FINAL REPORT

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This report has been translated into English and published by the AIBN to facilitate access by international readers. As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.
This investigation is limited in its extent. For this reason, the AIBN has chosen to use a simplified report format. The report format indicated in the ICAO annex 13 is only used when the scope of the investigation makes it necessary.

All times given in this report are local times (UTC+2 hours), unless otherwise stated.

Aircraft:		
- Type and reg.:	Boeing 737-800, TC-APH	
Operator:	Pegasus Airlines	
Radio call sign:	PGT872	
Date and time:	Sunday 23 October 2005, at time 2110	
Incident site:	Oslo Airport Gardermoen (ENGM) Norway	
ATS airspace:	Gardermoen CTR, class D	
Type of occurrence:	Air traffic incident, attempted take-off from a taxiway	
Classification:	Class 3. Major incident, according to Norwegian Aviation Regulations BSL A 1-10	
Type of flight:	Commercial, non-scheduled.	
Weather conditions:	Gardermoen METAR 2050 hrs.: 36006KT 9999 FEW019 SCT025 BKN130 00/M01 Q1008	
Light conditions:	Dark	
Flight conditions:	VMC	
Flight plan:	IFR	
No. of persons on board:	Unknown	
Injuries:	None	
Aircraft damage:	None	
Other damage:	None	
Crew:	Commander	First Officer
- Sex/age:	Female, 38 years old	Male, 43 years old
- Licence:	ATPL-A (Turkish)	CPL-A (Turkish)
- Flying experience:	Total 6,744 hours. Last 30/7/3/1 days: 78/32.5/19/4.5 hours.	Total not reported. Last 30/7/3/1 days: 78.5/14/14/4.5 hours.
Air Traffic Controller:		
- Sex/age:	Female, 37 years old	

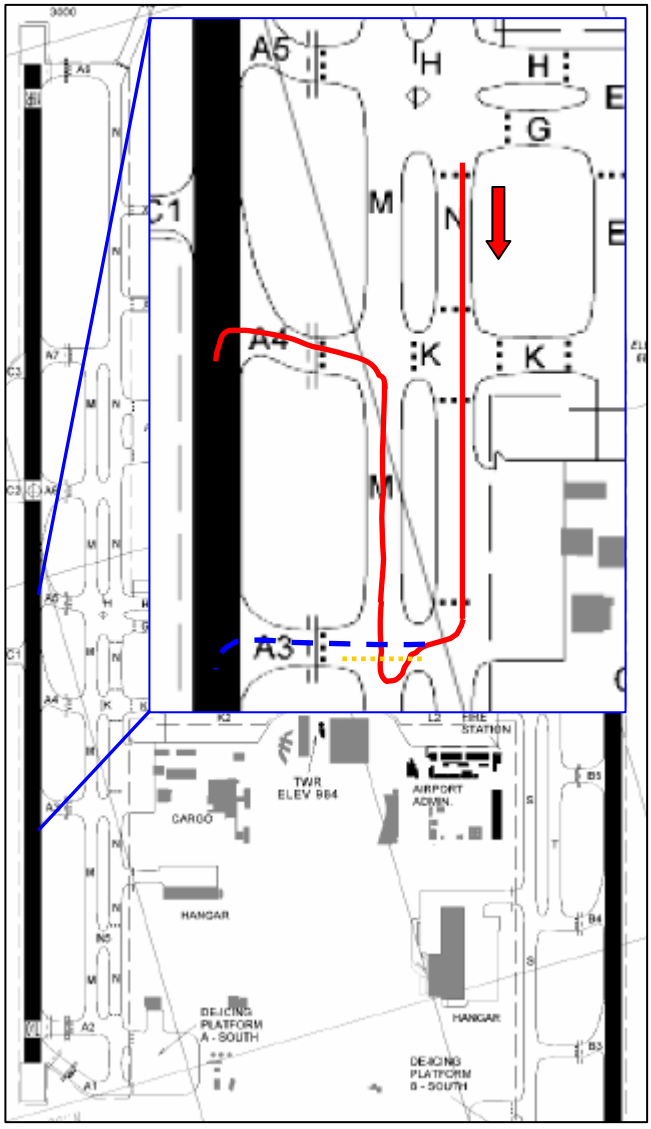
- Licence: December 1996
- Authorised: March 2001
- Ratings: ADI, ADV, APP

Sources of information: Report from Gardermoen Air Traffic Services, commander's report, and AIBN's own investigations.

FACTUAL INFORMATION

TC-APH, a Boeing 737-800 operated by Pegasus Airlines, was carrying out the airline's flight PGT872 from Oslo Airport Gardermoen (ENGM) to Antalya (LTAI) in Turkey. The scheduled departure time was at time 2100, local time and the departure runway (RWY) in use was 01L. A "Notice to airmen" (NOTAM) had been issued for RWY 01L: *"A1 and A2 clsd, RWY 01L TORA 3200M via A3 and backtrack. RWY 01L not available for landing*". The crew was aware of this and the commander was strongly focused on using the available runway from intersection A3.

The crew taxied, in accordance with their clearance, in a southerly direction on taxiway (TWY) N (see map). The commander was pilot flying (PF) and the first officer was responsible for radio communication with Air Traffic Services. There was also a third pilot in the cockpit who had newly joined the airline and was being trained. He had no other tasks than to observe. While taxiing in a southerly direction on TWY N the crew was given clearance for take-off on RWY 01L via intersection A3. The first officer acknowledged this with the flight's radio call sign, and the air traffic controller followed up with clearance to taxi in a southerly direction on RWY 01L, if necessary. The crew had calculated that the runway available from A3 was sufficient for take-off. The stated TORA in AIP for RWY 01L from A3 is 2,696 metres. The red line on the map shows the aircraft's movement. The data source is the airport ground radar.



In her report, the commander says that when they were given clearance for take-off and turned to the right towards A3 she increased the engine rpm slightly and lit the landing lights. She then saw the yellow dashed line across TWY M, south of A3 which marks the intermediate holding point. The commander writes:

"When I saw the yellow dash lines on the left on taxiway, because of the notam, I misinterpreted the lines as if I am aligning on the runway centreline".

The commander had a strong focus on the crew making an intersection take-off and that the available RWY was shorter than normal. She knew that the part of the runway to the south of the aircraft was closed, and interpreted the yellow dashed line as a marking of the closed part of the RWY. There and then, this seemed logical to the commander because it "coincided" with the NOTAM. The commander has flown to many different airports in many countries, and claims to be used to ground conditions not always being in accordance with ICAO standards. An airport operator marking a closed part of the RWY in this way was considered absolutely possible by the commander. In hindsight, the commander has no problems in understanding the actual function of this line.

From this point in time, the commander was mentally on the "runway" and, as clearance for take-off had already been given, the take-off procedure was initiated. Because the available runway was shorter than normal, the commander took the aircraft all the way down to the yellow dashed line on TWY M (which she now believed to be the RWY) before turning north to ensure that there was no available runway behind the aircraft. In the control tower, this turn was understood as being the crew turning south on TWY M and the air traffic controller thought that the crew was continuing to taxi southwards here. The air traffic controller therefore called the crew: "*Confirm you are entering runway now, seems like you are turning onto Mike". Continue right turn, right turn and then left again to enter the runway"*. The first officer responded "turning right".

When the right turn had been completed, and the nose of the aircraft pointed towards the north on TWY M, the commander pressed the TO/GA button and the aircraft accelerated to reach take-off speed. The air traffic controller immediately understood what was about to happen when she heard the strong increase in engine rpm. She called the crew immediately: "*hold position, you are on taxiway Mike*". The commander says in her report: *" I immediately disconnected the autothrottles, closed the thrust levers and braked just slowly to reduce the speed, almost 80 knots it was"*. Because the commander had focused on take-off and the conditions in front of the aircraft when the right turn was completed, she did not notice the illuminated sign "A3, 01L – 19R" which was positioned to the left of the aircraft at the stop line between TWY M and the RWY.

With this acceleration and braking, the aircraft quickly reached intersection A4, 400 m north of A3. The air traffic controller wanted to turn the aircraft to the right here and back on TWY N so that the crew could make a new attempt at take-off via A3. The air traffic controller gave the turn instruction, but the turn was not performed. The first officer said "Alpha 4". Instead of a right turn the crew turned left towards RWY. PGT872 was the only aircraft in the immediate area, so the air traffic controller gave clearance to enter the RWY via A4 and taxi southwards via RWY. This was performed and the crew took off to the north after having received new clearance for take-off.

PGT872 was alone on TWY N and TWY M. There was no other traffic on the RWY. DLH4WN taxied west on TWY H and had reached the intersection between TWY H and N at the time that the crew of PGT872 turned left onto RWY at A4. The air traffic controller of GND N instructed DLH4WN to hold short of TWY M just before PGT872 turned off onto A4 and was allowed to continue just afterwards without having to stop. TWY M runs from A2 to A7 and is significantly shorter than the western runway. The crew started acceleration for take-off from A3. From this point the distance to the northern end of TWY M is 1,601 m.

The commander had flown to Gardermoen on several previous occasions. The first officer has his pilot training and experience with military aviation, and had flown civil aircraft for less than one year. The commander and first officer had met previously, but this was their first flight together. Both had attended the company's CRM training, as they are required to do five times per year. Apart from operational communication, the conversation between them was characterised as polite

chat. In the opinion of the commander they got on well together. The commander has reported that the "atmosphere" in the cockpit was calm. During the ground stop at Gardermoen, which lasted approx. an hour, the commander did not leave the aircraft. The first officer only left the aircraft for a walkaround inspection. The third pilot, who was being trained, had civil aviation training, and had recently completed courses and simulator training. He had been employed by the company for approx. two months, and this was his second flight. His role in the cockpit was only to observe. The company had not equipped him with charts, NOTAM or other information regarding the flight and it was not expected that he should participate or otherwise intervene during the flight.

The commander has stated that the flight was not characterised by being rushed. They had left around the planned departure time, and she had no appointments/plans after landing. The following day was a day off, and she had no particular plans. She claims that there were no conditions that influenced her ability to concentrate during taxiing.

The air traffic controller on duty of TWR W was authorised in Gardermoen tower March 2001. Before that she had worked as an air traffic controller at Oslo APP in Røyken from the time she received her licence in December 1996. Playback of the recording of the radio communication shows that the air traffic controller spoke very fast (120 – 220 words per minute).

The incident took place in the dark, and the airport lighting was an important aid for the crew. When visibility is good, all of the taxiways at Gardermoen have equal distance between the centre line lights, i.e. 30 metres on straight stretches. TWY N is part of the standard taxi route in low visibility procedures and TWR can turn on more lights to halve the distance between the centre line lights. TWY N and M therefore have different lighting, although this was not activated at the time of the incident, since visibility was good.

The air traffic controllers in the TWR adjust the intensity of all runway lights as necessary. The centre line lighting on TWY, runway warning lights (wig-wags) and red stop light arrays at the intersections are connected and are adjusted simultaneously in steps 100%, 30% and 10%. Under good visibility conditions during darkness, the intensity of the centre line lights and wig-wags are set at minimum (10%) and the stop line lights are turned off. The yellow intermediate holding point lights would be turned off. RWY lighting is also set at low intensity when visibility is good. These lights are very directional in the direction parallel to the RWY. At low intensity, the RWY edge lights are barely visible when you look at the RWY perpendicular to its length.

The taxiways at Gardermoen do not have blue edge lights with the exception of C1, C2 and C3 between the GA terminal and western RWY.

The control system for the RWY lighting has no recording function showing which intensity has been in use at any given time, or which lights have been turned on or off.

ICAO's Annex 14 contains international standards for airport design. The report states the following concerning runway lighting:

> *5.3.9.7 Runway edge lights shall be fixed lights showing variable white.*
>
> *5.3.9.8 The runway edge lights shall show at all angles in azimuth necessary to provide guidance to a pilot landing or taking off in either direction.*
>
> *5.3.12.7 Runway centre line lights shall be fixed lights showing variable white from the threshold to the point 900 m from the runway end; alternate*

red and variable white from 900 m to 300 m from runway end; and red from 300 m to the runway end….

5.3.16.6 Taxiway centre line lights on a taxiway other than exit taxiway and on a runway forming part of a standard taxi-route shall be fixed lights showing green with beam dimensions such that the light is visible only from aeroplanes on or in the vicinity of the taxiway.

5.3.16.12 ***Recommendation*** *– Taxiway centre line lights on a straight section of a taxiway should be spaced at longitudinal intervals of not more than 30 meters, except that:*

a) .....

b) .....

c) on a taxiway intended for use in RVR conditions of less than a value of 350 m, the longitudinal spacing should not exceed 15 m.

5.3.16.14 ***Recommendation*** *– On a taxiway intended for use in RVR conditions of less than a value of 350 m, the lights on a curve should not exceed a spacing of 15 m and on a curve of less than 400 m radius the lights should be spaced at intervals of not greater than 7.5 m. This spacing should extend for 60 m before and after the curve.*

5.3.17.1 Taxiway edge lights shall be provided at the edges of a runway turn pad, holding bay, de-icing/anti-icing facility, apron, etc. intended for use at night and on a taxiway not provided with taxiway centre line lights and intended for use at night, except that taxiway edge lights need not be provided where, considering the nature of the operations, adequate guidance can be achieved by surface illumination or other means.

5.3.17.2 Taxiway edge lights shall be provided on a runway forming part of a standard taxi-route and intended for taxiing at night where the runway is not provided with taxiway centre line lights.

5.3.22 Runway guard ligths

Note – The purpose of runway guard lights is to warn pilots, and drivers of vehicles when they are operating on taxiways, that they are about to enter an active runway. There are two standard configurations of runway guard lights as illustrated in Figure 5-27

5.3.22.1 Runway guard lights, configuration A, shall be provided at each taxiway/runway intersection associated with a runway intended for use in:

a) runway visual range conditions less than a value of 550 m where a stop bar is not installed; and

b) runway visual range conditions of values between 550 m and 1 200 m where the traffic density is heavy.

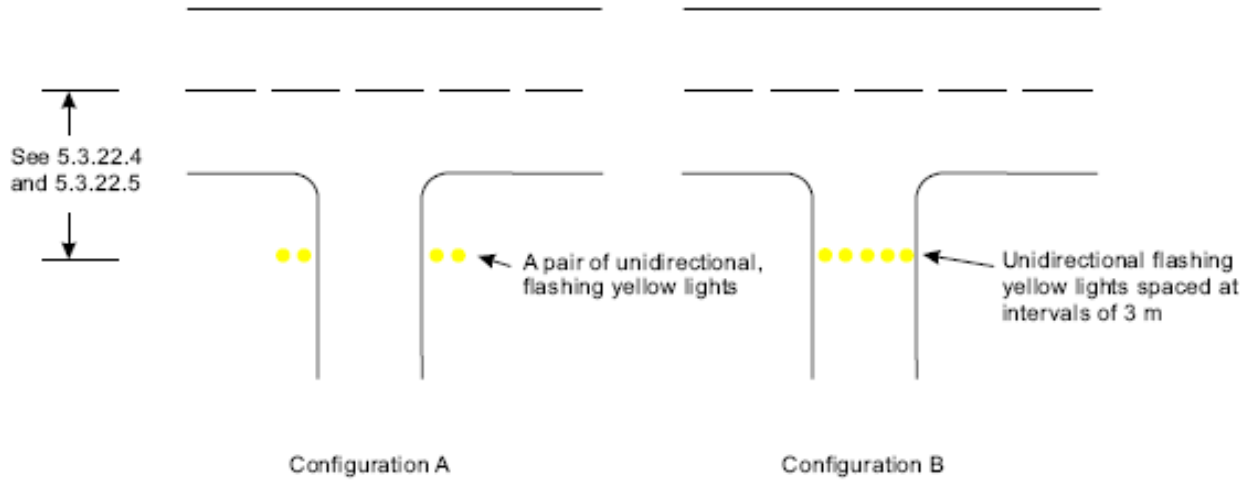


Figure 5-27. Runway guard lights

The RAAS (Runway Awareness & Advisory System) is available as a software upgrade to EGPWS Mk V and Mk VII. The system contains a database of runways (not taxiways) at all airports registered in RAAS and compares the aircraft's GPS position with runway positions at the relevant airport. Gardermoen is registered in this database. The system provides an aural alarm “On Taxiway” if the aircraft's speed exceeds 40 kts when an aircraft is not on the runway.

To illustrate lighting of taxiways and the runway in use at the time of the incident, the AIBN has made photos and enclosed them with this report. The pictures are taken from 4 m above surface. They do not represent a reconstruction, as there is not enough information available from the incident. Further the pictures were taken during a Nordic summer night and ambient light is therefore artificially made darker using underexposure. Lights were set at 10%, as is common during darkness in good weather. On the picture taken from TWY A3, intersection TWY N, runway guard lights are barely visible, halfway between the instruction signs and taxiway centre lights.

COMMENTS FROM THE ACCIDENT INVESTIGATION BOARD

The AIBN considers that the most important cause for the incident is found in human factors of the crew. The commander was experienced, with almost 7,000 flying hours, but came into a situation where she misinterpreted the standard ICAO markings so that they "coincided" with her impression that she was on the RWY. The AIBN has not been successful in finding a clear reason for this. According to the commander, there were no personal matters affecting her concentration or awareness. The commander states that the atmosphere in the cockpit was calm and relaxed. There were three qualified commercial pilots in the cockpit. The AIBN considers, like the company, that one could not expect the third pilot to react. Good CRM between the commander and First Officer shall, among other things, lead to co-operation to reveal errors before they have an impact. It is the opinion of the AIBN that this crew's CRM has not been sufficiently good. One possible reason why the First Officer did not point out what the commander was in the process of doing may be that he did not discover it, but very different levels of experience could have affected the authority gradient and thereby influenced the course of events.

OSL has chosen to use the opportunity offered in ICAO Annex 14 not to mark taxiway edges with blue lights. It is possible that blue edge lights would have contributed to reducing the probability of misunderstanding, although this is not certain. The commander commenced take-off on a paved path having clear green centre line lights, which a runway never has. No runway lit in accordance

with Annex 14 exists without edge lights, but edges of the path on which the commander accelerated were unlit. The type of lighting and the colour of the lights were evidently not sufficient to make the commander doubt her own decision.

AIBN has not been successful in gaining access to the aircraft's take-off mass or number of passengers, and has therefore not carried out any real calculation of required RWY distance. According to Janes All The World's Aircraft, a Boeing 737-800 at MTOM requires a RWY distance of 2,100 m for take-off at sea level and with an air temperature of 30 °C. Available distance on TWY M from A3 was 1,601 m, the air temperature was 0 °C and the wind was from straight ahead. If the aircraft was not fully loaded, the crew would probably have been able to complete a take-off, but it would not have been a safe operation. The risk of rolling off the end of the taxiway at almost take-off speed was definitely present.

The crew were given clearance for take-off while taxiing south on TWY N. It is the opinion of the AIBN that the probability of the incident occurring would have been reduced if take-off clearance had been given at a later stage (also commented on in SL Report 39/2004). Without take-off clearance, the commander would not have pressed the TO/GA button after line up on TWY M. In such case, the commander's misunderstanding would have been detected while the aircraft was stationary. There was little traffic at the time of interest, and AIBN understands that it was practical for the air traffic controller to give clearances early, since it was clear at an early stage that take-off clearance could be given. If the flight had been cleared for "line up and wait" or "taxi to holding point A3" first, and then given clearance for take-off, the incident would probably not have occurred. Splitting a clearance in this way could be made even more explicit by using the lights in the stop bar to indicate cleared/not cleared to enter the runway. It is the opinion of the AIBN that more powerful lights in the wig-wags and a lit stop bar at A3 would have reduced the probability of misunderstanding by the commander, because the lights would have attracted attention and made it clear that the aircraft had not yet reached the runway. The AIBN makes two recommendations regarding these conditions.

It is known to the AIBN that a similar practice has been adopted at Auckland International Airport on New Zealand. There, clearance for take-off is not given before the air traffic controller can visually confirm that the aircraft is in a correct take-off position on the runway. When visibility is poor, a person is positioned on the field to watch the aircraft, communicating a visual confirmation to the air traffic controller. This arrangement was established after repeated incidents were aircraft crew confused the runway and a parallel taxiway.

Norwegian Aviation Regulations BSL G 5-1 Aeronautical telephony procedures, § 10, part 2 b) prescribes a rate of speech not to exceed 100 words per minute. Exact pronounciation and correct phraseology contributes to reducing the possibility of misunderstandings. It is known to the AIBN that Gardermoen TWR has focused on this in its "Operational Info no 20/05", dated 27. October 2005.

As far as RAAS is concerned, it is the opinion of the AIBN that, in this case, it would not have prevented the commander believing that she was on the runway. The system could have made her aware of what was about to happen, so that the attempted take-off could have been aborted even if the air traffic controller had not discovered that acceleration of the aircraft had begun.

SAFETY RECOMMENDATIONS [1]

At airports where taxiways run parallel to the runway, there is a risk that air crews become confused and try to use a taxiway for take-off. The AIBN recommends that Avinor considers implementing a procedure where take-off clearance is not issued before the air traffic controller has verified that the aircraft has passed a point where the only remaining possibility for departure is on the intended runway. (SL Recommendation 31/2006)

At Oslo Airport Gardermoen, Norway, intensity of runway guard lights and taxiway centre line lights are adjusted simultaneously. This results in runway guard lights being subdued to low intensity during periods of good weather conditions during darkness, and their conspicuousness is partly lost. The AIBN recommends that the airport operator, OSL, installs a separate light intensity control for runway guard lights. (SL Recommendation 32/2006)

[1] The Ministry of Transport and Communication ensures that safety recommendations are presented to the aviation authority and/or other relevant ministries for consideration and follow-up. Cf. the regulation concerning official investigation of aviation accidents and incidents in civil aviation, section 17.

On TWY A3 at intersection TWY N.

On TWY A3 at the holding point for RWY 01L.

On TWY M at intersection TWY A3.

On RWY 01L at intersection TWY A3.