National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: April 15, 2002

In reply refer to: A-02-06 and A-02-07

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On March 17, 2001, about 0708 eastern standard time, an Airbus Industrie A320-200, N357NW, manufacturer serial number 830, being operated by Northwest Airlines as flight 985, ran off the runway and onto terrain during a rejected takeoff at the Detroit Metropolitan Wayne County Airport, Detroit, Michigan. An emergency evacuation was performed. The captain, first officer, 4 flight attendants, and 145 passengers were not injured. Three passengers reported minor injuries that occurred during the emergency evacuation. The airplane sustained substantial damage. The 14 *Code of Federal Regulations* Part 121 flight was operating in instrument meteorological conditions, and an instrument flight rules flight plan had been filed. The flight was destined for Miami, Florida.

The flight crew reported that, during the takeoff roll at an airspeed of about 110 knots,[1] the nose of the airplane began to lift off the runway. In a postaccident interview, the captain stated that he continued the takeoff to rotation speed, but, because he believed the airplane pitch was uncontrollable, he initiated a rejected takeoff. The airplane then became airborne and climbed a few feet. As the airplane returned to the surface, its tail struck the runway. The airplane traveled about 700 feet off the end of the 8,500-foot runway and came to rest in muddy terrain.

During the investigation, National Transportation Safety Board staff determined that the airplane was loaded so that its center of gravity (CG), although within limits, was in the aft region of the permissible range. Further, the flight crew had incorrectly set the trim for the trimmable horizontal stabilizer (THS) at -1.7°UP (airplane nose up). This setting resulted in a pitch-up trim condition. The proper trim setting, 1.7°DN (airplane nose down), would have

[1] The computed rotation speed used for this flight was 143 knots.

resulted in a correct trim condition for the way the airplane was loaded. The improperly set trim caused the nose of the airplane to lift off the runway prematurely.[2]

The Safety Board is aware of a similar event that occurred in April 2000 when the crew of a Lufthansa A320-200 flight departing Brussels successfully aborted takeoff without incident after the nose began to lift off below its computed rotation speed. The postincident investigation conducted by the German Federal Bureau of Aircraft Accidents Investigation and Lufthansa revealed that the airplane was loaded with an aft CG, and that the flight crew had inadvertently set the THS trim at -2.2°UP rather than the correct setting of 2.0°DN.

Although the investigation into Northwest Airlines flight 985 accident is ongoing,[3] the Safety Board identified a safety issue regarding the procedures used by some airlines for setting the THS trim on the A320. The Board also identified a safety issue regarding inconsistent formats for presenting trim setting data to flight crews.

Airbus Industrie equips its A319, A320, and A321 airplanes with two index scales located adjacent to the THS trim wheel. (See figure 1.) One scale indicates the CG as a percentage of mean aerodynamic chord. In the accident airplane, the CG scale showed the values 10.5, 17, 20, 25, 30, 35, and 41.[4] The CG scale is not graduated and does not show intermediate values. The other scale indicates the number of degrees of THS deflection above or below zero (neutral), followed by "UP" or "DN" to indicate the corresponding pitch direction of the airplane. These values are 4DN, 3DN, 2DN, 1DN, 0, 1UP, 2UP, 3UP … 13UP, 13.5UP. Like the CG scale, the degree scale is not graduated and does not show intermediate values. Both the CG scale and the degree scale are fixed in relation to each other and move together when the trim is set.

[2] Postaccident simulator flight tests have shown that, even with the improper trim setting, the airplane would have been controllable if the takeoff had continued. According to Airbus Industrie, the airplane is controllable on takeoff as long as the airplane's CG is within the limits of the green band, and the trim, regardless of whether it is set incorrectly, is also within the green band. (The "green band" is the range of CG and trim positions approved for takeoff.)

[3] The description for this accident, CHI01FA104, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

[4] Values shown on the CG scale differ depending on the type of engines installed on the airplane.

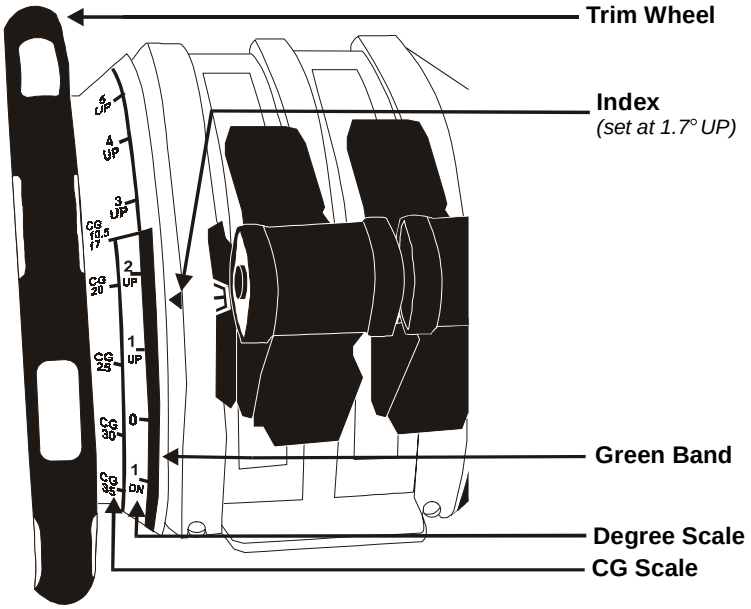

Figure 1. Airbus THS Trim Wheel Indicator Scales.

The trim setting (in degrees) is also shown on the flight control page of the electronic centralized aircraft monitoring (ECAM) display. This display, which correlates to the degree scale on the trim wheel, shows the trim in tenths of degrees followed by "UP" or "DN" to show the corresponding pitch direction of the airplane. On the ECAM display, pitch-up trim values are preceded by a minus sign ("-"), but pitch-down trim values are not preceded by a plus sign ("+"). The ECAM display for this accident would have shown the THS trim as "-1.7°UP." If the trim had been set correctly, it would have shown as "1.7°DN."

The A320 flight manual issued by Airbus Industrie specifies use of the CG scale for setting the THS trim. However, Northwest Airlines' Flight Operations Manual at the time of the accident called for the first officer to set the THS trim in degrees by turning the trim wheel while looking at the ECAM display.[5] The proper trim setting was provided to the crew on the load data sheet from the aircraft communication addressing and reporting system (ACARS) but was not followed by "UP" or "DN." In this case, the trim setting was given as "1.7." According to the manual, the captain was to cross-check the trim setting during the taxi checklist by looking at the "pitch trim wheel index." Northwest Airlines' pilots indicated that this cross-check was

[5] Because it displays the trim setting in tenths of degrees, the ECAM display provides a more precise way to cross-check the trim setting than the degree scale does.

supposed to be accomplished by the captain looking at the ECAM display (in degrees) and calling out the setting shown.[6] At the time of the Lufthansa event, Lufthansa's procedure for setting the trim was similar to Northwest's procedure.

After the accident, Northwest Airlines changed its procedures. Although the first officer continues to set the trim using degrees, the revised procedure requires the captain to cross-check the trim setting as indicated on the CG scale against the CG information contained in the load data sheet provided by ACARS.

Safety Board staff contacted three other major U.S. carriers that operate Airbus Industrie A320s regarding their procedures for setting the THS trim. One carrier reported using the CG scale to set the trim. The other two carriers reported using the degree scale without requiring the crew to cross-check the setting on the CG scale against the airplane's calculated CG.

The Safety Board is concerned that the procedure of using degrees to set and cross-check the THS trim setting has resulted in flight crews improperly setting the trim by using a minus (or UP) value when a plus (or DN) value should have been used. The Safety Board considers pilots of the two carriers who currently follow this procedure to be at risk for incorrectly setting the trim as did the pilots on Northwest flight 985 and the April 2000 Lufthansa flight. This confusion is possible because the degree scale shows some values twice: once to denote pitch up ("UP") and once to denote pitch down ("DN"). The CG scale, however, uses a consecutive series of unique, positive values, which eliminate the opportunity for such confusion.

The Safety Board is also concerned that the revised procedure currently used by Northwest Airlines to set the trim still calls for the first officer to use the degree scale initially in setting the trim. Although this procedure makes the captain responsible for catching any mistake made by the first officer by using a different scale to cross-check the trim setting, this procedure does not preclude the possibility of mistakes. The Safety Board concludes that a procedure that uses the CG scale to set and cross-check the trim setting will greatly reduce the potential for errors that are possible when using the degree scale to set the trim. Therefore, the Safety Board believes that the FAA should require operators of Airbus Industrie A319, A320, and A321 airplanes to set and cross-check the trim using CG values only.

In addition, the Safety Board is concerned about the inconsistent formats in which trim unit information is presented to Northwest flight crews and the possibility that other operators may also use inconsistent formats. As already noted, the degrees scale located next to the THS trim wheel shows trim values without a "+" or "-" sign, followed by "UP" or "DN" to indicate the corresponding pitch direction of the airplane. The ECAM also displays trim values to Northwest flight crews as "UP" or "DN" but also precedes trim values resulting in a nose-up pitch direction with a "-" sign. Finally, Northwest's ACARS load data sheet, which is the crew's initial source of trim unit information, precedes the trim value with a "-" sign for any setting that results in a nose-up pitch direction but does not display the corresponding "UP" or "DN" designations as appear on the trim wheel scale and ECAM display. The Board recognizes that a

[6] The CVR indicated that the captain performed the cross-check by stating the trim setting as "negative 1.7."

procedure for setting and cross-checking trim that uses only CG information would not require flight crews to consult the ECAM or ACARS information regarding the trim setting in degrees. However, the Board notes that crews may nonetheless choose to consult that information to confirm that the CG setting selected is consistent with the THS position in degrees. Therefore, to avoid confusion, the Safety Board believes that the FAA should require operators of Airbus Industrie A319, A320, and A321 airplanes to ensure that the ECAM display and the ACARS load data sheet are configured so that they display THS trim unit information in a manner that is consistent with the display on the degree scale of the trim wheel indicator.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Require operators of Airbus Industrie A319, A320, and A321 airplanes to set and cross-check the trim using center of gravity trim values only. (A-02-06)
>
> Require operators of Airbus Industrie A319, A320, and A321 airplanes to ensure that the electronic centralized aircraft monitoring display and the aircraft communication addressing and reporting system load data sheet are configured so that they display trimmable horizontal stabilizer trim unit information in a manner that is consistent with the display on the degree scale of the trim wheel indicator. (A-02-07)

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

Original Signed

By: Marion C. Blakey
Chairman