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Rejected Takeoff Prevents Runway Collision After System of ATC Defenses Fails

The Dutch Transportation Safety Board said that the Boeing 767 flight crew observed the Boeing 747 as it was being towed across the runway in low-visibility conditions. The takeoff clearance involved misinterpretation of the surface movement radar display of the B-747's position and direction of movement.

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FSF Editorial Staff

On Dec. 10, 1998, at 1032 local time, the flight crew of Delta Air Lines Flight 39, a Boeing 767-300, rejected takeoff on Runway 24 at Amsterdam Airport Schiphol, Netherlands, after receiving takeoff clearance from air traffic control (ATC). The crew had initiated the takeoff roll and then observed a Boeing 747 being towed across the runway escorted by a yellow airport van (call sign Charlie 8). The B-767 was stopped before reaching the position of the tow aircraft and van. No injuries were reported among the 12 crewmembers or 126 passengers, and no damage was reported. The B-767 was departing for a scheduled passenger flight from Amsterdam to Atlanta, Georgia, U.S., under instrument flight rules in instrument meteorological conditions.

The Dutch Transportation Safety Board, in its final report, said that at the time of the incident, reduced visibility and a low cloud base made impossible the visual control of aircraft and



vehicles from the airport control tower and that low-visibility procedures were in use by ATC.

"All possible defense lines for ATC [were] crossed," said the report. "[Flight 39] started the takeoff roll while Charlie 8 was crossing the runway from the S apron [an area used for the temporary parking of aircraft] to the taxi tracks on the west side of the active takeoff runway (from exit 2E towards exit 2W). Only due to a reasonable actual visibility at the takeoff runway and quick and proficient action by the flight crew, who [rejected] the takeoff, a catastrophic accident was avoided. ... This serious

incident happened because — on the assumption that the runway was clear — [Flight 39] was given takeoff clearance while in reality [Charlie 8] was still in the process of crossing the runway. An important reason for this (wrong) assumption was the misinterpretation about the actual position and direction of crossing of Charlie 8."

Weather conditions near Runway 24 at the time of the incident were 1,700 meters [5,578 feet] visibility in mist; runway visual range at Runway 24 of 1,600 meters [5,250 feet] at position A and 1,800 meters [5,906 feet] at position B and position C; seven-eighths overcast at 100 feet and eight-eighths overcast at 1,200 feet.

Aprons, taxiways and runways were not visible to the ATC working positions — located approximately 87 meters (285 feet) above the ground — because of the low cloud base and because the visibility from Schiphol tower was “close to zero,” said the report.

“At the time of the incident, low-visibility [ATC] procedures ... had been in force from 1750 the previous day; the status was phase B [one of four phases],” said the report. “There was no log entry at Air Traffic Control [Netherlands] indicating that the implementation of the low-visibility procedures was passed on to the [required] organizations. When low-visibility procedures are in force, all tow movements at the [airport] require prior permission from ground control, therefore the apron tower has to coordinate these movements with the ground controller.”

Stop Bars Designed for Incursion Protection

General protection against incursions during nighttime and/or low-visibility weather conditions runway operations is provided by stop bars, activated by pressing a button at the central console in the tower.¹

“To allow aircraft or vehicles to cross a runway, stop bars at some crossing points can be switched off,” the report said. “Extinguishing individual stop bars is done by pushing a corresponding button at the control panel in the console, normally at the working positions T6 and/or T8. [Seven controller working positions faced outward inside an oval arrangement of ATC consoles in the Amsterdam Airport Schiphol control tower. Each position was designated by the letter T (for ‘table’) followed by a number. At the time of the incident, an assistant controller at working position T2 was responsible for start-up control and clearance delivery; an assistant controller at T3 was responsible for computer inputs to activate the internal electronic data flow for departing aircraft; a ground controller at T4 was responsible for ground traffic on the northern side of the airport; a ground controller at T5 was responsible for ground traffic on the southern side of the airport; and a tower controller/trainee at T8 (with a coach) was responsible for departures from Runway 09. Duties of a tower controller/trainee at T6, an assistant controller at T7 and a tower supervisor/coach are listed under ‘Tower Personnel Cited in Incident.’] After being extinguished, the stop bars will automatically switch on again when an aircraft or car passes vehicle/aircraft detection systems on both sides of the taxi track or after a time interval

of approximately 60 seconds, whichever comes first. The majority of movements with towed aircraft at Schiphol involve the crossing of [Runway] 04/22 and [Runway] 01R/19L. At all positions at these runways where towed aircraft may be crossing, there are traffic lights (Runway 04/22) or a combination of traffic lights and stop bars (Runway 01R/19L).”

Airport tow regulations for drivers of tow vehicles included requirements that stop bars be activated when the visibility is below 1,500 meters; that activated stop bars never be crossed; that tow trucks be equipped with a radio to establish two-way radio communication with the apron tower; and that all tow movements be coordinated in advance by the apron tower with the ATC control tower and require prior permission from ground control when the visibility is less than 1,500 meters (4,921 feet).

“The traffic lights are connected to a built-in warning system in the tower to alert controllers that one or more runway(s) is/are occupied,” said the report. “This system consists of a visual [alert] and an aural alert. The visual alert will cause a yellow-lit runway to blink on all panels in the tower whenever a controller switches a traffic light at that runway to ‘green.’ The aural alert is a clicking sound activated automatically and simultaneously with the visual alert. (Note: It should be noted that [International Civil Aviation Organization (ICAO)] regulations as provided for in Annex 14 [Aerodromes] require the use of stop bars with regard to runway protection as a standard as from 1 January 2000. Consequently, the use of traffic lights in this connection is no longer in accordance with international standardization. Following this standard, it is the intention that all relevant traffic lights at [Amsterdam Airport] Schiphol [be] replaced by stop bars.)”

The report said that remote-controlled stop bars were installed at exit 2 of Runway 06/24 — with no traffic light or automatic visual alert or aural alert during crossing of the runway — because S apron (from which Charlie 8 crossed the runway) was designed initially to be a freight platform for the loading and unloading of cargo, and exit 2 was not upgraded after 1997, when the airport began to use the platform as a buffer for temporary parking of aircraft, which involved frequent tows.

The stop bars at exit 2 of Runway 06/24 were constructed after the design and installation of the geographical control panel for all other runway stop bars, on which switches are superimposed on an airport diagram. Stop-bar control buttons for Runway 06/24 were identified by printed labels on a separate control panel.

Tower Personnel Cited in Incident

Among 11 controllers on duty in the control tower at the time of the incident — seven working positions, two coaches (on-the-job-training instructors, including the tower supervisor)

and two relief controllers — those involved directly in the incident were the following:

- The tower supervisor who was the coach monitoring the actions of the controller/trainee at tower position T6;
- A controller/trainee at tower control position T6, one of two tower control positions. This controller was responsible for landings on Runway 19R and departures from Runway 24 at the time of the incident; and,
- An assistant controller at position T7 who communicated with vehicles on the airport maneuvering area using the Dutch language on a dedicated radio frequency.

Controllers at some positions had multi-mode computer screens with the ability to select, as needed, text display, terminal approach radar display or a display from the ground radar system, known as surface movement radar (SMR) and as airport surface detection equipment (ASDE). They also could adjust range, brightness and gain, and could shift the ground-radar display on the screen off center as required by individual controllers.

“Although there are only few basic directives given for the use of this appliance, ground [controllers] and tower controllers often use this facility, especially during low-visibility weather conditions,” the report said.

Events Show Loss of Situational Awareness

The rejected takeoff occurred approximately 15 minutes after ATC changed from using Runway 19R and Runway 01R for landings and Runway 09 for departures, to using Runway 09 and Runway 24 for departures and Runway 19R for landings.

Ground-radar display data at Schiphol tower were not recorded [and the report’s recommendations included the addition of a logging device], and a reconstruction of the incident was conducted by positioning aircraft and vehicles, and studying the resulting displays.

The report said that the following events occurred following the runway changes:

- “At 1027 the controller at T6 cleared Martinair 629 to line up on Runway 24. He then shifted his attention to Runway 19R to observe the landing of an aircraft on that runway. This aircraft had to be positively on the ground before he could clear Martinair 629 for takeoff from Runway 24;
- “A few seconds later, the assistant controller at T7 received a call via channel 1 (the dedicated frequency

for vehicles, etc.) from [Charlie 8]. Charlie 8 reported that he was in front of Runway 06/24, with a tow following him, and he requested to cross the runway at exit 2. Although the transmission from Charlie 8 was distorted, the [tower] controller at T6 heard the request and told the assistant controller at T7 to instruct Charlie 8 to hold position. The assistant controller did so, and Charlie 8 acknowledged that he was holding position. The [tower] controller subsequently asked the assistant controller what the position of Charlie 8 was, to which the assistant controller replied that Charlie 8 was waiting to cross towards the ‘S’ apron. From this the controller derived that Charlie 8 had to be waiting on the [west] side of Runway 24 (which is consistent with a movement toward [this] apron);

- “After he had cleared Martinair 629 for takeoff and was positive that the aircraft was airborne, [the tower controller at T6] authorized the assistant controller to give Charlie 8 permission to cross. While giving this authorization to the assistant controller, he was called by [the crew of] Delta [Flight] 39, who had just been transferred by ground control to the tower frequency. The controller authorized Delta [Flight] 39 to line up [taxi into position] on Runway 24 at almost the exact moment that the assistant controller told Charlie 8 that [the tow] was permitted to cross Runway 06/24;
- “When Charlie 8 acknowledged the permission to cross, the driver immediately asked the tower [controller] to extinguish the stop bar. This may have coincided with the action by the controller to push the button that extinguishes the stop bar on the west side at exit 2 of Runway 06/24, or the request may have triggered that same action. In any case, during the subsequent conversation between the assistant controller and Charlie 8 to repeat what was said [the request to extinguish the stop bar], the controller was already pushing the button on his control panel. ... The controller then noticed that there was no result from pushing the button on his control panel and realized that this panel was still configured for the previous [runways configuration]. The panel at T6 only controlled the west sector of the airport (i.e., Runway 01L/19R) while the remaining three sectors were still allocated to the panel at [controller position] T8. He immediately asked the controller at T8 to extinguish the stop bar on the west side at exit 2 of Runway 06/24, which this controller did. The controller then switched his attention to his approach-radar [display] to monitor the inbound sequence for Runway 19R;
- “Meanwhile, in the tower, a discussion had developed between the [tower] supervisor ... and a third controller, who had arrived to relieve the

controller/trainee and [the] coach at T8, about the stop bar control-panel allocation in relation to the respective responsibilities at T6 and T8. The supervisor explained to the third controller that the current situation was consistent with the previously used runway configuration. It was then agreed that in view of the current runway configuration it would be preferable to allocate only the north sector to T8 and the other three sectors to T6. This new allocation was instantly effected by the coach of the controller/trainee at T8. The result of this was that now the controller at T6 had command of the stop bars at exit 2 of Runway 06/24;

- “One minute and 10 seconds after his previous call, Charlie 8 called the tower again with the request to extinguish the stop bar. The assistant controller relayed this request to the [tower] controller at T6, who once again pushed the button for the west side of exit 2 of Runway 06/24. This action was reported by the assistant controller to Charlie 8, after which Charlie 8 reported that the stop bar was still activated. With the consent of his coach, the controller then pushed the buttons for both sides of exit 2 of Runway 06/24, thus extinguishing the stop bars on the west [side] and east side simultaneously;
- “Meanwhile the [tower] controller [at T6] had also been monitoring the inbound sequence for Runway 19R where Air UK [Flight] 82S was approaching for landing. In his judgment, there would be an opportunity for the departure of Delta [Flight] 39 as soon as Air UK [Flight] 82S was on the ground at Runway 19R. The ‘departure window’ was not overly large, for the next aircraft approaching for landing (call sign CSA 316) was already on the tower frequency. If he wanted to use this ‘departure window’ he had to ensure that Delta [Flight] 39 would have commenced its takeoff before CSA 316 would be three nautical miles from touchdown [on] Runway 19R, as prescribed in the standing ATC procedures regarding separation between landing [aircraft] and departing aircraft. He therefore switched his attention to the ground-radar [display] in order to watch for the landing of Air UK [Flight] 82S. When he saw on the ground-radar [display] that Air UK [Flight] 82S had landed on Runway 19R, he was aware that he only could clear Delta [Flight] 39 for takeoff once the crossing [van] and tow would have vacated Runway 06/24. He therefore looked at the bottom of his ground-radar [display], where exit 2 of Runway 06/24 was visible ... and noticed a target on the exit, at the side of the S apron, well clear of the runway;
- “[The controller at T6] then turned to the assistant controller with the intention to ask for confirmation that the [van] and tow had vacated the runway, and

while turning he noticed that the indicator lights at his stop-bar control panel had changed from green to red again. This meant that the stop bars at exit 2 of Runway 06/24 were activated again, as required. Subsequently, he heard an exchange between Charlie 8 and the assistant controller, which he assumed to be the report from Charlie 8 that the runway was vacated. He looked at the assistant controller for confirmation, but the assistant controller’s back was turned to him [because] she was busy looking at the ground-radar [display] at [tower position] T7R (to her right, and to the left of the trainee at T8). He looked at his approach-radar [display] and noticed that the ‘window’ for the departure of Delta [Flight] 39 was still available but about to expire;

- “In the belief that Charlie 8 and the tow had already crossed the runway, he cleared Delta [Flight] 39 for takeoff. When, some 20 seconds later, Delta [Flight] 39 reported [rejecting] takeoff, his first thought was that there had to be a technical problem with the aircraft and that the aircraft probably would require assistance. He said in a loud voice in the tower that there was an ‘alert’ because of [a rejected] takeoff of a [B-767] on Runway 24;
- “[The controller at T6] looked at the ground-radar [display] and saw that Delta [Flight] 39 had slowed down to an almost complete stop, somewhere in between [exit] 4 and [exit] 3 of Runway 06/24. At that moment, Delta [Flight] 39 reported that they had ‘a KLM’ [aircraft] in front of them. ... Only when Delta [Flight] 39 added that the KLM aircraft was being towed [did] he [realize] what had caused the [rejected] takeoff, and he noticed for the first time that the [airport van] and tow were crossing in the direction opposite to what he had been expecting;
- “The [tower] supervisor ... had not heard the takeoff clearance given to Delta [Flight] 39. ... He therefore was completely surprised by the ‘alert’ announcement. ... The tow was well across the runway but not yet clear [on the ground-radar display];
- “The assistant controller had been looking at the ground-radar [display] at T7R (to her right) a couple of times in order to spot Charlie 8, but had been unsuccessful. ... The screen at T7R was used by the controller (working at T8) to monitor his traffic on Runway 09 [and he had] ... adjusted the [display] in a way that ... the southernmost boundary of the [display] was just across exit 2 of Runway 06/24, which made it difficult for the assistant controller to correctly assess the situation. ... When the [tower] controller [at T6] announced the ‘alert’ and [the rejected] takeoff, [the assistant controller] was unaware that there had been a takeoff in progress on Runway 24.”

Lines of Defense Failed in Low-visibility Procedures

The report said that points at which procedural defense lines failed before the rejected takeoff included the following:

- No information was given about actual position, requested taxi route and destination when the driver of Charlie 8 first called the assistant controller. The assistant controller did not clarify these items of information and consequently passed incorrect information to the controller at T6. The misinterpretation of Charlie 8's position, taxi route and destination was not discovered before the incident;
- The controller at T6, based on the misinterpretation, pressed an incorrect button to extinguish the stop bar seen by the driver of Charlie 8. This controller, with the consent of the tower supervisor/coach, extinguished the stop bars on both sides of Runway 24 without considering the possibility that misinterpretation of Charlie 8's position would explain the apparent stop bar problems;
- The controller at T6 rechecked his ground-radar display and observed a target at the exit 2E position ... where he expected the target of Charlie 8 after crossing;
- The controller at T6 assumed that Charlie 8 was reporting clear of the runway to the assistant controller, but "Charlie 8 was informing the assistant controller that he was beginning to cross the runway"; and,
- The tower supervisor/coach "probably missed" the takeoff clearance being transmitted to Delta Flight 39 and did not intervene because "an overall picture of the traffic situation was missing" at the time.

Investigation Identifies Other Problems

The report included the following additional conclusions:

- "There are no indications that prior coordination of the tow movement between apron control and tower, as required under low-visibility conditions, took place;
- "Design and position of the control panels for stop bars and traffic lights are not unambiguous and therefore [are] prone to human error;
- "The nonuse of checklists during the [airport runway] changeover ... resulted in an initially wrong setup for the stop-bar control panel in relation to the controller duties. This reinforced [the controllers'] doubt about the correct functioning of the system instead of realizing

their misunderstanding [about] the position and movement of the tow;

- "The supervisor/coach failed to adequately supervise the tower operations in general and did not timely intervene to prevent the incident; [and,]
- "The staff on duty was not working as a team."

The Dutch Transportation Safety Board said that the probable causes of the incident were the following:

- "Low-visibility weather conditions, which prevented [ATC from] visually [identifying] vehicles on the ground;
- "Inadequate information during the radio communications between [the] tow (yellow van) and tower;
- "Misinterpretation of position and movement of the tow;
- "Takeoff clearance [issued] without positive confirmation that the runway was unobstructed; [and,]
- "Insufficient teamwork and supervision."

Recommendations Target Devices, Human Factors Problems

The report contained the following safety recommendations (designating the responsible organization in parentheses at the end of each recommendation):

- "Technical facilities with regard to the protection of runway exits at Amsterdam Airport Schiphol should be identical to allow standard procedures for all runway crossings ([particularly] so with regard to exit 2 of Runway 06/24). In the meantime, movements to/from S apron, other than by taxiing aircraft, should not be allowed during low-visibility weather conditions). In this connection, it is recommended to follow up ICAO Annex 14 standards as soon as possible (Amsterdam Airport Schiphol);
- "Refresher training [on] procedures and radio communication should be provided to ATC tower staff and [other] employees (Air Traffic Control and Amsterdam Airport Schiphol);
- "A tower supervisor should not have additional duties (Air Traffic Control);
- "Checklists should be used when changing the [runway] configuration (Air Traffic Control);
- "The control panels for stop bars and traffic lights should be redesigned and integrated geographically to avoid

any ambiguity (Amsterdam Airport Schiphol and Air Traffic Control);

- “Add a logging device to the existing ground radar (Air Traffic Control);
- “Assistant controller positions should be equipped with a multi-mode screen (Air Traffic Control);
- “Team resource management training should be implemented for [ATC] staff (Air Traffic Control); [and,]
- “Reevaluate present coordination [procedures] and communication procedures between Air Traffic Control and Amsterdam Airport Schiphol (Air Traffic Control and Amsterdam Airport Schiphol).”♦

[FSF editorial note: This article, except where specifically noted, is based on the Dutch Transportation Safety Board Final Report no. 98–85/S–14, *N193DN, Boeing 767, 10 December 1998, Amsterdam Airport Schiphol*, January 2001. The 50-page report contains appendixes, diagrams and photographs.]

Note

1. International Civil Aviation Organization standards and recommended practices in Annex 14, *Aerodromes*, 5.3.17 “Stop Bars,” say (paragraph numbering omitted), “A stop bar shall be provided at every runway-holding position serving a runway when it is intended that the runway will be used in runway visual range conditions less than a value of 350 meters [1,148 feet], except where appropriate aids and procedures are available to assist in preventing inadvertent incursions of aircraft and vehicles onto the runway; or operational procedures exist to limit, in runway visual range conditions less than a value of 550 meters [1,805 feet], the number of aircraft on the maneuvering area to one at a time and vehicles on the maneuvering area to the essential minimum.” Section 5.13.17 says, in part, “Stop bars shall be located across the taxiway at the point where it is desired that traffic stop. ... Stop bars shall consist of lights spaced at intervals of three meters [9.8 feet] across the taxiway, showing red in the intended direction(s) of approach.”

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