4 - RECOMMENDATIONS

4.1 Preliminary Recommendations

Evidence brought to light in the course of the investigation led the Bureau Enquêtes-Accidents to issue the following safety recommendations in the preliminary report issued in October 1994:

Operation

Examination of the circumstances of the accident showed that the possibilities of a go-around during approaches using the vertical navigation and autothrottle modes are apparently not well-known to crews. What is more, documentation obtained as of this date is not explicit regarding this point.

Consequently, the Bureau Enquêtes-Accidents recommends:

that crews be informed of the circumstances surrounding the accident

that as a temporary measure, use of the autothrottle controls and the automatic modes of the AFDS in standard approach be prohibited below the decision height

Note: distribution of the preliminary report could be one means of informing flight crews.

Aircraft

Following the accident, normal electrical power sources (alternating current and batteries) cut out following damage to the electronics bay and its submersion.

Thus, communication systems between the cockpit and the cabin, as well as the public address system, were not working, and action on the shut-off valves, fuel shut-off valves and extinguishers were ineffective (the engine kept running throughout the evacuation), as power to all of these systems is supplied by normal electrical sources.

However, all systems in the airplane did not shut down. For example, the electrical power providing for transmission of the signal giving the position of the throttle controls between the transducer and the corresponding engine was supplied directly by the engine through its ECU.

Consequently, the Bureau Enquêtes-Accidents recommends:

that a study be undertaken to examine the possibility of supplying electrical power directly from the engines to controls for shut-off valves, engine fuel shut-off valves and extinguishers

that a study be undertaken to examine the possibility of having an autonomous battery-run power supply for communication systems between the cockpit and the cabin and within the cabin.

The Control Tower

During evacuation of passengers from the airplane who were on threshold 04, the Tahiti Faa'a airport control tower allowed an ATR 72 inbound from Bora Bora to land at QFU 22 on the part of the runway between threshold 22 and the service road located 2,100 meters from threshold 22 (or 1,300 meters from threshold 04).

The following measures were taken prior to the airplane's landing:

The portion of the runway cited above was inspected to ensure that no foreign bodies were present.
The service road was closed.
A radio call was issued to personnel present on the accident site (firemen, gendarmes or the captain) requesting that they clear the runway of passengers and vehicles.

When the ATR came in for landing, a great many passengers and crew members were walking along the runway towards the terminal in darkness. The announcement that an airplane was about to land (without mention of the type) caused slight panic.

Passengers, some of whom were barefoot, were herded off the runway into the brush and towards a swampy area.

In addition, no check was made to make sure that no passengers were still on the portion of the runway to be used for landing..

Consequently, the Bureau Enquêtes-Accidents recommends:

that following an accident on or near a runway, said runway be closed totally until rescue operations are completed

4.2 Intermediate Recommendation

As a result of several accident investigations in which the Bureau Enquêtes-Accidents was involved, the following recommendation was issued on 24 January 1995:

Various incidents or accidents (see summary in appendices) involving wide-body passenger carriers have the following characteristics in common:

1) Configuration: Autopilot and/or auto-controls (or autothrottle) in operation.

2) Circumstances: the pilot at the controls overrides (voluntarily or involuntarily) the automatic flight system, or performs actions contrary to the instructions of the flight director.

3) Aggravating Circumstances:

a) The pilot flying is not always conscious that his actions contradict those of the automatic flight systems and never notices the consequences of them.

b) The pilot not flying (even an instructor) is not aware of the contradictions between the pilot at the controls and the automatic flight systems.

4) Consequences:

- *The reaction of automatic flight systems causes potentially dangerous configurations: out of trim, engine thrust incompatible with the path chosen by the pilot, ...*

- *The crew—*
  - *is either unaware of the situation and therefore cannot take appropriate corrective action,*
  - *or notices the configuration of the airplane but fails to understand the causes. This lack of understanding (also linked to a limited knowledge of systems) leads to a waste of time in analyzing the situation, or even an erroneous analysis, usually combined with a lack of communication among crew members.*

This has caused very dangerous attitudes: extreme pitch or roll attitudes, loss of speed (leading to stalls) excessive speed, etc...

Consequently, the Bureau Enquêtes-Accidents recommends:

that a study be commissioned so that the priority of the pilot over automatic flight systems be maintained under all circumstances.

This could translate into either or both of the following actions:

a) Disconnecting automatic flight systems (autopilot and autothrottle or autothrottle) in cases where pilot actions are in contradiction with those of the automatic flight system or the flight director.

b) Providing for a clear message (or possibly an alarm) in the cockpit alerting the crew to such a contradictory situation.

APPENDIX, Reminders regarding the following events:

1. *Incident involving an A 300-B4 on the approach to Helsinki (Finland) on 9 January 1989*
2. *Accident involving the A320-231 VT-EPN in Bangalore (India) on 14 February 1990*
3. *Incident involving the A310 D-ADAC on the approach to Moscow on 11 February 1991*
4. *Accident involving the B747-400 F-GITA at Tahiti-Faa'a on 13 September 1993*
5. *Accident involving the A310-300 F-OGQS near Novokuznetsk (Siberia) on 22 March 1994*
6. *Accident involving the A300-600 B1816 in Nagoya on 26 April 1994*
7. *Incident involving an A310-325 on the approach to runway 26 at Orly on 24 September 1994*

Caution: information presented below does not purport to be a summary of the accidents or incidents, but rather a reminder of those circumstances and characteristics pertinent to the enclosed recommendation.

Incident involving an A 300-B4 on the approach to Helsinki (Finland) on 9 January 1989

During an ILS approach with the autopilot (AP) and autothrottle engaged, the pilot accidentally engaged go-around.

To remedy the situation, the pilot disconnected the autothrottle and pulled back on the thrust levers after four seconds while countermanding the AP by pushing forward on the control column for 10 seconds to avoid having passengers undergo a sudden change in attitude.;

The trimmable stabilizer reached 8° nose-up pitch (the initial approach value was 5.5° nose-up pitch).

Subsequently, the AP was disconnected or disconnected itself without the crew noticing.

Then, seeing that the approach had not stabilized, the pilot performed a Go-around by selecting the autothrottle go around mode.

The combined effect of the pitch-up moment of the engines and the nose-up pitch of the trimmable stabilizer took the airplane to an attitude of 35.5° then 94 kt indicated airspeed in spite of the crew's pushing forward on the control column.

Not long before reaching these values, the crew moved the trimmable stabilizer to 0°. The speed increased again while the attitude decreased.

Accident involving the A320-231 VT-EPN on 14 February 1990 in Bangalore (India)

During a "Captain's" inspection flight the pilot at the controls made a visual approach with the autothrottle and the flight director active (in mode V Speed: vertical speed holding).

On final approach, he requested display and selection of a vertical descent speed of 700 ft/mn on the Flight Control Unit (FCU). For unknown reasons, the pilot not flying –the instructor- displayed an altitude below that of the airfield on the FCU (instead of the vertical speed requested) and did not make the call-outs required when making a change to the FCU.

Subsequent to this action, the active mode of the automatic flight systems went from Speed Vspeed (speed holding-vertical speed) to Idle Open Desc (engine in flight idle- change of level in descent).

The pilot at the controls was not aware of this, and the instructor did not call it out clearly.

To maintain the descent path—visually—the pilot at the controls pulled the control column gradually back, causing the landing angle to increase and the speed to decrease, engine thrust being in flight idle.

The anti-stall function led to an increase in the rate of descent, and the alpha floor initiated an automatic go-around. This occurred at too low a level and the airplane touched the ground and hit a mound

The airplane caught fire. 92 persons were killed and 22 were seriously injured.

Incident involving the A310 D-ADAC on 11 February 1991 on the approach to Moscow

During a go-around procedure in autopilot mode (CMD mode), the pilot tried to limit the pitch-up attitude, which he thought to be excessive, by pushing on the control column (14° nose down). The autopilot then ordered the trim to -12 nose up in an attempt to maintain the specified parameters.

On arrival at the safety altitude, the autopilot went into Altitude Acquire mode and disconnected automatically because of the effort on the controls exerted by the pilot (disconnection is inhibited below the safety altitude).

The crew then found itself in manual control with a significant pitch up moment caused by the out of trim pitch, to which was added the pitch up moment caused by the engines in go-around power mode. The movement of the elevator control was insufficient to countermand this combined pitch-up and prevent an increase in attitude. The airplane stalled three times in a row, pitching down and recovering at 2.5 g each time.

The pilot regained control of the airplane by reducing engine power. The out of trim correction phase occurred later.

Accident involving the B747-400 F-GITA at Tahiti-Faa'a on 13 September 1993

The crew made a visual VOR DME approach, with instrument confirmation, with the flight director engaged and the auto-throttle controls active in VNAV (vertical navigation) mode.

The copilot (pilot flying) was following the flight path manually while the auto-throttle controls controlled the speed.

In keeping with the logic of the active mode of the automatic flight system, this system triggered an automatic go-around upon arrival at the End of Descent point (located at 2.3 Nm from the runway threshold) and displayed it on the FMA (on the upper portion of the Primary Flight Display cathode-ray tube).

The pilot not flying called out the change in mode status on the FMA, but made no comments or analysis.

The airplane went above the descent path and the speed increased (eventually reaching Vref + 35 kt at a height of 150 feet).

The pilot at the controls pulled the throttle levers back and held them in the idle position. He indicated that he felt the handles "pulling forward" and tried to disconnect the auto-throttle, but did not find the instinctive disconnect button located on the levers.

Following a remark from the captain regarding the excessive speed, the pilot at the controls mumbled a confused response without referring to the problem he was having with the throttle levers, and he continued the approach, holding the levers in the idle position.

Approximately 2 seconds before touchdown, throttle levers no. 1 slipped out of his hand, the auto-throttle still active in Go-around mode. Lever no. 1 and the thrust of engine no. 1 went into full forward thrust and stayed there, without the crew noticing it, until the airplane came to a stop.

Consequently, upon landing, the spoilers were not raised, the autobrake function was disarmed and thrust was very uneven.

The airplane left the runway and came to a rest in the lagoon with no bodily injuries.

Accident involving the A310-300 F-OGQS near Novokuznetsk (Siberia) on 22 March 1994

Cruising in autopilot with auto-throttle engaged, the captain's son sat in the front left pilot's seat, then, with his father's authorization, moved the wheel and rolled the aircraft.

This overrode the autopilot, causing the roll to become more and more pronounced.

At first, the captain and the duty pilot —both at the back of the cockpit—did not understand the origin of the roll and came to an erroneous conclusion.

When they seemed to realize what was happening, a communication problem between the copilot and the captain's son made them lose time, and by the time someone took over the controls, the airplane was out of control.

After a series of uncontrolled maneuvers, the airplane hit the ground.

All 75 persons on board were killed instantly.

Accident involving the A300-600 B1816 in Nagoya (Japan) on 26 April 1994

The crew was making an ILS approach in manual operation with flight directors active (in ILS mode), under night visual flight conditions.

At about 1100 ft, the pilot at the controls accidentally engaged the go-around actuator. As a result, the automatic flight systems went into « Go-around » mode. Speed increased and the airplane went above the descent path.

The crew reduced the throttle, disarmed the go-around and engaged the autopilot (probably thinking they could more easily regain the approach path), failing to note that it was in go-around mode.

In addition, the crew pushed the control column forward to regain the approach path, thus countering the autopilot, which was moving the trimmable stabilizer to pull up until a balance was reached between the trimmable stabilizer at 12.3° nose-up pitch and the elevator at 9° nose-down pitch.

The alpha floor initiated another automatic go-around, leading to a decision by the crew to abandon the approach and continue with the go-around thrust.

The combination of the pitch up moment linked to the engine thrust and the trimmable stabilizer in full nose-up pitch was such that the movement of the elevator in full nose-down pitch was not sufficient to prevent an increase in attitude.

The attitude reached 52° while the airplane stalled, then hit the ground during recovery.

264 persons on board were killed, and 7 were seriously injured.

Incident involving an A310-325 on the approach to runway 26 at Orly on 24 September 1994

The captain (PF), during the approach to landing on runway 26 at Orly (AP and auto-throttle (ATH) engaged), wanted to make an ILS approach with ILS autocapture. Seeing that the aircraft was not intercepting the glide, he disengaged the AP and continued the interception in manual operation with Vertical Speed Holding (V/S) in longitudinal mode and Localizer (LOC) in horizontal mode, and ATH still engaged (the fact that the glide was not intercepted was consistent with the logic of this airplane; it cannot be intercepted before the LOC). The airplane's configuration was then landing gear extended, slats, flaps 15°, altitude selected on the FCU of 4,000 feet and calculated airspeed 205 knots decreasing.

The airplane was lined up on the LOC and above the descent path. The crew selected the flaps at 20 degrees; the calculated airspeed was then 197 knots.

With the AP disengaged, the flight director and the ATH activated, the A 310 has a protective feature in V/S mode that shifts automatically into «Level Change» mode in case of excessive speed on the path. It has been established that selecting the 20° position for the flaps at a speed of 197 knots, just over the maximum speed for this configuration (which is 195 knots) triggered activation of this feature. The crew did not identify the causes of the airplane's behavior.

They observed that the thrust levers were moving forward and that engine power was increasing.

The crew countermanded the power increase by a nose-down action on the elevator, with the ATH still engaged. The thrust levers were then brought back to idle position. At the same instant, the trimmable stabilizer moved into a nose-up position. This tendency to pull up was countermanded by pushing on the control column. When the trimmable stabilizer reached its maximum nose-up value (-13°), and the elevator reached its maximum nose-down value (+14.7), the thrust levers surged forward to their mechanical stop (TRA = 84°). The airplane's attitude increased + 6° to 59° and the airplane climbed to an altitude of 4,000 feet at a calculated airspeed of less than 45 knots (minimum recorded value). No longer receiving information on speed, the ATH disengaged automatically. Witnesses saw the airplane stall first on the right wing, then on the left wing—before assuming a pronounced negative attitude (-32,7°). The flaps were retracted.

The crew regained control of the airplane at about 800 ft. The landing gear was retracted. The crew circled the airport, then landed.

4.3 Other Recommendations

4.3.1 Analysis of the accident showed that there was a lack of communication and decision-making between the two pilots, especially after the automatic go-around engaged and during the final, non-stabilized approach.

Consequently, the Bureau Enquêtes-Accidents recommends:

that crew training in cockpit resource management be used to:

- **improve the effectiveness of reciprocal exchange of information between crew members, including during phases of flight with a heavy workload,**

- **encourage crew members to continuously analyze parameters and information linked to how the flight is proceeding so as to make the necessary decisions in a timely manner**

4.3.2 Following the investigation of the accident involving the A320 F-GGED on 20 January 1992, the Commission which investigated that accident had issued the following recommendation in its final report:

> ***« 41.7 – Generalities on Call-outs***
>
> *The investigation has shown that during the accident flight, there were significant discrepancies with call-out procedures stipulated by the airline. Our analysis reveals that the failure to make these call-outs may have contributed to undermining cross-checking and each pilot's awareness of the real situation.*
>
> *More generally, it seems clear that in this airline's daily practice, the average rate of call-outs has diminished in relation to stipulated call-outs, without the reasons for or scope of this phenomenon being known. It is important to note that cross-checking is critical to safety, especially in the latest generation of aircraft.*
>
> *Consequently, the commission recommends:*
>
> - ***that a study be undertaken to determine normal practice regarding call-outs as well as the cause of the deterioration of standard practices in this area and to find methods and procedures to consistently ensure effective reflex responses as well as cross-checking between crew members***

Similar discrepancies with stipulated call-out procedures were also brought to light during analysis of the of the F-GITA accident.

Consequently, the Bureau Enquêtes-Accidents issue a reminder of the pertinence of the above recommendation.

4.3.3 Within the framework of the technical investigation, and with reference to information provided verbally by the captain, the Bureau Enquêtes-Accidents requested access to certain data in his medical records in order to confirm in writing the information provided. This was not possible because of "medical secrecy."

If the pilot had not provided this information of his own volition, the investigators would not have been aware of it and would have been unable to take it into consideration in analyzing the accident.

Consequently, the Bureau Enquêtes-Accidents recommends:

- **that in every country, a doctor who is part of (or who regularly works for) the organization responsible for technical investigations be given unrestricted access to the medical records of personnel involved in an accident or incident and inform the designated investigator of relevant data.**

Note: Law N°99-243 of 29 March 1999 relating technical investigations of accidents and incidents in civil aviation changed the legal situation in France in line with the above recommendation.