy that the use of checklists are [sic] to be as they are written – verbatim, smartly, and professionally. Skipping items, modifying checklist flow or adding items undermines the effectiveness, standardization and is prohibited. If divergence from standard checklist use is observed, it is the duty of any Trans-Pacific Air Charter employee to query the divergence and, if necessary, restart the checklist as it is written.
>
> Checklists should be initiated by command of the PF. Good resource management requires that, if in the opinion of the PNF (pilot not flying), the initiation of a checklist has been overlooked, the PNF inquire with the PF as to whether that checklist should commence.

According to the Trans-Pacific SOPs, the Before Taxi checklist was a challenge and response checklist. The Taxi, Before Takeoff, After Takeoff, Climb, Cruise, Descent, Approach, and Before Landing checklists were all challenge and self-response checklists.

During the accident flight, the crew referenced three checklists. The PIC verbalized steps from the Runway Lineup checklist and the After Takeoff checklist.[40] The PIC also called out the initiation of the Before Landing checklist. The latter two checklists, which are relevant to the accident, are shown below.

The After Takeoff checklist read as follows:

	PM	**PF**
1.	Landing Gear	UP
2.	Yaw Damper	ENGAGED
3.	Flaps	UP
4.	Thrust Reversers (below 200 kts)	OFF
5.	Anti-ice Systems	AS REQUIRED
6.	Air Ignition	AS REQUIRED or OFF
7.	Landing/Taxi Lights	OFF
8.	Pressurization	MONITORED
9.	Autopilot APPR Light	OUT
10.	Hydraulic Pressure	NORMAL
11.	Angle-of-attack Sensors	CROSS CHECK

[40] Checklists were initiated by PF callouts. Most checklists were initiated by a PF callout of the checklist title, such as "Descent Checklist." Other checklists were initiated with callouts that included the checklist title after a command. For example, the PF callout to initiate the Before Landing checklist was "Gear down, Before Landing Checklist." The initiating callout for the After Takeoff checklist did not include the title of the checklist. The PF callout to initiate the After Takeoff checklist was "Gear up, Yaw Damper on."

The Before Landing checklist read as follows:

	PM	PF
1.	Spoilers	RETRACTED
2.	Flaps	AS DESIRED (8° or 20°)
3.	Landing Gear	DOWN
4.	Engine Sync	OFF
5.	Anti-Skid	ON/LIGHTS EXTINGUISHED
6.	Landing/Taxi Lights	ON
7.	Thrust Reversers (below 200 kts)	ARMED
8.	Cabin	CHECKED
9.	Flaps	DOWN
10.	Hydraulic Pressure	CHECKED
11.	Air Ignition	ON
12.	Autopilot	DISENGAGED
13.	Yaw Damper	DISENGAGED

Trans-Pacific SOPs also provided specific guidance for distinct flight phases. Section 5.1.1 of the SOPs stated that, before the top of descent,

> A review of the assigned arrival procedure will be conducted by both the Pilot Flying and Pilot Not Flying and the Pilot Not Flying will validate that the waypoints in the FMS or GPS match the waypoints defined by the applicable navigation chart.

1.10.1.3 Crew Coordination

Section 12.4.5 of the Trans-Pacific GOM identified actions performed by the PF and the PM, stating the following:

> A coordinated crew is required for maximum workload dispersal, awareness, and general safety. Seemingly small duties can lead to serious distractions if a divergence from the standard protocols occurs.

Section 12.4.5 listed all FMS functions as PM actions.

1.10.1.4 Approach Briefing

According to section 12.4.4 of the Trans-Pacific GOM and section 5.1.5 of the Trans-Pacific SOPs, pilots were required to conduct an approach briefing for every approach and landing.[41] The brief could be completed any time before the airplane reached 10,000 ft height above the airport. (The manual did not specify when the approach brief should be conducted on flights that were operated below 10,000 ft, such as the accident flight.) The approach brief (SOPs, page 5-5) consisted of 14 items, including the following:

- type of approach (approach chart page number and revision date);
- approach navigation aid frequencies and identifying code, as defined by the approach chart;
- intercept altitude or altitude stepdowns, as defined by the approach chart;
- expected altitude at the final approach fix;
- the missed approach point, MDA, and/or decision altitude, as defined by the approach chart; and
- any deviations from the SOPs.

1.10.1.5 Stabilized Approach

The Trans-Pacific GOM and SOPs required that all flights be stabilized by 1,000 ft height above the airport unless that criteria could not be met "due to approach considerations or abnormal aircraft conditions." Trans-Pacific's SOPs (section 6.1.1) provided the following criteria for a stabilized approach:

- On the correct vertical and lateral flight path.
- Requiring only small changes to pitch and heading.
- Within 10 knots of target speed as defined by the approach briefing.
- Aircraft configured for landing.
- Sink rate of no greater than 1,200 [feet per minute], unless required by the approach.
- Appropriate power settings for the approach without need for drastic changes.

[41] According to the Trans-Pacific SOPs, section 5.1.5, "dictating 'Standard Briefing' is not considered a proper briefing by Trans-Pacific Air Charter and should not be used." The SOPs further stated, "operations defined in these SOPs are applicable to a standard approach, and when abnormal routing is expected the flight crew shall brief any divergence from these SOPs."

- Aircraft aligned with the runway for straight-in landing by no less than 500 feet [height above the airport].

- All briefings and checklists complete.

1.10.1.6 Circle-to-Land Approach

Trans-Pacific's operations specification C075 authorized pilots to conduct a circle-to-land maneuver to the runway of intended landing using the lowest IFR landing minimums. Trans-Pacific pilots were required to complete approved training and a proficiency check on the circle-to-land approach.[42]

1.10.1.7 Approach Speeds

Trans-Pacific SOPs (section 5.1.7) defined a precision approach as "any instrument approach with vertical and lateral guidance" and stated that precision approach SOPs "shall be followed even if that precision approach is executed in VMC." Trans-Pacific SOPs for a precision approach called for an approach speed of V_{REF} +20 kts before glideslope intercept and an airspeed of V_{REF} +10 kts after glideslope intercept. Trans-Pacific SOPs for a visual approach called for an approach speed of V_{REF} +20 kts until established on final approach to the landing runway and an approach speed of V_{REF} +10 kts thereafter.

1.10.1.8 Trans-Pacific Second-in-Command Policy

At the time of hire, Trans-Pacific SICs were classified SIC-0, which meant that they could only perform PM duties. To be authorized as PF, an SIC had to first be designated SIC-1 by management, which would allow the SIC to act as PF with a check airman or management pilot for evaluation on nonrevenue flights before potential advancement to SIC-2 through -4. The designations SIC-2 through -4 allowed an SIC to be PF in various scenarios under the supervision of a line PIC. The following table outlines the guidance provided in the Trans-Pacific GOM (section 11.3.3, page 11-4) for each of the SIC levels.

Table. Trans-Pacific SIC positions and authorized duties.

Position	Authorization
SIC-0	Pilot may only perform SIC duties as PM.
SIC-1	Pilot may act as PF on nonrevenue flights when authorized for observation by a Trans-Pacific Air Charter check airman or management pilot.
SIC-2	Pilot may act as PF from the right pilot seat on nonrevenue flights.
SIC-3	Pilot may act as PF from the left pilot seat on nonrevenue flights.
SIC-4	Pilot may act as PF on alternating legs from the left pilot seat at the discretion of the PIC.

During a postaccident interview, the director of operations stated that he had adopted the Trans-Pacific SIC policy from a previous employer. He stated that the SIC policy was intended to

[42] The PIC attended recurrent training that included circle-to-land training from July 15 to 18, 2016; the SIC attended circle-to-land training on September 22 and 26, 2016. For more information, see section 1.2 of this report.

ensure that SICs had acceptable skills before giving them additional responsibilities. The director of operations stated that the company tried to assess SICs' readiness to advance about once per month. He stated that the accident SIC, who was designated SIC-0 at the time of the accident, was not yet ready to perform PF duties but was improving.

During the accident SIC's period of employment at Trans-Pacific, there were no Learjet-qualified management pilots or check airmen to fly with an SIC-1.[43] The SIC from the company's other Learjet flight crew, who was an SIC-0 and had been with the company for 6 months, reported that the PIC with whom he was normally paired had allowed him to act as PF on five or six positioning flight legs.

1.10.2 Crew Resource Management Training

Title 14 *CFR* 135.330, "Crew Resource Management [CRM] Training," requires each Part 135 certificate holder to have an approved CRM training program that includes initial and recurrent training and at least the following elements:

1. Authority of the pilot in command;
2. Communication processes, decisions, and coordination, to include communication with Air Traffic Control, personnel performing flight locating and other operational functions, and passengers;
3. Building and maintenance of a flight team;
4. Workload and time management;
5. Situational awareness;
6. Effects of fatigue on performance, avoidance strategies and countermeasures;
7. Effects of stress and stress reduction strategies; and
8. Aeronautical decision-making and judgment training tailored to the operator's flight operations and aviation environment.

Trans-Pacific used a PowerPoint presentation consisting of 27 slides for its CRM training. The presentation addressed effective communication, team building, the use of strategies for workload management, and the use of crew briefings.[44] The training also included scenarios for discussion. The training materials highlighted the negative effects of excessive workload and stated that high workload could be "mitigated through use of effective crew coordination."

Trans-Pacific's CRM training presentation discussed leadership in three bullet points on one slide, which stated that "a leader's actions and ideas influence the thoughts and behavior of others," "leadership is acquired," and "a leader can be either crew member and must know how to

[43] Trans-Pacific no longer operates Learjet airplanes.

[44] The PIC attended Trans-Pacific CRM training on July 8, 2016, and the SIC attended this training on August 26, 2016.

effectively communicate ideas and observations." Trans-Pacific's CRM training also advised that "good followership skills allow for the follower to step up to leader when necessary."

1.10.3 Trans-Pacific Safety Policy

According to the Trans-Pacific GOM, the company safety officer was responsible for monitoring company activities using safety assessments, identifying areas in which corrective measures were necessary, recommending improvements, and ensuring continued compliance with best practices for operational safety. During a postaccident interview, the director of operations stated that the company had no formal safety reporting systems but that an open-door, nonpunitive policy was in place. The director of operations stated that, at the time of the accident, the company was in the process of adopting a safety management system (SMS) that would include a formal risk assessment tool.[45]

1.11 Manufacturer Guidance on Wind Additives

The Learjet 35A airplane flight manual (AFM) stated the following concerning approach speed in gusty wind or windshear conditions:

> It is recommended that if turbulence is anticipated due to gusty winds, wake turbulence, or wind shear, the approach speed be increased. For gusty wind conditions, an increase in approach speed of one half the gust factor is recommended.

1.12 Federal Aviation Administration Oversight

An FAA principal operations inspector (POI) based in the Van Nuys, California, flight standards district office (FSDO) had provided oversight for the Trans-Pacific certificate for about 6 years at the time of the accident.[46] According to the POI's postaccident interview, his primary method of conducting oversight was reviewing company records, including the GOM, SOPs, and PRIA documents. The POI had observed Trans-Pacific's basic indoctrination training for new employees from August 24 to 26, 2016, in Honolulu but had never observed a Trans-Pacific pilot checkride at CAE Simuflite. He was not aware of the Trans-Pacific SIC qualification policy.

Because Trans-Pacific did not have any Learjet-qualified check airmen before and at the time of the accident, the POI conducted line checks for the company's Learjet pilots. The POI completed the accident PIC's line check on October 7, 2016, which he passed. The POI stated that

[45] The FAA describes SMS as a "formal, top-down business-like approach to managing safety risk" (FAA 2016). The FAA states that SMS provides structure, accountability, policy, and procedure to the safety process. Only Part 121 carriers are required to incorporate SMS; however, the FAA has advocated for SMS implementation beyond Part 121 operations. To demonstrate the scalability of SMS, the FAA released a video, *SMS for Small Operators*, in 2013 that described a process for SMS implementation by any operator (FAA 2013).

[46] Oversight of Trans-Pacific's certificate was transferred from the Van Nuys FSDO to the Honolulu FSDO in June 2017. The POI considered his working relationship with the director of operations at Trans-Pacific to be "amicable" but stated that Trans-Pacific had "buried us in paperwork" associated with the company's move from Van Nuys to Honolulu.

he had debriefed the PIC on disengaging the yaw damper during the circle-to-land maneuver and using standard callouts as part of CRM.

The POI added that "you would never really know if pilots were complying with SOPs for every flight" based on the primary method of ensuring compliance with SOPs through line checks for PICs. FAA Order 8900.1, *Flight Standards Information Management System*, states the following about the benefits of FAA en route inspections:

> The primary objective of cockpit en route inspections is for an inspector to observe and evaluate the in-flight operations of a certificate holder within the total operational environment of the air transportation system. En route inspections are one of the Federal Aviation Administration's (FAA) most effective methods of accomplishing its air transportation surveillance objectives and responsibilities. These inspections provide the FAA with an opportunity to assess elements of the aviation system that are both internal and external to an operator.

Thus, unlike a line check, an en route inspection allows an FAA inspector to observe and assess a certificate holder's operation as a whole. The order further states that cockpit en route inspections provide an opportunity to observe flight crews during each phase of flight and evaluate crewmember adherence to approved procedures and checklists. The standard for evaluation of the approach phase of flight states, "Procedures used during the selected approach (instrument or visual) should be accomplished as outlined in the operator's maneuvers and procedures document." In addition, the order directs FAA inspectors to observe PICs' CRM techniques, delegation of duties, and overall conduct.

The POI indicated that he had never done an en route inspection of Trans-Pacific or any other Part 135 operator, stating that "the operator would not like it on a revenue flight." The POI also stated that he would have to pay for a return flight and that an en route inspection would be difficult to schedule.

The en route inspection information cited above appeared in a section in the FAA order (volume 6, chapter 2, section 9) with a title that referenced the FAA's Safety Assurance System (SAS). In its August 2015 response to a 2003 safety recommendation that resulted from an accident involving a Part 135 on-demand passenger charter flight (Safety Recommendation A-03-51), the FAA stated that the SAS would be implemented as a new oversight system for Part 135 operators.[47] As of February 2019, the SAS had not been fully implemented for Part 135 operations.

[47] Safety Recommendation A-03-51 asked the FAA to "conduct en route inspections and observe ground training, flight training, and proficiency checks at all 14 *Code of Federal Regulations* Part 135 on-demand charter operations as is done at Part 121 operations and Part 135 commuter operations to ensure the adequacy, quality, and standardization of pilot training and flight operations." The NTSB issued this recommendation as a result of the October 2002 accident involving a Raytheon (Beechcraft) King Air A100 in Eveleth, Minnesota (NTSB 2003). The crash occurred while the flight crew was attempting to execute a VOR approach; a loss of control and impact with terrain ensued. The NTSB classified this recommendation "Closed—Unacceptable Action" on November 19, 2015.

2. Analysis

2.1 Introduction

This accident occurred when the Learjet 35A, operated by Trans-Pacific Jets (a Part 135 operator) as a Part 91 positioning flight, departed controlled flight and crashed during a circling approach to TEB, killing the two pilots and destroying the airplane.

This analysis discusses the accident sequence (section 2.2) and evaluates the following:

- the effect of preflight planning and decision-making on flight crew performance during the accident flight (section 2.3),
- the use of FDM programs for detecting noncompliance with SOPs (section 2.4),
- FAA safety programs for Part 135 operators (section 2.5),
- CRM and leadership training requirements for Part 135 operators (section 2.6), and
- Trans-Pacific policies relating to SIC qualification and approach speed wind additives (section 2.7).

Having completed a review of the circumstances that led to the accident, the NTSB found no evidence that any of the following contributed to the cause of the accident:

- **Flight crew FAA qualifications:** The PIC and SIC were certificated, current, and qualified in accordance with federal regulations.
- **Flight crew medical conditions:** The PIC and SIC held valid and current FAA airman medical certificates. A review of information about the PIC's and SIC's recent activities, work schedule data, and other company and FAA records showed no evidence of impairment or performance degradation due to preexisting medical conditions for either pilot.
- **Flight crew alcohol or other drug use:** Toxicology testing on specimens from each pilot revealed no evidence of alcohol, medication, or other substance that could have affected the ability of either pilot to safely fly the airplane.
- **Airplane mechanical condition:** Examination of the airplane's airframe, engines, and systems identified no evidence of preimpact anomalies or malfunction that would have precluded normal operation. The crew did not discuss or report to ATC any airplane anomalies or malfunctions during the flight.

Thus, the NTSB concludes that the flight crew was properly certificated; there was no indication that the flight crew was impaired by medical conditions, alcohol, or other drugs; and there were no preimpact airplane anomalies that would have precluded normal operation.

In addition, as stated in section 1.2.1, Trans-Pacific requested, but did not receive, PRIA records for the PIC and placed him in revenue service for the company without an evaluation of these records. The NTSB reviewed the PRIA records for the PIC as part of this accident investigation and found no failures at the PIC's previous employer. Thus, the lack of PRIA records for the PIC was not a factor in this accident because nothing in the records would have precluded Trans-Pacific from placing the PIC in revenue service.

2.2 Accident Sequence

2.2.1 Preflight Planning, Taxi, and Takeoff

Trans-Pacific SOPs did not include specific preflight planning tasks but required the PIC to include planned routing, pertinent navigation aids, and en route weather (among other information) in a crew mission briefing before every flight. The only evidence of preflight planning for the accident flight was the IFR flight plan filed using the PIC's DUATS account less than 1 hour before the accident flight's departure. The flight plan listed an estimated flight time of 28 minutes and requested an en route altitude of 27,000 ft, which were not compatible with each other because it would have been impractical to climb to and descend from 27,000 ft in 28 minutes. Such a discrepancy suggests that the PIC devoted little attention to planning the flight from PHL to TEB and that the planning that he did accomplish was inadequate. Although a weather forecast for TEB was obtained at 0637 in preparation for an earlier flight, there was no evidence that the crew obtained weather information for the accident flight leg to TEB, which was contrary to the Trans-Pacific's SOPs requiring that the PIC obtain weather information within 3 hours of a scheduled departure. Thus, the NTSB concludes that the PIC's preflight planning was inadequate and incomplete.

About 4 minutes before takeoff, the PIC told the SIC, "okay I think we're next man. hand on your yoke," indicating that the SIC was the PF. The PIC coached the SIC through the takeoff sequence and most of the remainder of the short flight. Due to the SIC's lack of experience, he had the lowest classification under Trans-Pacific's graduated SIC qualification program. As a result, he was not authorized by the company to act as PF. Thus, the NTSB concludes that the PIC's decision to allow the SIC to act as PF was improper and contrary to company SOPs. (See section 2.7.1 for more information on Trans-Pacific's SIC policy.)

As the PF, the SIC did not initiate the After Takeoff checklist, as required by Trans-Pacific SOPs, which the PIC corrected by initiating the items on the checklist himself and telling the SIC "ya gotta tell me to do that." However, the reminder did not prompt the SIC to initiate any other checklists, which he should have done as PF. The crew's nonstandard checklist execution likely occurred because they were not acting in their usual roles during the accident flight (the PIC usually acted as PF, and the SIC usually acted as PM). The effects of this role reversal are discussed further in section 2.3.1.

2.2.2 En Route and Approach

About 2 minutes after takeoff, as the airplane leveled off at 4,000 ft, the PIC coached the SIC's power control and use of trim and reminded him to "watch the altitude." About 8 seconds later, the PIC told the SIC to keep the airspeed below 250 kts; about 24 seconds after that (the first of 12 times during the flight), the PIC prompted the SIC to check the airspeed. The CVR did not record either pilot initiating, verbalizing steps from, or announcing the completion of the Climb or Cruise checklists (as required by Trans-Pacific SOPs for those phases of flight).

About 8 minutes after takeoff, the PIC requested a higher altitude from PHL approach control despite the estimated flight duration of 28 minutes, as indicated in the flight plan. PHL approach control told the flight crew that the request was denied because it would require resequencing the flight's arrival. About 2 minutes later, New York approach control provided the crew vectors for the ILS approach to runway 6, circle to runway 1 at TEB. The PIC repeated the vectors but not the approach assignment and commented to the SIC, "he was saying circling # six or something. I don't know what the # they thinkin' we're doin'. we're # hundreds of miles away man." Radar data indicated that the airplane was about 48 nm away from TEB at that time. The SIC responded to the PIC by indicating that they would arrive in "like # an hour." About 15 seconds later, the PIC acknowledged the New York approach controller's clearance to descend to 3,000 ft.

At 1515:22, the PIC stated, "we're # gonna be there in ten minutes. I gotta get the # ATIS. #. I didn't realize we're that # close." This discussion indicates the pilots' lack of understanding of the route and positional awareness along the route (likely due to his poor preflight planning). Further, although the crew was provided with the approach to expect into TEB, the PIC did not seem to be clear about the approach and did not ask for clarification; he expressed his confusion only to the SIC and not the controller. Had the PIC asked the controller for clarification about the circling approach, the pilots might have had a better mental model of the circle-to-land maneuver that they would be flying; that clarification could then have been reinforced during an approach briefing (which the crew did not perform).

While the PIC listened to the ATIS broadcast beginning at 1515:46, the New York approach controller instructed the flight crew to turn southeast to a heading of 120°, which the PIC acknowledged. The PIC then tuned the radio off the ATIS frequency and relayed only the altimeter setting to the SIC, with the PIC stating that he did not have time to listen to the full broadcast. The CVR did not record the crew verbalizing steps from or announcing the completion of the Descent checklist, which the operator's SOPs required the PF to initiate and the PM to perform using the challenge and self-response method.

Radar data indicated that the airplane was southwest of TEB when the PIC stated, "but they got us at # three thousand. really?…and we're goin' # south we're not goin' # north" in a high-pitched loud voice. The ATC instruction to turn southeast appropriately placed the airplane on a course that would intercept the final approach course, which tracked northeast; the PIC's confusion further indicates his lack of understanding of the route and approach and the airplane's position on the route.

The flight crew began the approach but did not conduct an approach briefing, which the operator's SOPs required for every approach and landing. The PIC was likely referencing the Approach checklist when he stated, at 1517:59, "let's do the checklist," which the SIC should have initiated as the PF. About 25 seconds later, the PIC stated, "approach is one twenty-six. V-ref is one-nineteen," but did not verbalize any checklist steps.

At 1519:17, the controller instructed the flight crew to intercept the localizer for runway 6. At 1519:40, the PIC told the SIC to set his navigation equipment for the TEB ILS. At 1520:09, the PIC stated that he was also setting his navigation equipment for the ILS. Shortly afterward, the airplane flew through the localizer course to TEB.[48] Neither pilot noted that the airplane had not intercepted the course until informed twice by the controller. In addition, neither pilot detected that one of the navigation receivers was not tuned to the TEB VOR, which was necessary to identify DANDY (the third approach fix). This error might have been detected if an approach briefing had been conducted.

After the airplane began to track the localizer course about 1521, the PIC continued to coach and reassure the SIC on airspeed and navigation. Between 1521 and 1524, the PIC mentioned being "on" the FMS three times and appeared to have added VINGS (the second approach fix) to the FMS flight plan (as indicated by the PIC's statement "V-I…N-G-S"). However, these statements indicate that the crew had not programmed the approach waypoints into the FMS flight plan before descent, as Trans-Pacific policy required; the pilots' failure to program the FMS might have also contributed to their poor positional awareness on the approach. After receiving (at 1523:23) and reading back a clearance for the ILS runway 6 approach, along with an instruction to conduct a circle-to-land maneuver, the PIC reminded the SIC to circle to runway 1 and added "so circling minimums. is seven hundred and sixty [ft]."

From about 1525 to 1528, the flight crew mismanaged the vertical profile for the TEB ILS approach. After reaching VINGS, the PIC told the SIC, at 1525:31, to reduce thrust "all the way to idle" to decrease the airspeed to 180 kts, as instructed by New York approach control. The power reduction caused the airplane to descend, and the PIC stated "no" four times and, "don't # do that yet. we haven't captured the glideslope," suggesting that the PIC did not understand that the approach required a descent to 1,500 ft. At 1526:32, the controller instructed the flight crew to contact the TEB tower and added, "be sure (you) cross DANDY (fitch) hundred feet circle at TORBY[the final approach fix]."[49] The PIC read back the instruction to circle at TORBY. The circling maneuver is generally begun at the pilots' discretion because it is a visual maneuver at that point. However, in this case, because the controller told the flight crew to circle at TORBY, the flight crewmembers were required to either comply with the instruction or tell the controller that they were unable to comply. Neither occurred.

The controller repeated the instruction for the airplane to be at 1,500 ft at DANDY, and the PIC twice stated this information to the SIC. When the SIC asked if he should descend, the PIC replied, "not yet." The airplane crossed DANDY at 2,050 ft and passed through the glideslope without capturing it. It is possible that the autopilot glideslope mode was not armed and the glideslope button on the AFCS panel was not pressed, which had to be accomplished before reaching the glideslope, and that neither pilot monitored to ensure activation. It is also possible

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[48] At 1520:49, the SIC asked the PIC, "you want me to hit nav?" About 7 seconds later, the PIC responded, "there we go." Given these cockpit communications, which occurred when the airplane was turning toward the localizer, and the airplane's straight-line track (as shown by radar data), the flight crew had likely armed the localizer in autopilot NAV mode, and the autopilot tracked the localizer inbound. Specifically, because the autopilot would follow inputs only from the left side of the cockpit, the PIC had likely tuned the ILS frequency on the navigation receiver on his side of the cockpit and pressed the NAV button on the AFCS panel.

[49] Although (fitch) was unintelligible on the CVR transcript, it is likely that the controller said "fifteen."

that the glideslope was armed but was not captured because the airplane was above the glideslope signal at the time. The PIC stated, "it did not capture. trim the nose over," indicating his belief that the autopilot glideslope mode was armed. The PIC then instructed the SIC (with emphasis) to "follow the glideslope. do not go below fifteen," indicating that the PIC was unaware that, at this point in the approach, it was permissible to descend below 1,500 ft. After crossing DANDY, the SIC leveled the airplane at 1,600 ft near TORBY, which was 100 ft higher than the maximum altitude allowed during that portion of the approach.

The airplane crossed TORBY at 1528:08 at an altitude of 1,550 ft. At 1528:10, the PIC again told the SIC (with emphasis) to "follow the # glideslope." The SIC replied, "alright you said don't go below one—," and the PIC interrupted with, "yeah don't go below fifteen 'til I call TORBY." About that time, the airplane was about 0.3 nm past TORBY and was above the glideslope (see figure 10). At 1528:54, the PIC responded to a low-priority ATC transmission asking about the crew's intended parking location instead of focusing on the approach.

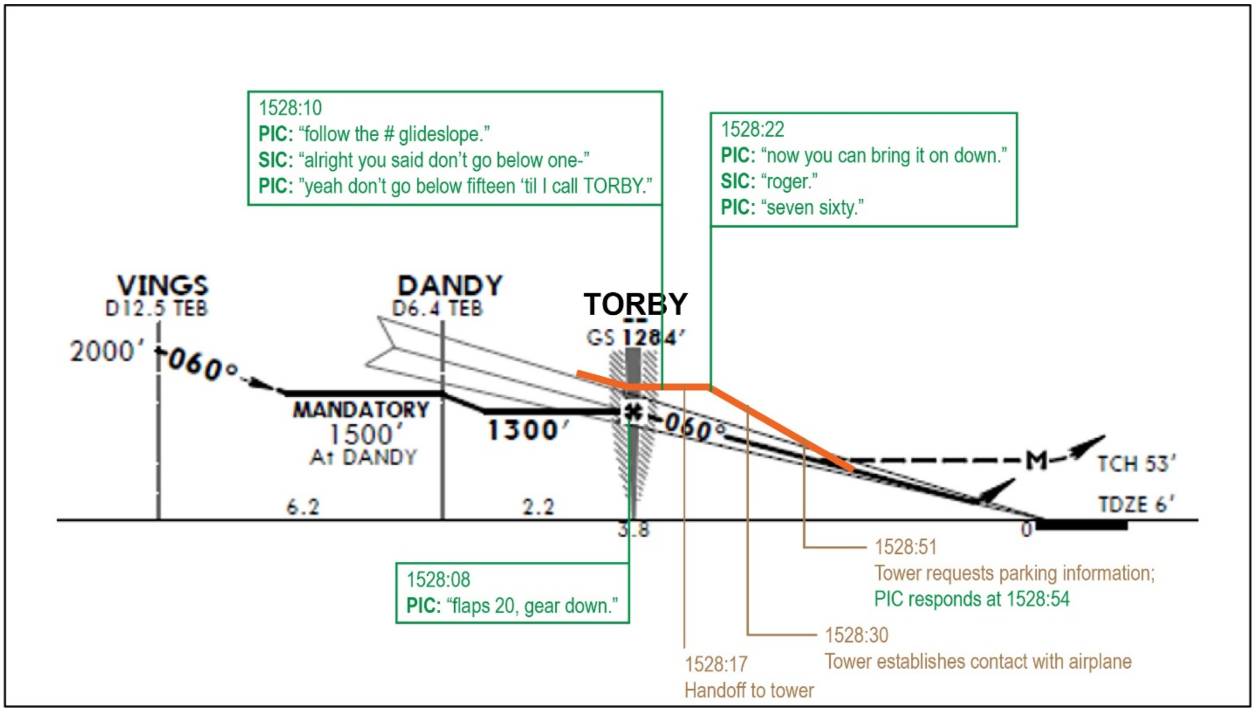

Figure 10. Diagram illustrating the airplane's vertical profile between TORBY and the MDA along with relevant events.

Note: The orange line approximates the airplane's vertical path from 1527:54 to 1528:58. The dashed line (MDA) is shown on the Jeppesen instrument approach chart for TEB (see figure 5).

Neither pilot verbally acknowledged crossing the final approach fix, and neither mentioned the ATC instruction to begin the circle-to-land maneuver at TORBY. Thus, the NTSB concludes that the flight crewmembers' failure to verify the approach and conduct an approach briefing resulted in confusion and errors that led them to mismanage the vertical profile for the approach and not initiate the circle-to-land maneuver according to ATC instructions.

2.2.3 Circle-to-Land Maneuver and Stall

Contrary to the ATC clearance, the crew did not begin the circle-to-land maneuver at TORBY and continued to fly past TORBY before the PIC instructed the SIC to descend to the MDA. Although the MDA for a circling approach was 760 ft, the weather was clear, and the pilots did not have to descend to the MDA to see the airport environment. Further, the crew began the descent to the MDA from an altitude about 250 ft above the minimum crossing altitude for TORBY and continued to fly inbound toward the airport; thus, the MDA was reached when the airplane was beyond a position at which the crew could maneuver to runway 1 and fly a stabilized approach. However, the crew continued to fly the approach without discussing that the turns to align with the runway would be late. During this critical period, the PIC remained focused on coaching the SIC and ensuring that the SIC stopped the airplane's descent at the MDA. According to CVR and radar data, the airplane was 1 nm from the threshold of runway 6 by the time the flight crew began the circling maneuver to runway 1 (see figure 11).

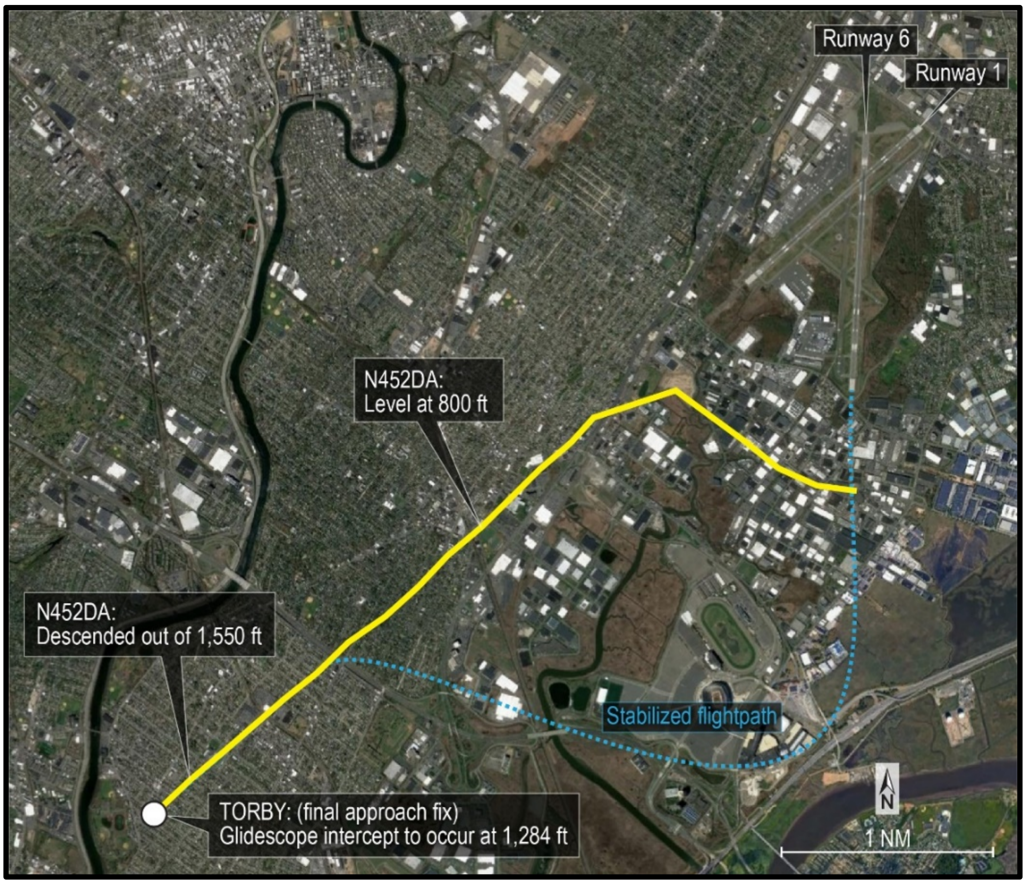

Figure 11. Overhead image showing a stabilized flightpath to runway 1 (in blue) compared with the accident airplane's flightpath (in yellow).

Two turns (first to the right and then to the left) were required for the circling maneuver to align the airplane with runway 1. Per SOPs, the target airspeed was 139 kts (V_{REF} of 119 plus 20 kts); the PIC had previously indicated that the approach speed was 126 kts, which is further evidence that he did not adequately prepare for the approach. Early in the right turn, the SIC attempted to transfer the controls to the PIC, stating with emphasis, "your flight controls." The

PIC did not verbally acknowledge the attempted control transfer. Radar data showed that, as the airplane turned to the right, it slowed from 127 to about 123 kts and reached a right bank angle of 28º. The airplane's altitude also decreased from 650 to 350 ft during the right turn. (At 1529:18, the EGPWS activated a 500-ft aural alert, which the PIC told the SIC to disregard.) By the end of the right turn, the airplane was below 500 ft and was not stabilized on the landing runway heading, which should have prompted the flight crew to call for and perform a go-around per Trans-Pacific SOPs.[50] The aural alert "sink rate. pull up" occurred about 3 seconds after the 500-ft alert, which should also have prompted the flight crew to call for a go-around, but neither pilot made the callout. CVR and radar data indicated that, after the alerts, the airplane rolled wings level and climbed 100 ft.

About 17 seconds before the end of the CVR recording, the SIC again attempted to transfer the controls to the PIC, stating in a strained voice, "I'm gonna give ya your controls okay?" The PIC responded, "alright. my controls"; he then said "# eh" in an angry tone and told the SIC to monitor the airspeed. Radar data indicated that the airplane then made a rapid left turn toward runway 1 at an altitude of 450 ft and that the airplane's airspeed decreased to 120 kts. The CVR did not record the PIC stating that he intended to perform a go-around, and the CVR sound spectrum study could not determine whether he increased engine power, which would be necessary to begin a climbing turn for a missed approach. Therefore, the rapid left turn was likely the PIC's attempt to continue the approach to landing. Thus, the NTSB concludes that the PIC's decision to continue the approach was inappropriate because the approach did not meet the company's stabilized approach criteria and the airplane was not in a position to make a safe landing. A notice to airmen regarding maneuvering to TEB runway 1, which became effective in December 2018, indicated that pilots should begin the circling maneuver "as soon as practical to establish a stabilized approach."

The SIC, now acting as PM, announced "V-ref" while the airplane was in the left turn and then emphasized "add airspeed" and exclaimed "airspeed" three times as the airspeed continued to rapidly decrease to 111 kts (the slowest airspeed derived from radar). About this time, radar data indicated that the airplane reached a left bank angle of 35° at an altitude of 450 ft. One second later, the PIC announced "stall" in a strained voice, and the SIC replied "yup."

According to manufacturer-provided data, the stall speed for the accident airplane in a 35° level turn was 102 kts. Although this stall speed is 9 kts lower than the slowest airspeed derived from radar for the accident flight, the manufacturer's data does not account for wind gusts (about 1 minute before the accident, the tower controller told the pilots that the wind was from 360° at 16 kts gusting to 32 kts) or flight control inputs that could have eliminated the 9-kt margin. For example, the left-wing-down aileron input required to make the turn to final and counter the strong (possibly gusting) left crosswind would have increased the right wing's AOA and potentially led the wing to stall first, inducing the airplane's roll to the right (shown on radar data) just before impact.

Despite the SIC's airspeed callouts, the PIC continued the left turn without adding power or lowering the airplane's nose to reduce AOA. The PIC might not have processed the SIC's

[50] The flight crew's decision to fly the circling approach to the published MDA of 760 ft precluded using Trans-Pacific's 1,000-ft stabilized approach criterion as a threshold for evaluating the stability of the approach.

callouts warning him that airspeed was decreasing due to a phenomenon known as inattentional deafness in which pilots tune out critical auditory alerts in the cockpit during times of stress (Dehais et al. 2014). As a result, the PIC's announcement of "stall" might have been a response to the stall warning system's stick shaker activation rather than any of the SIC's callouts. Although the AOA indicator would have depicted the decreasing stall margin, the PIC likely did not scan the AOA indicator because he was focused on the visual task of aligning the airplane with the landing runway. Thus, the NTSB concludes that the PIC's focus on the visual maneuver of aligning the airplane with the landing runway distracted him from multiple indications of decreasing stall margin, resulting in an aerodynamic stall at low altitude.

2.3 Flight Crew Performance

The NTSB explored reasons for the pilots' poor performance throughout the flight. As discussed below, the PIC's distraction resulting from the improper decision to allow the SIC to fly, the PIC's inadequate preparation for the flight, and the flight crew's inadequate preparation for the approach led to many of the failures occurring throughout the accident flight.

2.3.1 Decision to Allow the Second-in-Command to Act as Pilot Flying

The PIC's decision to allow the SIC to act as PF placed both pilots in roles that they did not routinely perform. As PF, the SIC was responsible for controlling the airplane and initiating configuration changes and checklists. As PM, the PIC was responsible for monitoring the aircraft; calling out deviations from the intended flightpath; and completing tasks that did not directly involve controlling the airplane, such as checklist execution and FMS programming. However, the SIC's performance of PF tasks was weak and required frequent coaching from the PIC. This frequent coaching appeared to distract the PIC, degrading his situational awareness and performance of PM tasks.

The SIC's difficulties in the role of PF were evident throughout the short flight. The PIC initiated checklists that the SIC should have called for, including the After Takeoff and the Before Landing checklists. The SIC also had difficulty with primary flight control tasks, especially maintaining airspeed; the CVR indicated that the PIC often prompted the SIC to adjust thrust to control airspeed. In addition, the SIC was coached through most altitude changes and turns. Although monitoring the PF's actions is an explicit PM duty, the SIC required a substantial amount of attention and instruction during the accident flight.

The PIC's improper decision to allow the SIC to act as PF resulted in neither pilot being able to consistently meet the requirements of their roles. The effects of this decision were evident in execution errors (by both pilots), monitoring errors (by the PIC), and the general lack of situational and positional awareness exhibited by both pilots. For example, the PIC's instruction to the SIC to tune his navigation receiver to the ILS frequency and set the final approach course on his navigation display resulted in the improper setup of the airplane's navigation equipment for the instrument approach.[51] In addition, the PIC did not (1) effectively perform his PM role while he was coaching and directing the SIC because the PIC did not call for the Climb, Cruise, or Descent checklists (which the SIC, as PF, failed to initiate), (2) listen to the full ATIS broadcast, and (3) detect that the autopilot might not have been armed to capture the glideslope. Finally, the time devoted to coaching the SIC during the short flight reduced time available for the PIC to ensure that he had an accurate understanding of the airplane's position and state. Thus, the NTSB concludes that the PIC's extensive coaching of the SIC in his PF duties distracted the PIC, interfered with the normal division of PF and PM duties, and degraded the flight crew's overall performance.

2.3.2 Inadequate Preflight and Approach Planning

Trans-Pacific SOPs state that, in addition to the mission briefing items discussed in section 1.10.1.1, the briefing may include other items "as necessitated by the nature of the mission," indicating that, for certain missions, the published briefing items (and associated preflight activities) may not be adequate. In the case of the accident flight, opportunities for in-flight planning of the likely instrument approach to TEB would be limited because of the estimated 28-minute flight duration. The PIC should have recognized the potential time pressure inherent in the short flight and conducted additional planning and briefing, including a discussion of the likely approach procedure, before the flight to reduce the pilots' workload and increase their situational awareness and understanding of the flight. Doing so would have provided the crewmembers a common understanding of the challenges that they could face during the flight and an opportunity to plan how to mitigate them.

The result of the PIC's inadequate and incomplete planning was evident in the confused and agitated statements that he made during the flight. For example, when the PIC requested ATC clearance for a higher altitude, he did not appear to understand that the airplane was already being sequenced for arrival at TEB, and he subsequently questioned the controller's competence in a conversation with the SIC. Similarly, when initial vectors for the circling approach were issued, the PIC expressed surprise and confusion. If the flight crew had reviewed the available instrument approach procedures at TEB before the flight, the PIC would have known that there were no instrument approaches to runway 1 and could have anticipated a circling approach.

Further, because the approach was likely not discussed before the flight and an approach briefing was not completed in flight, the pilots had to figure out the approach as it was being flown, which increased their workload and led to errors, such as failing to detect that their navigation equipment was not tuned to the TEB VOR. Further, the pilots failed to set up the FMS before descent, which led to their lack of understanding of the approach waypoints and glideslope. After the controller instructed the crew to circle at TORBY, the pilots seemed confused about the airplane's position on the approach, did not identify TORBY, and continued past the point at which they had been instructed to begin the circle-to-land maneuver. Thus, the NTSB concludes that the PIC's inadequate and incomplete preflight planning and the flight crew's lack of an approach

[51] DME information was required to identify DANDY for the approach. To fly the ILS runway 6 approach procedure using the autopilot, the accident airplane needed to be configured with the ILS frequency tuned on NAV-1 and the VOR frequency tuned on NAV-2. This configuration would provide course and glideslope information to the PIC's HSI and autopilot and DME information to the SIC's HSI.

briefing contributed to the crew's confusion and lack of situational awareness during the accident flight.

2.4 Flight Data Monitoring

As discussed in sections 2.2 and 2.3, the flight crew repeatedly deviated from company policy and procedures. If the flight had not ended in an accident, Trans-Pacific would not have a way to identify this crew's deviations from policy and SOPs, and the company had no way to determine whether this (or any) crew's previous operations were conducted in accordance with company policy and SOPs. As discussed in the NTSB's report on a 2014 accident involving a Gulfstream G-IV at BED, procedural drift and normalization of procedural deviance can pose a significant threat to the safety of flight operations, particularly for small operators (including Trans-Pacific) with limited operational oversight and consistent crew pairings (NTSB 2015). Flight data monitoring (FDM) can be a very useful tool for combating these problems.[52]

As a result of an increase in fatal helicopter air ambulance (HAA) accidents in 2008, the NTSB recommended that the FAA "require helicopter emergency medical services operators to install flight data recording devices and establish a structured flight data monitoring program that reviews all available data sources to identify deviations from established norms and procedures and other potential safety issues" (Safety Recommendation A-09-90). On February 21, 2014, the FAA issued a comprehensive final rule, "Helicopter Air Ambulance, Commercial Helicopter, and Part 91 Helicopter Operations" (79 *Federal Register* 9932), addressing many aspects of these operations. The final rule included 14 *CFR* 135.607, "Flight Data Monitoring System," which required that helicopters used for Part 135 HAA operations be equipped with an approved FDM system capable of recording flight performance data (FAA 2014). However, the final rule did not require that all HAA operators establish an FDM program.

In a November 1, 2017, response to Safety Recommendation A-09-90, the FAA said that it endorsed using *voluntary* flight operational quality assurance programs to continuously monitor and evaluate operational practices and procedures. However, because the protections provided in Part 193, "Protection of Voluntarily Submitted Information," pertain only if data are collected by operators as part of a voluntary FAA-approved program, the FAA did not intend to initiate rulemaking to mandate that HAA operators establish FDM programs. In a January 25, 2018, response, the NTSB pointed out that the intent of Safety Recommendation A-09-90 was for HAA operators to establish an internal program that analyzes recorded FDM system data and monitors trends in their operations. Because the data collected would not need to be shared with the FAA, there would be no need to protect the data. Because the FAA did not intend to take any additional actions regarding this recommendation, the NTSB classified Safety Recommendation A-09-90 "Closed—Unacceptable Action."

During our investigation of the November 10, 2015, accident involving an Execuflight Hawker 700A that departed controlled flight while on an instrument approach to Akron Fulton

[52] FDM programs consist of a system or combination of systems that record an aircraft's flight performance and operational data. These data are downloaded, evaluated, and used to identify and mitigate risks by modifying operational and maintenance procedures, providing feedback to pilots in training, and highlighting areas in which additional training may be needed.

International Airport, Akron, Ohio, the NTSB found that operational FDM programs could provide Part 135 operators with objective information regarding the manner in which their pilots conduct flights (NTSB 2016). Our investigation also found that a periodic review of such information could assist operators in detecting and correcting unsafe deviations from company SOPs (NTSB 2016). Therefore, the NTSB recommended that the FAA "require all 14 *Code of Federal Regulations* Part 135 operators to install flight data recording devices capable of supporting a flight data monitoring program" (Safety Recommendation A-16-34). We also recommended that the FAA, "after the action in Safety Recommendation A-16-34 is completed, require all 14 *Code of Federal Regulations* Part 135 operators to establish a structured flight data monitoring program that reviews all available data sources to identify deviations from established norms and procedures and other potential safety issues" (Safety Recommendation A-16-35).

In a January 9, 2017, response addressing Safety Recommendation A-16-34, the FAA stated that it would evaluate the costs and benefits of requiring all Part 135 operators to install flight data recording devices. The FAA also stated that, in advance of the 2014 rule change to 14 *CFR* 135.607, it conducted a similar study of the costs and benefits to require data recording devices for HAA operators. The FAA determined, through a financial analysis, that the proposed rule change "did not meet the cost-benefit requirements for safety" but noted that the proposed change, as mandated, applied only to Part 135 operators providing air ambulance services.

In an April 6, 2017, response to the FAA, the NTSB expressed surprise that the FAA's published regulatory evaluation of the rule change to 14 *CFR* 135.607 showed costs of about $20.4 million over a 10-year period but that the benefits determination amounted to $0. The NTSB's response provided the results of our review of major aviation accident investigations from 2000 to 2015 involving Part 135 on-demand operators to identify accidents with findings related to pilot performance. The review identified seven such accidents in which a total of 53 people died and 4 people were seriously injured. Our response restated that an effective FDM program could help an operator identify issues with pilot performance (such as noncompliance with SOPs) and, through an SMS, could lead to mitigations that would prevent future accidents. The NTSB asked that the FAA, in its review of Safety Recommendation A-16-34, consider likely benefits from such a mandate instead of determining that there would be no quantifiable benefit. Pending completion of the FAA's review and actions, the NTSB classified Safety Recommendation A-16-34 "Open—Acceptable Response."

In its January 9, 2017, response concerning Safety Recommendation A-16-35, the FAA stated that it planned to review Part 135 operators' level of participation in voluntary programs and evaluate additional actions needed to increase the level of participation; however, the FAA also stated that "maintaining a voluntary nature is paramount to the success of [FDM] programs." In our April 6, 2017, response, the NTSB stated that, based on our review of major aviation accident investigations involving Part 135 on-demand operators (as discussed above), FDM programs are not common among Part 135 operators; as a result, we disagreed that the implementation of voluntary programs was successful. The NTSB further stated that the FAA's planned review might be a basis for an acceptable alternate action to satisfy Safety Recommendation A-16-35 if the review identified additional actions to encourage and periodically evaluate the level of Part 135 operators' voluntary compliance. However, the NTSB cautioned that any acceptable response must measure the level of voluntary participation in FDM programs and must find widespread participation among Part 135 operators. Pending completion of the FAA's review of its voluntary FDM programs and the identification and implementation of additional activities to encourage and measure Part 135 operators' level of voluntary participation in FDM programs, the NTSB classified Safety Recommendation A-16-35 "Open—Acceptable Alternate Response."

Another recent accident investigation that demonstrated the benefits of FDM programs for Part 135 operators involved a Cessna 208B operated by Hageland Aviation Services, which collided with terrain in low-visibility conditions near Togiak, Alaska, on October 2, 2016 (NTSB 2018). The NTSB found that the company had safety programs in place—including an aviation safety action program (ASAP), an online internal reporting system, and an anonymous safety hotline—and that safety program deficiencies did not play a role in the accident.[53] However, the investigation also identified two instances of the flight crew's noncompliance with SOPs on the day of the accident that were not related to the accident and found that the company did not have a process to ensure compliance with SOPs and regulations. The NTSB concluded that operational FDM programs could provide Part 135 operators with objective information on how their pilots conduct flights and that a periodic review of such information could assist operators in detecting and correcting unsafe deviations from company SOPs. As a result, the NTSB reiterated Safety Recommendations A-16-34 and -35 to the FAA.

As with the operators involved in the accidents in BED, Akron, and Togiak, the NTSB's investigation of the TEB accident found a Part 135 operator that had no means to monitor flights to identify and mitigate operational deficiencies (such as noncompliance with established SOPs) before the accident occurred. An FDM program would have enabled Trans-Pacific to identify issues, such as airspeed deviations and unstable approach profiles, and address them. Such a program could have led to corrective actions before the accident. Thus, the NTSB concludes that an FDM program could help Part 135 operators identify and mitigate procedural noncompliance, including the operational deficiencies identified in this accident investigation. Therefore, the NTSB reiterates Safety Recommendations A-16-34 and A-16-35. In addition, the NTSB notes that, on February 4, 2019, we announced our 2019-2020 Most Wanted List of Transportation Safety Improvements, and Safety Recommendations A-16-34 and -35 were associated with one of the issue areas on the Most Wanted List, "Improve the Safety of Part 135 Aircraft Flight Operations."

[53] The FAA's website states that the goal of an ASAP "is to enhance aviation safety through the prevention of accidents and incidents. Its focus is to encourage voluntary reporting of safety issues and events that come to the attention of employees of certain certificate holders. To encourage an employee to voluntarily report safety issues even though they may involve an alleged violation of Title 14 of the *Code of Federal Regulations*…enforcement-related incentives have been designed into the program. An ASAP is based on a safety partnership that will include the [FAA] and the certificate holder, and may include any third party such as the employee's labor organization" (FAA 2017b).

2.5 Operational Safety Programs

2.5.1 Safety Management System

Despite having a dedicated safety officer position within the organization, Trans-Pacific did not have any formal safety programs in place, such as an anonymous hazard reporting program. The director of operations (who was acting as safety officer) said that he was available to pilots if a safety concern developed and that he had an "open door" policy. The director of operations also provided anecdotal evidence that the company had addressed concerns that pilots reported but did not describe any means for identifying hazards beyond informal reports. The managing director stated that, at the time of the accident, the company had begun, but had not completed, the process of implementing an SMS. After the accident, the company planned to expedite the implementation of an SMS.[54] However, Trans-Pacific provided no indication, as of February 2019, that the company's SMS had been implemented.

The NTSB recognizes the value of SMS for all operators and has recommended broadening requirements for SMS.[55] In the Akron accident report, the NTSB stated that the company's "casual attitude" toward compliance with standards "illustrates a disregard for operational safety, an attitude that likely led its pilots to believe that strict adherence to standard operating procedures was not required" (NTSB 2016). (That accident report also referenced three other accidents involving Part 135 operators that could have benefitted from an SMS.)[56] As a result, the NTSB concluded that all Part 135 operators could benefit from an SMS because formal system safety methods would be incorporated into internal oversight programs and recommended that the FAA "require all 14 *Code of Federal Regulations* Part 135 operators to establish safety management system programs" (Safety Recommendation A-16-36).

In a January 9, 2017, response concerning Safety Recommendation A-16-36, the FAA noted that Part 135 operators could participate in a formal voluntary SMS. The FAA also stated its intention to conduct a review and hold meetings to determine if further action was needed on SMS for Part 135 operators.

Our April 6, 2017, response to the FAA concerning Safety Recommendation A-16-36 again cited the results of our review of major accident investigations involving Part 135 on-demand operators (see the discussion of Safety Recommendation A-16-34). We stated that these accidents involved a safety problem that an SMS could have mitigated. Given the FAA's stated intention of reviewing Part 135 operations regarding voluntary SMS, we classified Safety Recommendation A-16-36 "Open—Acceptable Response."

The NTSB again recognized the benefits of SMS for Part 135 operators as a result of our investigation of the June 25, 2015, accident involving a de Havilland DHC-3 operated by Promech Air, which struck mountainous terrain northeast of Ketchikan, Alaska, in near-zero

[54] Trans-Pacific's postaccident actions can be found in appendix B.

[55] As stated earlier, only Part 121 carriers are required to incorporate SMS; however, the FAA has advocated for SMS implementation beyond Part 121 operations.

[56] These accidents are NTSB case numbers ERA14FA120, ANC14MA008, and ANC14LA007.

visibility conditions (NTSB 2017). The NTSB's investigation found that Promech had an anonymous safety reporting system that company managers believed was effective. Promech's director of operations stated his belief that the company's informal flight risk assessment process accomplished the same objective as formal risk assessment forms (which he had used at other jobs). The company president said that, typically, pilots verbally reported concerns to managers.

Despite their confidence in the company's existing safety programs, Promech managers were unaware of serious incidents that had occurred. For example, the accident pilot had struck trees during a different takeoff; this event was known to other company pilots but had never been reported to management. The NTSB concluded that, "although Promech had a hazard reporting system, the system was underused by the pilots, and the company's informal safety processes were not effective for identifying major risks in the company's flight operations and did not facilitate organizational learning about major areas of risk." Similar to the Akron accident investigation, the NTSB concluded that an SMS could benefit all Part 135 operators because SMS requires the operators to incorporate formal system safety methods into their internal oversight programs. As a result, the NTSB reiterated Safety Recommendation A-16-36.

The recommendation was again reiterated as a result of the Togiak, Alaska, accident investigation. The NTSB noted that Hageland Aviation Services had three accidents in 3 years involving continued visual flight rules flight into instrument meteorological conditions.[57] The NTSB believed that the similar circumstances of these three accidents indicated the potential for underlying safety issues that an SMS might have identified.

Trans-Pacific's management (as with Promech's and Hageland's) likely believed its existing safety programs effectively identified and mitigated hazards. However, the company's programs did not identify or mitigate the hazards that contributed to this accident. For example, Trans-Pacific's safety program did not identify or mitigate the hazard of unapproved (and likely inexperienced) SICs acting as PF. Similarly, Trans-Pacific did not identify the hazard associated with pairing two pilots who had both exhibited difficulties in training.

Under an SMS, Trans-Pacific's progressive qualification policy could be considered part of the risk management component of SMS. In theory, the policy provided a structured way for SICs to develop experience (first under the supervision of management pilots or check airmen and then with company PICs). However, Trans-Pacific lacked the safety assurance component of SMS that would have triggered a review of the progressive qualification policy. Such a review would have likely identified that SICs could not gain experience or advance according to the policy because no Learjet-qualified management pilots or check airmen were employed by the company during the time that the accident SIC was employed by the company.

As previously discussed, an FDM program would have provided the company information about how flights were being conducted during normal operations. SMS complements FDM because SMS ensures formal review of strategies developed to mitigate risks identified through FDM. Thus, the NTSB concludes that an SMS would have improved Trans-Pacific's ability to identify and mitigate risks because an SMS requires operators to incorporate formal system safety methods into their internal oversight programs. Therefore, the NTSB reiterates Safety

[57] For information about the other two cases, see NTSB case numbers ANC14MA008 and ANC14LA007.

Recommendation A-16-36. In addition, the NTSB notes that Safety Recommendations A-16-36 was associated with the “Improve the Safety of Part 135 Aircraft Flight Operations” issue area on the agency’s 2019-2020 Most Wanted List of Transportation Safety Improvements.

2.5.2 Procedural Compliance

Although section 2.4 discussed the benefits of an FDM program, the NTSB recognizes that some procedural noncompliance, such as the flight crew’s apparent omission of programming the FMS with all of the approach waypoints, could be difficult to detect using FDR data. FAA Order 8900.1 states that en route inspections are another method for detecting deviations from SOPs. However, the POI responsible for Trans-Pacific’s oversight during the 6 years before the accident stated that his primary method of conducting oversight was by reviewing company records. The POI said that he had little first-hand knowledge of Trans-Pacific’s operations. He also stated that funding and logistical issues associated with scheduling en route inspections prevented him from conducting them and that he had never done an en route inspection of Trans-Pacific or any other Part 135 operator.

Trans-Pacific did not have any Learjet-qualified check airmen on staff, so the POI conducted line checks for the company’s Learjet pilots (including the PIC’s line check on October 7, 2016). Because of logistical issues, these checks were conducted on short nonrevenue flights, and the POI stated that he did not know if company pilots were complying with SOPs during revenue flights. Thus, the NTSB concludes that, because the FAA was not conducting checks in a manner that allowed observation of routine flight operations, the FAA could not evaluate Trans-Pacific pilots’ compliance with SOPs during these operations.

The impediments to conducting en route inspections and line checks mentioned by Trans-Pacific’s POI are neither unique nor new. As a result of our investigation of the July 31, 2008, East Coast Jets accident in Owatonna, Minnesota, the NTSB determined that Part 135 line checks were not adequate because they were not conducted on flights that represented typical revenue operations (NTSB 2011). The NTSB recommended the following to the FAA:

> Require that 14 *Code of Federal Regulations* Part 135 pilot-in-command line checks be conducted independently from other required checks and be conducted on flights that truly represent typical revenue operations, including a portion of cruise flight, to ensure that thorough and complete line checks, during which pilots demonstrate their ability to manage weather information, checklist execution, sterile cockpit adherence, and other variables that might affect revenue flights, are conducted. (Safety Recommendation A-11-30)

On August 8 2013, the FAA responded that the action in Safety Recommendation A-11-30 would be logistically problematic and would increase the FAA’s workload without a corresponding improvement in safety. The FAA also asserted that current guidance to POIs concerning line checks was appropriate and stated that it planned no further action. Given this response, the NTSB classified Safety Recommendation A-11-30 “Closed—Unacceptable Action” on November 7, 2013.

Lack of verification of procedural compliance remained a problem after the Owatonna accident. During the Akron accident investigation, the NTSB found multiple flight crew failures to comply with SOPs and noted that the FAA had never conducted an en route inspection of the operator. The accident report stated that, although the FAA's new oversight system for Part 135 operators (SAS) had not been fully implemented at the time of the accident, SAS was "an opportunity to develop and use oversight procedures to identify and correct problems with failures of…Part 135 operators to use SOPs."[58] As a result, the NTSB recommended that the FAA "review the Safety Assurance System and develop and implement procedures needed to identify 14 *Code of Federal Regulation*s Part 135 operators that do not comply with standard operating procedures" (Safety Recommendation A-16-41).

In its January 9, 2017, response to the NTSB, the FAA indicated that it would conduct a review and make necessary corrective actions to the SAS to develop and implement a methodology to identify Part 135 certificate holders that either had or had not established procedures to ensure pilot compliance with SOPs. On April 6, 2017, pending the results of the FAA's review and the development of effective procedures to ensure pilot compliance with Part 135 carriers' SOPs, the NTSB classified Safety Recommendation A-16-41 "Open—Acceptable Response."

Although the NTSB notes that the FAA assesses pilot compliance with SOPs during line checks, the intent of Safety Recommendation A-16-41 was to ensure that the FAA used the SAS to develop a strategy to identify those Part 135 operators that do not have procedures promoting pilot adherence to SOPs. As of February 2019, the FAA had not provided the results of its SAS review to the NTSB and had not released any revisions to SAS to address pilot noncompliance with SOPs during Part 135 operations. The NTSB concludes that effective oversight procedures within the SAS would help the FAA identify operators that do not ensure flight crew compliance with SOPs. Therefore, the NTSB reiterates Safety Recommendation A-16-41. In addition, because of the FAA's lack of action in this area since January 2017, the NTSB reclassifies Safety Recommendation A-16-41 "Open—Unacceptable Response."

2.5.3 Monitoring Pilots with Performance Deficiencies

Although Trans-Pacific did not have a method to determine whether the accident pilots routinely complied with company policy and procedures, the company did have information that could have prompted increased surveillance and evaluation of the pilots. Trans-Pacific's director of operations was aware of the flight crew's training difficulties; he was informed about them by CAE Simuflite (which provided training to the pilots after they were hired by Trans-Pacific). For example, the PIC did not properly execute the circling approach, and the SIC struggled with aircraft control. Subsequently, the Trans-Pacific director of operations approved additional training sessions for both pilots. Even with knowledge of the PIC's and SIC's training difficulties, Trans-Pacific assigned both pilots to revenue operations without any formal company evaluation or monitoring of their performance in an airplane.

[58] According to the FAA, "the SAS policy and procedure provide aviation safety inspectors…with standardized protocols to evaluate certificate holder programs required by regulations to be approved or accepted. SAS implements FAA policy by providing safety controls (i.e., regulations and their application) of business organizations and individuals that fall under FAA regulations" (FAA 2017).

The NTSB encountered a similar issue in a Part 121 operation during our investigation of the December 18, 2003, accident involving a Boeing MD-10-10F operated as Federal Express Corporation (FedEx) flight 647, which crashed while landing at Memphis International Airport Memphis, Tennessee (NTSB 2005). The first officer, who was the PF during the landing, had a history of repeated substandard performance on checkrides. Each substandard performance was addressed as a singular event that did not require further evaluation or monitoring after the checkrides were satisfactorily completed. As a result of our findings, the NTSB recommended that the FAA take the following action:

> Require all 14 *Code of Federal Regulations* Part 121 air carrier operators to establish programs for flight crewmembers who had demonstrated performance deficiencies or experienced failures in the training environment that would require a review of their whole performance history at the company and administer additional oversight and training to ensure that performance deficiencies are addressed and corrected. (Safety Recommendation A-05-14)

On November 12, 2013, the FAA issued a final rule titled, "Qualification, Service, and Use of Crewmembers and Aircraft Dispatchers" (78 *Federal Register* 67800), which was applicable only to Part 121 operators (FAA 2013b). Among the revisions in this final rule were new crewmember requirements in 14 *CFR* 121.415(h) and (i) that fully satisfied the recommendation. On March 18, 2014, the NTSB classified Safety Recommendation A-05-14 "Closed—Acceptable Action."

Similar to the first officer in the FedEx accident, the accident flight crew's training difficulties at CAE Simuflite appear to have been treated as singular events that were perceived as corrected by additional training. However, Trans-Pacific did not oversee the pilots' performance after their additional initial training to determine whether the noted performance deficiencies were fully resolved or were continuing and necessitated further training. On the accident flight, both pilots exhibited performance problems that had previously occurred during their simulator training courses. Thus, the NTSB concludes that the pilots' performance on the accident flight included deficiencies that were noted during their initial Trans-Pacific training, but the company did not monitor the pilots' subsequent performance to identify and correct any continued deficiencies. Therefore, the NTSB recommends that the FAA require all 14 *CFR* Part 135 operators to establish programs for flight crewmembers who have demonstrated performance deficiencies or experienced failures during training and administer additional oversight and training to address and correct performance deficiencies.

2.6 Crew Resource Management and Leadership Training

2.6.1 Crew Resource Management

The FAA's *Risk Management Handbook* defines CRM as "[t]he application of team management concepts in the flight deck environment" (FAA 2016a). The handbook also states that CRM training emphasizes "situation awareness, communication skills, teamwork, task allocation, and decision making within a comprehensive framework of standard operating procedures (SOP)." During the accident flight, the crew deviated from prescribed roles and responsibilities, disregarded numerous SOPs, and exhibited poor planning, which led to high workload and degraded situational awareness. In addition, the crew did not communicate effectively. The SIC made several comments during the flight that appeared to indicate that he was not comfortable flying the approach procedure, but the PIC did not respond directly to any of these comments. During the circle-to-land maneuver, the SIC announced a control transfer, but the PIC did not respond to the call for a control transfer until the SIC made a second request. The crewmembers compounded their errors by not responding appropriately when the approach became unstable. Simply stated, the flight crew’s teamwork was less than optimal and did not represent effective CRM.

CRM skills are developed and reinforced through mandatory initial and recurrent training. Since March 22, 2013, all Part 135 operators have been required to provide CRM training to flight crews; 14 *CFR* 135.330 requires operators to provide training that includes, at a minimum, eight specific CRM topics. Trans-Pacific’s CRM training, which was approved by the FAA and presented to company pilots, including the PIC and SIC involved in this accident, consisted of a computer-based, 27-slide presentation used for both initial and recurrent training. These materials referenced all required topics to some extent. However, the training materials did not explicitly state the importance of adhering to SOPs to facilitate effective teamwork, which was a major deficiency observed in this crew.

Trans-Pacific training materials advised that “good followership skills allow for the follower to step up to leader when necessary”; however, the SIC did not apply this guidance and call for a go-around when the PIC elected to continue an unstable approach. The materials advised the use of crew briefings, but a standard approach briefing was omitted, and the PIC’s weather briefing was incomplete (because he relayed only the altimeter setting to the SIC and stated that he did not have time to listen to the full ATIS broadcast). Although the training materials highlighted the negative effects of excessive workload and stated that high workload could be “mitigated through use of effective crew coordination,” the materials did not describe the influence of planning, briefing, and decision-making on workload and time management. Many of the flight crew’s performance deficiencies occurred during conditions of high workload that stemmed from inadequate planning, briefing, and decision-making. In short, Trans-Pacific’s CRM training curriculum did not adequately address some aspects of CRM and was ineffective at producing the desired behaviors that the training addressed.

The FAA provided guidelines for developing, implementing, reinforcing, and assessing CRM training in AC 120-51E, “Crew Resource Management Training.” The AC states that its guidance was developed for Part 121 operators required by regulation to provide CRM training and that Part 135 operators “electing to train in accordance with part 121 requirements” should also use the guidance. AC 120-51E also makes extensive reference to line-oriented flight training (LOFT), which is described as “an extremely effective means of practicing CRM skills and receiving reinforcement” (FAA 2004).

Although LOFT is commonly used by Part 121 air carriers to evaluate CRM behaviors as part of an advanced qualification program, LOFT is not commonly used by Part 135 operators, particularly small operators. The FAA has not provided clear guidance on how Part 135 operators should implement required CRM training so that the training would be effective in producing desired flight crew behaviors. Thus, the NTSB concludes that, although Trans-Pacific’s CRM training program complied with the requirements of 14 *CFR* 135.330, the FAA had not provided adequate guidance for Part 135 operators to develop and implement effective CRM training programs; consequently, Trans-Pacific's training did not result in the flight crew effectively using CRM to mitigate safety risks. FAA-funded scientific research has identified factors that influence the effectiveness of CRM training (Salas et al. 2006). These findings could be used to develop guidance for CRM training programs that is tailored to the specific characteristics of Part 135 operators. Therefore, the NTSB recommends that the FAA develop guidance for Part 135 operators to help them create and implement effective CRM training programs.

2.6.2 Leadership

The PIC was responsible for setting the appropriate tone in the cockpit and managing communications and workload in a manner that promoted professionalism and adherence to SOPs. The absence of adequate preflight planning and the omission of required checklists, callouts, and briefings demonstrated the PIC's inadequate leadership. Paragraph (a)(1) of 14 *CFR* 135.330 requires operators to provide training that addresses the PIC's authority. However, this requirement is vague because the regulation does not specify the leadership skills that should be trained, which could include professional standards of conduct and strategies for (1) briefing and debriefing, (2) reinforcing and correcting skills, and (3) encouraging adherence to SOPs. Thus, the topic of PIC leadership responsibilities may not receive adequate attention in Part 135 operators' CRM training programs.

Trans-Pacific's CRM training, for example, contained very little information explicitly addressing the responsibilities of the PIC as the team leader. Leadership was only covered in three bullet points on one slide that stated that "a leader's actions and ideas influence the thoughts and behavior of others," "leadership is acquired," and "a leader can be either crew member and must know how to effectively communicate ideas and observations." This material did not adequately describe core leadership functions necessary for ensuring effective crew performance.

The NTSB has noted deficiencies in PIC leadership in previous accidents, most notably in our investigation of the February 12, 2009, accident in Clarence Center, New York, involving Colgan Air flight 3407, a Bombardier DHC-8-400, while on an instrument approach to Buffalo-Niagara International Airport, Buffalo, New York (NTSB 2010). In that accident report, the NTSB emphasized the importance of effective leadership for ensuring successful crew performance and recommended that the FAA take the following actions:

> Issue an advisory circular with guidance on leadership training for upgrading captains at 14 *Code of Federal Regulations* Part 121, 135, and 91K operators, including methods and techniques for effective leadership; professional standards of conduct; strategies for briefing and debriefing; reinforcement and correction skills; and other knowledge, skills, and abilities that are critical for air carrier operations. (Safety Recommendation A-10-13)
>
> Require all 14 *Code of Federal Regulations* Part 121, 135, and 91K operators to provide a specific course on leadership training to their upgrading captains that is consistent with the advisory circular requested in Safety Recommendation A-10-13. (Safety Recommendation A-10-14)

In a September 24, 2012, response, the FAA reported its intent to issue a notice of proposed rulemaking (NPRM) addressing leadership training for Part 121 operations. On January 11, 2013, the NTSB noted that the FAA did not plan to include Part 135 or Part 91K operations in the proposed rule and indicated that "leadership skills are essential for all upgrading captains, regardless of the operation." Thus, the NTSB classified these recommendations "Open—Unacceptable Response."

On October 7, 2016, the FAA issued an NPRM titled, "Pilot Professional Development" (81 *Federal Register* 69908), which proposed modifying requirements for leadership training that were primarily applicable to Part 121 air carriers conducting domestic, flag, and supplemental operations to enhance the professional development of pilots in those operations (FAA 2016c). On January 4, 2017, the NTSB commented on the rulemaking, stating that "catastrophic outcomes associated with unprofessional behavior are not limited to Part 121 operations."

This accident provides another example of inadequate leadership on the part of a PIC, contributing to poor CRM and ineffective flight crew performance. The PIC was responsible for setting the appropriate tone in the cockpit, but the PIC's numerous expletives throughout the flight and negative comments about a controller handling the flight ("she's a # idiot") were unprofessional. The PIC was also responsible for following company SOPs (including those for preflight planning and briefings) as a means of managing crew workload and avoiding errors, but his actions during the flight demonstrated disregard for the SOPs. As with the captain of Colgan Air flight 3407, the PIC's failure to establish a professional cockpit tone and show appropriate command authority is disconcerting.

The NTSB notes that the PIC in this accident had never been employed as a Part 135 PIC before being hired by Trans-Pacific and had never received formal specific leadership training to prepare him for the leadership duties associated with the upgrade to PIC. The NTSB is concerned that, even if the FAA provides the CRM training guidance recommended in Safety Recommendation A-19-8 for Part 135 operators, leadership training for future captains might not be provided at the time of upgrade, when the training would have the greatest impact. The NTSB continues to believe that specific leadership training for PICs provided during the upgrade process would help standardize and reinforce the critical command authority skills that PICs need. Lack of leadership in the cockpit can occur in any dual-pilot operation; without appropriate training, some Part 135 and Part 91K PICs may lack the necessary leadership skills to operate as PIC, which poses a safety risk to the traveling public. Thus, the NTSB concludes that specific leadership training provided to Part 135 and 91K pilots at the time of upgrade to PIC would help standardize and reinforce critical command authority skills and improve flight safety. Therefore, the NTSB reiterates Safety Recommendations A-10-13 and -14.

2.7 Trans-Pacific Jets Policy

2.7.1 Second-in-Command Policy

A review of Trans-Pacific's policy pertaining to SIC classification revealed that staffing in the months before the accident did not allow Trans-Pacific Learjet SICs to advance to higher qualification levels. Thus, there was no mechanism in place for a Learjet SIC to develop PF skills.

In fact, being an SIC who was only approved to perform PM duties, as was the case for the accident SIC for 8 months, posed a risk of flying skill decay if company pilots rigorously adhered to the policy. Opportunities for SICs to serve as PF would benefit both SICs and PICs. SICs would gain experience for upgrade by acting as PF. Also, it would be in the PIC's interest to allow SICs to act as PF to ensure they would be able to fly the airplane in the event of an emergency, such as PIC incapacitation.

Because developing skills as PF was beneficial to Trans-Pacific SICs and the PICs who flew with them, pilots in both crew positions had incentive to not comply with the policy. The accident flight crew did not comply with this policy during the accident flight leg (and possibly other flight legs), and Trans-Pacific's other Learjet flight crew was also not complying with the policy.[59] The company's lack of a method to discover noncompliance with the SIC policy may also have increased the opportunity for the flight crews' noncompliance. Given that both Learjet flight crews at Trans-Pacific were not complying with the company's SIC policy, decisions about when a SIC could fly were regularly being made at the PIC level, which removed supervisory oversight at the company level.

The company's director of operations indicated that Trans-Pacific's SIC qualification policy was intended to mitigate the hazard of an inexperienced SIC acting as PF. However, company staffing at the time of the accident did not allow Learjet SICs, including the accident SIC, to develop experience and skills according to the company's policy. Thus, the NTSB concludes that, because the company did not have a Learjet-qualified management pilot or check airman on staff during the accident SIC's period of employment, Trans-Pacific's graduated SIC qualification policy could not provide him and the other company Learjet SIC a viable, well-structured path to gain experience as a PF. The NTSB notes that the company staffing concern identified in this accident investigation was resolved after the accident because Trans-Pacific no longer operates Learjet airplanes (and thus has no need for a Learjet-qualified management pilot or check airman) and had management pilots on staff who were qualified to fly the aircraft models that the company operated.

2.7.2 Approach Speed Wind Additives

Trans-Pacific SOPs indicated that, for a visual approach, pilots were expected to maintain V_{REF} + 20 kts until aligned with the landing runway. While en route to TEB, the PIC stated, "V-ref is one-nineteen." NTSB investigators verified that the PIC had correctly determined V_{REF} for the airplane's configuration. Therefore, according to Trans-Pacific SOPs, the pilots should have been flying at 139 kts during the approach until the circling turn to runway 1 was completed and the airplane was aligned with the runway. However, radar and EGPWS data indicated that the airplane flew significantly slower than 139 kts during the approach phase of the flight. The pilots' intended airspeed for the approach could not be determined because they did not discuss it.

[59] The SIC from that crew, who had been with the company for 6 months, reported that the PIC with whom he was normally paired had allowed him to act as PF on five or six positioning flight legs.

The approach speeds listed in Trans-Pacific's SOPs were consistent with manufacturer guidelines, but the SOPs did not include the manufacturer's wind additives. The Learjet 35A AFM stated the following:

> It is recommended that if turbulence is anticipated due to gusty winds, wake turbulence, or wind shear, the approach speed be increased. For gusty wind conditions, an increase in approach speed of one half the gust factor is recommended.

Although the airplane was flown significantly slower than directed by SOPs, it remained above the manufacturer-published stall speed of 102 kts for a 35° level turn. However, the strong, gusting wind might have momentarily reduced the airplane's airspeed below the stall speed. Thus, including a wind additive (if appropriate) when calculating approach speeds would provide additional stall margin.

The NTSB notes that FAA-approved GOMs and SOPs provide the policies and procedures that crews must use to operate company aircraft. However, the NTSB is concerned that Trans-Pacific's manual did not incorporate the manufacturer-recommended procedures for approach speed wind additives, which could affect flight safety. The NTSB is also concerned that other operator-published manuals might not include that information. Thus, the NTSB concludes that including the manufacturer-recommended approach speed wind additives in operations manuals for Learjet 35A airplanes could reduce the risk of a stall by requiring pilots to increase the approach speed in weather conditions conducive to rapid and possibly unexpected wind changes. Therefore, the NTSB recommends that the FAA review operators' Learjet 35A operations manuals to determine whether they contain manufacturer-recommended approach speed wind additives and encourage those operators without that information to add it to their operations documents.

3. Conclusions

3.1 Findings

1. The flight crew was properly certificated; there was no indication that the flight crew was impaired by medical conditions, alcohol, or other drugs; and there were no preimpact airplane anomalies that would have precluded normal operation.

2. The pilot-in-command's preflight planning was inadequate and incomplete.

3. The flight crewmembers' failure to verify the approach and conduct an approach briefing resulted in confusion and errors that led them to mismanage the vertical profile for the approach and not initiate the circle-to-land maneuver according to air traffic control instructions.

4. The pilot-in-command's inadequate and incomplete preflight planning and the flight crew's lack of an approach briefing contributed to the crew's confusion and lack of situational awareness during the accident flight.

5. The pilot-in-command's decision to allow the second-in-command to act as pilot flying was improper and contrary to company standard operating procedures.

6. The pilot-in-command's (PIC) extensive coaching of the second-in-command in his pilot flying (PF) duties distracted the PIC, interfered with the normal division of PF and pilot monitoring duties, and degraded the flight crew's overall performance.

7. The pilot-in-command's decision to continue the approach was inappropriate because the approach did not meet the company's stabilized approach criteria and the airplane was not in a position to make a safe landing.

8. The pilot-in-command's focus on the visual maneuver of aligning the airplane with the landing runway distracted him from multiple indications of decreasing stall margin, resulting in an aerodynamic stall at low altitude.

9. A flight data monitoring program could help Title 14 *Code of Federal Regulations* Part 135 operators identify and mitigate procedural noncompliance, including the operational deficiencies identified in this accident investigation.

10. Because the Federal Aviation Administration (FAA) was not conducting checks in a manner that allowed observation of routine flight operations, the FAA could not evaluate Trans-Pacific Jets pilots' compliance with standard operating procedures during these operations.

11. A safety management system (SMS) would have improved Trans-Pacific Jets' ability to identify and mitigate risks because an SMS requires operators to incorporate formal system safety methods into their internal oversight programs.

12. Effective oversight procedures within the Safety Assurance System would help the Federal Aviation Administration identify operators that do not ensure flight crew compliance with standard operating procedures.

13. The pilots' performance on the accident flight included deficiencies that were noted during their initial Trans-Pacific Jets training, but the company did not monitor the pilots' subsequent performance to identify and correct any continued deficiencies.

14. Although Trans-Pacific Jets' crew resource management (CRM) training program complied with the requirements of Title 14 *Code of Federal Regulations* (*CFR*) 135.330, the Federal Aviation Administration had not provided adequate guidance for 14 *CFR* Part 135 operators to develop and implement effective CRM training programs; consequently, Trans-Pacific's training did not result in the flight crew effectively using CRM to mitigate safety risks.

15. Specific leadership training provided to Title 14 *Code of Federal Regulations* Part 135 and 91K pilots at the time of upgrade to pilot-in-command would help standardize and reinforce critical command authority skills and improve flight safety.

16. Because the company did not have a Learjet-qualified management pilot or check airman on staff during the accident second-in-command's (SIC) period of employment, Trans-Pacific Jets' graduated SIC qualification policy could not provide him and the other company Learjet SIC a viable, well-structured path to gain experience as pilot flying.

17. Including the manufacturer-recommended approach speed wind additives in operations manuals for Learjet 35A airplanes could reduce the risk of a stall by requiring pilots to increase the approach speed in weather conditions conducive to rapid and possibly unexpected wind changes.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the pilot-in-command's (PIC) attempt to salvage an unstabilized visual approach, which resulted in an aerodynamic stall at low altitude. Contributing to the accident was the PIC's decision to allow an unapproved second-in-command to act as pilot flying, the PIC's inadequate and incomplete preflight planning, and the flight crew's lack of an approach briefing. Also contributing to the accident were Trans-Pacific Jets' lack of safety programs that would have enabled the company to identify and correct patterns of poor performance and procedural noncompliance and the Federal Aviation Administration's ineffective Safety Assurance System procedures, which failed to identify these company oversight deficiencies.

4. Recommendations

4.1 New Recommendations

As a result of this investigation, the National Transportation Safety Board makes the following new safety recommendations to the Federal Aviation Administration:

> Require all Title 14 Code of Federal Regulations Part 135 operators to establish programs for flight crewmembers who have demonstrated performance deficiencies or experienced failures during training and administer additional oversight and training to address and correct performance deficiencies. (A-19-7)

> Develop guidance for Title 14 Code of Federal Regulations Part 135 operators to help them create and implement effective crew resource management training programs. (A-19-8)

> Review operators' Learjet 35A operations manuals to determine whether they contain manufacturer-recommended approach speed wind additives and encourage those operators without that information to add it to their operations documents. (A-19-9)

4.2 Previously Issued Recommendations Reiterated in This Report

The National Transportation Safety Board reiterates the following recommendations to the Federal Aviation Administration:

> Issue an advisory circular with guidance on leadership training for upgrading captains at 14 *Code of Federal Regulations* Part 121, 135, and 91K operators, including methods and techniques for effective leadership; professional standards of conduct; strategies for briefing and debriefing; reinforcement and correction skills; and other knowledge, skills, and abilities that are critical for air carrier operations. (A-10-13)

> Require all 14 *Code of Federal Regulations* Part 121, 135, and 91K operators to provide a specific course on leadership training to their upgrading captains that is consistent with the advisory circular requested in Safety Recommendation A-10-13. (A-10-14)

> Require all 14 *Code of Federal Regulations* Part 135 operators to install flight data recording devices capable of supporting a flight data monitoring program. (A-16-34)

> After the action in Safety Recommendation A-16-34 is completed, require all 14 *Code of Federal Regulations* Part 135 operators to establish a structured flight

data monitoring program that reviews all available data sources to identify deviations from established norms and procedures and other potential safety issues. (A-16-35)

Require all 14 *Code of Federal Regulations* Part 135 operators to establish safety management system programs. (A-16-36)

Review the Safety Assurance System and develop and implement procedures needed to identify 14 *Code of Federal Regulations* Part 135 operators that do not comply with standard operating procedures. (A-16-41)

4.3 Previously Issued Recommendation Reclassified in This Report

Safety Recommendation A-16-41 is reclassified "Open—Unacceptable Response" in section 2.5.2 of this report.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT, III
Chairman

EARL F. WEENER
Member

BRUCE LANDSBERG
Vice Chairman

JENNIFER HOMENDY
Member

Adopted: March 12, 2019

5. Appendixes

Appendix A: Investigation

The National Transportation Safety Board (NTSB) was notified of this accident on May 15, 2017. The NTSB investigator-in-charge and the airworthiness group chairman arrived on scene about 0800 on May 16, 2017.

Investigative groups were formed for operations and human performance, air traffic control, airworthiness, cockpit voice recorder (CVR), and meteorology. Also, specialists were assigned to evaluate pilot medical issues, maintenance records, the enhanced ground proximity warning system, and the digital electronic engine controls. Radar, CVR sound spectrum analysis, and surveillance video studies were also completed.

The Federal Aviation Administration (FAA); Trans-Pacific Air Charter, LLC; Bombardier; Honeywell Aerospace; and the National Air Traffic Controllers Association were parties to the investigation.

Appendix B: Trans-Pacific Jets Postaccident Actions

Trans-Pacific Jets, in a submission to the NTSB dated March 1, 2018, reported taking the following actions in response to the accident:

- required pilots to sign for receipt of the company manuals and acknowledge an intention to comply with the directives in the manuals;
- revised the training program to include a presentation on “Procedural Intentional Non-Compliance”;
- updated annual training to review and analyze the accident and discuss how standard operating procedures can reduce the risk of every aircraft operation;
- required pilot route checks at 6-month intervals rather than the FAA-mandated 12 months;
- planned to expedite full implementation of a safety management system;
- retained a third-party safety auditor to conduct periodic safety inspections, record audits, and make recommendations toward systemic improvement; and
- required that all passenger and positioning flights be conducted under the same guidelines.

Appendix C: Cockpit Voice Recorder Transcript

The following is a transcript of a Universal CVR-30 solid-state cockpit voice recorder, unknown serial number, installed on a Trans-Pacific Jets Learjet 35A (N452DA), which crashed during approach to land at Teterboro Airport in Teterboro, New Jersey:

LEGEND

CAM	Cockpit area microphone voice or sound source
HOT	Flight crew audio panel voice or sound source
RDO	Radio transmissions from N452DA
TWR-PHL	Radio transmission from Philadelphia airport tower controller
DEP-PHL	Radio transmission from Philadelphia Departure controller
APP-PHL	Radio transmission from Philadelphia Approach controller
APR-NYC	Radio transmission from the New York Approach controller
TWR-TEB	Radio transmission from the Teterboro airport tower controller
ATIS-TEB	Teterboro airport Automatic Terminal Information Service
AC-$$$	Radio transmission from a relevant aircraft (see note 5)
EGPWS	Enhanced Ground Proximity Warning System
-1	Voice identified as the pilot-in-command
-2	Voice identified as the second-in-command
-?	Voice unidentified
*	Unintelligible word
#	Expletive
@	Non-pertinent word
( )	Questionable insertion
[ ]	Editorial insertion
—	Cut-off in utterance

Note 1: Times are expressed in eastern daylight time (EDT).

Note 2: Generally, only radio transmissions to and from the accident aircraft were transcribed.

Note 3: Words shown with excess vowels, letters, or drawn out syllables are a phonetic representation of the words as spoken.

Note 4: A non-pertinent word, where noted, refers to a word not directly related to the operation, control or condition of the aircraft.

Note 5: $$$ is replaced in the transcript with a partial call-sign of the related aircraft; AC-UNK is used when the aircraft call sign could not be determined.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
14:59:44.4 EST **START OF RECORDING START OF TRANSCRIPT**			
14:59:44.4 **HOT-1**	[recording begins] —we uh go to five.		
14:59:46.4 **HOT-1**	or go to three.		
14:59:46.6 **HOT-2**	gotch'ya		
14:59:47.7 **HOT-1**	but we're only ten. ten.		
14:59:50.8 **HOT-1**	'kay he's waiting for everybody to clear the airspace. this guy's landing. that's why he's holding us.		
15:00:00.6 **HOT-1**	go. one oh eight ninety five. that's the localizer. we don't want that.		
15:00:04.1 **HOT-1**	twelve zip is North Philadelphia.		
15:00:06.9 **HOT**	[sound of multiple clicks]		
15:00:22.3 **HOT-1**	test. test. test. test. test. there's my volume.		
15:00:23.7 **HOT-2**	loud and clear.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:00:25.3 **HOT-1**	I've been have'n my volume all the way down for some stupid reason.		
15:00:29.0 **HOT-1**	test. test. test. talk to me.		
15:00:30.5 **HOT-2**	one two. one two. one two. one two.		
15:00:32.9 **HOT-1**	there we go.		
15:00:34.0 **HOT-(2)**	on the microphone.		
15:00:36.1 **HOT**	[sound of two static bursts, similar to VHF radio static noise]		
15:00:36.9 **HOT-2**	wow. look how slow he looks like he's goin'.		
15:00:39.0 **HOT-1**	I know. it's that # wind man. it's gusting to what the # was it gusting to? thirty-five?		
15:00:44.3 **HOT-2**	yeah.		
15:00:44.6 **HOT-1**	no. twenty five.		
15:00:46.6 **HOT-2**	Air Wisconsin.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:00:47.2 **HOT-1**	Air Wisconsin.		
15:00:48.6 **HOT-1**	weren't you uh doin' a # ground thing for em?		
15:00:50.8 **HOT-2**	yeah.		
15:00:51.6 **HOT-1**	okay I think we're next man. hand on your yoke.		
15:00:55.7 **HOT-1**	standing on the brakes. you got your handbrake. to— your parking brake is set.		
15:00:59.3 **HOT-2**	yes sir.		
15:01:05.8 **HOT-2**	go around.		
15:01:07.6 **HOT-2**	is it working?		
15:01:07.6 **HOT-1**	yeah. it's supposed to disengage yeah but it's not. there we go. now it's disengage.		
15:01:12.9 **HOT-1**	ehhh. # it's not working.		
15:01:16.4 **HOT-1**	there we go. disengage.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:01:17.7 **CAM**	[sound of 1.2-second tone (480Hz increase to 560Hz), similar to yaw damper alert tone]		
15:01:22.6 **HOT-2**	look at that big boy.		
15:01:26.3 **HOT-1**	was that a crosswind landing?		
15:01:27.7 **HOT-2**	yeah it was.		
15:01:28.6 **HOT-1**	#.		
15:01:28.6 **HOT-2**	it had to be- look at that #.		
15:01:30.6 **HOT-1**	yeah.		
		15:01:33.4 **RDO-1**	and tower four five two delta alpha we're ready to go at three five.
		15:01:37.1 **TWR-PHL**	yeah just uh one more to land for (november) two delta alpha then we'll get you goin'. there just wasn't enough room with the two (separate) arrivals to squeeze ya out.
		15:01:43.8 **RDO-1**	not a problem.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:01:44.8 **CAM**	[sound of click]		
15:01:47.2 **HOT-2**	Frontier.		
15:01:52.4 **CAM**	[sound similar to cabin air flowing from cabin vents]		
15:01:53.6 **HOT-2**	wooo.		
15:01:54.3 **HOT-2**	that's that heat.		
15:02:01.0 **HOT-1**	okay. power setting was ninety-five?		
15:02:03.2 **HOT-2**	yeah.		
15:02:03.9 **HOT-1**	ninety-four nine?		
15:02:04.5 **HOT-2**	ninety-four five.		
15:02:10.9 **HOT-2**	I thought Frontier was come’n this way.		
15:02:14.6 **HOT-1**	three forty-nine. [exhale]		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:02:22.7 **HOT-1**	there we go a little Pilatus. I guess we're gonna go after him.		
15:02:25.9 **HOT-1**	unless there's someone come'n in on two seven right.		
15:02:28.2 **HOT-2**	# Pilatuses		
15:02:30.2 **HOT-1**	aren't you glad you're not # with Pilatuses?		
15:02:32.2 **HOT-2**	I would have been captain though.		
15:02:37.3 **HOT-2**	he's gonna say line up and wait.		
15:02:39.7 **HOT-1**	stand by.		
		15:02:41.1 **TWR-PHL**	[Tower talks to a helicopter lacking a transponder code]
15:02:46.5 **HOT-1**	(ehhh) dude you're in a # controlled airspace.		
15:02:54.3 **HOT-1**	yeah bother the poor controller because you didn't get a clearance for V-F-R		
15:03:04.4 **HOT-1**	* four thirty-five.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
		15:03:06.6 **TWR-PHL**	november uh four five two delta alpha runway three five full length line up and wait traffic four out for runway ah two seven (right) I'll get ya goin' as soon as the runway's clear.
15:03:07.6 **HOT-1**	there we go.		
15:03:08.9 **CAM**	[sound of clicks]		
15:03:11.5 **HOT-1**	I'll get it.		
		15:03:14.2 **RDO-1**	alright. line up and wait three five. two delta alpha.
15:03:15.9 **CAM**	[sound of increase in engine thrust]		
15:03:17.2 **HOT-1**	get runway line ups. pitot heat. stall warning.		
15:03:21.3 **HOT-1**	** (heading).		
15:03:24.8 **HOT-1**	gear lights are all done.		
15:03:26.0 **CAM**	[sound similar to engine igniters begins and continues through takeoff]		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:03:26.3 **HOT-2**	yes sir.		
15:03:27.5 **HOT-1**	under the thumb sir.		
15:03:28.6 **HOT-2**	yeah I am. look.		
15:03:29.8 **HOT-1**	alright.		
15:03:31.5 **HOT-2**	I've been learning.		
15:03:33.3 **HOT-1**	power— power to idle.		
15:03:34.3 **CAM**	[sound similar to decrease in engine thrust]		
15:03:37.3 **CAM**	[sound of multiple thunks, similar to aircraft's landing gear taxiing over grooved surface, and continues during takeoff roll]		
		15:03:47.1 **TWR-PHL**	Lear four five two delta alpha just fly runway heading runway three five. clear for takeoff. traffic's three out for two seven right.
		15:03:52.3 **RDO-1**	alright. clear for takeoff three five. runway heading. two delta alpha so long.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:03:57.1 **HOT-1**	alright ninety-five somethin'.		
15:03:59.6 **HOT-2**	ninety-five five.		
15:03:59.6 **CAM**	[sound similar to increase in engine thrust]		
15:04:01.0 **HOT-2**	ninety-four five.		
15:04:01.5 **HOT-1**	alright a little more. keep advancing it slowwwwly [emphasized] don't go crazy on it. little more. more. more. more.		
15:04:07.3 **HOT-1**	there ya go airspeeds set. airspeed's alive.		
15:04:10.1 **HOT-1**	airspeed alive. eighty knots crosscheck. I didn't say # V-one.		
15:04:13.6 **HOT-2**	yup.		
15:04:14.0 **HOT-1**	V-one [emphasized].		
15:04:16.2 **HOT-1**	rotate.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:04:18.2 **HOT-1**	slowwwwly. positive rate. gear up. yaw dampener engaged. ya gotta tell me to do that.		
15:04:22.0 **CAM**	[sound of clunk, similar to gear movement]		
15:04:22.7 **HOT-2**	yup.		
15:04:25.9 **CAM**	[sound of clunk, similar to gear door closing]		
15:04:26.5 **HOT-1**	there ya go.		
15:04:34.0 **HOT-1**	'kay four hundred feet.		
15:04:35.4 **HOT-2**	flaps up.		
15:04:36.5 **HOT-1**	after takeoff checks.		
15:04:37.7 **HOT-2**	yes sir.		
15:04:40.8 **HOT-1**	and if you'd like autopilot engaged you can go ahead and do so at this time.		
15:04:45.3 **HOT-2**	roger.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:04:45.7 **HOT-1**	it'll be off my heading.		
		15:04:46.4 **TWR-PHL**	(four) two delta alpha runway heading contact departure. have a good one.
		15:04:49.5 **RDO-1**	four. two delta alpha. so long.
15:04:53.9 **HOT-1**	'kay two thousand. one thousand to go.		
		15:04:57.7 **RDO-1**	and departure Lear jet four five two delta alpha out of one thousand for two thousand runway heading.
15:04:59.4 **CAM**	[sound of high pitch tone, similar to altitude alerter]		
		15:05:01.7 **DEP-PHL**	november four five two delta alpha. Philly departure radar contact.
15:05:02.1 **CAM**	[sound of click]		
15:05:05.8 **HOT-1**	ahhh. [spoken in almost a whisper]		
15:05:08.7 **HOT-2**	it's on right?		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:05:09.8 **HOT-1**	uhhh it is now. yeah.		
15:05:11.9 **HOT-2**	okay.		
15:05:16.6 **HOT-1**	five hundred feet to go.		
15:05:17.9 **HOT-2**	roger.		
15:05:18.3 **HOT-1**	start trimmin' that thing nose down it'll punch right through two thousand.		
15:05:26.1 **HOT-1**	go ahead and turn off your uhhh...		
15:05:29.5 **HOT-1**	...(I have) nothing really. leave everything goin'.		
15:05:34.4 **HOT-1**	there ya go.		
		15:05:34.5 **DEP-PHL**	november two delta alpha climb to maintain four thousand and contact approach on one twenty three point eight.
		15:05:40.1 **RDO-1**	'kay. four thousand. twenty three point eight. four five two delta alpha so long.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:05:46.1 **HOT-1**	up to four.		
15:05:46.9 **HOT-2**	up to four.		
		15:05:59.5 **RDO-1**	four five two delta alpha's out of two point five for four thousand runway heading.
		15:06:03.9 **APP-PHL**	november four five two delta alpha Philly approach altimeter is two niner eight one.
		15:06:07.7 **RDO-1**	two niner eight one.
15:06:12.4 **CAM**	[sound of high pitch tone, similar to altitude alerter]		
15:06:13.5 **HOT-2**	one to go.		
15:06:13.6 **HOT-1**	one to go.		
15:06:14.8 **HOT-1**	trim that nose over.		
15:06:20.0 **HOT-1**	there ya go.		
15:06:22.1 **HOT-2**	smaaall.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:06:24.5 **HOT-2**	corrections.		
15:06:33.3 **HOT-1**	okay when you hit that you want that thing to be less than a thousand.		
15:06:36.7 **HOT-2**	roger.		
15:06:37.4 **HOT-1**	you want your V-S-I to be less than a thousand.		
		15:06:37.9 **APP-PHL**	november four five two delta alpha proceed direct MAZIE.
		15:06:41.5 **RDO-1**	direct MAZIE four five two delta alpha.
15:06:43.2 **HOT-1**	don't. don't lose altitude.		
15:06:51.3 **HOT-1**	zero three six on the heading.		
15:06:53.0 **HOT-2**	zero three six.		
15:06:55.1 **HOT-1**	watch the altitude.		
15:06:56.4 **HOT-2**	turn it. thank you.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:06:57.3 **HOT-1**	there ya go. I'll give you nav select nav mode when (we're) ready.		
15:07:01.3 **HOT-2**	yup.		
15:07:03.9 **HOT-1**	and four thousand altitude is selected. good. watch the airspeed. don't get above two fifty.		
15:07:11.5 **HOT-1**	you can hit A-C if you want. get some A-C goin' on in here.		
15:07:13.6 **HOT-2**	it's already in there.		
15:07:14.7 **HOT-1**	yeah did we takeoff with A-C?		
15:07:16.7 **HOT-2**	no.		
15:07:17.1 **HOT-1**	ah 'kay.		
15:07:19.9 **HOT-1**	air conditioning I know it's hot so.		
15:07:27.5 **HOT-1**	speed.		
15:07:28.6 **CAM**	[sound similar to decrease in engine thrust]		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:07:28.8 **HOT-2**	pullin' back.		
15:07:32.8 **HOT-1**	much # better.		
15:07:36.8 **HOT-2**	I thought you were gonna say why are you # up?		
15:07:38.8 **HOT-1**	no. no. much # better.		
15:07:41.5 **HOT-1**	you've been paying attention to what I've been doin'. you're # understanding the #.		
15:07:45.6 **HOT-1**	you know what to # look for now.		
15:07:46.7 **CAM**	[sound similar to decrease in engine thrust]		
15:07:49.4 **HOT-1**	see how # ya # (it) and # incredible man. you're # doin' good right now.		
15:07:55.3 **CAM**	[sound similar to decrease in engine thrust]		
15:07:56.7 **HOT-1**	(at) least I've got the # radio so...		
15:07:58.9 **HOT-2**	yup.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:07:58.9 **HOT-1**	...that. that—		
15:08:00.3 **HOT-1**	mean you can see how I'm # handle the radios.		
15:08:03.2 **HOT-1**	while you're # flying.		
15:08:04.7 **HOT-2**	yes sir.		
		15:08:05.5 **APP-PHL**	november four five two delta alpha you have traffic at your one o'clock and about four miles is a Grumman V-F-R three thousand five hundred west bound.
		15:08:12.4 **RDO-1**	yeah lookin' for that traffic two delta alpha.
		15:08:14.3 **APP-PHL**	november one one niner six golf, you have traffic at your ten o'clock four miles eastbound it's a Learjet four thousand
15:08:17.1 **HOT-1**	Grumman.		
15:08:20.6 **HOT-1**	and if they give us # higher.		
		15:08:20.6 **AC-N1196G**	okay. ***.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:08:22.7 **HOT-2**	we wouldn't have to worry about it.		
15:08:24.1 **HOT-1**	yeaaah.		
15:08:26.1 **HOT-1**	he's thirty-five. I don't even # see him on the-the traffic here.		
15:08:30.8 **HOT-1**	traffic is failed.		
15:08:33.1 **HOT-1**	don't ask me why # traffic is failed.		
15:08:33.2 **CAM**	[sound similar to increase in engine thrust]		
15:08:37.7 **CAM**	[sound similar to increase in engine thrust]		
15:08:39.8 **HOT-1**	two fifty on the speed. four thousand and we're direct MAZIE.		
15:08:42.1 **CAM**	[sound similar to increase in engine thrust]		
15:08:42.4 **HOT-2**	yup.		
15:08:43.7 **HOT-1**	nav mode select. so-so far # good. no issues what so # ever.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:08:49.1 **HOT-2**	seventy-five should do it. right now that's good right there. seventy-three. seventy-four.		
15:08:52.7 **HOT-1**	yeah that'll do it.		
15:08:54.7 **HOT-2**	keep us below two fifty.		
15:08:56.5 **HOT-1**	yup. uhhh.		
15:08:58.9 **HOT-2**	a Grumman at what? one o'clock? two o'clock?		
15:09:00.8 **HOT-1**	well he's # below us and ah not a factor I'm guess'n. I don't # see 'em.		
		15:09:04.9 **APP-PHL**	november four five two delta alpha turn left heading three six zero (it's) a vector for sequence I'll have you back direct MAZIE in a few more moments.
15:09:10.4 **HOT-2**	three six zero.		
		15:09:11.3 **RDO-1**	okay three six zero on the heading for two five brav— errr two delta alpha I'm (sorry).
15:09:17.0 **HOT-1**	heading select.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:09:18.9 **HOT-1**	there we go.		
15:09:22.6 **HOT-1**	someone's come'n behind us that the what they # wanna do. there's no one in front of us they want someone to climb over the top of us so they give us # uh forty-five degree bank to # MAZIE.		
15:09:30.7 **HOT-2**	# those guys.		
15:09:31.9 **HOT-1**	yeaaah. what the # man. we're a # Learjet. get us # higher.		
15:09:34.5 **HOT-2**	we could go faster.		
		15:09:35.7 **APP-PHL**	november four five two delta alpha. what's your airspeed?
15:09:37.5 **CAM**	[sound similar to decrease in engine thrust]		
		15:09:38.3 **RDO-1**	(now) we're showin' right now at twwwo siiiixty. four five two delta alpha.
15:09:44.5 **HOT-2**	(slowin') down.		
15:09:45.5 **HOT-1**	yes sir. # just admitted I violated # airspace but we're far enough away.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:09:49.3 **HOT-2**	that's why I was like ahhhhhhh.		
15:09:53.8 **HOT-2**	come on baby slow down for me.		
15:10:00.4 **HOT-2**	there we go.		
15:10:03.7 **HOT-1**	(eh) its within ten.		
15:10:05.8 **HOT-1**	I don't think (shh) we'll be violated for that.		
15:10:18.5 **HOT-1**	that's good. just right there. it'll bleed off a little.		
15:10:24.6 **HOT-1**	okay. where the # man? who why the # are they jackin' us on this? let us get the # up and get home.		
15:10:31.0 **HOT-2**	that's why. they don't want us to go home.		
15:10:33.4 **HOT-1**	#. give it a little power [sound similar to sigh].		
15:10:36.9 **HOT-1**	keep it within ten.		
15:10:39.4 **CAM**	[sound similar to increase in engine thrust]		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:10:48.2 **CAM**	[sound similar to increase in engine thrust]		
		15:10:53.0 **AC-789HA**	seven eight nine hotel alpha check'n on four thousand tango.
15:10:56.8 **HOT-1**	that's who (ya is).		
15:11:19.8 **HOT-1**	come on man. what the #. over.		
		15:11:23.0 **APP-PHL**	november four five two delta alpha turn right direct uh MAZIE.
		15:11:27.0 **RDO-1**	'kay right turn direct MAZIE. four five two delta alpha.
15:11:30.0 **HOT-2**	number six.		
15:11:32.0 **HOT-2**	enter.		
15:11:33.3 **HOT-2**	aaand one zero nine please.		
15:11:33.7 **HOT-1**	one zero nine.		
15:11:39.6 **HOT-1**	and nav mode select when able.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:11:40.9 **HOT-2**	yup.		
15:11:42.6 **HOT-1**	there ya go.		
15:11:45.7 **HOT-1**	airspeed's good. # everything's # good.		
15:11:45.8 **HOT-2**	one zero nine.		
15:11:49.3 **HOT-1**	# MAZIE. it's gonna be-# behind us by the time we # get lined up for it.		
15:11:53.9 **HOT-2**	yup.		
15:12:03.3 **HOT-2**	# balls.		
		15:12:04.7 **RDO-1**	yeah four five two delta alpha any chance we can get higher?
		15:12:07.6 **APP-PHL**	four five two delta alpha. unable higher. I would have to ah spin you back around and sequence you with the rest of the traffic goin' into Teterboro.
		15:12:14.5 **RDO-1**	four five two delta alpha.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:12:17.0 **HOT-2**	ha [exclaimed].		
15:12:19.9 **HOT-2**	it's like she doesn't like us.		
15:12:21.7 **HOT-1**	whatever. it's four # miles. it's right here somewhere.		
15:12:25.7 **HOT-1**	we're never gonna # get there. we're gonna fly right # over it before we # get there.		
15:12:32.0 **HOT-2**	it's holdin' the speed.		
15:12:32.8 **HOT-1**	now it's a # tail wind so yeah you have to pull back the power juuust a little.		
15:12:35.5 **HOT-2**	yup.		
15:12:36.1 **CAM**	[sound similar to decrease in engine noise]		
15:12:37.0 **HOT-2**	I've been listenin' to what you say.		
15:12:39.0 **HOT-1**	yeaaap.		
15:12:41.6 **HOT-2**	I've been keepin' it. and watching.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:12:47.3 **HOT-1**	two miles. right over # MAZIE.		
15:12:50.1 **HOT-1**	gonna be a left turn heading offfff zero five nine.		
15:12:54.1 **HOT-2**	yup.		
15:12:55.0 **HOT-2**	zero five nine.		
15:12:55.5 **HOT-1**	zero five nine.		
15:13:00.1 **HOT-2**	set right.		
15:13:01.9 **HOT-1**	zero five nine. set left.		
15:13:06.4 **HOT-1**	goin' to # BIGGY. #. how the #—		
15:13:10.2 **HOT-1**	yeah (now) don't # put us at # at four thousand all the # way. what the #? [high pitch, exclaiming].		
15:13:14.1 **HOT-2**	(and) zig zagging.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:13:16.7 **HOT-1**	yeah. she's gonna # carry it we-we won't # make it if we got (a) four thousand. she's a # idiot. get us someone else if she can't do it [high pitch, exclaiming].		
15:13:27.1 **HOT-1**	I # filed for #...		
15:13:30.0 **HOT-1**	...what is it? for twenty-seven man.		
		15:13:31.8 **APP-PHL**	november four five two delta alpha contact New York approach on one three two point eight good day.
		15:13:37.4 **RDO-1**	one three two point eight four five two delta alpha so long.
		15:13:40.7 **APP-NYC**	[prior cut off, similar to frequency change] —two niner seven five expect vectors I-L-S six circle runway one.
15:13:41.4 **HOT-2**	uhhh.		
		15:13:46.1 **AC-RRBZ**	two niner seven five. uh expect vectors I-L-S six. circle runway zero one. romeo bravo zulu.
		15:13:53.1 **RDO-1**	and New York center Learjet four five two delta alpha's checkin' in four thousand uh direct BIGGY at this time.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
		15:13:58.2 **APP-NYC**	Lear four five two delta alpha New York approach Newark altimeter two niner seven five. fly heading zero two zero vector I-L-S six circle one.
15:14:06.4 **HOT-1**	okay what was the heading—		
		15:14:08.5 **RDO-1**	okay we got a two niner niner er uhh excuse me. what was that again. say again altimeter for two delta alpha.
15:14:10.9 **HOT-2**	two nine seven five.		
		15:14:12.8 **APP-NYC**	the altimeter's two niner seven five at Newark. Lear two delta alpha fly heading zero two zero vector I-L-S six circle one.
15:14:14.8 **CAM**	[sound of high pitch tone, similar to altitude alerter]		
		15:14:20.0 **RDO-1**	'kay zero two zero. four five two delta alpha.
		15:14:23.1 **APP-NYC**	papa romeo romeo bravo zulu descend and maintain five thousand.
15:14:24.3 **HOT-2**	zero two zero on the heading.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
		15:14:26.5 **AC-RRBZ**	five thousand. romeo bravo zulu.
15:14:26.7 **HOT-1**	what the # are they doing man? circling six?		
15:14:28.1 **HOT-2**	uh zig zagging man.		
		15:14:29.8 **APP-NYC**	Jetlink mike foxtrot nine five kilo New York.
15:14:29.8 **HOT-2**	heading zero two zero.		
15:14:32.1 **HOT-1**	well we got the power pulled all the way # back you know so it's—		
15:14:36.8 **HOT-1**	no # point in—		
15:14:39.3 **HOT-2**	zero two zero.		
15:14:40.6 **HOT-1**	yeah. we're set.		
15:14:41.6 **HOT-2**	alright.		
15:14:42.0 **HOT-1**	zero two zero on the left.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:14:43.1 **HOT-2**	yup.		
15:14:44.1 **HOT-2**	#. alright.		
15:14:45.7 **HOT-2**	(set on the) right.		
15:14:47.4 **HOT-1**	he was saying circling # six or something. I don't know what the # they thinkin' we're doin'. we're # hundreds of miles away man.		
15:14:51.9 **HOT-2**	[sound similar to heavy breathing]		
		15:14:54.5 **APP-NYC**	(Jetlink) nine five (kilo) if you read New York ident.
15:14:58.9 **HOT-2**	what the # over?		
15:15:01.0 **HOT-2**	dude we're gonna get there like # an hour and you're gonna look at me and you're gonna say why is the time like this?		
		15:15:03.7 **APP-NYC**	roger papa romeo romeo bravo zulu turn right zero niner zero descend and maintain three thousand.
15:15:08.3 **HOT-1**	be there in twenty # minutes.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
		15:15:09.4 **AC-RRBZ**	right heading zero niner zero descend three thousand. romeo bravo zulu.
15:15:12.5 **HOT-1**	no act—		
15:15:12.5 **HOT-2**	no we're doin' S turns on this #.		
15:15:13.5 **HOT-1**	actually—		
		15:15:13.6 **APP-NYC**	Lear two delta alpha descend and maintain three thousand.
		15:15:16.2 **RDO-1**	three thousand. two delta alpha.
15:15:18.6 **HOT-1**	# eh man.		
15:15:20.5 **HOT-1**	let's go down to three.		
15:15:21.5 **HOT-2**	yup. doin' it.		
15:15:22.3 **HOT-1**	we're # gonna be there in ten minutes.		
15:15:25.0 **HOT-1**	I gotta' get the # ATIS. #. I didn't realize we're that # close.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:15:30.4 **HOT-1**	of course I don't have # uh G-P-S that's why.		
15:15:32.9 **HOT-2**	you wanna use my ipad?		
15:15:34.1 **HOT-1**	naw that's okay. (we'll/will) #—		
15:15:36.5 **HOT-1**	Teterboro—		
15:15:38.1 **HOT-1**	thirty-two eighty five.		
15:15:42.2 **CAM**	[sound of multiple clicks]		
15:15:44.1 **HOT-1**	I'm goin' off of one.		
15:15:45.1 **HOT-2**	yes sir.		
		15:15:46.9 **ATIS-TEB**	departure. ** (fly the procedure as published). all pilots follow noise abatement procedures. read back hold short instructions ** — [static throughout transmission]
		15:15:56.4 **APP-NYC**	Lear(jet) two delta alpha turn right heading one two zero.
		15:15:59.1 **RDO-2**	one two zero. four five two delta alpha.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:16:02.6 **HOT-1**	what the #? one two zero? [high pitch, loudly]		
15:16:04.4 **HOT-2**	yes sir.		
15:16:05.2 **HOT-2**	turn right to one two zero sir.		
15:16:05.2 **HOT-1**	holy #.		
15:16:07.6 **HOT-1**	yes sir. one two zero.		
		15:16:12.8 **ATIS-TEB**	[static] visibility [static].
15:16:14.0 **CAM**	[sound similar to decrease in engine thrust]		
		15:16:16.0 **ATIS-TEB**	light rain. five thousand five hundred scattered. temperature one eight. dew point six. altimeter two niner seven four [static throughout transmission].
15:16:25.4 **HOT-1**	two nine seven four.		
		15:16:26.9 **ATIS-TEB**	* approach in use ***. V-F-R departures contact clearance delivery on one two eight point zero five prior to taxi. bird activity in the vicinity of Teterboro airport. *** — [static throughout transmission]

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:16:31.8 **HOT-2**	hey it's uh at least it's good practice.		
15:16:41.0 **HOT-1**	watch the altitude.		
15:16:42.1 **HOT-2**	yup I'm on it.		
15:16:42.9 **HOT-1**	shallow it out.		
15:16:44.0 **HOT-2**	I already did.		
		15:16:44.8 **ATIS-TEB**	(departure.) comply with altitude restrictions as published— [static throughout transmission]
		15:16:48.8 **APP-NYC**	papa romeo romeo bravo zulu turn right one one zero. vector for your descent.
		15:16:54.0 **AC-RRBZ**	right heading one one zero. vector for descent romeo bravo zulu.
		15:16:54.2 **ATIS-TEB**	advise on initial contact you have information zulu [static throughout transmission].
15:16:58.6 **HOT-1**	zulu.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:16:59.5 **CAM**	[sound similar to papers rustling]		
15:17:00.9 **HOT-1**	information zulu. who the # knows what's going on (in) Teterboro.		
		15:17:02.8 **APP-NYC**	(seven mike foxtrot) nine (mike) kilo New York.
15:17:05.3 **HOT-1**	don't have time to listen to it.		
15:17:08.2 **HOT-1**	I just got the altimeter.		
		15:17:09.1 **APP-NYC**	* nine five kilo
15:17:10.1 **HOT-2**	no worries.		
15:17:11.2 **HOT-1**	it's zulu two nine seven four.		
15:17:14.1 **CAM**	[sound similar to either papers rustling or seat moving on seat track]		
15:17:14.9 **HOT-2**	roger.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:17:15.5 **HOT-1**	I guess we're #— do you see New York out there anywhere?		
15:17:18.0 **HOT-2**	negative. we're so # far from it. like—		
15:17:19.8 **HOT-1**	yeah.		
		15:17:20.3 **APP-NYC**	romeo romeo bravo zulu. turn left zero eight zero intercept the six localizer.
15:17:22.1 **HOT-2**	we're (in) the boonies.		
		15:17:25.4 **AC-RRBZ**	zero eight zero ** the localizer runway six ** bravo **.
15:17:25.4 **HOT-1**	well it's less than fifty miles man. that's why. two five zero on the speed sir.		
15:17:26.7 **CAM**	[sound similar to increase in engine thrust]		
15:17:29.9 **HOT-2**	yup.		
15:17:30.7 **HOT-1**	that's why. we're less than fifty miles away. #.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:17:33.8 **HOT-1**	no wonder they're s— got us so # low.		
15:17:38.0 **HOT-1**	but they got us at # three thousand. really? [high pitch, loudly]. what the # over? [high pitch, loudly] and we're goin' # south we're not goin' # north [high pitch, loudly].		
15:17:49.1 **HOT-1**	I don't know what. (well it) must be a flow issue.		
15:17:49.3 **HOT-2**	** al-al-altitude is good. three thousand's good. speed is good.		
15:17:55.5 **HOT-1**	yeah. there we go man. let's get some V-speeds (on the way).		
		15:17:55.8 **APP-NYC**	papa romeo romeo bravo zulu. contact New York approach on one two seven point six.
15:17:59.6 **HOT-1**	let's do the checklist.		
		15:18:01.5 **AC-RRBZ**	one two seven six. romeo bravo zulu so long.
15:18:05.0 **HOT-1**	so we got five. ten. fifteen. twenty. I'm gonna say one twenty-two.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
		15:18:06.7 **AC-UNK**	*** five thousand for seven thousand direct REGLE we have zulu at Teterboro.
15:18:10.9 **HOT-1**	now (you) got thirteen. fourteen. let's go uh. one twenty-six one nineteen.		
		15:18:12.4 **APP-NYC**	* zero *. *** wind gusts * two niner seven five. expect vectors I-L-S six circle one.
15:18:16.0 **HOT-2**	one twenty-six to one nineteen. roger.		
15:18:18.6 **HOT-1**	so just make it one twenty-six (man).		
		15:18:19.9 **AC-N900QC**	two nine seven five. uh I-L-S runway six circle to runway one. zero quebec charlie.
15:18:24.6 **HOT-1**	approach is one twenty-six. V-ref is one-nineteen.		
15:18:31.3 **CAM**	[sound similar to decrease in engine thrust]		
15:18:31.3 **HOT-2**	speed. I gotta' slow down a lot.		
15:18:33.6 **HOT-1**	yeah. we're only you know three thousand. #. two fifty's our top speed.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:18:40.5 **HOT-1**	# red sled man. and they got it— havin' us doing # S-turns into Teterboro. what the #. over?		
15:18:48.6 **HOT-2**	do some (airframes) have like a speed-dometer like you like can hold the speed?		
15:18:53.2 **HOT-1**	yeah. we do.		
15:18:54.3 **HOT-2**	oh.		
15:18:55.8 **HOT-1**	well—		
15:18:56.1 **HOT-2**	oh right there.		
		15:18:56.9 **AC-UNK**	uhh New York uhh * * *.
15:18:58.0 **HOT-1**	yeah. speed. but what it'll do to maintain that— it'll pitch up or down to maintain two fifty.		
		15:19:02.0 **APP-NYC**	* * alpha. New York approach * one niner zero. descend and maintain four thousand. newark altimeter two niner seven five.
15:19:04.9 **HOT-2**	I gotch'ya.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:19:06.6 **HOT-1**	because we—		
		15:19:08.8 **AC-95K**	one niner zero down to four thousand. two niner seven five for (compassion flight) niner five kilo.
15:19:08.9 **HOT-1**	we don't have auto throttles.		
15:19:11.2 **HOT-2**	I gotchy'a.		
		15:19:17.1 **APP-NYC**	Lear two delta alpha fly heading zero niner zero intercept the six localizer contact New York approach one two seven point six.
15:19:20.9 **CAM**	[sound similar to increase in engine thrust]		
		15:19:25.0 **RDO-1**	okay one two seven point six. fly heading zero nine zero to intercept the six into Teterboro. four five two delta alpha.
		15:19:31.6 **APP-NYC**	Falcon zero quebec charlie descend and maintain three— [cut off by frequency change]
15:19:37.0 **HOT-1**	# runway six I-L-S.		
15:19:38.0 **CAM**	[sound similar to increase in engine thrust]		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:19:40.5 **HOT-1**	set this up on your side. one oh nine point nine.		
15:19:45.1 **HOT-1**	or excuse me. one oh eight point nine.		
15:19:47.1 **HOT-1**	zero six zero on the— localizer.		
		15:19:49.8 **RDO-1**	New York Learjet four five two delta alpha. three thousand. zero nine zero on the heading for the I-L-S six into Teterboro.
15:19:55.2 **HOT-1**	zero six zero. [spoken in a whisper]		
		15:19:55.8 **APP-NYC**	Learjet four five two delta alpha New York approach roger.
15:20:00.2 **HOT-1**	one oh eight point nine and zero six zero.		
		15:20:01.2 **APP-NYC**	(Gotham) eight three two about eight miles from DANDY. (two thousand) * localizer. cleared I-L-S runway six approach circle runway one. traffic no factor.
15:20:09.1 **CAM**	[sound similar to increase in engine thrust]		
		15:20:09.1 **AC-GOTH832**	two thousand ** localizer *** Gotham ***.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:20:09.7 **HOT-1**	'kay we're radar vectors so I'm gonna go ahead and set my # up for it as well.		
15:20:13.2 **HOT-2**	roger.		
15:20:16.5 **HOT-1**	you're on heading mode (nav) select one oh eight point nine.		
		15:20:19.1 **AC-N10MB**	Lear one zero mike bravo. eight thousand descending six thousand zulu at Teterboro.
15:20:19.2 **HOT-2**	yes sir.		
		15:20:23.5 **APP-NYC**	Learjet one zero mike bravo New York approach. Newark altimeter's two niner seven five.
15:20:23.7 **CAM**	[sound similar to increase in engine thrust]		
		15:20:28.4 **AC-N10MB**	nine(r) seven five.
15:20:29.5 **HOT-2**	runway in sight.		
15:20:31.2 **HOT-1**	for six?		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
		15:20:32.0 **APP-NYC**	Learjet two delta alpha make sure you intercept the localizer.
15:20:32.0 **HOT-2**	right there.		
		15:20:34.8 **RDO-1**	four five two delta alpha copy.
15:20:36.8 **HOT-1**	what the # over?		
15:20:38.0 **HOT-1**	zero six zero why aren't you not—		
15:20:40.0 **HOT-1**	intercepting it. I guess it's # left.		
15:20:42.0 **HOT-1**	we're makin' the left.		
		15:20:42.6 **APP-NYC**	Learjet two delta alpha left turn twenty heading (if) you (need it) to join.
15:20:42.9 **HOT-2**	yup.		
		15:20:45.7 **RDO-1**	we got it four five two delta alpha.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
		15:20:47.3 **APP-NYC**	papa romeo romeo bravo zulu descend and maintain (two) thousand.
15:20:49.7 **HOT-2**	you want me to hit nav?		
		15:20:50.9 **AC-RRBZ**	** romeo bravo zulu.
15:20:51.1 **HOT-1**	#. that's why.		
15:20:57.0 **HOT-1**	there we go. #—		
15:21:00.1 **HOT-1**	# runway's out there somewhere. I don't know why you're lookin' over there.		
		15:21:00.2 **APP-NYC**	Gotham eight three two *** five.
15:21:01.7 **HOT-2**	yeah that was Newark. that was Newark.		
15:21:04.8 **HOT-2**	I thought that was Teterboro.		
		15:21:04.8 **AC-UNK**	*** Teterboro nineteen five *** . copy (and you too).
15:21:09.0 **HOT-1**	alright your localizer is captured.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:21:11.5 **HOT-1**	and we've got nav mode selected on the F-M-S.		
		15:21:13.4 **APP-NYC**	Learjet one zero mike bravo (depart metro) heading * * *.
15:21:15.4 **HOT-1**	go ahead and slowwwwly bring it on back on the power not not crazy though 'cause we still got a ways to go.		
15:21:20.8 **HOT-2**	I'll put it at like one eighty.		
15:21:22.4 **HOT-2**	what do ya think?		
15:21:22.6 **HOT-1**	not. no. no.		
		15:21:23.1 **AC-N10MB**	what's uh give me again uh * again the phonetic.
15:21:24.0 **HOT-1**	keep it about two forty.		
15:21:25.4 **HOT-2**	okay.		
15:21:26.8 **HOT-1**	we're not far enough.		
		15:21:27.2 **APP-NYC**	Learjet one zero mike bravo. MUGZYs come'n up at a mile. ummm ***.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:21:30.0 **HOT-1**	I'm showing twenty nine miles to go to Teterboro. so we got a # ways to go.		
		15:21:33.4 **AC-N10MB**	*** one zero mike bravo.
15:21:37.8 **HOT-1**	we're so # far out he wants us to #—		
15:21:38.6 **CAM**	[sound similar to decrease in engine thrust]		
		15:21:40.0 **AC-GOTH72**	New York Gotham seven two from seven to six thousand with zulu.
15:21:40.2 **HOT-1**	#—		
15:21:42.9 **HOT-1**	you got two forty on your speed. two four zero.		
		15:21:43.2 **APP-NYC**	* New York approach. altimeter's two niner seven five.
15:21:44.9 **CAM**	[sound similar to decrease in engine thrust]		
15:21:45.4 **HOT-2**	roger.		
		15:21:47.1 **AC-GOTH72**	Gotham seven two.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:21:50.0 **HOT-1**	yeah that's all # up.		
15:21:51.7 **HOT-1**	let me get the—		
		15:21:52.6 **APP-NYC**	Learjet two delta alpha. uhhh just go— can you go to VINGS? can you do that? VINGS? and then just localizer six?
		15:21:58.1 **RDO-1**	four five two delta alpha copy.
		15:22:00.7 **AC-RRBZ**	New York. papa romeo romeo bravo zulu.
		15:22:03.7 **APP-NYC**	go ahead.
		15:22:04.9 **AC-RRBZ**	can I (talk) for (checking) our speed please?
15:22:05.2 **HOT-1**	#.		
		15:22:06.9 **APP-NYC**	papa romeo romeo bravo zulu you're about five miles from VINGS. cross VINGS at two thousand feet. cleared I-L-S runway six. circle one. maintain two five zero knots until VINGS and then after that you can maintain one eight zero knots or greater till TORBY.
15:22:08.7 **HOT-1**	V-I…		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:22:12.1 **HOT-1**	…N-G-S.		
		15:22:20.2 **AC-RRBZ**	okay VINGS at two thousand aaand then * circle *** after VINGS at least *** —
15:22:23.7 **HOT-1**	zero five five. zero five five in there.		
15:22:25.0 **HOT-2**	zero five five.		
15:22:26.8 **HOT-1**	gonna go in nav mode.		
15:22:29.0 **HOT-2**	go ahead and take over I'll uh— I'll uh—		
15:22:29.8 **HOT-1**	on the F-M-S * we're there we're going direct VINGS at this time. twelve miles away to VINGS.		
		15:22:32.4 **APP-NYC**	Learjet two one zero mike bravo descend and maintain four thousand.
15:22:36.8 **HOT-1**	you still got the localizer on your side so we're doin' good.		
		15:22:37.0 **AC-N10MB**	four thousand mike bravo.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:22:39.7 **HOT-2**	alright.		
15:22:41.5 **HOT-2**	I don't wanna # up.		
15:22:41.6 **HOT-1**	(he's) got us twenty-six # miles out and he expects us to collect the #— uh be able to uh—		
		15:22:46.7 **APP-NYC**	Learjet four five two delta alpha descend and maintain two thousand.
		15:22:49.8 **RDO-1**	two thousand. four five two delta alpha.
15:22:51.7 **HOT-1**	down to two.		
15:22:52.4 **HOT-2**	roger.		
15:22:52.6 **HOT-1**	go ahead and pull it all the way to # idle.		
15:22:54.8 **CAM**	[sound similar to decrease in engine thrust]		
15:22:55.1 **HOT-1**	only a thousand feet per minute descent so it's not a big deal.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:22:56.0 **CAM**	[sound of high pitch tone, similar to altitude alerter]		
15:22:58.9 **HOT-1**	don't have to chase after it-it will come down on its own at a decent rate.		
15:23:04.1 **HOT-1**	try to keep the speed at about one er two forty.		
		15:23:08.8 **APP-NYC**	papa romeo romeo bravo zulu make sure you cross * at (two) thousand Teterboro tower nineteen five good day.
15:23:11.0 **CAM**	[sound similar to increase in engine thrust]		
15:23:11.4 **HOT-1**	let me help you out we're trimming it forward a little.		
		15:23:16.3 **AC-RRBZ**	okay. DANDY one thousand five hundred feet. aaand call Teterboro tower (roger).
15:23:19.7 **HOT-2**	should I trim more?		
15:23:21.4 **HOT-1**	trimmin' yourself forward.		
15:23:22.9 **HOT-2**	yeah.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:23:23.4 **HOT-1**	that's okay.		
		15:23:23.7 **APP-NYC**	Learjet four five two delta alpha is eight miles from VINGS cross VINGS at two thousand feet, cleared I-L-S runway six. circle runway one.
		15:23:31.1 **RDO-1**	okay cleared I-L-S six circle one uh VINGS two thousand. four five two delta alpha.
15:23:35.3 **CAM**	[sound similar to increase in engine thrust]		
		15:23:35.9 **APP-NYC**	Learjet two delta alpha what's your current airspeed?
		15:23:38.4 **RDO-1**	eh we're showin' two forty.
		15:23:39.8 **RDO-1**	two delta alpha.
		15:23:40.5 **APP-NYC**	two four zero knots till VINGS and then uh you can slow to one eight zero knots maintain that till TORBY.
		15:23:45.3 **RDO-1**	alright. two forty until VINGS eh two thousand on the altitude and we can slow it down to one eighty to TORBY. four five two delta alpha.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
		15:23:53.5 **AC-N900QC**	nine hundred quebec charlie is with you three thousand about to join the ah localizer.
15:23:55.8 **CAM**	[sound similar to increase in engine thrust]		
		15:23:56.8 **APP-NYC**	Falcon 900 quebec charlie ** localizer two five zero knots.
15:23:58.4 **HOT-1**	localizer's come'n alive.		
15:24:01.0 **HOT-1**	you are nav mode selected. we're on F-M-S still		
		15:24:01.3 **AC-N900QC**	* fifty knots ** .
		15:24:03.1 **APP-NYC**	Gotham seventy two fly heading * * sequence descend and maintain * *
15:24:04.2 **HOT-1**	six miles to VINGS. maintain two forty till VINGS two thousand on the altitude. we're circling runway one.		
		15:24:08.4 **AC-GOTH72**	***.
15:24:11.1 **HOT-1**	so circling minimums.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:24:13.3 **HOT-1**	is seven hundred and sixty.		
15:24:15.6 **HOT-2**	oh #.		
15:24:16.6 **HOT-1**	yeah.		
15:24:18.3 **HOT-2**	alright I'm gonna go— you're gonna have—		
15:24:19.4 **HOT-1**	slow it on down to— well we're two forty— we're right— * *—		
15:24:22.0 **HOT-2**	yeah. you come’n to two forty so—		
		15:24:23.1 **APP-NYC**	Learjet one zero mike bravo descend and maintain tree thousand.
15:24:24.5 **CAM**	[sound similar to decrease in engine thrust]		
		15:24:26.5 **AC-N10MB**	three thousand *** .
15:24:26.8 **HOT-1**	'kay when your localizer comes alive we're gonna # trout— did he clear us for the localizer?		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:24:31.4 **HOT-2**	yeah.		
		15:24:31.4 **AC-FLEX562**	New York. Flexjet five six two with you level six thousand zulu.
15:24:32.3 **HOT-1**	yes he did.		
15:24:34.2 **HOT-1**	yeah I'm going heading mode select.		
		15:24:35.6 **APP-NYC**	Flexjet five forty two New York approach roger altimeter. Newark's altimeter two niner seven five. zulu current.
15:24:36.5 **HOT-1**	it's # bumpy.		
15:24:38.8 **HOT-1**	gonna dial myself up one oh eight nine.		
15:24:41.1 **HOT-1**	inbound course is zero five— zero six zero.		
		15:24:41.5 **AC-FLEX562**	two nine seven five. five (six) *.
15:24:43.4 **HOT-2**	yeah. yes. zero six zero. I turned it by accident.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
		15:24:43.7 **APP-NYC**	Flexjet five forty two (reset your transponder) squawk tree tree seven zero.
15:24:47.1 **HOT-2**	there ya go.		
		15:24:48.2 **AC-FLEX562**	three three seven zero.
15:24:50.8 **HOT-1**	your localizer's coming alive so it should be come'n alive on my side.		
15:24:56.1 **HOT-1**	two forty 'til VINGS and then we can slow it down to one eighty all the way to TORBY which is the final approach fix.		
15:25:01.6 **CAM**	[sound similar to increase in engine thrust]		
15:25:03.9 **HOT-1**	VINGS is two miles away and counting.		
15:25:06.8 **HOT-2**	roger.		
15:25:08.2 **HOT-2**	you're gonna have to get on with it— with me when we uh start this #.		
15:25:10.8 **HOT-1**	hey we're tracking the V-O-R inbound now.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:25:13.1 **HOT-2**	there's the airport.		
15:25:13.9 **HOT-1**	yes sir. we're tracking— we're tracking the localizer excuse me.		
15:25:17.3 **HOT-1**	two forty on the speed sir.		
15:25:19.4 **HOT-2**	okay. reducing speed.		
15:25:20.7 **CAM**	[sound similar to decrease in engine thrust]		
15:25:23.7 **HOT-1**	and—		
15:25:25.4 **HOT-1**	VINGS.		
		15:25:26.6 **APP-NYC**	Hawker nine zero zero quebec charlie— you're about thirteen miles from VINGS. cross VINGS at two thousand (I-L-S) six circle to runway one.
15:25:29.8 **HOT-1**	'kay.		
15:25:31.9 **HOT-1**	go ahead and pull all the way to idle.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:25:34.2 **CAM**	[sound similar to decrease in engine thrust]		
		15:25:35.4 **AC-N900QC**	VINGS at two thousand. cleared uh for the I-L-S six circle to one. zero quebec charlie.
		15:25:39.7 **APP-NYC**	Hawker zero quebec charlie *** until VINGS * reduce speed to ***.
15:25:40.9 **HOT-1**	down to one eighty on the airspeed.		
15:25:43.1 **HOT-1**	no. no. no. no.		
15:25:44.4 **HOT-1**	don't # do that yet. we haven't captured the glideslope.		
		15:25:48.0 **AC-N900QC**	okay two hundred until VINGS we can reduce to one eight zero (november) nine * * quebec (charlie).
15:25:48.4 **HOT-1**	don't trim forward.		
15:25:50.8 **HOT-1**	'kay. one eighty.		
15:25:52.5 **HOT-1**	is the slowest.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
		15:25:53.3 **AC-EXEC302**	Execjet three zero two * * * hundred for three thousand.
15:25:54.6 **HOT-1**	one eighty will be our slope-ist.		
		15:25:57.4 **APP-NYC**	Execjet three oh two. roger New York approach. direct uh (KWITE)
		15:26:00.3 **AC-EXEC302**	direct (KWITE) for Execjet three zero two.
15:26:02.1 **HOT-1**	tower's nineteen five.		
		15:26:03.0 **AC-N999GC**	* for triple niner golf charlie six thousand four hundred for six thousand at MUGS uhhh MUGZY we have zulu.
		15:26:08.5 **APP-NYC**	november nine nine nine golf charlie New York approach Newark altimeter's two niner seven five and * zulu ***.
15:26:13.2 **HOT-2**	wow it's # bumpy as #.		
15:26:13.8 **HOT-1**	one— one eighty to one ninety. yeah. yoke.		
		15:26:15.7 **APP-NYC**	november niner golf charlie roger. depart MUGZY a heading one four zero vector sequence.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:26:17.3 **CAM**	[sound similar to engine igniters begin and continue until end of recording]		
15:26:20.2 **CAM**	[sound similar to increase in engine thrust]		
		15:26:21.0 **AC-N999GC**	depart MUGZY heading one four zero triple nine golf charlie.
15:26:21.1 **HOT-1**	before landing checks.		
		15:26:23.8 **APP-NYC**	Flexjet five forty two fly present heading * * * .
15:26:24.9 **HOT-2**	set.		
15:26:25.5 **HOT-1**	one eighty on the speed. one ninety on the speed. there ya go.		
15:26:26.8 **CAM**	[sound similar to gear warning horn briefly audible]		
15:26:27.5 **CAM**	[sound similar to increase in engine thrust]		
		15:26:28.5 **APP-NYC**	***.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:26:28.6 **HOT-1**	I'll give you flaps at eight. uh. this will help you out.		
15:26:31.2 **HOT-2**	yup. flaps eight please.		
		15:26:32.1 **APP-NYC**	Learjet two delta alpha contact Teterboro tower one one niner point five. be sure (you) cross DANDY (fitch) hundred feet circle at TORBY.
15:26:37.0 **CAM**	[sound similar to increase in engine thrust]		
		15:26:38.9 **RDO-1**	alright DANDY at two hundred feet. circle at TORBY. nineteen five. four five two delta alpha.
		15:26:43.1 **APP-NYC**	uh DANDY at fifteen hundred feet two delta alpha.
		15:26:46.0 **RDO-1**	DANDY at fifteen. four five two delta alpha.
15:26:48.4 **HOT-1**	I'm not gettin' flap indicator.		
		15:26:48.4 **AC-UNK**	*** two sixty heading.
15:26:48.9 **CAM**	[sound similar to decrease in engine thrust]		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:26:51.8 **HOT-1**	there we go.		
		15:26:52.8 **APP-NYC**	Gotham eight thirty two New York approach roger. and uh expect re-sequence the I-L-S six circle one. what happened uh **.
15:26:57.8 **HOT-1**	fifteen at DANDY.		
		15:26:59.3 **AC-GOTH832**	yeah just the winds weren't favorable at that time so ** another one.
15:26:59.4 **CAM**	[sound similar to decrease in engine thrust]		
15:27:01.5 **HOT-1**	mandatory at fifteen.		
		15:27:03.1 **APP-NYC**	roger.
15:27:07.4 **HOT-1**	you got any indication on uh distance for DANDY?		
15:27:07.7 **CAM**	[sound similar to decrease in engine thrust]		
		15:27:10.1 **APP-NYC**	Execjet three oh two your * miles from (KWITE) cross ** R-nav G-P-S runway five.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:27:10.8 **HOT-2**	nope I got nothing.		
15:27:12.0 **HOT-1**	six point four Teterboro.		
15:27:16.2 **HOT-1**	okay we're fine.		
		15:27:17.0 **AC-EXEC302**	alright * KWITE *** for the R-nav ** Execjet three zero two.
15:27:17.4 **HOT-2**	go ahead and descend?		
15:27:18.6 **HOT-1**	not yet.		
15:27:19.6 **HOT-1**	glideslope's come'n in you gotta' look at my side.		
15:27:22.7 **HOT-2**	roger.		
15:27:23.1 **HOT-1**	'kay. slow it on down.		
		15:27:23.2 **APP-NYC**	Gotham eight (thirty two) runway one I can ** get you in behind the (Learjet) * two thousand ***.
15:27:25.4 **HOT-1**	one eighty till DANDY. or Tobey [mispronunciation of TORBY].		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:27:28.3 **HOT-1**	which is the final approach fix.		
15:27:28.7 **CAM**	[sound similar to decrease in engine thrust]		
		15:27:29.2 **AC-GOTH832**	yeah whatever's easiest for you for Gotham eight three two.
15:27:31.0 **HOT-1**	okay now we should—		
		15:27:31.1 **APP-NYC**	Gotham eight three two okay turn left heading one eight zero vectors for a visual approach runway one.
		15:27:35.2 **AC-GOTH832**	okay one eighty vectors visual ***.
15:27:36.3 **HOT-1**	it did not capture. trim the nose over.		
		15:27:37.6 **APP-NYC**	one zero mike bravo descend and maintain two thousand.
15:27:40.4 **HOT-1**	you're gonna have to fly on— you gotta' glideslope on your side?		
		15:27:40.5 **AC-N10MB**	two thousand zero mike bravo *** .

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
		15:27:42.6 **APP-NYC**	** charlie ***.
15:27:43.4 **HOT-2**	yes sir.		
15:27:44.1 **HOT-1**	follow your glideslope. do not go below fifteen [emphasized].		
		15:27:46.9 **APP-NYC**	Gotham seven two turn left heading one six zero descend and maintain tree thousand.
15:27:47.2 **HOT-2**	roger.		
		15:27:50.9 **AC-GOTH72**	one six zero at three thousand. Gotham seven two.
15:27:52.0 **HOT-1**	(okay)		
		15:27:53.4 **APP-NYC**	Execjet three zero two. radar services terminated. contact Morristown tower (one) one eight point one.
15:27:54.6 **CAM**	[sound of increased background noise, similar to air drag on landing gear during extension]		
		15:27:58.1 **AC-EXEC302**	eighteen one for Execjet ***.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:27:58.7 **HOT-1**	'kay. slow to one eighty.		
15:28:02.6 **CAM**	[sound similar to decrease in engine thrust]		
15:28:05.2 **HOT-1**	'cause I gotta' get ya flaps twenty.		
15:28:06.8 **HOT-1**	there ya go.		
		15:28:06.9 **APP-NYC**	Gotham eight thirty two turn left heading of one three (zero) * traffic twelve o'clock (Learjet) * circle to runway one.
15:28:08.9 **HOT-1**	flaps twenty. gear down. [emphasized]		
15:28:10.8 **HOT-1**	follow the # glideslope [emphasized]		
15:28:13.2 **HOT-2**	alright you said don't go below one—		
15:28:14.3 **HOT-1**	yeah don't go below fifteen 'til I call TORBY.		
		15:28:15.1 **AC-UNK**	***.
		15:28:17.4 **APP-NYC**	(delta) alpha contact Teterboro tower nineteen five.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
		15:28:19.4 **RDO-1**	nineteen five. four five two delta alpha.
15:28:21.1 **HOT-1**	alright.		
		15:28:21.4 **APP-NYC**	Hawker zero quebec charlie (reduce to) one eight zero knots.
15:28:22.0 **HOT-1**	now you can bring it on down.		
15:28:23.8 **HOT-2**	roger.		
15:28:24.2 **HOT-1**	bring it on down.		
		15:28:25.1 **AC-N900QC**	'kay reducing. zero quebec charlie.
		15:28:26.7 **APP-NYC**	Learjet one zero mike bravo reduce speed to one eight zero
15:28:27.1 **HOT-1**	seven sixty. [emphasized]		
15:28:29.7 **HOT-2**	seven sixty roger.		
		15:28:30.4 **TWR-TEB**	november four five two delta alpha Teterboro tower.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
		15:28:32.4 **RDO-1**	yeah we're up uh for the circling uhhh onnne two delta alpha.
15:28:33.1 **CAM**	[sound of high pitch tone, similar to altitude alerter]		
		15:28:36.2 **TWR-TEB**	roger Lear four five two delta alpha. wind three six zero at one six gust three two. runway one continue traffic holding in position.
		15:28:42.2 **RDO-1**	four five two delta alpha.
15:28:43.9 **HOT-1**	kay do not go below your—		
		15:28:44.9 **TWR-TEB**	* winds—
15:28:45.4 **HOT-1**	eight hundred.		
		15:28:45.8 **TWR-TEB**	** zero one eight gusts to three two.
15:28:46.6 **HOT-2**	alright there's eight hundred.		
		15:28:47.3 **TWR-TEB**	** cleared for takeoff traffic * half miles final ***.

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:28:48.2 **HOT-1**	eight— eight hundred. right there. hold eight hundred.		
15:28:49.9 **HOT-2**	(yeah) I am.		
		15:28:50.3 **AC-UNK**	*** for (one thirty one).
15:28:51.5 **HOT-1**	watch your airspeed. hand on the # throttle.		
		15:28:51.6 **TWR-TEB**	** delta alpha *** parking.
		15:28:54.5 **RDO-1**	yeah we're gonna be at Jet Aviation. four five two delta alpha. cleared to land one.
15:28:58.2 **HOT-1**	'kay we're gonna circle for runway one.		
15:29:00.1 **HOT-2**	okay.		
15:29:00.7 **HOT-1**	so we're kinda on a downwind.		
15:29:03.7 **HOT-1**	so. go'head.		
15:29:04.3 **HOT-?**	[sound of unintelligible whisper]		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:29:05.1 **HOT-1**	break off the autopilot.		
15:29:06.1 **CAM**	[sound similar to autopilot disconnect tone]		
15:29:06.8 **HOT-2**	there ya go.		
15:29:07.1 **HOT-1**	hand on the #—		
		15:29:07.3 **TWR-TEB**	(delta alpha) you gonna start that turn?
		15:29:09.2 **RDO-1**	yeah sir we're doin' it right now four (sixty) delta alpha.
15:29:12.1 **HOT-1**	right.		
15:29:12.6 **CAM**	[sound similar to decrease in drag noise]		
15:29:13.8 **HOT-1**	[sound similar to sigh]		
15:29:14.7 **HOT-1**	watch the airspeed.		
15:29:15.3 **HOT-2**	your flight controls. [emphasized]		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:29:16.7 **CAM**	[sound of faint mechanical whine]		
15:29:17.6 **CAM**	[sound of high pitch tone, similar to altitude alerter]		
15:29:18.0 **HOT-1**	there we go.		
15:29:18.8 **EGPWS**	five hundred.		
15:29:19.8 **HOT-1**	disregard.		
15:29:21.1 **HOT-2**	roger. [strained voice]		
15:29:21.6 **EGPWS**	sink rate. pull up.		
15:29:26.2 **HOT-2**	meeeh. [strained voice] I'm gonna give ya your controls okay?		
15:29:28.5 **HOT-1**	alright. my controls.		
15:29:29.2 **HOT-2**	your flight controls.		
15:29:30.3 **HOT-1**	# eh. [spoken in angry tone]		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:29:31.5 **HOT-1**	watch my airspeed.		
15:29:32.7 **HOT-2**	yup.		
15:29:32.8 **CAM**	[sound similar to high frequency aerodynamic noise]		
15:29:33.6 **HOT-1**	[heavy breathing]		
15:29:34.5 **HOT-2**	lookin' good.		
15:29:35.5 **HOT-2**	V-ref.		
		15:29:35.6 **TWR-TEB**	* contact departure one one niner point two.
15:29:35.6 **HOT-1**	no.		
15:29:38.1 **HOT-2**	add airspeed. [emphasized] airspeed. airspeed. airspeed. [exclaimed]		
15:29:40.6 **HOT-1**	stall. [strained voice]		
15:29:41.2 **HOT-2**	yup.		

TIME/ SOURCE	INTRA-COCKPIT CONTENT	TIME/ SOURCE	AIR-GROUND COMMUNICATION CONTENT
15:29:41.6 **CAM**	[sound similar to high frequency aerodynamic noise]		
15:29:42.3 **HOT-1**	[sound of strained breathing]		
15:29:43.1 **HOT-2**	airspeed. airspeed. [exclaimed]		
15:29:43.2 **HOT-1**	#.		
15:29:43.7 **EGPWS**	sink rate. pull up.		
		15:29:43.9 **RDO-1**	ahhh # [yelled] [based on Teterboro Tower air traffic control recording, this utterance was transmitted over the radio]

END OF TRANSCRIPT
END OF RECORDING
15:29:44 EST

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