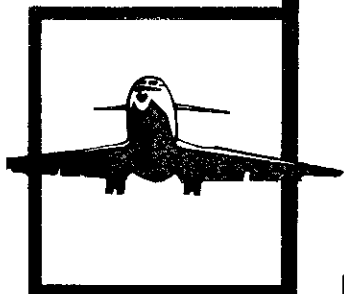


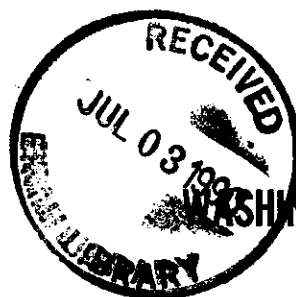
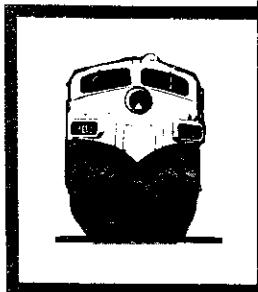
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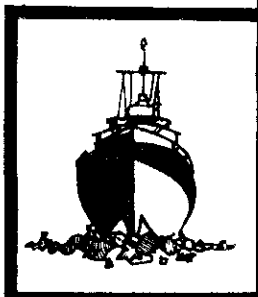
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NATIONAL TRANSPORTATION SAFETY BOARD



WASHINGTON, D.C. 20594

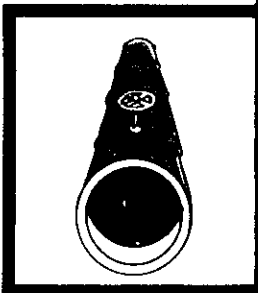


AIRCRAFT ACCIDENT/INCIDENT SUMMARY REPORT

KANSAS CITY, MISSOURI--APRIL 13, 1987

See also :

*NTSB Reporter
January 1990, p. 5*



NTSB/AAR-89/01/SUM

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SUM



UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB/AAR-89/01/SUM	2. Government Accession No. PB89-910403	3. Recipient's Catalog No.	
4. Title and Subtitle Aircraft Accident/Incident Summary Report		5. Report Date March 31, 1989	
		6. Performing Organization Code	
7. Author(s)		8. Performing Organization Report No.	
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 4650A	
		11. Contract or Grant No.	
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Aircraft Accident/Incident Summary Report, 1989	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract This report is a summary of an aircraft accident investigated by the National Transportation Safety Board. The accident location and date is Kansas City, Missouri, April 13, 1987.			
17. Key Words ✓ flightcrew coordination; ✓ instrument landing system approach; ✓ decision height; ✓ minimum safe altitude warning; ✓ ground proximity warning system		18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 14	22. Price



**National
Transportation
Safety Board**

Washington, D.C. 20594

AIRCRAFT ACCIDENT/INCIDENT SUMMARY

File No:	330
Aircraft Operator:	Buffalo Airways, Inc.
Aircraft Type and Registration	Boeing 707-351C, N144SP
Location:	Kansas City, Missouri
Date and Time:	April 13, 1987, 2155 central daylight time
Injuries	4 fatal
Aircraft Damage:	Destroyed
Type of Occurrence:	Collision with ground
Phase of Operation:	Instrument landing system approach

On April 13, 1987, Buffalo Airways flight 721, a regularly scheduled cargo flight, was operating under 14 CFR Parts 91 and 121 between Oklahoma City, Oklahoma, and Fort Wayne, Indiana, with en route stops at Wichita, Kansas, and Kansas City, Missouri. The flight to Wichita was routine. The ground crew at Wichita stated that they did not observe anything out of the ordinary while the airplane was on the ground. At 2122, after the flightcrew filed and received an instrument flight rules (IFR) flight plan to Kansas City International Airport (International Airport), flight 721 departed Wichita. Four persons--the captain, the first officer, the second officer (flight engineer), and one authorized person--were aboard the airplane.

The flightcrew did not report any difficulties or irregularities to the Kansas City Air Route Traffic Control Center during the 25-minute flight into the Kansas City area. Except for some deviations from course to avoid thunderstorms, the descent into the terminal area was routine, and, at 2142:55, flight 721 contacted the International Airport Traffic Control Tower's (ATCT) Terminal Radar Approach Control's (TRACON) arrival radar controller. The controller directed the flight to turn to 060° and told the flightcrew that they were being vectored to the instrument landing system (ILS) localizer for the ILS approach to runway 1.

The localizer course for the ILS runway 1 approach was 007°, and the outer marker (LOM), named DOTTE, was 4.4 nmi from the threshold of the runway. The glideslope intercept altitude was 2,400, and the glideslope crossed the LOM at 2,391 feet. The runway's touchdown zone (TDZ) elevation was 1,011 feet. The published decision height (DH) was 1,211 feet or 200 feet above ground level (agl), and the runway visual range minimum was 1,800 feet for the approach. The CVR showed that, at 2133:09 and before beginning the descent from the en route cruise altitude, the first officer had briefed the flightcrew on the runway 1 ILS approach. The briefing was correct and included the DH and the glideslope crossing altitude at the LOM.

At 2145:32, the flightcrew received Automatic Terminal Information Service (ATIS) information "Romeo" containing the following pertinent weather information:

measured ceiling two hundred (feet) overcast; visibility one half (mile in) fog...wind zero four zero at one one; altimeter two niner six one...ILS runway one approach....

About 2147:55, while the airplane was descending through about 6,500 feet, the first officer, who had been flying the airplane, turned the controls over to the captain. Buffalo Airways' regulations required captains to make all the approaches and landings whenever the ceilings and visibilities were less than 400 feet and 1 mile, respectively. The CVR transcript showed that the ILS frequency had been selected on the first officer's radio and that the first officer had inserted the ILS frequency in the captain's radio after the captain took control of the airplane.

At 2150:17, after several intermediate descent clearances, flight 721 was cleared to descend to 2,400 feet. At 2151:01, the controller told flight 721 that it was "five miles from DOTTE (the LOM), turn left zero four zero, maintain two thousand four hundred until established, cleared ILS runway one approach." At 2151:08, the first officer read back the clearance. The CVR transcript showed that by 2152:10 the crew had completed the before-landing checklist, that the landing gear was down and locked, and that the flaps had been extended to 25⁰, as required, for landing.

At 2152:37, flight 721 contacted the International Airport tower, and, at 2152:40, the local controller advised flight 721 that it was No. 2 to land, that it was 4 miles behind a Southwest Airlines' Boeing 737, that the winds were zero four zero at eight knots, and that the RVR on runway 1 was more than 6,000 feet. At 2152:47, the first officer stated, "Localizer alive," indicating that the course deviation indicator (CDI) on his horizontal situation indicator (HSI) had started to move toward the centered position.

At 2153:03, the first officer stated, "You're five hundred above minimums." Thereafter, he continued to report the airplane's altitude during the descent in 100-foot increments above "minimums (DH)" until the airplane reached the DH.

At 2153:07, the first officer called, "Marker inbound." At 2153:18, the flightcrew received ATIS information "Sierra" which stated that the weather at the airport was in part: ceiling--100 feet, overcast; visibility 1/2 mile, fog; wind 40⁰ at 8 knots. At 2153:24, the captain remarked, "Already started the approach."

At 2153:32, 4 seconds after reporting that the airplane was 200 feet above minimums, the first officer told the local controller that, "Seven twenty-one is the marker inbound." The local controller acknowledged receipt of the message.

At 2153:41, after receiving a low-altitude alert generated by the Automated Radar Tracking System III (ARTS III) computer's Minimum Safe Altitude Warning (MSAW) function, the local controller warned flight 721 to "check altitude immediately should be two thousand four hundred, altimeter two nine six one." Flight 721 did not respond. However, the captain said "Call the radar (radio) altimeter please." At 2153:46, the first officer responded, "Okay, there's twelve hundred on the (radio) altimeter." At 2153:50, the local controller again called

the flight and warned, "I have a low altitude alert, climb and maintain two thousand four hundred." Again, the flightcrew did not acknowledge receipt of the warning. At 2153:51, a crewmember called out "pull it up," and at 2153:52, the captain applied power followed almost simultaneously by sounds of initial impact. The CVR recording ended at 2153:53.

The local controller stated that flight 721's radar target disappeared off the radar scope in the tower shortly after he issued the second warning.

Flight 721 struck the tops of trees on a 950-foot-high ridge about 3 nmi short of the approach end of runway 1. The airplane cut a relatively level 750- to 800-foot-long swath through the tree tops about 20 to 30 feet above the ground, and the swath's path was aligned with the localizer course to runway 1. The swath ended as the ridge and tree tops sloped downward. The airplane then rolled and turned to the right as it descended into the main impact area 2,000 feet beyond the initial impact site. All four occupants were killed.

The airplane broke into four main sections during the impact sequence. Examination of the wreckage revealed that at impact, the landing gear was extended, the flaps were positioned at 25°, and the flap selector handle was in the landing flap position (25°).

The engines separated from the wings during the impact sequence. The damage patterns in all four engines were consistent with high power and rotation rates at impact. The physical evidence corroborated the sounds of increasing engine power recorded by the CVR at 2153:53 just before impact.

The cockpit area and instrument panels were destroyed by impact forces and postimpact fire. The CDI on the captain's HSI was centered, and the glideslope pointer was deflected to the full "fly up" command position. The course setting was unreadable. Because of the extensive damage to this area, the examination of the controls and postimpact conditions of the autopilot, radio altimeter, flight director system, altitude alerting system, and barometric altimeters did not yield any useful information. However, the fact that the CVR, FDR, radios, and other electrically powered instruments and systems were operating until impact showed that the airplane's electrical power generating systems were operating.

The radio altimeter's transmitter receiver unit (TRU) was found submerged in muddy water several days after the accident. The Safety Board examined the TRU at the manufacturer's Fort Lauderdale, Florida, facility. The examination disclosed that several TRU components had failed. However, the Safety Board could not determine whether these failures had occurred before or during impact, or had been caused by the unit's immersion in the muddy water.

The airplane's engines were equipped with the Comtran/Tracor noise abatement Quiet 707 (Q707) modification. The company Boeing 707 Operating Manual (OM) stated that the authorized landing flap setting with the Q707 modification was 25° and that "Flaps 40° and 50° are no longer authorized landing flaps (except for emergency purposes)..." The OM's limitations section stated that the "Use of auto pilot (is) not permitted for flaps 25° final approach and landing from a minimum of 500 feet above the destination airport." The ground proximity warning system (GPWS) also was modified and functions normally with the 25° landing flap setting.

The airplane was equipped with a Collins model-108 flight director system (FD-108). The FD-108 uses a single V-shaped command bar (V-bars) to provide both pitch and roll steering commands. The steering command is superimposed over the attitude director indicator's (ADI) horizon bar and the pilot satisfies the command by maneuvering the airplane to insert the ADI's triangle-shaped fixed airplane symbol within the notch formed by the V-bars.

The FD-108 has five operating modes: go-around, heading (HDG), very high frequency omnirange radio/ILS localizer (VOR/LOC), glideslope automatic (GS AUTO), and glideslope manual (GS MAN). The pilot selects the desired mode by rotating the mode selector switch on the FD control panel to the applicable position. A pitch control knob located on the FD control panel allows the pilot to set a desired climb or descent pitch angle for the airplane. N144SP had two FD control panels, one located on the captain's side and the other on the first officer's side of the center control pedestal forward of the throttles.

The FD-108 allows the pilot to select or arm the VOR/LOC or GS AUTO modes before the airplane has reached the point where the localizer or glideslope signal is of sufficient strength to allow the flight director to supply steering commands. When an airplane on an ILS approach is close enough to receive electronic guidance from the localizer or glideslope transmitters, the FD-108 will capture the signal and provide steering commands to the pilot to track either the localizer heading if in VOR/LOC mode or the localizer heading and glideslope path if in GS AUTO mode. Flight director pitch and roll annunciators located above the captain's and first officer's ADIs advise when the VOR/LOC and GS AUTO modes are armed and when they have captured their respective radio signals.

Both the VOR/LOC and GS AUTO modes exercise priority over previously selected heading and pitch guidance commands, respectively. Thus, if on approaching the ILS localizer in HDG mode on a selected heading the pilot selects and thereby arms the VOR/LOC mode, when the flight director captures the localizer signal, it will null out the previously selected heading signal and provide steering commands to intercept and track the localizer course. Pitch guidance commands, if selected, remain unaffected.

When the pilot selects and arms the GS AUTO mode, previously selected pitch guidance commands remain in effect until the glideslope is captured. Then the higher priority glideslope signal overrides the previously selected pitch guidance commands and the flight director provides pitch guidance commands to intercept and track the center or "on course" of the glideslope signal. Glideslope capture occurs when the airplane is within $.05^\circ$ of the glideslope center. At the LOM, capture occurs about 25 feet below the glideslope's center. At 6 and 7 nmi from the end of runway 1 at International Airport, the capture distance increases to about 34 and 38 feet, respectively. If the flight director fails to capture either the localizer or glideslope signals, it will continue to provide steering commands to satisfy the heading and pitch values selected by the pilot before the VOR/LOC and GS AUTO modes are armed.

Glideslope scales and pointers were located on the left sides of the captain's and first officer's ADIs and CDIs. The pointer showed the vertical displacement of the airplane from the glideslope's center or on course (raw data). The airplane's displacement from the center of the localizer course was depicted by the position of the CDIs on the lateral displacement scales on the captain's and first officer's HSIs (raw data).

The company procedures for a flight director ILS approach recommended that the pilot use the HDG mode to intercept the localizer and select the VOR/LOC mode when the CDI begins to center; altitude hold can be engaged when appropriate. After the localizer course has been captured and the flight director is tracking it, GS AUTO should be selected. At glideslope capture, the pilot should check that the proper pitch commands are presented and, if appropriate, that the altitude hold switch has disengaged. The procedures also stated that the pilots should use the localizer and glideslope raw data presentations to verify all localizer and glideslope tracking commands.

Before the accident, Buffalo Airways operated five Boeing 707s. One 707 had a Bendix model 300A flight director, two 707s had Collins mode 105 flight directors (FD-105), and two 707s had FD-108s. The Bendix 300A had only one control panel located at the aft most part of the center pedestal and aft of the throttles. It used a single command bar with a semicircular arc in the center to present its steering commands. The ADI's fixed airplane symbol was a divided white line with a white dot bisecting the space between the two straight lines.

The FD-105 uses two separate command bars to provide vertical and horizontal steering guidance. The flight director's mode select knobs are located on the lower right sides of the captain's and first officers ADIs and pitch command knobs are located on the lower left sides of the ADIs.

Interviews with company personnel revealed that the captain knew the FD-108 system very well and used it often. According to one first officer, the captain would use the flight director from the top of the descent in HDG mode using the pitch control knob to present the desired descent pitch angle. He said that the captain "could really fly the flight director" and that sometimes he would appear to concentrate on the flight director to the extent that he did not seem to notice raw data information.

Between January 21, 1987, and April 10, 1987, the captain had flown 118 flights for the company. Twenty-three flights were in the airplane with the Bendix flight director; 16 flights had been in airplanes with the FD-105; and 79 flights had been in airplanes with the FD-108. On April 11, 1987, his last duty day before reporting for the accident flight, the captain flew N144SP from Fort Wayne to Oklahoma City with en route stops at Kansas City and Wichita. The first officer also flew with the captain on April 11; the flight engineer did not.

Company training records showed that the three flightcrew members had been trained in accordance with applicable Federal and company regulations and were qualified to operate the airplane.

The Safety Board's examination of the airplane's wreckage and its review of the airplane's maintenance records showed that the airplane was operating properly when it struck the trees. This evidence was supported by the absence of any type of distress calls on the radio to either ATC or the company dispatcher and the lack of conversation on the CVR about any airplane malfunction or emergency that would have compromised the crew's capability to operate the airplane satisfactorily during the approach and landing.

Since the Boeing 737 just ahead of flight 721 completed an ILS approach to runway 1 and did not report any difficulties and since the postaccident flight inspection of the runway 1 ILS on April 14, 1987, found that the facility was operating within its prescribed tolerances, the Safety Board concludes that the ILS facility did not contribute to the accident. Therefore, the Safety Board directed its attention to analyses of the flightcrew's performance during the descent and landing approach and the performance of the two pertinent altitude alerting and warning systems: the ARTS III MSAW system and the airplane's GPWS.

The Safety Board reconstructed the final portion of flight 721's flightpath. The reconstruction, which was based on recorded radar data that had been time correlated with the CVR transcript, began at 2145:04, when the flight was cleared to descend from 10,000 to 5,000 feet and ended, at 2153:53, just after the sounds of initial impact on the CVR.

The reconstructed flightpath showed that flight 721 descended from 10,000 to 5,000 feet at a descent rate of about 1,260 fpm. Between 2149:06 and 2152:24, the flight descended from 5,000 feet to 2,300 feet, the flight crew extended the landing gear and lowered the flaps to the 25⁰ landing position and the descent rate decreased to about 818 fpm. The reconstruction showed that at 2152:24, when the first officer called, "Localizer alive," the airplane had entered the periphery of the localizer signal and shortly thereafter it turned to the localizer heading and began to track the localizer course inbound. Between 2152:24 and impact at 2153:32, the remainder of the descent was made at a rate of about 900 fpm. At 2153:03, the first officer reported that the flight was 500 feet above minimums (1,711 feet); thereafter, he called the altitude every 100 feet above minimums down to minimums and all of these callouts were consistent with the recorded ATC radar altitudes.

At 2151:01, the radar controller vectored the flight to intercept the localizer, to maintain 2,400 feet "until established, cleared ILS runway one approach." This clearance required the captain to maintain 2,400 feet until he had intercepted both the ILS localizer and the glideslope and, thereafter, to fly the approach in accordance with the published procedures and altitudes. Thus, the captain should not have descended below 2,400 feet until he had intercepted the glideslope.

The CVR showed that the captain took control of the airplane about 2147:55. At this time, the airplane was descending through about 6,500 feet and ATC had cleared the flightcrew to descend to 4,000 feet. After the captain took control, the descent rate decreased to about 825 fpm and then remained fairly constant while the flightcrew reconfigured the airplane for the approach and landing and during the interception of the localizer course. Given the virtually constant descent rate during a period of the flight where external electronic descent guidance signals were not being used and the evidence concerning the captain's reliance on the flight director during this phase of flight, the Safety Board concludes that the captain used the FD-108 for heading and pitch control guidance.

When the first officer called, "Localizer alive," flight 721 was about 2 nmi from the LOM and about 2,400 feet. Given his ATC clearance, the captain should have leveled off 2,400 feet until glideslope capture occurred. However, the airplane continued to descend at an almost constant rate while it intercepted and then began to track the localizer course. Since the Safety Board does not

believe that the captain intentionally failed to comply with an ATC clearance by descending below an altitude restriction, the Safety Board believes that the captain mistakenly decided that he had intercepted the glideslope about the same time the localizer was intercepted and that this mistake was a causal factor in the accident.

Several factors probably contributed to the captain's decision that he had intercepted the glideslope. During the descent, flight 721 deviated from course toward the airport to avoid thunderstorms. Since the radio facilities on the airport did not have distance measuring equipment, the captain could not determine precisely his distance from it and he may have believed that the flight was closer to the airport and the LOM than it would have been had the weather deviations not been necessary.

At 2151:01, the radar controller vectored the flight to intercept the ILS localizer and told the crew that they were 5 nmi from the LOM. However, flight 721 did not intercept the localizer until about 1 minute 30 seconds later, and, at the time of the intercept, it was descending through 2,400 feet and within 9 feet of the altitude at which the glideslope crossed the LOM. Therefore, the captain might have believed that he was either at, or very near the LOM when, in accordance with company procedures, he would have selected the flight director's GS AUTO mode. However, because flight 721 was almost 600 feet below the center of the glideslope and outside the parameter within which the flight director could automatically capture and track the glideslope signal, the glideslope was not captured and the flight director continued to supply the same descent pitch angle command the captain had previously selected with the pitch command knob. The fact that the localizer course intercept coincided with the selection of the GS AUTO mode and that both occurred at an altitude that was within 100 to 200 feet of the glideslope's LOM crossing altitude could have led the captain to decide that the airplane had intercepted the glideslope, that the flight director had captured it, and that the portrayed pitch command was valid.

During the 1 minute 28 second period between the first officer's callout, "Localizer alive" and the airplane's initial impact with the trees, flight 721 descended at an average rate of about 900 fpm. The descent path was steady and consistent with a path flown using guidance supplied by a flight director, however, the resultant path was not consistent with the published glideslope and the airplane's downward divergence from the glideslope continued to increase. The airplane's flightpath during this time substantiates the Safety Board's conclusions that the flight director did not capture the glideslope, that the captain believed that the glideslope had been captured, and that the pitch commands presented to him by the command bar were maintaining his airplane on the ILS glideslope.

In addition to the "localizer alive" callout, the company procedures required the first officer to provide the captain with the following callouts: glideslope alive (on the first positive movement of the glideslope pointer on the glideslope scale); the time and altitude over the LOM; 1,000 and 500 feet above field elevation; 100 feet above minimums (DH); and, at minimums, he was to call "minimums, approach/strobe/ centerline lights in sight-runway (or no runway) in sight."

The CVR showed that the first officer did not make any callouts concerning either the initial movement or the subsequent positions of the glideslope pointer to the captain nor did he make the 1,000 and 500 feet above field elevation calls. He did call the LOM inbound, but he did not point out that they were almost 700 feet below the glideslope when they passed over the LOM.

Beginning at 500 feet above minimums (1,711 feet), the first officer called the airplane's altitude above minimums in 100-foot increments. He called minimums but he did not inform the captain that the runway was not in sight. Except for the 100 feet above minimums and the minimums callouts, none of these callouts were required. The evidence showed that one of the first officer's previous employers had required these callouts and the first officer appeared to have reverted to this procedure.

During the descent from 4,000 to 2,400 feet, the first officer was occupied with the change of duties from pilot flying to pilot not flying. He changed the frequencies of the navigation radios, assumed the ATC communications duties, actuated flap and landing gear mechanisms in response to the captain's commands, responded to checklist callouts by the flight engineer, changed radio frequencies from approach control to tower, called "Localizer alive," and called passage of the outer marker. The Safety Board believes these activities, which occurred in a rapid sequence, degraded the first officer's instrument monitoring to the extent that he was unable to monitor the flight's descent adequately. Had the first officer properly made the callouts required by company procedures, the Safety Board believes that either he or the captain might have had a better chance of recognizing the dangerous situation that was developing. The breakdown in crew coordination was a factor in the events leading to the accident.

Although the pointers on the glideslope scales must have shown full scale "fly-up" commands, apparently neither pilot ever noticed their positions and that they never moved from those positions. It seems evident, therefore, that the captain's instrument scan had focused solely on his ADI and, in particular, on the flight director presentation to the exclusion of the ILS raw data presentations and his altimeters. After calling "Localizer alive," the first officer also seemed to have experienced a narrowing of his visual scan. However, in his case, his attention seemed to have been devoted solely to his barometric altimeter.

With regard to the flight engineer, the company procedures did not levy any requirements on him to monitor the flight instruments. Therefore, the Safety Board can only assume that he was monitoring the engine instruments and guarding the throttles during the descent.

Despite the procedural omissions of the first officer, the Safety Board believes that the 100-foot increment callouts he provided to the captain during the descent from 500 feet above minimums down to minimums were sufficient to advise the captain of the airplane's progress during the descent and to alert him of its arrival at the DH. At 2153:33, the captain was told the airplane was 100 feet above minimums. At 2153:40, he was told the airplane was at minimums (1,211 feet); there was no subsequent callout that the runway or approach lights had been sighted. Pursuant to the provisions of 14 CFR Part 121.651(c), since the runway, the runway lights, or any part of the approach light system was not in sight, the captain was not authorized to descend below the approach's published DH. At 2153:41, the local controller told the captain that the flight should be at 2,400 feet and asked him to check his altitude. The captain's response was to ask the

first officer to "Call the radar (radio) altimeter please." At 2153:50, the local controller told the captain that he had received a low altitude alert and to "climb and maintain two thousand four hundred." Despite these warnings and the fact that the airplane was at minimums without the runway environment in sight, the captain did not apply power until 2153:52, 1 second after a crewmember had called out "pull it up." Had the captain, at 2153:40, in compliance with existing regulations, applied power and either executed a missed approach or merely maintained the DH, the accident would not have occurred.

The airplane's radio altimeter, a circular dial-type instrument, was located on the upper left side of the center instrument panel. Company procedures required the flightcrews to set the altitude warning pointer to the published DH for the approach, in this case 200 feet agl, during the approach checklist. At 2144:02, while accomplishing this checklist, the flight engineer challenged, "Radio altimeters?" An unidentified crewmember responded, "Set there." The Safety Board assumes that the altitude warning pointer was set at the DH, and, assuming that the radio altimeter was functioning during the approach, the DH warning light would have illuminated when the airplane descended through 200 feet agl.

At 2153:46, when the airplane was about 200 to 300 feet above the terrain, the first officer told the captain, "Okay, there's twelve hundred on the radar (radio) altimeter." The Safety Board could not determine whether the radio altimeter system had malfunctioned, the first officer had miscalled the radio altimeter reading (i.e., the radio altimeter reading was 200 feet and he converted it to barometric altitude before calling it to the captain), or the first officer had erroneously referred to one of the airplane's three barometric altimeters and reported that readout to the captain.

In any event, the captain never arrested the airplane's descent rate when it reached the DH. The CVR transcript showed that the captain knew that the ceiling at the airport had lowered to 100 feet and, therefore, he knew he might not be able to sight the runway environment at the 200-foot AGL DH. The evidence indicated that the captain believed the airplane was on the glideslope and that he fully expected the runway environment would become visible if he maintained the descent rate. Since the Safety Board concluded that the first officer's altitude callouts during the descent provided the captain with adequate warnings of the airplane's approach to and arrival at the DH, the Safety Board can only conclude that the captain intended to continue the descent below the DH to acquire the runway environment visually and, thereafter, to land. Consequently, the airplane continued to descend and, at impact, it was about 31 feet below the runway's TDZ elevation.

The MSAW computer program is designed to enhance the ARTS III's capabilities by providing controllers with visual and aural warnings whenever a tracked airplane that is equipped with an altitude encoding transponder (Mode C) is either detected below the systems warning parameters or its projected altitude will violate these parameters. In addition to providing general terrain clearance protection, the program provides terrain clearance protection in the areas containing the approach paths to selected runways. The latter program provided the MSAW alert for flight 721.

The approach path monitoring program is designed to provide terrain clearance protection for all approaches that serve the runway. Since the program can monitor both precision and nonprecision approaches, the altitude warning parameters are based on the approach having the highest minimum altitude. Since runway 1 at International Airport was served by an ILS and two nonprecision approaches, its altitude warning parameters were based on the minimum descent altitude (MDA) for the nonprecision approach. Because of the different pilot techniques involved in descending to a MDA or DH, the program does not monitor deviations from a prescribed descent flightpath. MSAWs are generated when the tracked target either is detected below an altitude warning parameter or when the computer predicts that within the next 15 seconds, based on its present rate of descent, the target will descend below an altitude warning parameter.

The Safety Board's investigation showed that the structure of the runway-1 MSAW capture box was within current FAA ARTS III program specifications and that the MSAW program, with regard to flight 721, operated within programmed specifications. The recorded ARTS III data showed that flight 721's MSAW alert was received in the tower at 2153:34.17. Based on the information provided to flight 721 by the controller, the controller obviously verified the aural alarm by observing the visual alarm on the tower's radar display as well as the information contained in flight 721's data block. The Safety Board concludes that the controller's actions were initiated in a timely manner since comparison of timing information showed that he provided a warning to flight 721 within 3 to 6 seconds after the receipt of the alarm.

However, the Safety Board does note that the local controller failed to preface his initial safety alert to the flight with the required statement "low altitude alert." The remainder of the controller's safety alert message complied with existing phraseology requirements. The flightcrew did not transmit a reply to the controller regarding the alert. However, the CVR transcript indicates that about 2 seconds after receiving the alert, the captain requested that the first officer "call the radar (radio) altimeter...." The CVR transcript indicates that about 3 seconds after the request the first officer stated, "okay there's twelve hundred." At 2153:50, the local controller issued to the flightcrew a second safety alert; this alert complied with the existing phraseology requirements. The flightcrew failed to acknowledge this alert also. Neither transmission elicited any physical response from the captain to alter the airplane's flightpath.

The Safety Board is concerned that the controller's failure to use the proper phraseology during the first alert may have degraded the urgent nature of this alert. The phrase "low altitude alert" imparts specific information to the flightcrew and had the proper phraseology been used, it may have resulted in a heightened awareness of the need to slow or arrest the descent of the airplane immediately. However, the Safety Board cannot overlook the fact that the captain not only responded to the first alert by requesting the altitude but that he also had been informed by the first officer that the airplane was 100 feet above minimums, and thereafter, at minimums. Therefore, the Safety Board concludes that, under the circumstances of this accident, the initial alert transmission from the controller did not deviate sufficiently from the standard so as to contribute to this accident.

Although the GPWS provides flightcrews with five warning modes, the Safety Board's investigation showed that, based on the airplane's configuration and descent rate, the only GPWS warning mode that should have been available to alert the flightcrew was the unsafe deviation below the ILS glideslope warning.

The unsafe deviation below the ILS glideslope warning mode of the GPWS is completely independent of any flight director mode selection or the manner in which the ILS has been intercepted. Normally, the GPWS computer receives glideslope information from the same deviation information displayed on the glideslope scale on the captain's ADI. Therefore, flight 721 should have received a below glideslope aural and visual warning provided the following conditions were satisfied: the landing gear must be down, the airplane must be between 1,000 and 50 feet radio altimeter altitude and the radio altimeter must be operational, the captain's navigational radio head must be tuned to an ILS frequency and receiving a valid signal, and the airplane's divergence below the glideslope must exceed 1 1/3 dots on the captain's glideslope scale. Between 2152:50 and 2153:48, flight 721 satisfied all of these prerequisites; however, the CVR showed that it did not receive an aural, below glideslope warning.

The failure of the GPWS tends to indicate that the radio altimeter either was not operating or had malfunctioned in such a manner as to inhibit the performance of the GPWS. However, the Safety Board cannot rule out the possibility that the GPWS itself had failed. The Safety Board concludes that the failure of the GPWS to provide an unsafe deviation below the ILS glideslope warning to the flightcrew was a contributory factor to the accident; however, the Safety Board could not determine the cause of this failure.

Probable Cause

The Safety Board determines that the probable cause of this accident was the captain's intentional descent below the DH. Contributing to the accident was the breakdown in flightcrew coordination procedures which contributed to the failure of the captain and the first officer to detect that the airplane had not intercepted and was below the ILS glideslope. Also contributing to the accident was the failure, for unknown reasons, of the airplane's GPWS to provide an unsafe deviation below the ILS glideslope warning.

The attached brief of accident contains the Safety Board's findings.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES L. KOLSTAD
Acting Chairman

/s/ JIM BURNETT
Member

/s/ JOHN K. LAUBER
Member

/s/ JOSEPH T. NALL
Member

/s/ LEMOINE V. DICKINSON, JR
Member

January 19, 1989

File No. - 330 4/13/87 KANSAS CITY, MO A/C Reg. No. N144SP Time (LCL) - 2155 EDT

Brief of Accident (Continued)

Occurrence #1 IN FLIGHT COLLISION WITH TERRAIN
Phase of Operation APPROACH - FAF/OUTER MARKER TO THRESHOLD (IFR)

Findings(s)

1. LIGHT CONDITION - DARK NIGHT
2. WEATHER CONDITION - LOW CEILING
3. WEATHER CONDITION - FOG
4. GROUND PROXIMITY WARNING SYSTEM - FAILURE, TOTAL
5. CREW/GROUP COORDINATION - INADEQUATE -
6. IFR PROCEDURE - IMPROPER - PILOT IN COMMAND
7. DECISION HEIGHT - DISREGARDED - PILOT IN COMMAND
8. SAFETY ADVISORY - ISSUED - ATC PSNL(LCL/GND/CLMC)
9. UNSAFE/HAZARDOUS CONDITION WARNING - DISREGARDED - PILOT IN COMMAND

---Probable Cause---

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 6,7,9

Factor(s) relating to this accident is/are findings(s) 4,5