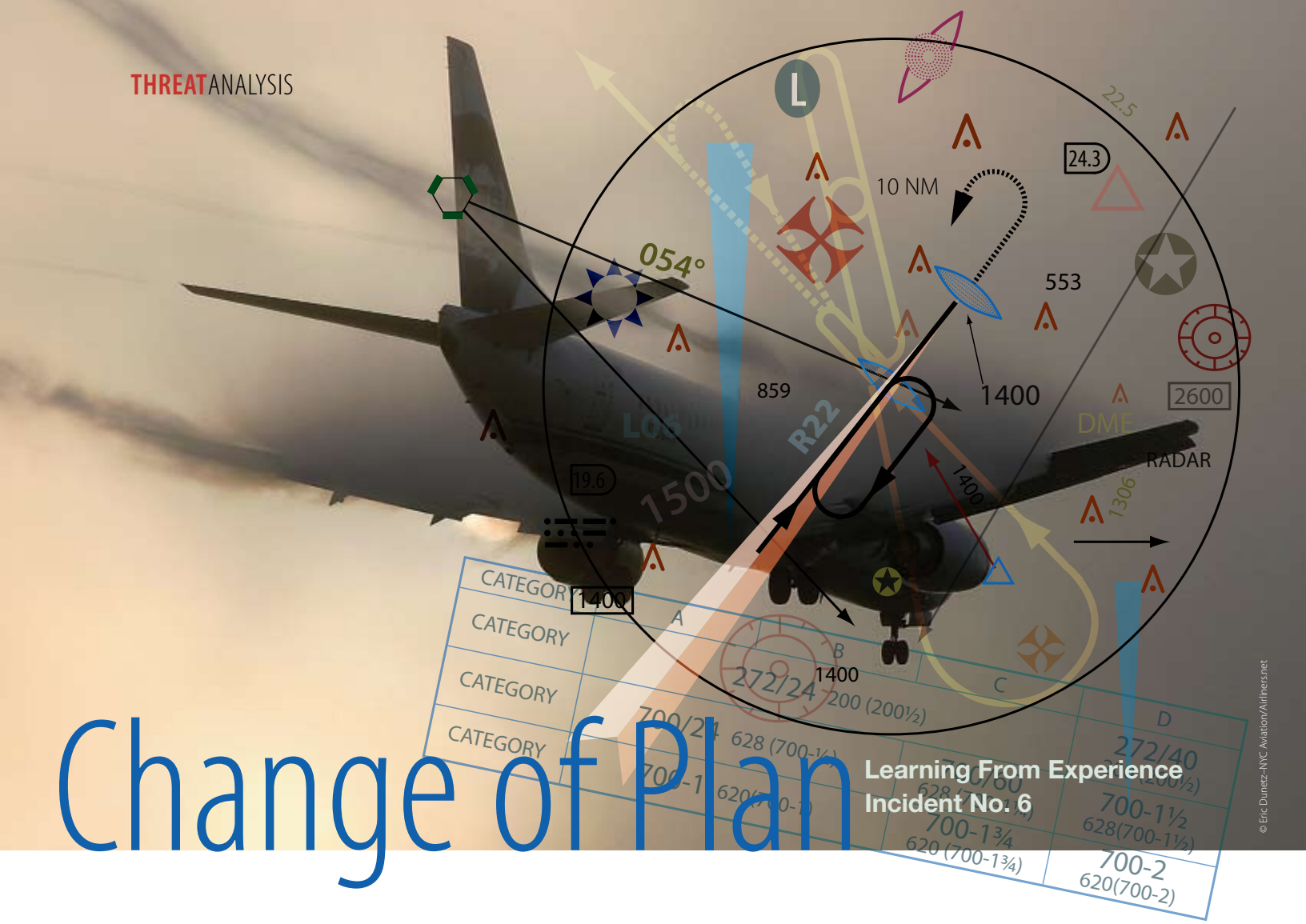


Change of Plan

Learning From Experience
Incident No. 6

Sixth in a series focusing on approach and landing incidents that might have resulted in controlled flight into terrain but for timely warnings by TAWS.

BY DAN GURNEY

A late change to a different instrument approach procedure, a hurried approach briefing and difficulty in deciphering a cluttered chart might have been involved in a premature descent that took a commercial aircraft about 1,500 ft below the proper altitude in instrument meteorological conditions.

The flight crew had been cleared for — and likely planned and briefed for — the ILS/DME (instrument landing system/distance measuring equipment) approach to the airport. However, just before the aircraft reached the initial approach fix, the tower controller told the crew that the ILS ground equipment had failed and re-cleared the crew to conduct the VOR (VHF omnidirectional radio)/DME approach, a "straight-in" nonprecision approach procedure to the same runway.

The aircraft was 6 nm (11 km) from the runway threshold and descending through 500 ft above ground level (AGL) when the terrain awareness and warning system (TAWS) generated a "TERRAIN, PULL UP" warning. The crew responded immediately and initiated a climb to a safe altitude.

The aircraft's flight path before the TAWS warning was equivalent to a final descent begun about 4 nm (7 km) before reaching the appropriate descent point, an error that might have resulted from mental workload imposed by the

complex approach chart that the crew is believed to have used.

Mixed Procedures

Civil aviation authorities (CAAs) are responsible for designing and approving instrument approach procedures for airports in their countries. They publish master copies that all chart providers must follow, but not necessarily using the same formatting and symbology. In this incident, the CAA had published separate master copies of the ILS/DME approach and the VOR/DME approach. Each chart clearly identifies the associated descent point and provides an altitude/range table specific to the approach. The altitude/range table on the CAA's VOR/DME approach chart has ranges from the DME ground station and also from the runway threshold to enable flight management system vertical navigation monitoring.

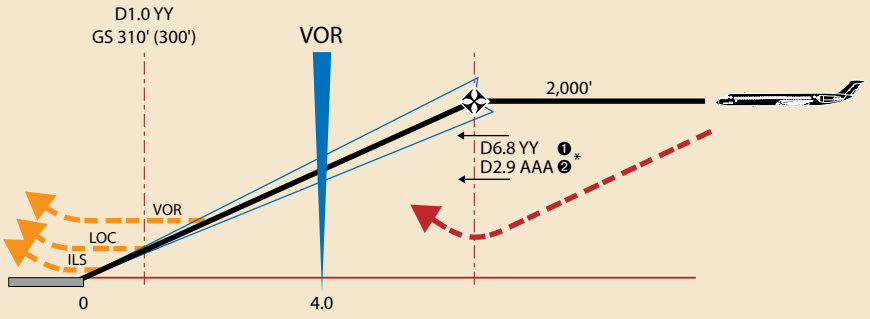
The chart that the incident flight crew is believed to have used, however, depicts an amalgamation of the ILS/DME and VOR/DME procedures, and includes details for a localizer procedure. The chart contains extensive supporting information for the three procedures. Although this decreases clarity, the chart content is typical of many charts that depict amalgamated procedures.

The chart identifies a common descent point at the final approach fix (FAF) for all three approach procedures by its distances from two DME ground stations: "D6.8 YY," or 6.8 nm from the DME ground station for the ILS/DME approach, and "D2.9 AAA," or 2.9 nm from the DME ground station for the VOR/DME approach (Figure 1). Next to each distance figure is a callout to a note identifying its respective approach procedure. The notes indicate that "D6.8 YY" should be used to identify the descent point while conducting the ILS/DME approach and that "D2.9 AAA" should be used to identify the FAF during the VOR/DME approach. The callouts are included in the chart's plan view and profile view; the notes, however, are included only in the plan view.

The plan view depicts the approximate locations of the DME ground stations. YY, which is colocated with the glideslope transmitter, is 0.1 nm beyond the runway threshold. AAA is about 0.2 nm beyond the VOR, which is 4 nm from the runway threshold. However, the positions of the ground stations are not depicted on the profile view.

The altitude/range table also is an amalgamation of data from the CAA's master copies. Its format provides the opportunity for misreading the data and is a potential threat to safety. The table is divided horizontally into "LOC," or localizer, and "VOR/DME" sections, and the altitude and range data are shown together — in much smaller type

Approach Profile View and Aircraft Flight Path



LOC (GS out)	YY DME	2.0	3.0	4.0	5.0	6.0
	ALTITUDE (*HAT*)	600' (*590'*)	890' (*880'*)	1,180 (*1,170'*)	1,470' (*1,460'*)	1,760' (*1,750'*)

VOR DME	AAA DME	2.0 After AAA	1.0 After AAA	0.0	1.0 Before AAA	2.0 Before AAA	2.9 Before AAA
	ALTITUDE (*HAT*)	560' (*550'*)	850' (*840'*)	1,140' (*1,130'*)	1,430 (*1,420'*)	1,720' (*1,710'*)	2,000' (*1,900'*)

*Callouts ❶ and ❷ refer to notes on approach plan view indicating that D6.8YY is used for the ILS/DME approach and D29.AAA is used for the VOR/DME approach.

Source: Dan Gurney

Figure 1

than appears in Figure 1. For each range figure, an altitude and a height above touchdown (HAT) are provided. This adds visual clutter that could slow data acquisition and increase mental workload. Similarly, the "After AAA" and "Before AAA" notations for the VOR/DME ranges also add complexity.

Moreover, the table shows the range values above the altitudes. As noted in the discussion of incident no. 2 in the August 2006 *Aviation Safety World*, it is essential to check altitude before range when monitoring the flight path. Thus, the table format, which is commonly used by chart providers, could bias the crew to check range before altitude, a procedure that could result in being at a dangerously low altitude at longer ranges.

Lessons to Be Learned

Based on the author's analysis, which was reviewed by a select group of aviation safety professionals, the most likely scenario for this incident is that the flight crew retuned their navigation receivers to the radio frequency for the VOR/DME approach but began the descent when the aircraft was 6.8 nm from the DME ground station for the VOR/DME approach; as previously discussed, the descent should have been initiated 2.9 nm from the station. This could have resulted from the crew following information reviewed during their first briefing, for the ILS approach, in which descent is begun 6.8 nm from the DME associated with that approach.

This lapse might have been compounded by the use of the LOC altitude/range data, rather than the VOR/DME altitude/range data, to monitor the flight path. The approach likely appeared safe and correct to the crew — until TAWS sounded the alarm.

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Among lessons to be learned from this incident are the following:

- Late changes of plan and hurried briefings expose flight crews to seemingly innocuous threats and opportunities for errors. A rule of thumb to remember is: "Retuning frequencies always requires retuning the mental map."
- Latent threats can originate from well-intentioned alterations of the chart format to simplify procedures or improve efficiency.
- Monitoring is only effective if the correct data are being used. Crews should take extra precautions when using amalgamated charts. ●

[This series, which began in the July issue of *Aviation Safety World*, is adapted from the author's presentation, "Celebrating TAWS Saves, But Lessons Still to Be Learned," at the 2006 European Aviation Safety Seminar, the 2006 Corporate Aviation Safety Seminar and the 2006 International Air Safety Seminar.]

Dan Gurney served in the British Royal Air Force as a fighter pilot, instructor and experimental test pilot. He is a co-author of several research papers on all-weather landings. Gurney joined BAE Systems in 1980 and was involved in the development and production of the HS125 and BAe 146, and was the project test pilot for the Avro RJ. In 1998, he was appointed head of flight safety for BAE Systems. Gurney is a member of the FSF CFIT/ALAR Action Group, the FSF European Advisory Committee and the FSF steering team developing the "Operators Guide to Human Factors in Aviation."