TERPS, CFIT And Me

The Korean Airlines B-747 controlled flight into terrain accident at Guam: DEJA VU.

By Wally Roberts

ONCE AGAIN A PROFESSIONAL airline flight crew has flown a perfectly good jet airliner into the ground during a non-precision instrument approach. In August 1997, Korean Airlines Flight 801 (a B-747-300) collided with terrain 3.5 miles southwest of the Guam Airport.

I was invited by the National Transportation Safety Board (NTSB) to testify at the public hearing of this accident, regarding the design of the approach procedure flown by KAL 801. As a result of my participation, I'll delve into the approach chart. At the end of the article, I'll reflect on the "technical emotions" triggered by this event from an accident that occurred in 1974. I'll also discuss my recommendations to the NTSB and what you can do to avoid a controlled flight into terrain (CFIT) accident. First, I'll review the circumstances of the accident.

The KAL crew was using the ILS Runway 6L approach chart (page 11, left). The glideslope had been notam'd inoperative (often informally referred to as a localizer approach). Guam ATC followed FAA practice by clearing KAL 801 for the "Runway 6L ILS approach, glideslope unusable."

Ill-fated flight path

Prior to clearing KAL 801 for the approach, Guam ATC vectored the aircraft at 2,600 feet to intercept the final approach course between FLAKE intermediate fix and GUQQY FAF. At this time the captain discussed with the other two crewmembers that the glideslope appeared to be working. As a result, a constant descent of approximately 3 degrees was begun shortly after localizer intercept. The descent continued until the crew initiated a missed approach, just prior to impacting terrain over 600 feet high and 700 feet to the left of the Nimitz VOR.

The accident occurred at 0142 hours local time. The reported weather at the airport: 1,600 feet scattered, 2,500 feet broken, 5,000 feet overcast, 7 miles visibility in rain, with scattered thunderstorms in the area.

The crew had discussed all pertinent aspects of the non-precision approach profile, including the 1,440-foot stepdown altitude over the VOR, but no attempt was made to level off at either 2,000 feet or 1,440 feet. It's apparent the captain had concluded that spurious glideslope deviation indications confirmed a valid glideslope. I in no way will attempt to justify the crew's action, other than to say I firmly believe they weren't intent on suicide.

Close look at Guam approach

The ILS 6L IAP is a no-brainer ILS when the glideslope is working. With the glideslope out, however, the VOR stepdown fix becomes critically important to get below 1,440 feet. In the case of air carrier aircraft, this means splitting the captain's and first officer's nav displays, which is contrary to sound cockpit resource management and makes display redundancy impossible.

Because of limited navigation facilities on this remote island, the FAA procedures designers were stuck with making VOR (essential for missed approach) and DME (essential for non-radar procedural entry and missed approach holding fix) a mandatory part of this IAP. The FAA added a note "DME required," but there is no "VOR required" note because the FAA considers VOR to be aboard every IFR aircraft. But, is that an intuitive concept for all instrument-rated pilots?

Had there been an outer compass locator (LOM), it would have been the preferred tracking facility for the missed approach procedure. This would have negated the mandatory aspect of VOR in this IAP, which would have triggered a TERPs provision to chart both 1,440 and 560 as MDAs, without and with stepdown fix. The charting of 1,440 as a conditional MDA, with its attendant higher visibility minimums would have been additional useful information for this IAP. Perhaps having the 1,440 MDA, in addition to the 560 MDA, could have been a CRM trigger point for the KAL crew.

CFIT Trend

Controlled flight into terrain (CFIT) is the single biggest cause of air carrier hull losses. Unless the trend is abated, by early next century experts predict there will be one air carrier hull loss per week due to CFIT worldwide.

The rate of CFIT accidents is lowest in North America and varies throughout the world to a horrific rate in the mountainous areas of South America. The rate of CFIT accidents during non-precision approaches is five times that of precision approaches.

Redundancy and Safety Nets

At Guam, not only was the glideslope out of service, the FAA's minimum safe altitude warning system (MSAW) was unknowingly inoperative. Had the Guam MSAW been working, there would have been ample time for ATC to have made the "save" with a low altitude alert. Had the aircraft been equipped with an enhanced ground proximity warning system (EGPWS) there would have also been ample early warning from that system.

These backup systems are not crutches. The more redundancy there is the bigger and stronger the safety net.

At the hearing I testified that, had I arrived at Guam under the circumstance that existed that night, I would have requested the VOR/DME Runway 6L IAP (below right). This IAP is less confusing than the non-precision localizer IAP, and would permit me to have full airline cockpit navaid display redundancy. (Note the difference in the profiles of the two IAPs, although the controlling terrain in the vicinity of the OM and VOR affects both procedures' TERPs-protected airspace in the same manner.)

Lessons for all of us

The lessons of this CFIT accident apply to all of us. Put yourself in the cockpit at night. Add a long, fatiguing day, with thunderstorms along the approach course. Think of your own training and proficiency when contemplating a dark hole, bouncy air approach. What affect will fatigue have upon you during such conditions? For some specific guidelines, see page 15.

On my way home from the hearing, I spoke with a senior pilot for a major airline. He made the astute comment that localizer approaches are unique among non-precision IAPs: they often have a useless, but wiggling glideslope deviation indicator—which is like a flame to the "moth" in the mind of a pilot who flies 98 percent of his ap-

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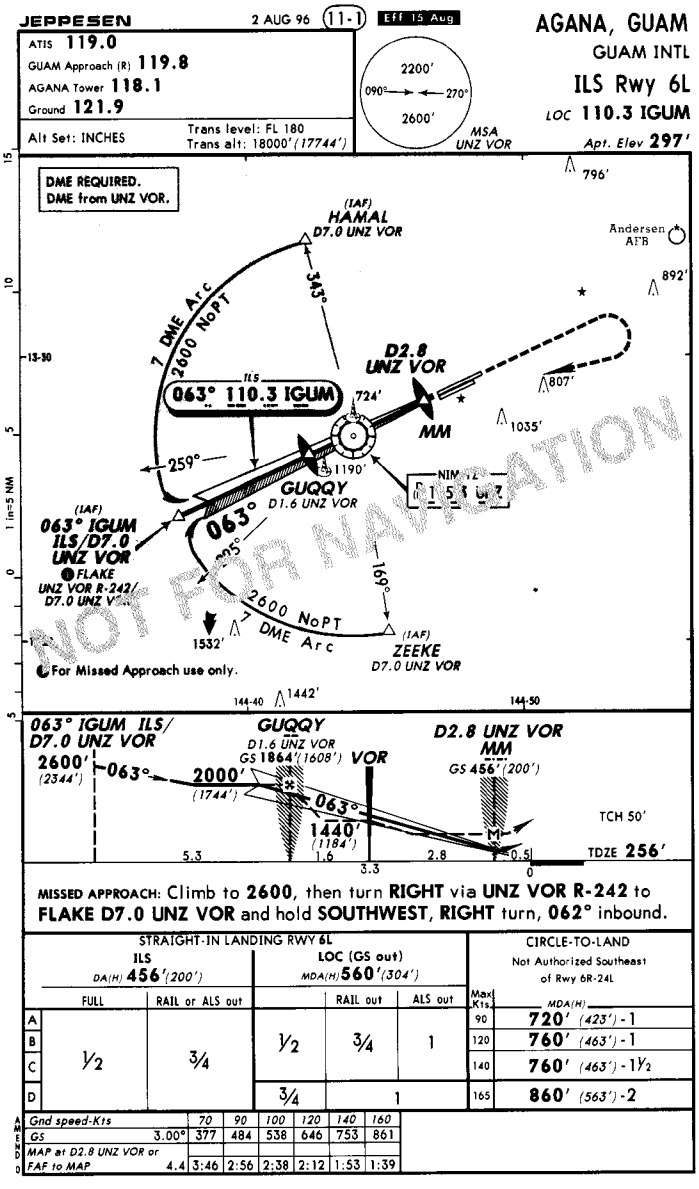

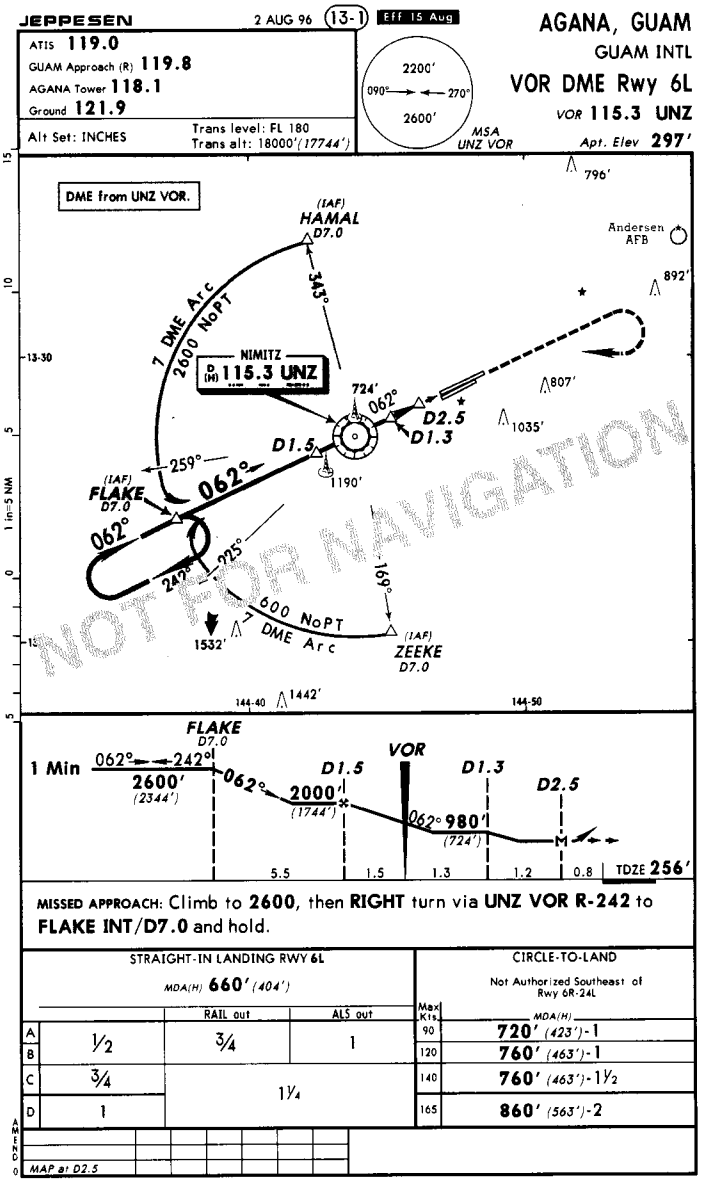

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The ILS at Guam (left) is a no-brainer when the glideslope is working. Take away the glideslope and the VOR stepdown fix becomes critically important to get below 1,440 feet. The VOR/DME procedure (right) is easier to interpret during a "dark and stormy" night approach. The LOC procedure is unusual in that the DME counts down to the final segment step-down fix, then counts up as you proceed to the missed approach point.

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proaches over the years with an electronic glideslope.

Deja vu

In late 1974, I became intimately and extensively involved in the investigation of TWA Flight 514; a B-727 that collided with a hill northwest of Washington Dulles Airport. I was an 11-year pilot for TWA at the time, was qualified as captain on the B-727 and was then chairman of the ALPA national TERPs Committee.

Once it was generally known about my involvement in that investigation, I was the subject of never-ending views and opinions from fellow TWA crewmembers and so-called aviation experts. The general consensus was the crew of TWA 514 just "didn't get it" or they wouldn't have flown into that hill. (As the years go by, the expert view of the crew's conduct has softened.)

At the time of the accident, I never felt as if I had the support of TWA management—that I was their worst nightmare—a line pilot who knew more than they did about TERPs. This attitude by flight operations management inevitably has a chilling effect, is close to the subtle (and sometimes not so subtle) implied intimidation to get the job done "or else."

Chilling effect

I'm not suggesting that Korean Airlines has a repressive flight operations management. In fact, I couldn't get a reading on their attitude (one way or another) at the hearing. What I *am* saying is this attitude does exist within some, if not many, flight operations managements throughout the world. Couple this with air carrier training curriculums that are all too often limited by economics, and you gain insight into some of the factors that eventually play in the chain of events that lead to CFIT accidents.

Lowest common denominator

I bristle when I hear the inevitable comments following an air carrier CFIT crash that had the crew only been competent, the accident wouldn't have occurred. This comment is often followed by some union bashing, e.g., if the pilot unions wouldn't arbitrarily protect pilots, the "incompetents" would be weeded out.

The reality is the airline hires the pilots and the airline trains and assesses pilot proficiency. Pilot unions provide the ability for pilots to collectively represent themselves to management on issues pertaining to wages and working conditions. As far as I know, no pilot union has ever successfully caused a pilot to be returned to duty when the company determined the pilot did not meet *minimum standards* and the company made a proper case.

The phrase *minimum standards* invokes emotions in everyone involved in standards issues. When I'm riding in the back, why shouldn't "my" captain be the best there is? Well, it's simply not possible to employ several thousand pilots, and have them all be the best.

Then, there are the factors of stress, fatigue, fear, work overload, etc. These factors work to temporarily reduce the abilities of both the sharp and not-so-

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Roberts' Recommendations on Guam and ILS vs. LOC Approaches

I recommended that an LOM be added to the Guam ILS RWY 6L outer marker. Further, a frequency-paired, collocated ILS/DME should be added to the instrument landing system. Most transport category aircraft do not permit separate tuning of the DME, so frequency paired DME assumes an even more important dimension for such aircraft. ILS DME provides great information for *everyone*. With it, you always have count-down DME to the runway and the procedures designer has the optimum flexibility in creating non-precision localizer procedures. Even with the full ILS, the ILS DME adds the ability to mark the precision FAF, and the DH-point, if the FAA were to use these sensible options.

The FAA promised in the 1960s that all FAA ILS installations would have frequency-paired, collocated DME. In spite of the promise of GPS, ILS is going to be the way of life at major airports for many years yet. DME should be part of the ILS equation.

ILS vs. LOC

We've all been exposed to the pros and cons of setting up an ILS approach for reversion to localizer minimums in the event of a sudden glideslope failure. Where a final segment stepdown fix is involved, I've always frowned on this technique. I believe any localizer IAP with one or more final segment stepdown fix(es) should be charted separate from the ILS IAP.

Where the ILS and localizer procedures continue to be charted together, there should be two titles: "ILS" and "LOC." When ATC knows the glideslope is out of service, they would clear you for the LOC procedure, thus eliminating another point of possible confusion or ambiguity.

The NTSB was also interested about the role users play in commenting on FAA design and development of individual IAPs. The FAA TERPs expert testified that the FAA coordinates all new and amended IAPs with all bonafide user groups. I pointed out this coordination consists of the regulatory textual document, which is nearly impossible for most pilots to decipher. Besides, the form does not contain nearly all the data which will appear on the final approach chart. I believe the FAA should circulate a proposed procedure in aeronautical chart form. In addition to being circulated to the "insider" user groups, the chart should be available at the local airport and on an FAA web site. With maximum pilot input, the product can only be improved.

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sharp pilot. The sharp pilot begins from higher ground, but that doesn't make him immune from a fatal mistake under sufficiently stressful conditions.

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Avoiding CFIT

Be aware of the following risk factors, present in many CFIT accidents:

- Airport near mountainous terrain;
- Limited or no ATC radar coverage (approaching an airport other than primary airport where ATC radar located);
- NDB or VOR approach;
- Night "black hole" approach;
- Limited runway/approach lighting.

A common element in all CFIT accidents is the loss or a lack of situational awareness. Here are some basic rules to avoid getting caught:

- Maintain altitude and terrain awareness. Know the minimum altitude for terrain/obstacle clearance for the area in which you're operating. Plan an emergency safe altitude you can climb to in the event you get lost or confused.
- When operating into an airport with terrain in the vicinity, don't descend unless you're on a published route or segment of the approach.
- Identify all navaids before following any course information.
- Constantly cross-check your position during the approach, even on an ILS.
- Remind yourself that you're most vulnerable to CFIT at night, especially after a long day. Do whatever it takes to stay alert and monitor the approach.