

What went wrong during the Tenerife Disaster, and how can we prevent similar accidents?

Questions/Key Points	Notes
<p>Backtracking is most commonly used at airfields without parallel taxiways, though it was used in this case because part of the parallel taxiway at TCI was occupied by parked aircraft.</p>	<p>Final Dutch Report https://www.faasafety.gov/files/gslac/courses/content/232/1081/finaldutchreport.pdf https://aviation-safety.net/database/record.php?id=19770327-1 https://aviation-safety.net/database/record.php?id=19770327-0 https://www.skybrary.aero/index.php/B742 / B741, Tenerife Canary Islands Spain, 1977</p> <ul style="list-style-type: none"> ● Key terms/info <ul style="list-style-type: none"> ○ Runways are numbered by rounding the magnetic heading of the direction they face and dividing by 10. 0/360 is north, and the direction goes clockwise (90 is east). Runway digits are read aloud separately; RWY 12 is read as "runway one two" and not as "runway twelve" <ul style="list-style-type: none"> ■ Taxiways are not numbered like this, they are usually assigned a letter that is independent of the direction of travel. ■ Intersections are named with the letter of the taxiway and a number; i.e. C3 (charlie-three) ○ Backtrack (or back taxi, depending on where you are): the aircraft taxis on the runway and does a U-turn at the point where it intends to begin the takeoff roll ○ Phraseology: standard aviation language conventions used by controllers and pilots ○ V1: decision speed. This will depend on the weight of the aircraft, the aircraft's available thrust, and the length of the runway. After V1, the aircraft cannot abort the takeoff without a runway overrun. ○ Tailstrike: early rotation causes the angle of attack of the aircraft to increase but the aircraft doesn't gain sufficient altitude, causing the tail to hit the ground ○ Rotation: when the aircraft first leaves the ground during takeoff as a result of backwards control input ○ Other background info in this case: <ul style="list-style-type: none"> ■ After LPA closed and flights were diverted to TCI, the airport did not have enough ramp or gate space for all the aircraft there, so some aircraft were parked on the parallel taxiway to the runway, hence why aircraft were instructed to taxi on the runway rather than the parallel taxiway ■ Weather during the incident: low clouds, mist, and low visibility <ul style="list-style-type: none"> ● The visibility was so low, that, the tower could not see either aircraft taxiing down the runway ● Basics <ul style="list-style-type: none"> ○ Aircraft: <ul style="list-style-type: none"> ■ 1: KLM B747-206B PH-BUF; KL4805 ■ 2: Pan Am B747-121 N736PA; PA1736 ○ Flight: <ul style="list-style-type: none"> ■ 1: AMS-LPA (Las Palmas, Gran Canaria) ■ 2: LAX-JFK-LPA ○ Location: <ul style="list-style-type: none"> ■ TCI, Tenerife airport

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The first issue that caused the "snowball" effect in this situation was the bomb that went off at LPA.

- Date: Sun. 27 Mar 1977
- Time: 17:05
- Synopsis
 - PA1736 departs LAX the night prior and arrives at JFK, where it then changes crew and departs for Gran Canaria
 - KL4805 departs AMS early Sunday morning and heads towards Gran Canaria
 - While the aircraft are enroute, a bomb goes off at LPA; the terminal is evacuated for fear of a second bomb and the airport is closed
 - Flights are diverted to Tenerife
 - KLM: passengers arrive and initially aren't allowed to deplane, but they are eventually brought to the terminal building. All but one passenger return to the aircraft later
 - Pan Am: No passengers deplane
 - LPA reopens at 1500



The Pan Am aircraft didn't actually know which intersection they were supposed to exit the runway from.

- At 1646, KLM contacts tower and requests permission to taxi
 - KLM is told to backtrack on 12 until the next available exit, to then taxi on the taxiway towards rwy 30.
 - This instruction is misunderstood by the crew, so the tower amends their clearance and tells them to backtrack all the way to the threshold of 30. They get there.
- At 1702, PA calls to confirm their taxi clearance. They are told to taxi down the runway and exit at the third intersection on the left.
- After this, KLM calls again to let tower know they are passing intersection C-4. They are again instructed to taxi to the end of the runway, turn 180 deg and report when ready
- Tower then tells both aircraft that the rwy centerline lights are out of service. Then reiterates to PA that they need to exit at the third taxiway, and report when leaving the runway. Key info: tower doesn't tell PA which specific intersection (C-3 or C-4) to exit at, which may have caused confusion

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<p>Is the tower controller partially at fault for misunderstanding the KLM aircraft and giving departure instructions without a takeoff clearance?</p>	<ul style="list-style-type: none"> ○ At 1705, KLM advises tower that they are ready and waiting for takeoff clearance. See specific language: <ul style="list-style-type: none"> ■ KLM: "The KLM four eight zero five is now ready for takeoff and we are waiting for our ATC clearance" ■ Twr: KLM eight seven zero five you are cleared to the Papa Beacon, climb to and maintain flight level nine zero, right turn after takeoff, proceed with heading four zero until intercepting the three two five radial from Las Palmas VOR ■ KLM: ah - Roger, sir, we are cleared to the Papa beacon, flight level nine zero until intercepting the three two five. We are now (at takeoff) (There is a short squeal heard after this transmission) ■ Twr: OK... stand by for takeoff, I will call you. ■ Pan Am: Clipper one seven three six. ■ Tower: ah - papa alpha one seven three six report the runway clear. ■ PA: ok, will report when we're clear. ■ Twr: Thank you. ○ There are no further radio comms from twr, PA, or KLM. No eyewitnesses see the collision. ○ Notice how the tower gave KLM departure instructions but never actually gave them a takeoff clearance, which is a very deliberate phrase (runway three zero, cleared for takeoff). Usually, the departure instructions are given to the aircraft along with the takeoff clearance, which could have confused the KLM pilots ○ At this point, PA is still taxiing down rwy 12 ○ KLM disobeys the instruction to standby for takeoff and begins their takeoff roll ○ Remember that nobody can see each other. Twr is relying solely on the aircraft transponders and position reports, but can't actually see. However, they know that the runway is still occupied by PA because they tell KLM to stand by ○ KLM cockpit voice recording shows that the flight crew say to themselves: <ul style="list-style-type: none"> ■ Flight engineer: is he not clear then? ■ C/A: what do you say? ■ PA channel: yup ■ FE: is he not clear that Pan American? ■ C/A: Oh, yes (emphatically) ○ The captain is very convinced that PA is clear of the runway. He still has not received a takeoff clearance yet, but the takeoff roll has already started. ○ The aircraft reaches V1 and begins to rotate, when they suddenly see the PA aircraft. The crew pulls back but the speed is insufficient, causing a tailstrike ○ Pan Am sees KLM around 8.5 seconds before impact, try to vacate the runway but at that point the collision was bound to happen either way <ul style="list-style-type: none"> ■ Remember that aircraft are not like cars; they have a lot of momentum and can't stop on a dime. They also can't accelerate as fast as cars do. ○ KLM runs over the back half of the PA aircraft. There is a fiery explosion. ○ Injuries and fatalities:
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- KLM: 14 crew + 234 passengers (everyone onboard) all die
 - Pan Am: 9 crew, 317 passengers die on the spot; 7 crew sustain nonfatal injuries, 63 passengers experience nonfatal injuries but 9 of them died later as a result.
 - Both aircraft were written off
 - This was the deadliest accident in the history of aviation
 - Probable cause and other factors
 - Probable cause:
 - KLM aircraft, specifically the captain, took off without clearance; did not obey the instruction to standby for takeoff; did not abort when Pan Am reported the runway was occupied; was convinced that PAA was clear of the runway.
 - Contributory factors:
 - Improper phraseology
 - "We are now at takeoff" is nonstandard and really doesn't adequately convey that the aircraft was taking off
 - Twr saying "OK" and instructing the a/c to "stand by for takeoff" was also nonstandard though the takeoff already began by then
 - Greater than normal congestion at the airport, with aircraft parked on taxiways, and the twr using unusual taxi directions in low visibility
 - PAA not leaving the runway at the third intersection; they didn't know whether it was C-3 or C-4, but this doesn't matter as much b/c they did advise on the radio that they weren't clear of the runway.
 - Human factors:
 - Duty time: the captain was legally allowed to extend the duty time of crew members at the c/a's discretion in order to complete the flight/service. Thus, the crew during this situation didn't know when they would be off work, which becomes a contributing factor.
 - Care: two types - conscious and unconscious. Increase in one causes a decrease in the other. In this case, the unconscious care about the highly variable visibility and taxiing within it causes a loss of conscious care
 - Fixation: because of the visibility issue, the flight crews were likely fixated on the goal to depart as soon as possible so they could fly using instruments, which is a more comfortable situation.
 - Relaxation: after completing the 180 turn at the threshold of 30, which was a difficult task, the crew probably felt some degree of complacency after it.
 - Fatigue: obviously, it had been a long and stressful day for the crew, and they were understandably beginning to get tired.
 - Overload/stress: There were a lot more unexpected issues/problems today than usual
 - Authority/hierarchy: at this time in CRM, the captain is given absolute authority. Although the c/a still has the final say even today, there is a much more democratic environment than before.
- Additionally, the c/a of the KLM aircraft was very high ranking in

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| | <p>the company and the F/O was relatively inexperienced with this aircraft type. This means the F/O is more likely to refrain from questioning the c/a or speaking up.</p> <ul style="list-style-type: none">● Takeaways<ul style="list-style-type: none">○ Importance of exact and unequivocal compliance with ATC instructions○ Absolutely standardized ATC language and phraseology. Although not necessarily a factor in this incident, increased english proficiency for non native speakers○ "Takeoff" is a hot word in ATC, and should be avoided when not issuing or not responding to a clearance. For example, if an aircraft is ready for takeoff, they should advise the tower that they are "ready" and NOT "ready for takeoff".○ Crew rest and fatigue is a significant factor and warranted stricter regulations |
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Summary