# The unknown risk of a flash flood

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# The unknown risk of a flash flood

Presentation overview:

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2. Aim
3. Description of the Event
4. Analysis
5. Investigation
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# Introduction

# Introduction

- Complex relationship of climate change, global warming and extreme weather events
- One consequence is the increased risk of flash floods
- Flash floods
  - sudden and intense floods
  - within minutes of heavy rainfall and storms
  - rapid melting of snow or ice
- Significant unknown challenges impacting
  - airport operations
  - flight schedules
  - infrastructure
  - overall safety

# Aim

# Aim

- To reveal the consequences of flash floods on aviation operations
  - by demonstrating the facts of a real incident
  - the subsequent investigation carried out

- Presentation of a TUI fly Belgium B737-700 incident "*Collision with obstacle on runway after landing*", where the aircraft suffered damage after hitting debris upon landing onto OUD RWY 13 (September 2nd 2023).

# Archive

- December 24th 2013
  - Airbus A330 (G-VNYC), Virgin Atlantic
  - From Tobago (TTCP) to St Lucia (TLPL)
  - After 35’ holding (due to weather), approach and landing on a flooded runway, the aircraft veered to the left but was kept on the runway

# Description of the Event

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- Flight: TB7242, from LFQQ (LIL) to GMFO (OUD), Oujda airport (evening flight).
- Aircraft Information:
  - OO-JAO, B737 – 700 NG
- Actual weather reported to the crew:
  - Wind 050°10kts, Clouds: Overcast 500ft
  - Temp.: 17°, Vis.: 8000m
- Just after touch down on Rwy13 at GMFO (OUD) Oujda airport, the flight crew noticed an object looking like a large branch or small tree just left of the centerline.
- After impact, a scraping noise was heard for a few seconds.

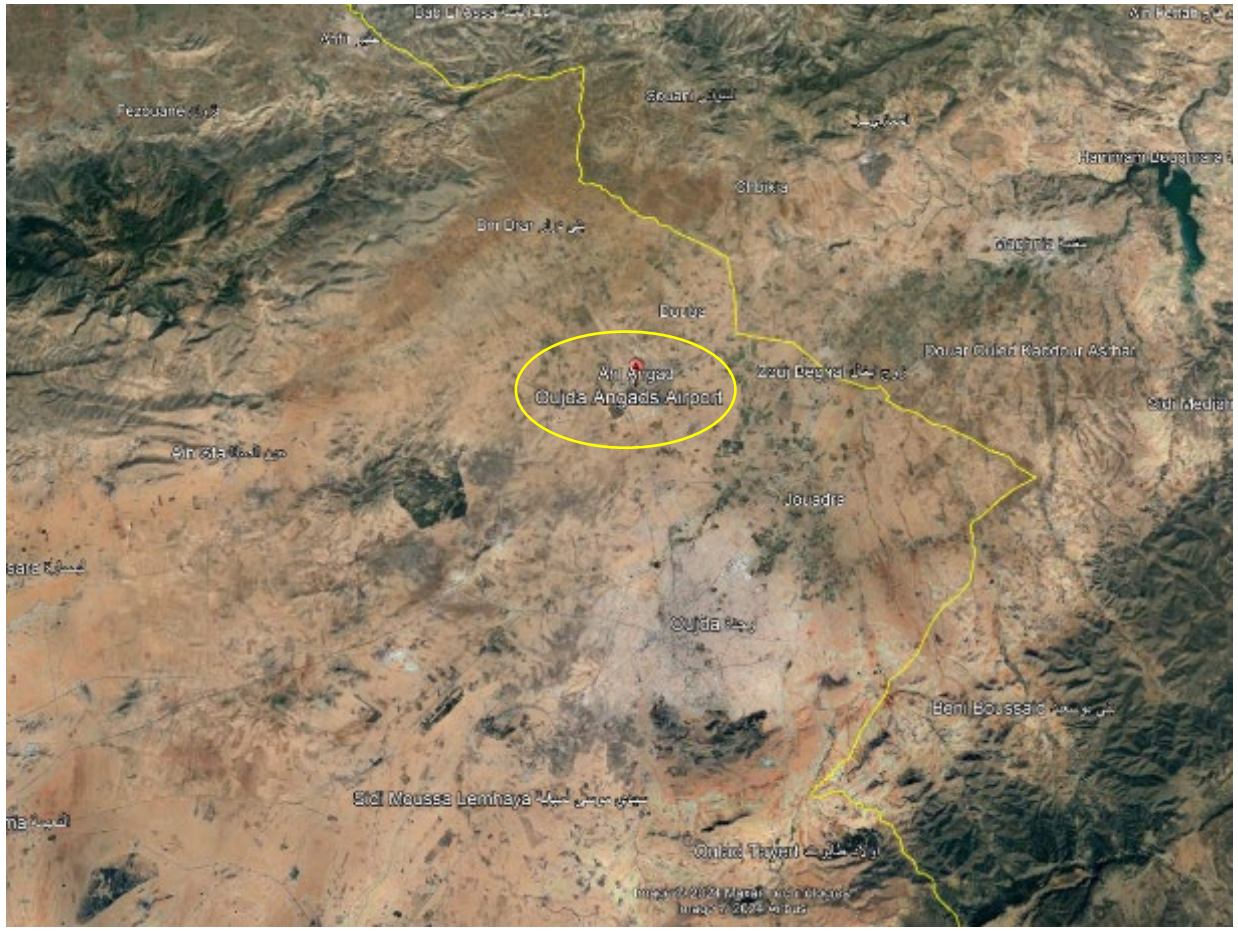
# Description of the Event

- During roll out, several master caution lights and non-normal indications popped up in the cockpit.
- After coming to a full stop, the crew decided to shut down the engines and ask for a technical inspection (on the runway) followed by a tow towards the apron.
- Damage occurred to the aircraft, debris and dirt on the runway seemed having caused the damage.

# Analysis

# Analysis

## Airport lay out



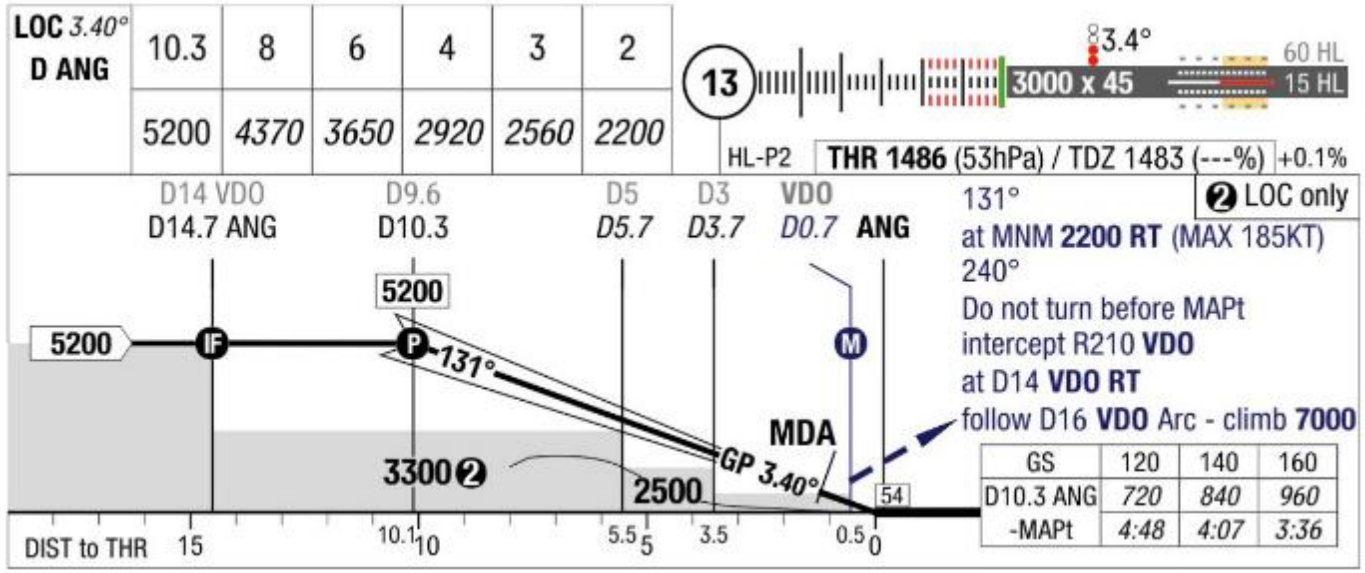


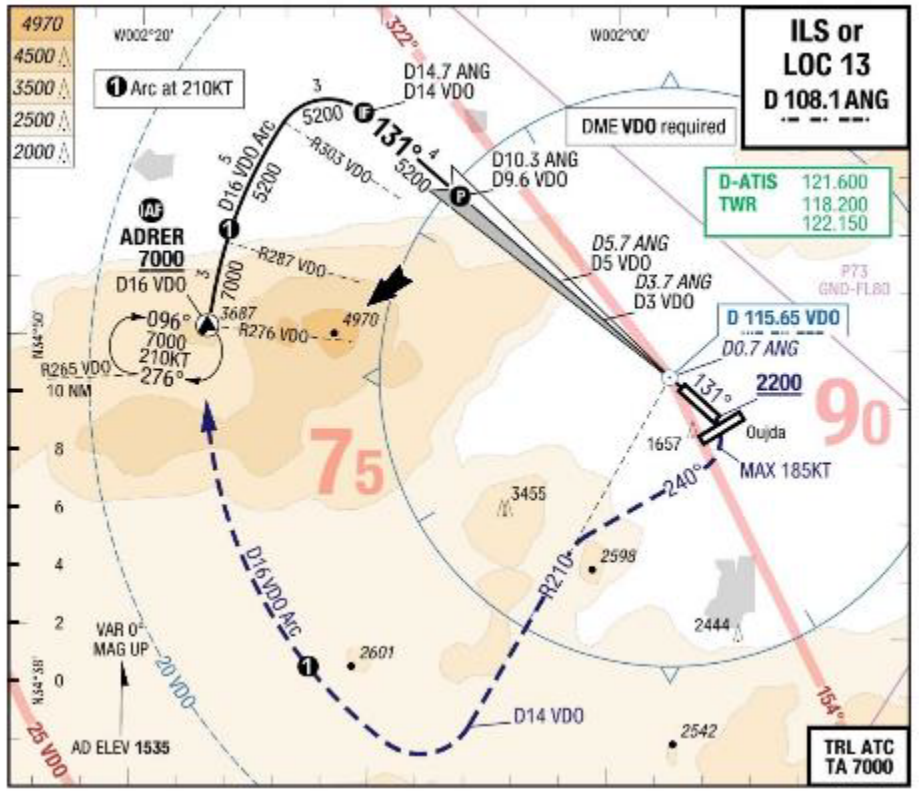
OUD airport is situated in the northeast of Morocco, located near mountains that separate Morocco from Algeria.

# Analysis

## Final approach

- Steeper glide (3.4°)
- IMC

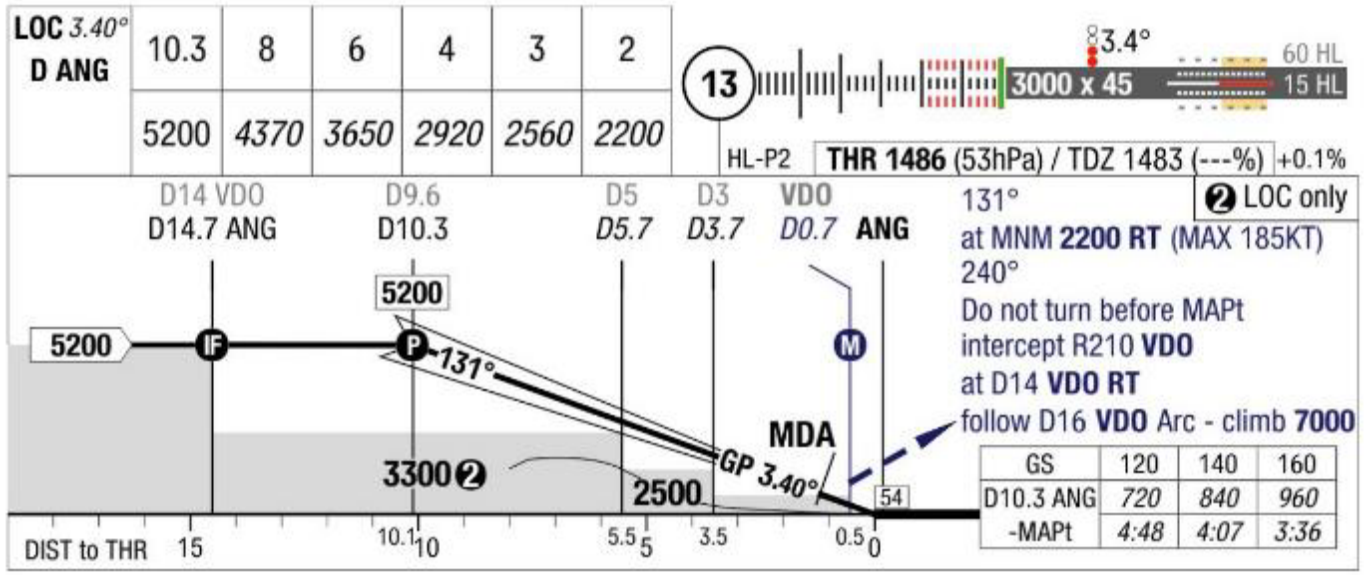


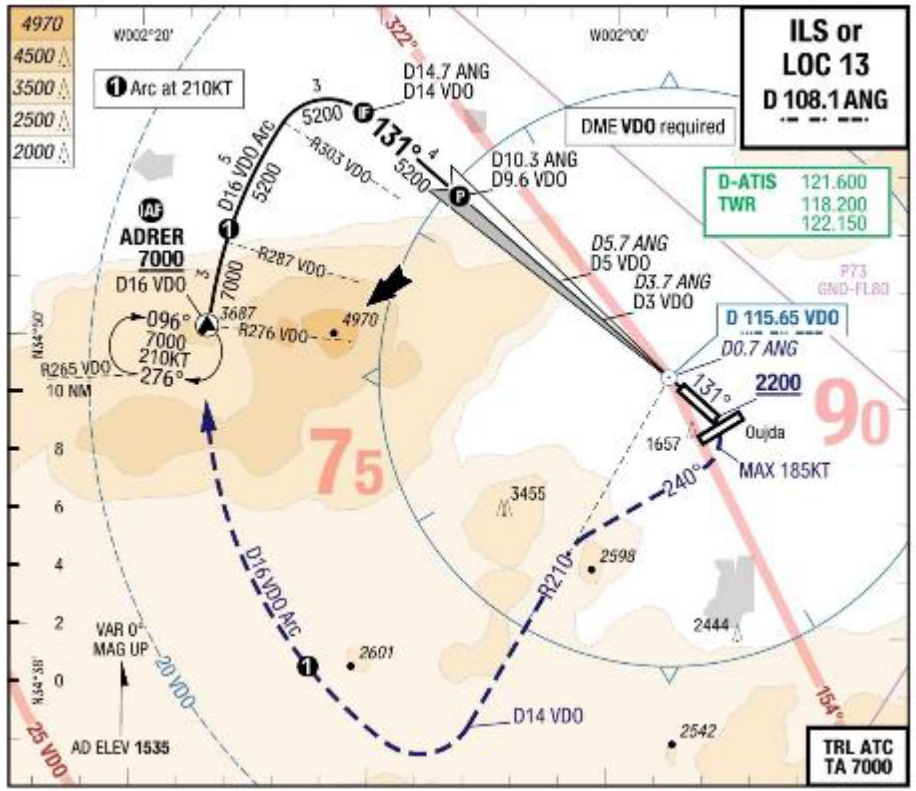



# Analysis

## Visual segment

- Runway became visible at about 500ft.
- Visibility below the cloud base was good.
- Runway lights partially U/S.
- Wind was light and steady from the northeast (050/10)



# Analysis

## Touchdown and landing roll

- Normal touchdown, obstacle observed just left of the centerline.
- A scraping noise was heard for a few seconds, deceleration was stronger than normal with autobrakes 2 selected.
- Directional control, braking and thrust reverser operation observed as normal.
- Normal engine parameters.

# Analysis

## Landing roll until full stop on the runway

- Several amber caution lights came on, aft cargo fire warning.
- Aircraft stopped on the runway just before taxiway V, appropriate calls to ATC and cabin were immediately performed.
- The cargo fire warning stopped by itself, a test proved the system was functional and working properly.
- The cabin crew reported all normal.

# Analysis

## Full stop, emergency services on the spot, decision for towing onto a parking stand

- Assistance vehicles approached the aircraft, APU started and engines shut down.
- The fire brigade reported a visible fluid leak (syst B).
- On the stand, pax disembarked via bridge.
- Found twigs, pieces of wood and other debris in the inboard leading edge devices, trailing edge flaps and all wheel wells.
- Main wheel well flooded with brown watery mud.
- A significant amount of water/mud was also present in both cargo holds, especially aft, causing damage to the pax luggage.
- Damage to the RH horizontal stabilizer leading edge.
- Several antennas on lower fuselage damaged.

# Investigation

# Investigation

## Observations after the Event

Operational visit at OUD airport after the event:

- The drainage system can process the excess of water under normal circumstances.
- At the time of the event, an enormous amount of water had come down from the mountains, in addition to the water that was caused by heavy rainfall.
- Concrete walls and pavements appeared to be demolished.

# Investigation

## Observations after the Event

- The airport and surroundings drainage system could no longer absorb this amount of water.
- A massive amount of water caused a flash flood over the runway just before our landing aircraft (21:43 UTC).
- The perimeter wall was destructed close to the touchdown point of RWY 13.

# Investigation

## Timeline

- Two aircraft landed ahead of the TUI flight
  - Royal Air Maroc at **21:17 UTC**,
  - Air Arabia at **21:35 UTC**.
- These aircraft did not report any problems.

- The Airport authorities carried out RWY 13 inspection checks;
  - at **19:50 UTC** after the first rainfall and
  - at **21:25 UTC.**

  All checks did not reveal anything particular, only some water patches were observed.
- Our plane (OO-JAO) landed at **21:43 UTC,** 8 minutes after the Air Arabia and reported that it had hit a piece of wood.

# Investigation

## Risk Assessment

| Severity \ Probability | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
|---|---|---|---|---|---|---|---|
| S6 | C21 | C27 | B33 | A45 | A57 | A69 | A89 |
| S5 | D15 | C19 | C23 | B29 | B35 | A48 | A61 |
| S4 | E10 | D12 | D14 | C19 | C26 | B35 | B44 |
| S3 | E6 | E8 | E10 | D13 | D18 | C23 | C28 |
| S2 | E3 | E5 | E7 | E9 | E11 | D13 | D15 |
| S1 | E1 | E2 | E3 | E4 | E5 | E6 | E7 |

The Event Probability : P2 (Rare)
The Event Severity : S5 (Hazardous)
The overall Risk Level : Medium (C19)

| | | |
|---|---|---|
| A | EXTREME (45-89) | MANAGE URGENTLY |
| B | High (29-44) | MANAGE URGENTLY |
| C | Medium (19-28) | MANAGE ACTIVELY |
| D | Low (12-18) | MONITOR & REVIEW |
| E | Minimal (1-11) | MONITOR & RECORD |

# Conclusion

# Conclusion

- The root cause of the event can be described as a “flash flood”.
- Debris and dirt were carried on the runway by a large flow of water that caught all parties involved by surprise.
- This was caused by heavy rainfall during the day.
- The amount of water was too much for the airport drainage system to handle.
- A runway inspection took place at 21:25z and found RWY 13 operational.
- OO-JAO landed at 21:43z and sustained substantial damage from dirt and debris.

# Conclusion

- OUD airport is a fairly dark place at night, a flooded runway is very difficult to see from the cockpit during the (final) approach phase.
- We are convinced that the airport authorities were overwhelmed by events.
- The investigation reveals that the flash flood must have happened a few minutes before landing.
- *Note*:
  - The crew acted in a very professional way, during all phases of this event.
  - The adamage was repaired and the aircraft was put back into service.

# Flooded airport building

# Recommendations

# Recommendations

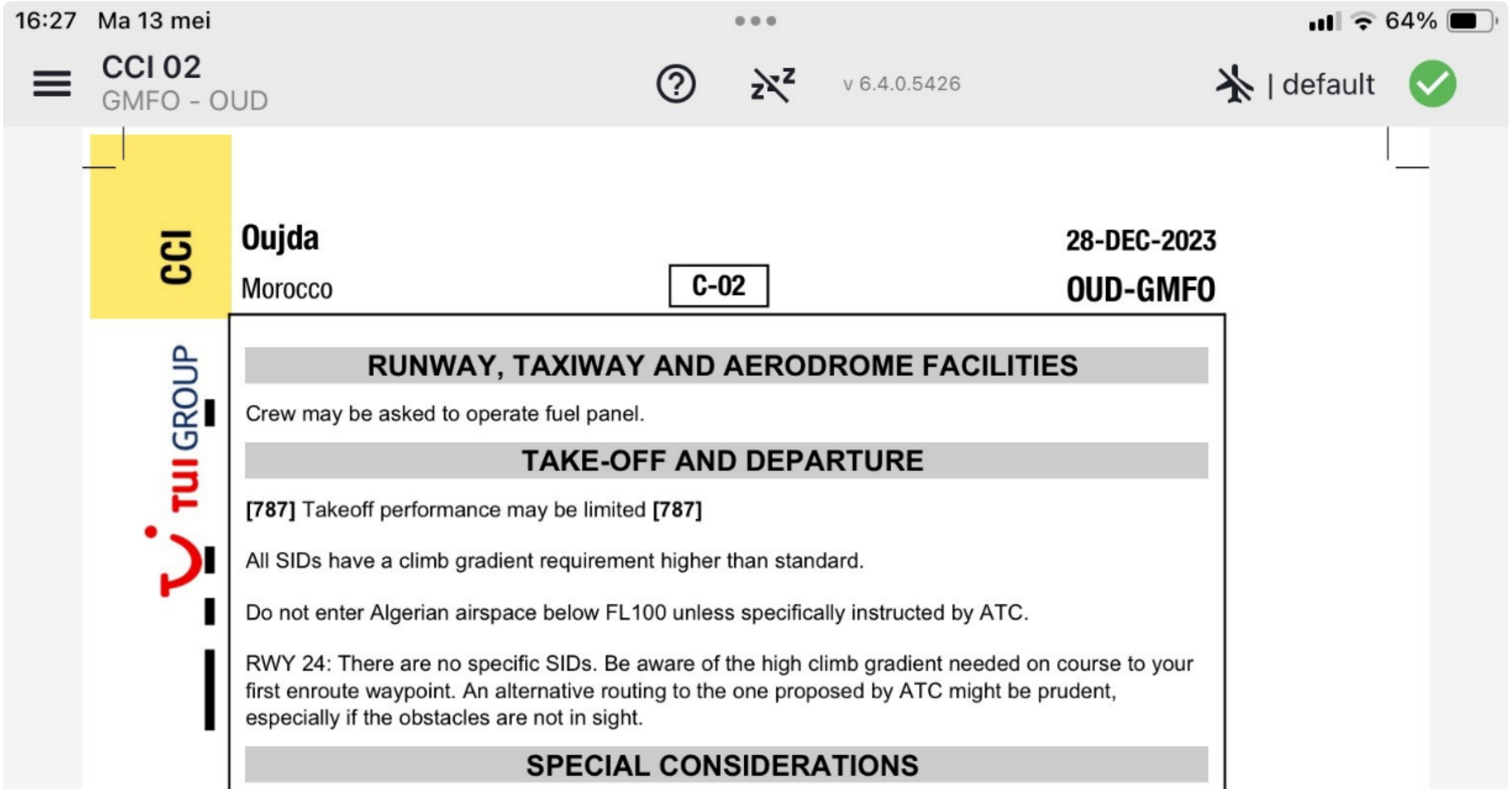
***Recommendation I***

***Accurate runway information must be available to pilots including the flash flood risk information on particular airports.***

***Recommendation II***

***Airport authorities must consider the risk of flash flood and develop precautions and adapt emergency response plans accordingly.***

# Recommendation I



Flash Flooding

- There may be a delay of up to 2 hours between heavy percipitation in the area and flash flooding affecting the aerodrome.
- No aerodrome flashflood warning system installed.
- Not all of the aerodrome is visible to ATC.
- In case of recent heavy precipitation, request a visual inspection of the runway.
- Be attentive to runway/taxiway conditions and surrounding area.
- At night or with reduced visibility and (recent) precipitation, pay special attention to area's where the RWY or TWY lights are inoperative, as this may be a sign that that area is flooded. If the area of affected lights is in the vicinity of RWY 13 TDZ do not land.
- Runway 13/31 crosses a (dry) riverbed, prone to flashfloods, situated under the last white touchdown zone marking of RWY 13 (i.e. at the end of the touchdown zone).
- If during night operations, runway lights (runway edge and/or center lights) show a gap, especially near the end of the touchdown zone of runway 13, do not land on RWY 13.
- If in doubt, request a runway inspection. Be aware that conditions can change in a matter of minutes.
- In case of uncertainty about flashflood status, especially with (recent) heavy precipitation nearby, divert to the alternate airport.

Changes: Flash Flooding Information added.

# THANK YOU

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