

Adopted: 2-1-92

Log 2335



National Transportation Safety Board

Washington, D.C. 20594
Safety Recommendation

Date: February 4, 1992

In reply refer to: A-92-8 and -9

Honorable Barry L. Harris
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

On November 14, 1990, a McDonnell Douglas DC-9-32, registered in Italy as I-ATJA and operated as Alitalia flight 404, (AZA-404) crashed into the side of a mountain about 5 miles north of Zurich-Kloten Airport (LSZH). The flight had departed Milano-Linate Airport (LIML) at 1936.¹ The accident occurred at 2013, during an instrument landing system (ILS) approach to runway 14 at LSZH. The captain, first officer, 4 flight attendants, and 40 passengers perished. The accident is under investigation by the Swiss Federal Aircraft Accident Investigation Bureau, and the National Transportation Safety Board, the Federal Aviation Administration (FAA), and Douglas Aircraft Company are participants in accordance with the provisions of the International Convention on Civil Aviation.

Details of the accident sequence of events and conclusions will be forthcoming when the Swiss Government publishes the report in March, 1992. The investigation has disclosed a possible failure mode of the very high frequency omnidirectional range (VOR)/ILS system, which was installed on the airplane, that could have contributed to this controlled flight into terrain. This failure mode could have led the flightcrew into believing they were on course and on the glidepath when they were not.

According to Douglas Aircraft Company engineers, it is possible that a short circuit or an open circuit in certain models of VOR/ILS receivers could cause navigation instruments to indicate "zero deviation." Thus, raw data deviation information on the attitude direction indicator, displayed by the flight director bars, and the horizontal situation indicator could center and remain centered with no failure or warning flag in view. In addition, this short circuit or open circuit could prevent the autopilot and the ground

¹All times are Zurich local time (UTC+1 hour).

proximity warning system (GPWS) from receiving the proper course and glidepath deviation signals. The autopilot would continue to guide the airplane according to previously established crew inputs, and the GPWS would not sound an alarm due to glideslope deviation or descent below a safe altitude. This could also occur if the VOR localizer (LOC) or glideslope signals to the autopilot were interrupted by an open circuit.

As a crosscheck of the system, the captain and first officer would normally use two separate VOR/LOC receivers for navigation information that would be displayed on their respective instruments. However, without warning flags indicating system failure, the pilots might accept as accurate centered indications and then use the "NAV" switching function to select the malfunctioning VOR/LOC receiver on both panels.

According to Douglas, some VOR/ILS receivers have an expanded self-monitoring capability to detect this type of failure. Receivers that do not have this feature are:

- Collins model 51RV-1
- Collins model 51RV-4
- Wilcox model 806
- King model KNR6030
- Bendix model RNA 26C (some versions)

Douglas issued two All Operators Letters (AOLs) (AOL No. C1-E60-HHK-L134, dated July 27, 1984, and AOL No. 9-1565, dated August 24, 1984,) that described the potentially hazardous failure modes. The company issued another All Operators Letter (Douglas AOL No. C1-JLO-TMR-91-L001) on March 1, 1991, following this accident that reiterated the information in the 1984 letters. According to Douglas records, Alitalia received the 1984 letters and other information relating to the anomaly in 1984. Alitalia pilots, however, were unaware of the potential problem until after the accident.

Douglas Aircraft Company revised DC-9 and MD-80 flightcrew operating manuals to reflect the possibility of short or open circuits within the VOR/ILS system. Douglas officials also believe that the failure scenario should be incorporated into all DC-9/MD-80 flightcrew training curricula. The Safety Board believes that this action is appropriate. Douglas officials are recommending that if a discrepancy exists between deviations displayed on the indicators of the same type of instrument, the pilots should carefully compare the VOR/LOC or glideslope deviation information with other navigational aids, such as distance measuring equipment, VOR bearing, radio and barometric altitude, marker beacon, automatic direction finder bearing, and vertical speed. Also, if "NAV" switching is used, it should be accomplished before localizer and glideslope capture on an instrument approach to allow positive verification of all deviation information that will be used for that approach. Douglas further recommends that if one VOR/ILS receiver is inoperative, the other receiver should be temporarily tuned to a nearby VOR station and the selected course varied to ensure that the course deviation indicator moves in accordance with the selected course.

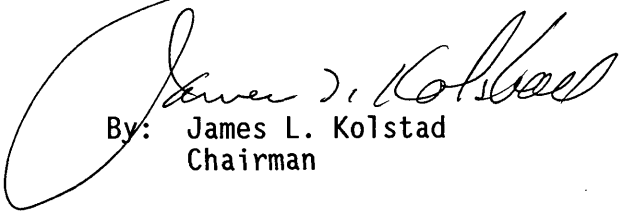
These VOR/ILS receivers may also be installed in an undetermined number of air carrier and other aircraft made by U.S. and other manufacturers. The Safety Board has no reasonable means to determine what other types of airplanes utilize these receivers or what companies operate these airplanes. However, because these VOR/ILS receivers may also be installed in some corporate or other general aviation aircraft, the Safety Board believes that information regarding this potential problem should be published in Advisory Circular (AC) 43-16, General Aviation Airworthiness Alerts, in addition to being disseminated to all air carriers.

In view of the findings, the Safety Board recommends that the Federal Aviation Administration:

Issue an Air Carrier Operations Bulletin to Principal Operations Inspectors requiring that operators of airplanes equipped with the following navigation receivers include in their Pilot Operating Manuals procedures for detecting malfunctions that result in the display of disparate information: Collins model 51RV-1; Collins model 51RV-4; Wilcox model 806; King model KNR6030; and some versions of Bendix model RNA 26C. Also, notify formally foreign airworthiness authorities about the potential failure modes in such equipment. (Class II, Priority Action) (A-92-8)

Publish the substance of this recommendation in Advisory Circular (AC) 43-16, General Aviation Airworthiness Alerts. (Class II, Priority Action) (A-92-9)

Chairman KOLSTAD, Vice Chairman COUGHLIN, and Members LAUBER, HART, and HAMMERSCHMIDT, concurred in these recommendations.



By: James L. Kolstad
Chairman

Attachments

Douglas AOL CI-JLO-TMR-91-L001, March 1, 1991
Douglas AOL 9-1565, August 24, 1984
Douglas AOL CI-E60-HHK-L134, July 27, 1984

MCDONNELL DOUGLAS

Douglas Aircraft Company

C1-JLO-TMR-91-L001
March 1, 1991
FO-AOL-8-001
FO-AOL-9-001

TO: All DC-8, DC-9, C-9, and MD-80 Operators

Subject: VOR/ILS POSSIBLE FAILURE MODES

Applicable to: DC-8, DC-9, C-9, and MD-80 Aircraft

Reference: (A) Douglas Aircraft Letter No. 9-1565, Dated August 24, 1984

(B) Douglas Aircraft Letter No. C1-E60-HHK-L134, Dated July 27, 1984.

The referenced AOLs (All Operators Letters) attached, describe the possibility of failures in the VOR/ILS systems on certain models of receivers that would cause raw data deviation information on the ADI, the computed data on the Flight Director bars, and the raw data on the HSI to center and remain centered with no failure flag in view. The purpose of this AOL is to identify other possible failure cases and to provide flight crews with additional information that will be of assistance, in the event of such occurrences.

The referenced AOLs describe a short circuit in the VOR/LOC or Glide Slope (GS) signals whereby the displays, Flight Directors, Autopilots, GPWS, and other using systems would receive a zero deviation signal. The same result could also occur if the VOR/LOC or GS output signals from the receiver were to fail open. This can cause the localizer and/or glideslope displays to indicate on course and/or on glideslope when in fact the aircraft may be off course or off glideslope. The VOR/ILS receivers listed in the attached AOLs may not detect an open (or short) circuit and thus would not display a failure flag should such a failure occur.

As stated in the referenced AOLs, with these type of failures it becomes possible, using NAV switching, for the crew to switch erroneous information to all using systems and displays with the same misleading results described above. For this reason, if there is a discrepancy between the deviation displayed on the various indicators on each side, the crew should carefully review the VOR/LOC or GS deviation information with other navigation data (DME, VOR Bearing, Radio and Barometric Altitude, Marker Beacon, ADF Bearing, Vertical Speed, etc.) to ascertain which information is correct. If the crew cannot ascertain which information is correct, then the VOR/ILS or GS information should not be used, and navigation, or an approach, should not be predicated on use of the uncertain information, including applicable modes of the Flight Director and Autopilot.

It is therefore recommended that if NAV switching capability is available and used, switching should be performed prior to VOR/LOC/GS capture so that a verification can positively be made for all deviation information that will be used for the navigation or approach. If switching is delayed until after capture (track), the failure may not be apparent until cross checked with the other navigation data, described above.

For example, should ATC radar vectoring result in a straight-in-approach on localizer centerline, the lack of localizer deviation may go unnoticed until the normal cross checking is accomplished.

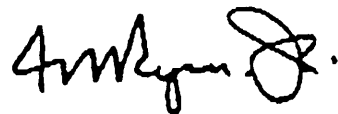
In the case where one receiver is suspect or known to be inoperative, it is recommended that the remaining receiver be tested by temporarily tuning to a nearby VOR station, and the course selector varied while observing the raw data course bar for a positive deflection from center. If a positive deflection is not observed, neither an ILS nor a VOR approach can be made safely.

Should the fault be in the GS deviation signal, a "Localizer Only" approach should be made.

Douglas is in the process of revising DC-9/MD-80 FCOMs to reflect the above information. In addition, it is recommended the VOR/ILS failed deviation case be incorporated into each flight crew training curriculum.

If you have any questions, please feel free to contact John P. Lane, Business Unit Manager, Flight Operations Customer Service; listed below is his pertinent company information.

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T. M. Ryan, Jr.
Vice President
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& Training

SRL:cs1

Enc. (2)

C1-JLO-TMR-91-L001
 March 1, 1991
 FO-AOL-8-001
 FO-AOL-9-001
 Attachment A

DAC 68-47 (b-3)



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August 24, 1984
 C1-750-179/TS/RAR
 9-22-30-0
 9-34-32-0

AOL 9-1565

To: A11 DC-9 and MD-80 Operators
 Subject: NAV SWITCHING FAILURE MODE
 Applicable To: A11 DC-9, C-9 and MD-80 Aircraft
 Reference: Flight Operations AOL C1-E60-HHK, dated July 27, 1984

REASON

WHEN CERTAIN VOR/ILS RECEIVERS ARE USED, A SHORT TO GROUND ON THE DEVIATION SIGNAL WILL RESULT IN "ON COURSE" INDICATIONS.

Douglas Flight Operations recently transmitted the referenced letter to the Flight Operations Department of all DC-9, C-9 and MD-80 operators.

Information contained in this letter may also be of interest to operator Engineering and Maintenance Departments; therefore, we are enclosing a copy for your review.



H. E. Whetro, Director
 Product Support
 MD-80 and DC-9 Programs

RAR:cr

Enclosure: Noted

July 27, 1984
CI-E60-HHK-L134

To: All DC-8, DC-9, C-9 and MD-80 Operators
Subject: NAV Switching Failure Mode
Applicable To: All DC-8, DC-9, C-9 and MD-80 Airplanes With NAV Switching

When certain VOR/ILS receivers are used, a failure that would cause either the VOR/Localizer or the Glideslope deviation circuit to become shorted to ground will result in a centered (on course, localizer or glideslope) indication on the associated raw data deviation indicator without a flag in view on either the HSI or ADI.

The Flight Director and Autopilot associated with the false signal will also respond to the "On Course, Localizer or Glideslope" deviation signal and will indicate "on course" regardless of aircraft position or flight path.

For example, a short to ground anywhere in the Glideslope pointer circuit will cause the Glideslope raw data display to indicate on Glideslope regardless of actual Glideslope deviation.

A Glideslope circuit failure will also affect the Ground Proximity Warning System (GPWS) so that it cannot announce an actual "below Glideslope" condition.

The following VOR/ILS receivers do not have the expanded monitoring capability to detect this type of failure:

Collins	51RV-1
Collins	51RV-4
Wilcox	806
King	KNR6030
Bendix	RNA 26C (may not be monitored depending on dash number)

Certain VOR/ILS receivers can detect a short on the deviation lines. These receivers will cause a LOC or GS flag to drop into view and, if NAV switching is exercised, all instruments and systems will recognize the lost validity. They are as follows:

Bendix	RNA 34A
Collins	51RV-2B
Collins	51RV-4B

CI-JLO-TMR-91-L001
FO-AOL-8-001
FO-AOL-9-001

March 1, 1991
Attachment B
Page 2 of 2

NAV Switching Failure Mode

CI-E60-HHK-L134
Page Two

The failures are compounded with NAV switching since the normal procedure is to switch the erroneously-reading instruments onto the good VOR/ILS receiver. Such NAV switching will result in the circuit fault and the resulting zero deviation being reflected in all instruments and systems.

It is therefore recommended that, if "BOTH ON 1" or "BOTH ON 2" switching is used, switching should be accomplished prior to VOR/ILS capture so that a positive deviation on all instruments can be identified. If switching is delayed until VOR/ILS capture/track, the problem may not be apparent.

Should ATC radar vectoring result in a straight-in approach on localizer centerline, the lack of localizer deviation may go unnoticed. In this situation, with one receiver inoperative, it is recommended that the remaining receiver be temporarily tuned to a nearby VOR station and the course selector varied while observing the raw data course bar for a positive deflection from center. If a positive deflection is not observed, neither an ILS nor a VOR approach can be made.

Should the fault be in the glideslope circuit, a "Localizer Only" approach should be made.

H. H. Knickerbocker

H. H. Knickerbocker
Director
Flight Operations