REPUBLIC OF RWANDA

Ministry of Infrastructure

Aviation Accident and Incident Investigation Division

Report on the serious incident to Airbus A330-300 with registration 9XR-WP, operated by RwandAir, involving an off-runway landing at Kigali International Airport, May 13th 2019

Ref AAID 2019-01

The sole objective of investigations carried out by the AAID is the prevention of accidents and incidents. It shall not be the purpose of such an investigation to apportion blame or liability.

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List of abbreviations used in this report

AIP	Aeronautical Information Publication
AMT	Aircraft Maintenance Technician
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATPL	Air Transport Pilot License
BECMG	Becoming, trend indicator used in weather forecasts
BGF	Bangui M'Poko International Airport
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DA	Decision Altitude
DFDR	Digital Flight Data Recorder
EBB	Entebbe International Airport
ft	feet
hPa	hectoPascal, unit for barometric pressure
HRYR	ICAO four letter identifier for Kigali International Airport
ICAO	International Civil Aviation Organisation
ILS	Instrument Landing System
KGL	Kigali International Airport
kts	Knots: nautical miles per hour (one NM equals 1.852 m)
MET	Meteorological
METAR	Meteorological Aerodrome Report
MSL	Mean Sea Level
NM	Nautical mile (1.852 m)
NOSIG	No significant change expected (used in weather forecasts)
NOTAM	Notice To Airmen
QAR	Quick Access Recorder
RA	Rain (used in weather forecasts)
RNAV	aRea NAVigation
RWY	Runway
SOP	Standard Operating Procedure
SPECI	Special weather report

TAF	Terminal Aerodrome Forecast
TEMPO	Temporary, trend indicator used in weather forecasts
TS	Thunderstorm (used in weather forecasts)
TSIB	Transport Safety Investigation Board
UTC	Universal Time Coordinated

Synopsis

The investigation into this serious incident is about the off-runway landing that occurred to flight WB 913, conducted with an Airbus A330-300, during landing at runway 28 of Kigali International Airport in daylight conditions on May 13th 2019. Visibility was impaired by heavy rain showers in the final approach path. Shortly before landing the aircraft veered to the right. As a result the right-hand main gear touched down on the grass area next to the runway shoulder and travelled outside the paved surface for approximately 475 meters before reaching the runway.

The off-runway landing resulted in shattering of a total of 11 runway edge lights, damage to all eight main wheels and some minor damage to the lower aft left fuselage of the aircraft. No one was injured.

The Aviation Accident and Incident Investigation Division (AAID) became aware of this serious incident immediately after its occurrence by telephone calls from both the airport authorities and the operator. Based on this preliminary information the AAID started an investigation in accordance with the provisions of the Rwanda Civil Aviation Regulation, Part 19, without delay.
The sole objective of the investigation of an accident or incident under this Regulation is the prevention of accidents and incidents. It shall not be the purpose of such an investigation to apportion blame or liability.
Within 48 hours after the incident the AAID received formal notification letters from the Airport Authorities and the operator.

The investigation has revealed, amongst others, shortcomings in supplying of weather information to the flight crew and significant Crew Resource Management issues related to multi-national crew operations.

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 General

Flight WB 913 on May 13th 2019 was a charter flight from Bangui M'Poko International Airport (BGF), Central African Republic, to Kigali International Airport (KGL), Rwanda. The flight was conducted with an Airbus A330-300 carrying the registration 9XR-WP. Flight WB 913 departed from BGF at time 09:39[1] and arrived at KGL at 11:48.

The cockpit crew consisted of the Captain and the First Officer (F/O). During the approach and landing at KGL the Aircraft Maintenance Technician (AMT), responsible for line maintenance activities and the technical release of the aircraft, was seated on the jump seat slantly behind the F/O's position. The F/O was Pilot Flying on the stretch from BGF to KGL until final approach, where after the Captain took over controls for the landing at KGL.

The cabin crew consisted of the Purser and seven additional cabin crew members.
Apart from the cockpit crew, the AMT and the cabin staff, also four Air Marshals, a Loadmaster and a Loader travelled on the flight.

Earlier that day the same crew had operated the 9XR-WP aircraft on the stretch from KGL to BGF as flight WB 912. Flight WB 912 departed KGL at 05:01 and arrived at BGF at 07:25.
Flight WB 912/WB 913 was conducted to enable exchange of 270 military staff members involved in a United Nations peacekeeping mission in the Central African Republic.

[1] All times are indicated in UTC. Local time in BGF is UTC+1; local time in KGL is UTC+2.

1.1.2 Operation of flight WB 912/913 until the approach to Kigali

From interviews with the Captain, the F/O, the Purser and the AMT it transpired that the operation of flight WB 912 from KGL to BGF had been uneventful.
To prevent the need for refuelling at BGF, flight WB 912 was dispatched from KGL with a total block fuel of 30.300 kgs. This amount of fuel allowed for the stretches KGL-BGF-KGL including the required taxi, trip, contingency, final reserve and alternate fuel.
Flight WB 912 landed on runway 16 of BGF at 07:12. For the F/O it was his first flight to BGF. He indicated that for runway 16 at BGF no RNAV approach[2] and no ILS glide path were available.

Flight WB 913 departed from BGF at 09:39 with 18.800 kgs of fuel, which was 720 kgs more than the minimum required fuel. The operation of flight WB 913 was uneventful until commencement of the approach to runway 28 at KGL.

1.1.3 Initial approach at KGL

When nearing KGL the crew briefed and prepared for an ILS approach for runway 28 with the F/O as Pilot Flying. At that stage the weather information for KGL that was available to the crew indicated a visibility of more than 10 km with a wind of 5 kts from variable directions with no significant change expected.

At time 11:34 the crew actually saw the heavy rain showers in the approach path for runway 28.
When assessing the heavy rain showers, both by looking outside and checking their weather radar system on board, the crew discussed the option to hold, thus delaying the approach to await better weather conditions.

Apart from the fuel required for diverting to the planned alternate Entebbe International Airport (EBB), the available fuel allowed for 15 to 16 minutes of holding at KGL. Based on this figure the Captain decided to continue the

[2] During an RNAV approach use is made of a pre-programmed approach profile in the Flight Management System of the aircraft in combination with global satellite navigation.

approach and confirmed to the F/O to conduct a go-around when the runway would not be visible upon reaching the Decision Altitude (DA)[3] of 5078 ft[4].

At time 11:36 the Captain asked Air Traffic Control (ATC) about the condition of the runway in view of the weather, whereupon ATC informed flight WB 913 of the wind being 140/13[5], followed by the statement: "visibility is ok … oh rain". Subsequently the Captain restated to the F/O to perform a go-around in case the runway would not be visible when reaching the Decision Altitude.
From time 11:41 ATC informed WB 913 twice about the rain now having reached the touchdown zone of runway 28.
When the F/O asked for selecting the gear down, the Captain raised the option to delay the approach "a few minutes" in view of the weather. Shortly thereafter it was confirmed to continue the approach until the Decision Altitude and to perform a missed approach procedure "if we don't see anything".
In view of a possible windshear due to the shower activity, the crew decided to use Flap Three for approach[6]. Further the autobrakes were selected to 'Medium'.

1.1.4 Final approach

During final approach to runway 28 flight WB 913 was established on the ILS with both autopilots engaged.
When issuing landing clearance at 11:43, ATC informed flight WB 913 again about rain in the touchdown zone. At that stage the wind was given as 160/14, meaning a tailwind component of 7 kts and a crosswind from the left of 12 kts.
During the interviews both the Runway Controller and the Tower Supervisor indicated that they had switched on both the approach and runway lighting in view of the poor visibility in the final approach path due to the showers.

[3] The decision altitude (DA) is a specified lowest altitude in the approach descent at which, if the required visual reference to continue the approach (such as the runway markings or runway environment) is not visible to the pilot, the pilot must initiate a go-around.
[4] Since the elevation of the touchdown zone at KGL is 4875 ft above Mean Sea Level (MSL), a Decision Altitude of 5078 ft equals a height of 203 ft above the runway surface.
[5] A landing on runway 28 with a wind from direction 140 degrees at a speed of 13 kts means 8 kts of crosswind from the left and 10 kts of tailwind.
[6] 'Flaps Three' instead of 'Flaps Full' results in a higher approach speed, allowing for better climb-out performance in case of a go-around manoeuvre to avoid a windshear.

At 11:44 the Captain asked ATC to switch on the lights, whereupon the crew in the ATC Tower turned up the lighting to its maximum intensity. 30 secs later the Captain announced to have visual reference stating “lights ahead … wait, you have the field”.
Five seconds later the Decision Altitude was reached whereupon the F/O announced “Go-around”, since he had, according to his statement, insufficient visual reference with the runway to continue the approach. During the interviews the F/O stated that when he announced “Go-around” the Captain had placed his hand on the throttles[7].

The interviews, the CVR readout and the Flight Data analysis all confirmed that from that moment on the Captain took over control from the F/O, thereby disconnecting both auto pilots and continuing the approach.
On the CVR transcript this phase of the flight is documented as follows:

UTC	Captain	First Officer	Remarks
11:45:05	No no go ahead…lights ahead…wait you have the field		
11:45:10		No	System callout "Four hundred", "Minimum"
	You have the…ok		
11:45:12		Go-around	
	You have the field you have the field		
		Alright	
11:45:15			Autopilot disconnect
11:45:17		You have control	
11:45:18	Yup I have it		

Table 1: Change of control as derived from CVR transcript

[7] According to the F/O the Captain had done so twice before prior to reaching the Decision Altitude.

From the post flight conversation between the Captain and the F/O on the cockpit voice recording, as well as from the interview statements by the Captain, it became apparent that the Captain did not hear or register the call 'Go-around' from the F/O when flight WB 913 had reached the Decision Altitude.
The voice and data recordings further indicated that after the change of control from the F/O to the Captain two automatically generated 'Sink Rate' warnings were triggered at 40 ft and 20 ft Radio Altitude (RA) respectively, indicating a vertical speed in excess of 1.100 ft/min.

1.1.5 Touchdown, landing, taxi-in and parking

After the Captain had taken over the aircraft, it started to drift to the right.
Shortly before touchdown the F/O stated "Turn to the left". 11 secs after the Captain had disconnected the autopilots both main gears touched down at the height of the nominal touch down point with the right-hand main gear on the grass area at a lateral distance of 2.13 metres from the edge of the right-hand shoulder, thus 9.63 metres from the runway boundary[8].
Subsequently the right-hand main gear travelled over a distance of approximately 475 metres through the terrain alongside the runway as is illustrated by picture 2 below and the schematic overview in Appendix 1.

[8] See paragraph 1.1.6 for the relevant runway dimensions.



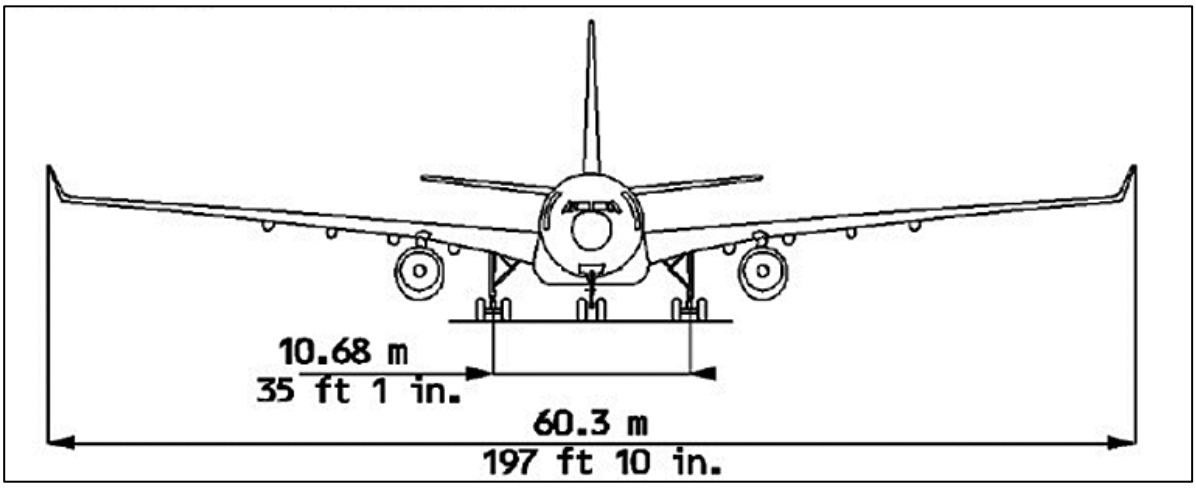
Picture 2: Track from right-hand main gear. Note: photo is taken when looking in Easterly direction.

1.1.6 Relevant runway data[9] and aircraft dimensions[10]

Runway 28 at KGL has a width of 45 meters and an available landing distance of 3279 meters. On both sides, adjacent to the surface intended for take-off and landing, the runway is equipped with paved strips, the so-called runway shoulders. Each shoulder is 7.5 meters wide, thus the lateral distance from the runway centreline to edge of the shoulder adds up to 30 meters.
The transition between runway and shoulders is marked by a broad white line.
Apart from centreline lighting, the runway is provided with runway edge lights. The armatures of these lights are located on the runway shoulders, close to the transition between runway and shoulder.

The Airbus A330-300 is equipped with a nose gear and two main gears. Each main gear has a bogie with four wheel assemblies. The lateral distance between the main gears is 10.68 meters, see picture 3 below.

[9] Additional data on the runway characteristics can be found in paragraph 1.10 'Aerodrome information'.
[10] Additional data on the aircraft can be found in paragraph 1.6 'Aircraft information'.



Picture 3: lateral dimensions Airbus A330-300

On two positions the track from the right-hand main gear deepened to 25 - 30 cm and showed spots where the soil had been heavily turned over. One of these spots can be seen on picture 4 below.
The maximum distance, as measured from the outer side of the outer right main gear wheels and the white line marking the runway boundary, was 15.7 metres as is indicated on the schematic overview in Appendix 1.
Track markings and flight data showed that the position of the nose gear, that at the initial stage of the landing roll still was up in the air[11], was initially above the grass area next to the right-hand runway shoulder.
During the landing roll the left main gear travelled over the paved surface of the runway shoulder, thereby shattering 11 runway light armatures.

Subsequently the right-hand main gear entered the paved runway shoulder at a height just passed the last touchdown zone marking as can been seen on picture 4 below.

[11] Flight data show that the nose gear landed 4 secs after the left-hand main gear touched the ground. See also paragraph 1.11 'Flight Recorders'.



Picture 4: Track from right-hand main gear entering the runway. Note: photo is taken when looking in Westerly direction.

During the remaining landing roll no further problems occurred. Flight WB 913 left the runway via taxiway Bravo to parking bay number 5.

From the cockpit voice recording it can be derived that shortly after landing the Captain expressed his concern about damage to the aircraft and to the runway lighting. He stated during taxi-in that it would have been better to make a go-around. The F/O repeatedly intervened and asked attention for the necessary actions to safely terminate the flight. After parking, after a suggestion from the F/O, the AMT who had been seated on the jump seat in the cockpit was sent outside to check on the condition of the aircraft.

At this stage it was not clear to the cockpit crew that the right-hand main gear actually had landed on the grass and not on the paved surface of the runway shoulder.

1.3 Damage to aircraft[12]

After parking it was found that all eight main gear tyres showed cuts and damage from contact with the runway edge light fixtures. The nose gear was not damaged.

Apart from the main gear tyre damage two small holes in the fairing between the left wing and the fuselage were found as well as several minor dents and scratches on the lower aft fuselage.

After the incident the landing gear and relevant flight data were inspected by specialists from Airbus Industries. The applicable serviceability statement indicated that the loads on the right-hand main gear had been within design limits. Therefore the aircraft could be kept in service provided repairs to a brake rod from the right-hand main gear were made within 30 days after the incident.

1.4 Other damage

In addition to the 11 shattered runway edge light fixtures, the edge of the runway shoulder showed damage at the position where the right-hand main gear reached the paved surface of the runway shoulder, as illustrated by the picture 5 below.

[12] This report follows the paragraph numbering according to Appendix 1 of ICAO Annex 13. Paragraphs numbers that are not listed, are not applicable to this investigation.



Picture 5: Damage to the edge of the right-hand shoulder of runway 28.

During a visit to the incident scene 9 days after the incident the loose pieces of asphalt had not been removed or secured.

1.5 Personnel information

The cockpit crew of flight WB 913 consisted of a Captain and First Officer. Both were qualified to fly A330-300 aircraft and had a valid medical certificate.

1.5.1 Captain

Age:	57
Licence type:	Airline Transport Pilot
First date of issue:	5 June 2007 in USA[13]
Valid until:	18 Aug.2019
Medical certificate valid until:	7 Nov. 2019
Total flying experience	13.157 hours
Total flying experience with the operator	2.590 hours
Total flying experience on type	365 hours

1.5.2 First Officer

Age:	48
Licence type:	Airline Transport Pilot
First date of issue:	23 Nov. 2008 (USA)
Valid until:	30 July 2019
Medical certificate valid until:	23 Oct. 2019
Total flying experience	7.644 hours
Total flying experience with the operator	178 hours
Total flying experience on type	2.075 hours

[13] During the interview the Captain declared that his first ATPL license was issued in 1992 by FAA USA. Since this license was lost, it was re-issued on 5 June 2007.

1.6 Aircraft information

Manufacturer	AIRBUS
Type	A330-343
Registration	9XR-WP
Engines	TRENT 772B-60 (#1 ESN: 42756 & #2 ESN: 42757)
Date of manufacture	30 Nov. 2016
Certificate of airworthiness	Date of issue: 29 Nov. 2018 Date of expiry: 30 Nov. 2019
Last maintenance check	A-check, performed on May 11th, 2019

1.7 Meteorological information

1.7.1 Terminal Aerodrome Forecast

A Terminal Aerodrome Forecast (TAF) indicates the expected meteorological conditions at an airport and its environment during a specified period (usually 24 hours or 30 hours).

During their flight preparations prior to departure at KGL the crew of flight WB 912/913 was supplied with a TAF, that is incorporated in Appendix 2. This TAF indicated light rain with a chance for thunderstorm activity between 12:00 and 15:00 UTC.

1.7.2 Meteorological Aerodrome Reports

The Meteorological Office at KGL issues a Meteorological Aerodrome Report (METAR) every 30 mins. Pilots can access the METAR's during their flight, besides the METAR's are displayed on the computer screens at the Approach and Tower stations of Air Traffic Control and at the Flight Dispatch office of the operator.

General information on METAR's

Other than TAF's, METAR's indicate the actual weather situation on the aerodrome itself and do not reflect the conditions in the direct environment of the airport. When no significant change in the weather conditions is expected within two hours of its issuance, the METAR will end with 'NOSIG', meaning 'no significant change expected'. When a significant change of the weather is foreseen within two hours, the NOSIG code will be replaced by the trend identifier BECMG ('becoming') or TEMPO ('temporary'), followed by a coded message on the nature and duration of that change.

The METAR that was issued 15 min prior to the landing of flight WB 913 is listed below.

METAR HRYR 131130Z 07005KT 020V100 9999 FEW020CB BKN025 25/18 Q1019 NOSIG[14]

The above METAR indicates light North Easterly winds, a visibility of more than 10 km, a lowest cloud base of 2.000 ft and cumulus type clouds covering approximately 75% of the sky. This METAR, as well as the preceding METAR's in the hours before landing of flight WB 913 all ended with 'NOSIG', meaning that no significant changes in the weather conditions at KGL were to be expected.

Next to regular METAR's special reports (so-called SPECI's) are being published when there is a significant deterioration or improvement in airport weather conditions.

Ten minutes after the above mentioned METAR, thus at time 11:40, a SPECI was issued, indicating 'light rain' at KGL airport. This SPECI also ended with NOSIG, meaning 'no significant change expected' in the next two hours.

[14] See Appendix 2 for a full decoding of this METAR.

1.7.3 Automatic Terminal Information Service

Next to METAR's the MET Office in Kigali controls the Automatic Terminal Information Service (ATIS).

ATIS provides automatically generated messages that are continuously broadcasted via a VHF radio channel. The ATIS messages supply the actual weather conditions at the aerodrome in a fixed format as well as information on specific operational circumstances. Pilots are expected to check the current ATIS message prior to departure or landing as applicable.

The two ATIS messages[15] that were applicable to the crew of flight WB 913 prior to landing at KGL, issued at respectively 11:00 UTC and 11:30 UTC, indicated light winds, a visibility of more than 10 km and no precipitation. Both ATIS messages ended with NOSIG, meaning that no significant changes in the weather conditions were to be expected.

The first ATIS message[16] that was broadcasted after the landing of flight WB 913 indicated south-easterly winds of 8 kts and a visibility of 8 km with thunderstorm showers. Also this ATIS message ended with the NOSIG designator.

1.7.4 Wind speed data

The wind velocity as derived from the latest ATIS message and as reported by ATC when issuing landing clearance to flight WB 913 indicate winds from an easterly or south-easterly direction at a speed of maximum 14 kts.

The flight data readout[17] indicate an increase of the windspeed from 18 kts to 40 kts during the last 15 ft of Radio Altitude (RA) prior to touchdown.

[15] See Appendix 2 for a transcript of these ATIS messages.
[16] See Appendix 2 for a full transcript of this ATIS message
[17] See also paragraph 1.11.1

1.7.5 Weather radar and windshear alert systems

The KGL Meteorological (MET) Office was equipped with a comprehensive weather radar system that supplies detailed information on (the severity of) shower activity at and around the airport.

Both the aircraft and the MET Office were equipped with a windshear alert system that generates a warning in case of sudden changes in wind direction and/or wind speed. During the approach phase of flight WB 913 no windshear alerts from either system were triggered.

1.9 Communications

During the interviews with the ATC controllers who were on duty during the approach and landing of flight WB 913 and after visiting KGL Approach and Tower Control, it became apparent that the ATC stations are not equipped with a weather radar system. To inform flight crews about changing weather conditions controllers must therefore rely on telephone communication with the MET Office and, for ATC Tower, their own visual observations.

1.10 Aerodrome information

As indicated in paragraph 1.1.5 Kigali International Airport is equipped with one runway (RWY) in the direction 10/28.
RWY 28 is used for landing, while RWY 10 is used for take-off. To this respect the Rwanda Aeronautical Information Publication (AIP) states:
"RWY 10 is not allowed for landing, except with ATC authorisation". No approach procedures for RWY 10 are published.

According to ICAO standards RWY 28/10 is a Category 4 runway. Such runways should be equipped with a so-called 'strip' area next to the runway in which no obstacles or drains are present that can cause damage to an aircraft accidentally running off the runway[18]. ICAO further documents that the strip for a Category 4

[18] Reference: ICAO Annex 14, paragraph 3.4.6.

runway should extend up to 100 m, measured from the runway centreline, on either side of the runway.
During field investigation following the off-runway landing of flight WB 913 it was found that the strip area North of RWY 10/28 contained a large uncovered drainage ditch at a distance of approximately 60 - 70 m from the centreline.

RWY 28 is equipped with an Instrument Landing System (ILS) Category I installation. In conformity with the requirements for an ILS CAT I installation, the runway is provided with runway edge lights that are spaced 60 m apart. ICAO standards do not allow ILS CAT I operations during night-time with two or more consecutive illuminated edge lights missing.
Following the off-runway landing of flight WB 913 no NOTAM[19]on the degraded ILS status because of the missing runway edge lights was issued. After sunset ATC did not inform the crews of incoming flights about the deficient runway edge lighting.
During the night following the off-runway landing sufficient lights were repaired to meet the ILS CAT I criteria.

After the off-runway landing incident, the runway was inspected by a RAC employee. The debris from the shattered edge lights was removed where after landing operations on RWY 28 were continued.
From the interview with the responsible engineer from the Rwanda Airport Authorities (RAC), it transpired that the decision to suspend or continue runway operation after an incident or accident rests with the Airport Operational Team. It was stated that the applicable procedures on runway operations and the role of the Airport Operational Team were documented in the Aerodrome Manual. Despite a repeated request a copy of this manual was not made available to the investigation team.

[19] NOTAM: A notice to airmen (NOTAM) is a notice containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations (definition from ICAO Annex 11).

1.11 Flight recorders

1.11.1 Flight data

The 9XR-WP aircraft was equipped with a Quick Access Recorder (QAR) that registers more data than the Digital Flight Data Recorder (DFDR). Analysis of QAR data is done on a regular basis by an external provider as part of the flight data management programme from the operator.

For the investigation of the WB 913 off-runway landing all relevant flight data were available.

From this data the following chronological listed facts on the final approach and landing transpired:

- Until disconnect of the autopilots flight WB 913 was fully stabilised on the ILS approach path of RWY 28.
- The Captain disconnected both autopilots at 179 ft above aerodrome level.
- Time between autopilot disconnect and touchdown was 11 secs.
- The vertical speed during the final approach phase was high. Below 100 ft above aerodrome level flight WB 913 continued descending with more than 1.000 ft/min. This resulted in two automatically generated 'sink rate' warnings at 40 and 20 ft Radio Altitude.
- From 15 ft Radio Altitude till touchdown the wind speed increased from 18 kts till 40 kts.
- During the last seconds before touchdown the Captain applied large and contradictory roll inputs (ranging from 16.5 degrees to the right till 12.4 degrees to the left) as well as a large right-hand rudder input of 19 degrees.
- Both main gears touched down within the same second at 11:45:26; the nose gear touched down 4 secs later at 11:45:30.
- With all landing gears on the ground, the heading of the aircraft reached 263 degrees.
- Left rudder input was used to bring the aircraft back to the centreline of the runway.

1.11.2 Voice data

After the incident the Cockpit Voice Recorder (CVR) of flight WB 913 was removed from the aircraft and taken to the Transport Safety Investigation Board (TSIB) of Singapore for readout. The TSIB offered swift and comprehensive support. For the investigation of the WB 913 off-runway landing all cockpit voice data between time 11:30:58 and 11:53:52 were transcripted. This timeframe covers the relevant part of the approach, the landing, taxi-in and after parking phase.

Paragraph 1.1.4 "Final approach at KGL" comprises the part of the transcript that reflects the change of control from the F/O to the Captain and the subsequent disconnect of the autopilots. Apart from paragraph 1.1.4, other relevant information from the cockpit voice recording is incorporated in the paragraphs 1.1.3 "Initial approach at KGL" and 1.1.6 "Touchdown, landing, taxi-in and parking".

1.17 Organisational and management information

1.17.1 Standard Operating Procedure for initiating a go-around

The applicable Standard Operating Procedures (SOP's) from the operator's Flight Crew Techniques Manual indicated that the crew must consider to perform a go-around when adequate visual references are not obtained at minima or are lost below minima. The applicable manuals further indicated that the F/O, when performing the Pilot Flying duties, has the authority to call for and initiate a go-around without awaiting consent from the Captain. The standard call to do so is: "GO-AROUND – FLAPS".

1.17.2 Standard Operating Procedure for transfer of control

The applicable Standard Operating Procedure (SOP) from the operator indicated that a transfer of control requires to following callouts:

To give control: The pilot calls out "YOU HAVE CONTROL". The other pilot accepts this transfer by calling out "I HAVE CONTROL".

To take control: The pilot calls out "I HAVE CONTROL". The other pilot accepts this transfer by calling out "I HAVE CONTROL".

1.17.3 Standard Operating Procedure after 'Sink Rate' warning

The applicable SOP indicated that "The flight crew must consider to perform a go-around" when a 'Sink Rate' warning is generated during the approach.

1.17.4 Training of cockpit crew

First Officer

The F/O entered the company of the operator in November 2018 as holder of an ATPL with a type rating certificate for the Airbus A330. Before being employed his proficiency was assessed by Lufthansa in Frankfurt, Germany, followed by simulator training by an instructor from the operator at the CAE[20] training facility in Gatwick, United Kingdom. Subsequently he was given line training according to the approved Training Syllabus of the operator. Overall his line training records showed above average results.

Captain

The Captain received his type qualification training for the Airbus A330 from the Airbus Training Facility in Toulouse, France, in August 2018. Subsequently his proficiency was assessed by an instructor from the operator at the CAE training facility in Gatwick, United Kingdom. Subsequently he was given line training according to the approved Training Syllabus of the operator. Overall his line training records showed satisfactory to good results with some repeated remarks about knowledge of and adherence to Standard Operating Procedures.

1.17.5 Cockpit crew composition

At the time of the incident the operator employed 169 pilots from 48 different nationalities. The four nationality groups that hold the largest number of pilots are depicted in the table below:

[20] CAE: Originally known as 'Canadian Aviation Electronics Ltd' is a company offering simulator training facilities.

LARGEST NATIONALITY GROUPS	Nr of PILOTS
RWANDA	38
KENYA	18
NIGERIA	15
USA	6

The nationalities of the remaining 92 pilots are spread all over the world. The Captain of flight WB 912/913 originated from an African country whereas the F/O originated from the Far East.

In the international aviation sector there is broad recognition that for multi-national crew operations language proficiency and Crew Resource Management (CRM) competencies are two fundamental pillars. Next to language proficiency requirements, dealing with different English accents can be a challenge.

Multi-national crew operation also requires additional attention for inter-cultural leadership[21].

1.17.6 Language proficiency and Crew Resource Management training

Language proficiency

Typically six proficiency levels in aviation English are distinguished:

Level 1 - Pre Elementary

Level 2 - Elementary

Level 3 - Pre Operational

Level 4 - Operational

Level 5 - Extended

Level 6 - Expert

According to ICAO standards, airline pilots should acquire language proficiency level 4 or above[22]. The F/O of flight WB 912/913 held a level 4 English proficiency level, the language proficiency level of the Captain was 6.

[21] See to this respect: "Multi-national cockpit crews: threat or opportunity towards flight safety? A risk management study" by Mark Roth, City University of London.

[22] See ICAO Doc 9835.

Crew Resource Management training

The operator fulfils the requirement for Crew Resource Management (CRM) training by offering an initial training of two days followed by a yearly recurrent training of one day. Currently the training syllabus does not contain elements that are specifically focussing on multi-national crew composition and inter-cultural aspects.

The effectiveness of CRM training is considerably enhanced when supplemented by a Line Oriented Safety Audit (LOSA) programme[23].

LOSA uses trained observers to collect data about pilot behaviour and its situational context on 'normal' flights from supernumerary seats on the flight deck. Such monitoring allows the capture of data which can characterise pilot strategies for managing "threats, errors and undesirable states".

At the time of the incident the operator had not implemented LOSA.

1.17.7 Human Factors

Next to the difference in nationality and cultural background between the Captain and the F/O as mentioned in paragraph 1.17.5 above, the following human factors are significant in the chain of events leading up to the incident:

- The difference in flying experience on the Airbus A330 between the Captain (365 hours) and the F/O (2075 hours).
- The difference in flying experience within the company of the operator between the Captain (2059 hours) and the F/O (178 hours).
- Accuracy of the supplied weather information: the cockpit crew became aware about the severity of the shower activity late during the approach. The cockpit voice recording indicates that their first conversation about the unexpected heavy showers took place 12 min. before landing at KGL.
- The uncertainty in decision making on continuation of the approach: the cockpit voice recording indicates that the Captain raised and abandoned the option to hold during intermediate approach (11 min. before landing)

[23] See ICAO Doc 9803

and during final approach (3:30 min. before landing). This last suggestion to 'wait' during final approach confused the F/O.

- The F/O calling out "Go-around" at Decision Altitude without instantly performing the related actions such as advancing the power levers[24] and commanding for flap retraction.
- The Captain not registering the call "Go-around" from the F/O. During the interview the Captain stated he might have been overloaded at that moment.
- The subsequent unannounced autopilot disconnect by the Captain and subsequent non-standard change of control from the F/O to the Captain.
- The two 'sink rate' warnings at 40 ft and 20 ft RA, that did not result in initiating a go-around.

[24] During the interviews the F/O stated that when he announced "Go-around" the Captain already had placed his hand on the throttles.

2. ANALYSIS

2.1 Supplied weather information versus actual weather conditions

All parties that were interviewed during the investigation, including the Air Traffic Control (ATC) Tower and Approach Controllers, indicated that the rain showers in the final approach path were extremely heavy, resulting in significantly impaired visibility. At the time of landing of flight WB 913 the showers had just reached the touchdown zone of runway 28. There after the downpouring rain slowly passed over the runway in Easterly direction over a period of approximately 30 min.

All relevant METAR's and ATIS messages that were made available to the crew of flight WB 913 did not forecast any precipitation. Although formally spoken the METAR and ATIS messages reflect the actual conditions on the aerodrome itself only, all messages ended with NOSIG. The NOSIG code indicates that no significant changes of the weather conditions on the aerodrome are expected to occur within the next two hours.
The actual weather pattern however would have justified the use of the TEMPO designator followed by a coded indication about the approaching heavy showers that were to pass directly over the field. Furthermore it would have been appropriate when the KGL MET Office would have warned ATC and the Operational Office of the operator about the heavy shower activity close to the field[25].

Although ultimately the Captain is responsible for the safe conduct of the flight, his decision making process was hampered by the deficient information on the prevailing weather conditions at KGL. The crew was now confronted with the actual weather pattern 11 min. prior to touchdown. This left them little time to consider aspects like diverting, holding, continuing the approach as well as the consequences of a possible go-around and the remaining fuel endurance.

[25] It must be noted that the MET Office did issue a so-called 'SPECI', a special weather report. This report however indicated light rain only and was given out around the time of landing of flight WB913; it therefore was of no value to the crew.

Since both ATC Approach and ATC Tower do not dispose of a weather radar system, they were not able to accurately inform the crew of flight WB 913 about the heavy rain. In view of the dynamic and rapidly changing weather conditions that prevail within the airspace of Rwanda, availability of a weather radar system at the ATC stations would constitute a useful and safety enhancing tool.

2.2 Runway availability at Kigali International Airport

As mentioned in paragraph 1.10, RWY 10 at KGL currently cannot be used for landing. Under the circumstances that existed during the approach of flight WB 913, an approach for RWY 10 would have instigated considerable safer conditions: the visibility would then not have been impaired by the shower activity, while the landing would have occurred under headwind instead of tailwind conditions.

It therefore is worthwhile to investigate if terms can be formulated that allow the use of RWY 10 for landing in case specific meteorological conditions impose a safety risk for landing operations on RWY 28.

2.3 Human factors and Crew Resource Management aspects

2.3.1 Introduction

The sequence of events that led up to the off-runway landing shows a typical threat and error chain. The first threat to the crew was formed by the unexpected adverse weather conditions in the final approach path. This threat initially was managed by the decision to refrain from holding, thus continuing the approach without delay and to perform a go-around when inadequate visual reference would be obtained when reaching the Decision Altitude.

There are however clear indications that, while the F/O full-heartedly had adopted this decision, the Captain felt uncertain about continuing the approach. Most notably this came to light when he shortly before 'gear down' selection suggested 'to wait a few minutes'. Waiting or holding during that stage of the flight is not a standard procedure and would not have been beneficial from an

operational point of view. Therefore the suggestion to 'wait' was confusing for the F/O and constituted a threat for proper crew coordination.

2.3.2 Transfer of control

When reaching the Decision Altitude the F/O judged that inadequate visual reference with the runway prevailed. At that moment he therefore called "Go-around". According to the applicable Standard Operating Procedure he should however have announced "GO-AROUND – FLAPS".

At DA the Pilot Flying has to call either "GO-AROUND – FLAPS" or "CONTINUE". Although the Captain must have expected either of these calls from the F/O, he did not register his non-standard callout "Go-around".
The Captain's uncertainty about the earlier decision not to hold or divert but to continue the approach, as well as his concentration on outside visual cues that identified the runway, are the most probable explanation for the missed "Go-around call.

While the F/O did clearly announce "Go-around", he did not advance the thrust levers as the first action for actually initiating the go-around manoeuvre. According to the F/O, he was hampered to do so, since the Captain had placed his hand on the thrust levers. At this stage it seems that the F/O was seeking confirmation and was expecting leadership from the Captain. It cannot be excluded that the cultural background of the F/O, who originated from a country in the Far East where generally spoken respecting hierarchy is considered a virtue, played a role to this respect.

Three seconds after the call "Go-around". from the F/O the Captain disconnected both autopilots without announcement, much to the surprise of the F/O who at that stage still was controlling the aircraft. During the first interview on the evening following the incident the Captain stated he did take-over control since in his view no decision from the F/O at the descent limit had been forthcoming.

Subsequently the F/O sought confirmation from the Captain that he actually had taken over the Pilot Flying duties by asking: "YOU HAVE CONTROL" whereupon Captain responded with the non-standard phrase "Yup, I HAVE IT". It must be noted that a Captain can take over control for urgent reasons that seriously affect the safe conduct of the flight. This is however an exceptional situation, furthermore: any transfer of control should be clearly announced and confirmed according to the applicable Standard Operating Procedure, see paragraph 1.17.2.

The unannounced autopilot disconnect and taking over of control by the Captain showed deficits in his decision making process and seriously affected effective crew coordination.
As an explanation for the actions by the Captain the following factors can be distinguished:

- The special nature of the charter flight which added to his feelings of responsibility;
- His limited experience in handling the Airbus A330;
- The unexpected poor meteorological circumstances;
- Uncertainty about his decision to conduct an approach in the prevailing type of weather;
- Uncertainty about his proficiency as compared to the F/O, knowing that the F/O had considerably more experience on the Airbus A330;
- Him seeking confirmation and more assertiveness from the F/O.

Although the cockpit voice recording did not reveal that the communication between the Captain and the F/O was hampered significantly by lack of English language proficiency, their different accents will have contributed to the workload in the cockpit. In this regard it is worthwhile to refer to the study "Multi-national cockpit crews: threat or opportunity towards flight safety?"[26] that amongst others indicates:

– Language proficiency and CRM/Human Factor competencies are two fundamental pillars of flight safety in multi-national crew operations.

[26] "Multi-national cockpit crews: threat or opportunity towards flight safety? A risk management study" by Mark Roth, City University of London.

- Even when holding a Level 4 in English language proficiency[27], there might be inability to articulate more complex operational issues among crew members.
- Non-routine and time critical scenarios bear risks in terms of potential misunderstandings amongst non-native English speakers.

2.3.3 Crew Resource Management Training Programme and language proficiency

Currently the CRM training programme that is offered by the operator does not address multi-national crew or inter-cultural related aspects, nor the possible barriers in communication due to limitations in language proficiency. Incorporation of these aspects in the CRM training programme seems of fundamental importance for a company that has employed pilots from 48 different nationalities, see also paragraph 1.17.4.

The effectiveness of the current CRM training programme can be further improved by:

- Using actual case studies involving multi-national crew operation, like the WB 913 off-runway landing, during CRM training sessions.
- Addressing inter-cultural leadership aspects.
- Introducing Line Oriented Safety Audits (LOSA), as described in paragraph 1.17.3.
- Instituting a short debriefing between the cockpit crew members after every flight as a standard company procedure. During such a debriefing any crew coordination issue that came up during the flight should be openly discussed.
- Investing in improvement of the overall English language proficiency of all pilots who are being hired by the operator.

[27] As indicated in paragraph 1.17.5: The F/O held language proficiency level 4, the Captain held level 6.

2.4 Final approach and landing

As indicated in paragraph 1.11.1, only 11 secs elapsed between autopilot disconnect and touchdown. This short time span and the sudden unplanned need to the control aircraft manually resulted in an unstabilised final approach.

The aircraft drifted to the right of the extended runway centreline, with a vertical speed of more than 1.000 ft/min. The two generated 'Sink Rate' warnings at 40 ft and 20 ft Radio Altitude were a clear indication that the flight path was no longer under control and should have been a trigger to perform a go-around as yet.
To this respect the Flight Crew Techniques Manual from the operator states:
"Failure to recognise the need for and to execute a go-around, when required, is a major cause of approach and landing accidents. Because a go-around is an infrequent occurrence, it is important to be "go-around minded".
Here the safety margins of executing a go-around versus a transfer of control close to touchdown should be considered. A transfer of control under adverse weather conditions close to the ground clearly constitutes a larger risk than reverting to a well-trained and carefully designed go-around procedure[28].

It therefore is advisable that the operator pays additional attention to the need to be "go-around minded" during briefings and simulator training for its pilots.[29]

Shortly before touch down the wind speed increased to a value of 40 kts, which further aggravated the situation.
The large and at some points contradictory flight control inputs from the Captain shortly before touch down are another illustration of the instability during this stage of flight and can only in part be explained by the apparent strong gust of wind that occurred at that time.

[28] The operator indicated that pilots are trained in performing go-arounds every 6 months during their recurrent simulator sessions.

[29] In reaction to the Draft Final Report the operator has taken the following measures:

- Introduction of 'balked landing' training (training in conducting a go-around at the very last stage of the approach) during recurrent simulator sessions.
- Disseminating of a Safety Bulletin on 'Go-around Decision Making' amongst all pilots.

Subsequently both main gears touched down within the same second, the right-hand main gear landed on the grass area next to the right-hand runway shoulder and travelled some 475 m through the terrain as described in paragraph 1.1.5, and depicted in Appendix 1.

The bearing strength of the terrain next to the runway proved to be adequate to support the weight and impact forces imposed by the right-hand landing gear. On two positions however the soil from the ground track of the right-hand main gear was found heavily overturned, indicating that the right-hand main gear almost got stuck into the terrain, a situation that would seriously have jeopardised the safety of the flight.

The nose gear touched down 4 secs after the main gears. From the runway and aircraft dimensions illustrated in paragraph 1.1.6 it can be deducted that the nose gear has been floating above the grass area next to the runway. By the time the nose gear actually touched down the track of the aircraft had sufficiently turned inward to the runway to allow for a landing on the paved surface.

The absence of any damage to the nose gear is an additional indication that it landed on the paved surface rather than on the grass area, a situation that would seriously have jeopardised the safety of the flight as well.

3. CONCLUSIONS

3.1 Findings

3.1.1 The crew of flight WB 912/913 was properly licensed.

3.1.2 The aircraft held a valid maintenance release certificate.

3.1.3 Flight WB 912/913 was uneventful until the approach for runway 28 at Kigali International Airport.

3.1.4 During flight WB 913 from Bangui until final approach to Kigali the F/O was the Pilot Flying.

3.1.5 During approach of flight WB 913 to Kigali heavy rain showers in front of runway 28 prevailed.

3.1.6 All weather reports given out by the Kigali Meteorological Office that were relevant to flight WB 913 did not mention precipitation and indicated that no significant changes in the weather were to be expected.

3.1.7 The crew decided to continue the approach and to perform a go-around when needed.

3.1.8 At decision altitude the First Officer called out “Go-around” because of insufficient visual reference with the runway.

3.1.9 The “Go-around” call from the First Officer was not registered by the Captain.

3.1.10 The First Officer did not actually initiate the go-around manoeuvre.

3.1.11 Three seconds after the go-around call from the First Officer, the Captain disconnected the autopilots and took over the control of the aircraft.

3.1.12 The ‘Standard Operating Procedure’ for the transfer of control was not adhered to.

3.1.13 At a height of 40 and 20 ft two ‘Sink Rate’ warnings were generated, indicating a vertical speed in excess of 1.100 ft/min.

3.1.14 The latest wind information that was given to the crew by the Air Traffic Controller indicated a crosswind of 12 knots from the left of and a tailwind of 7 knots.

3.1.15 The Flight Data System on board of the aircraft indicated that the wind speed during the last 15 feet before touchdown increased to 40 knots.

3.1.16 Shortly before landing the aircraft veered to the right.

3.1.17 Flight WB 913 touched down with the right-hand main gear on the terrain next to the paved surface of the runway.

3.1.18 The right-hand main gear travelled through the terrain over a distance of 475 m.

3.1.19 The maximum distance between the edge of the runway and the outer tyres of the right-hand main gear was 15.7 m.

3.1.20 During the landing roll a total of 11 runway edge lights were shattered.

3.1.21 The Captain applied left rudder input to bring the aircraft back on the runway.

3.1.22 4 secs after the main gears, the nose gear touched down on the paved surface of the runway.

3.1.23 After landing all eight main wheels needed to be replaced, the nose gear showed no damage.

3.1.24 No injuries because of the incident occurred.

3.1.25 The Captain had a total flying experience of 13.157 hours, of which 365 were on the Airbus A330.

3.1.26 The F/O had a total flying experience of 7.644 hours, of which 2.075 were on the Airbus A330.

3.1.27 At the time of the incident the operator employed pilots from 48 different nationalities.

3.1.28 For multi-national crew operations adequate language proficiency and Crew Resource Management (CRM) competencies are two fundamental pillars.

3.1.29 The presence of an uncovered drainage ditch at a distance of 60 - 70 m North of runway 10/28 is not in accordance with ICAO requirements for the so-called 'strip' area next to the runway.

3.1.30 During the evening following the off-runway landing of flight WB 913 crews of incoming flights were not informed about the degraded edge lighting of runway 28.

3.1.31 Despite a repeated request a copy of the Kigali Aerodrome manual was not made available to the AAID investigation team.

4. SAFETY RECOMMENDATIONS

4.1 The Meteorological Office at Kigali International Airport is recommended to assure that submitted weather reports contain the correct trend identifier when a significant change in the weather conditions is expected.

4.2 The Meteorological Office at Kigali International Airport is recommended to pro-actively and timely inform both ATC and the operator when a significant change in the weather conditions is expected.

4.3 The Rwanda Airport Company is recommended to provide the Air Traffic Control Approach and Tower stations with a weather radar system.

4.4 The RCAA and the Rwanda Airport Company are recommended to jointly investigate if terms can be formulated that allow the use of RWY 10 for landing in case specific meteorological conditions impose a safety risk for landing operations on RWY 28.

4.5 The operator is recommended to improve the effectiveness of its Crew Resource Management training programme by:

- Using actual case studies involving multi-national crew operation, like the WB 913 off-runway landing, during CRM training sessions;
- Addressing inter-cultural leadership aspects;
- Introducing Line Oriented Safety Audits;
- Instituting a short debriefing between the cockpit crew members after every flight as a standard company procedure;
- Investing in improvement of the overall English language proficiency of all pilots who are being hired by the operator.

4.6 The operator is recommended to train their crews to be "go-around minded".[30]

4.7 The Rwanda Airport Company is recommended to assure that the so-called 'strip' area around runway 10/28 meets the criteria as laid down in ICAO Annex 14 in particular with respect to the draining ditch North of runway 28[31].

4.8 The Rwanda Airport Company is recommended to submit their approved Aerodrome Manual to the Aviation Accident and Incident Investigation Division to demonstrate documented procedures for:

- submitting Notice to Airmen in case of degraded airport facilities;
- decision making by the Airport Operational Team in case of operational disruptions.

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[30] In reaction to the Draft Final Report the operator has taken the following measures:

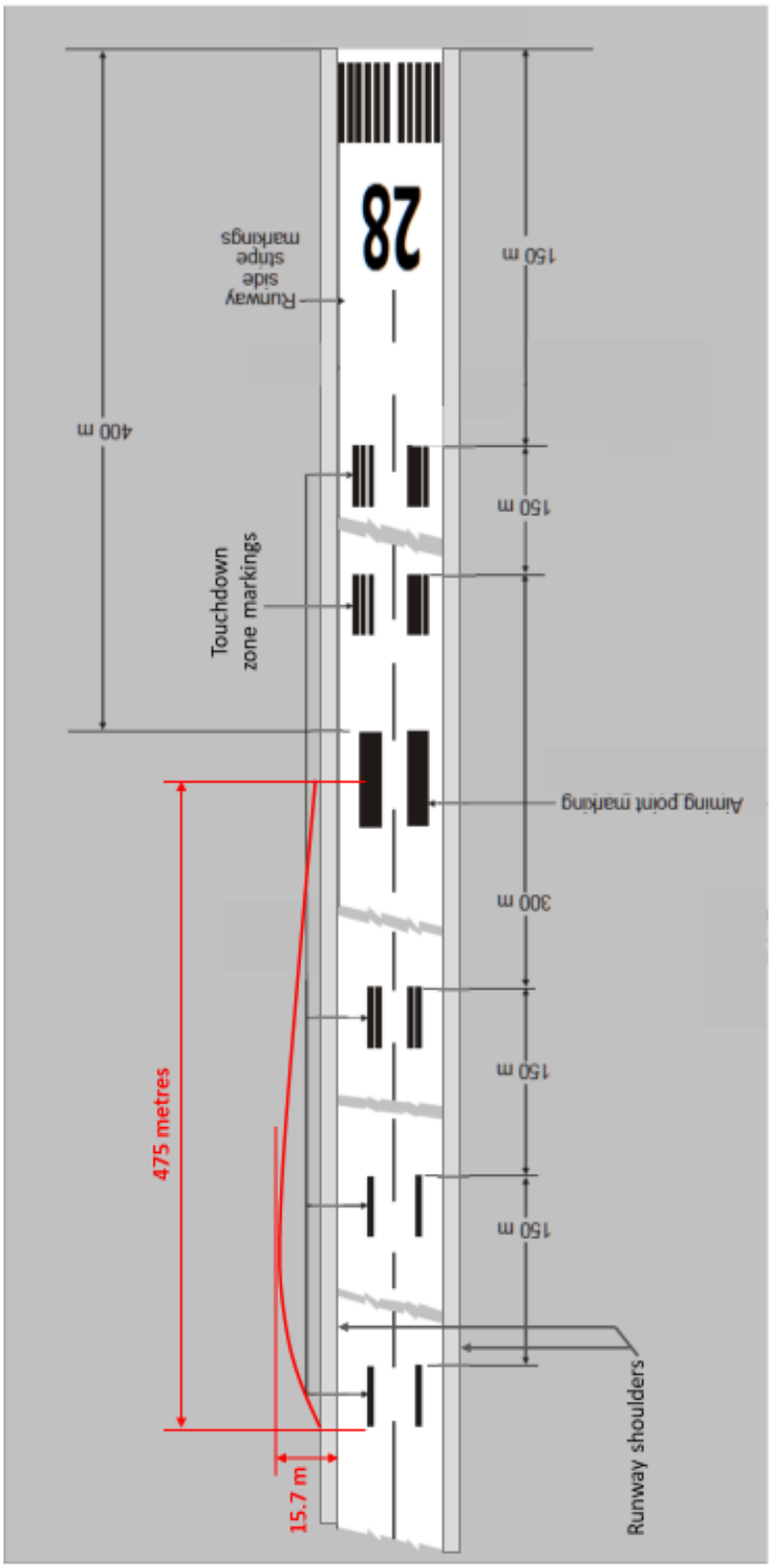
- Introduction of 'balked landing' training (training in conducting a go-around at the very last stage of the approach) during recurrent simulator sessions.
- Disseminating of a Safety Bulletin on 'Go-around Decision Making' amongst all pilots.

[31] In their comments on the Draft Final Report the Rwanda Airport Company has informed the AAID about an initiative that RAC is currently undertaking to reconstruct the strip area around runway 10/28 in order to meet ICAO Annex 14 requirements. The AAID appreciates this initiative and will monitor the progress of this reconstruction project through its recommendation implementation monitoring plan.

5. APPENDICES

Appendix 1

Schematic overview of track followed by right-hand main gear



Appendix 2: Meteorological data

App 2.1: Terminal Aerodrome Forecast (TAF) for Kigali Airport

During flight preparation at Kigali, prior to departure of flight WB 912/913, the crew was supplied with the following TAF:

```
TAF HRYR 130500Z 1306/1412 00000KT 9999 BKN025 BKN100
     FM 130900 17006KT 9999 -RA BKN025
     TEMPO 1312/1315 09012KT -TSRA FEW020CB BKN023
     BECMG 1318/1321 32004KT SCT026
     BECMG 1400/1403  SCT025 SCT100
    FM170900 17005KT BKN025=
```

App 2.2: Decoding of the Meteorological Aerodrome Report (METAR)

Below the last METAR that was issued prior to the landing of flight WB 913 is listed:

METAR HRYR 131130Z 07005KT 020V100 9999 FEW020CB BKN025 25/18 Q1019 NOSIG

The decoding of this METAR is as follows:

METAR	Meteorological Aerodrome Report
HRYR	ICAO four letter identifier for Kigali Airport
131130Z	Date: May 13th; Time: 11:30 UTC (13:30 local time)
07005KT	Wind of 5 knots from a direction of 070 degrees, thus a light wind from an Easterly direction
020V100	Direction of the wind is varying between 020 degrees and 100 degrees
9999	Visibility more than 10 km
FEW020CB	Cumulus clouds with a lowest base of 2.000 ft, covering up to 25 % of the sky
BKN025	Additional clouds with a lowest base of 2.500 ft covering 60 - 90% of the sky
25/18	Temperature 25°C, dewpoint 18°C
Q1019	Barometric pressure, referenced to sea-level, of 1019 hPa
NOSIG	No significant change in the weather conditions on the airport expected for the next two hours

App 2.3: Automatic Terminal Information Service (ATIS) messages

Relevant ATIS messages broadcasted before landing of flight WB 913:

ATIS information "Z"
1100Z
170/05 VAR 140-200
10+ km
FEW CB 20
BKN 25
23/18
1019
NOSIG

ATIS information "A"
1130Z
070/05 VAR 020-100
10+ km
FEW CB 20
BKN 25
25/18
1019
NOSIG

First ATIS message broadcasted after landing of flight WB 913:

ATIS "C"
1200Z
140/08 VAR 090-180
8 km
TS + RA
FEW 20
BKN 25
18/18
1019
NOSIG

Note: *in the above ATIS message TS stands for 'Thunderstorm' while RA is indicating 'Rain'.*

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