REPUBLIC OF RWANDA

Ministry of Infrastructure

Aviation Accident and Incident Investigation Directorate General

Report on the near mid-air collision incident involved RwandAir Flight WB 483, a CRJ 900 with registration 9XR-WH, and Ethiopian Airlines Flight ET 810, a B737-800 with registration ET-AQN, in Rwandan airspace, on 22nd January, 2022.

Ref AAID 2022-01

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

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List of abbreviations used in this report

AAID	Aviation Accident and Incident Investigation Directorate General (Rwanda)
CAA	Civil Aviation Authority
ATC	Air Traffic Controller
RA	Resolution Advisory
RAC	Rwanda Airports Company
RCAA	Rwanda Civil Aviation Authority
RCAR	Rwanda Civil Aviation Regulation
STCA	Short Term Conflict Alert System
S/N	Serial Number
TA	Traffic Advisory
TCAS	Traffic Collision Avoidance System
UTC	Universal Time Coordinated

Synopsis

On 22nd January, 2022 a RwandAir Operated CRJ 900 aircraft type, with registration number 9XR-WH using flight number WB 483[1], enroute from Bujumbura to Kigali was cleared to descend from flight level 190 to flight level[2] 110 routing direct to position GESOL. At the same time, Ethiopian airlines B737-800 aircraft type with registration number ET-AQN using flight number ET 810[3] was climbing to flight level 180 from Kigali international airport as cleared to GAVDA enroute to Bujumbura.

The WB483 informed ATC on initial contact that he was left of track of the cleared route to avoid bad weather. ATC cleared him from the position to route direct to GESOL after avoiding bad weather. The RwandAir Pilot realised that he was in conflict with the ET 810 with the possibility of collision impact and requested the controller to stop further climb of ET 810. However, the controller erroneously instructed the ET810 to stop descending and almost immediately, both aircraft experienced a TCAS Traffic Advisory (TA) followed by resolution advisory (RA). Both aircraft reacted appropriately to RA prompts with the WB 483 climbing and the ET810 descending to clear the conflict.

The incident was neither recorded in the ATC logbook according to procedure, nor was it reported to AAID as required by RCARs Part 19.

Investigation by AAID identified that the Approach Surveillance Radar system was equipped with Video and Audio Alert Systems. The Short term conflict Alert System (STCAS) was configured to activate when separation between aircraft falls below 10 nautical miles and the Audio Alert System is loud enough to draw the attention of any controller within the Tower console. Further investigation

[1] WB 483 is a RwandAir flight from Bujumbura to Kigali.
[2] Flight Level(FL) is an aircraft's altitude at standard air pressure, expressed in hundreds of feet.
[3] ET810 is an Ethiopian Airlines flight from Kigali to Addis Ababa via Bujumbura

confirmed that the radar and all related facilities were fully operational with no defect reported in the Radar Technical Log book. One possibility of averting the alerts is by muting the audio alert systems. All the Air Traffic Controllers who were on duty, at the time of incident, stated that they did not hear any form of audio alerts. The Investigation concluded that ATC inability to realise the traffic convergence in time and provide the requisite separation for the aircraft at a safe distance was due to a loss of situational awareness which continued degenerating until it finally culminated in a Resolution Advisory for both aircraft.

Both aircraft were equipped with functional and serviceable TCAS transponders. Had the TCAS in either or both aircraft been defective or non-functional, the result would certainly have been a mid-air collision with high fatalities.

This serious safety hazard could have been prevented by one or more of the following factors:

1. Proper monitoring of the Radar Screen by the Air Traffic Controller
2. Maintaining good situational awareness by Air Traffic Controller
3. Warranting that the Radar Audio Alert Systems are not muted.

Based on the investigations following this serious incident, the AAID derived seven (7) safety recommendations addressed to Rwanda Airport Company (RAC), RwandAir, and Rwanda Civil Aviation Authority (RCAA) in relation to the review and possible amendments to operational procedures.

1. FACTUAL INFORMATION

1.1. History of the Flight

1.1.1. General

Flight WB 483, conducted with a CRJ 900, registered 9XR-WH, was a scheduled passenger flight from Bujumbura International Airport in Burundi to Kigali International Airport, Rwanda on Jan. 22nd 2022.

Flight ET 810 conducted with a Boeing 737-800 with registration ET-AQN transited from Kigali International Airport to Bujumbura International Airport.

The air traffic control service was conducted by approach radar control for both WB 483 Aircraft descending and ET 810 climbing. On initial contacts, aircraft from Bujumbura to Kigali are normally cleared direct to GESOL thereby providing separation from all aircraft coming from Kigali to Bujumbura. However, on this very instance, The WB 483 was left of the route from Bujumbura to Kigali due to bad weather. The normal clearance did not provide that usual separation, rather a conflict ensued.

After clearing the weather, he was instructed by ATC to continue direct to GESOL descending to flight level 110.

The RwandAir Pilot enquired from Approach controller if there is no any possible traffic conflict. The Radar controller replied that there is no possible conflict. After a while, The WB 483 pilot realised that he was in conflict with the ET 810 with the possibility of collision impact and requested the controller to stop further climb of ET 810. However, the controller erroneously instructed the ET 810 to stop descending and almost immediately, both aircraft experienced a TCAS Traffic Advisory (TA) followed by resolution advisory (RA). Both aircraft reacted appropriately to RA prompts with the WB 483 climbing and the ET810 descending to clear the conflict.

Either Aircraft did not call out “TCAS climb” or “TCAS descent” as required by TCAS Resolution Procedures. However only the ET 810 called “Clear of Conflict”. Thereafter, both flights continued on ATC instructions.

The deviation from the initial clearance due to weather and final resumption to GESOL, resulted in route conflict between both airplanes. This was not observed by the air traffic controller most probably due to one or a combination of the following actions:

(1) He was not watching the Radar screen,

(2) He did not analyse the deviation of the airplane due to bad weather.

(3) His situation awareness was particularly lacking since he continued reporting “No conflict” to the pilots despite the calls from RwandAir pilots.

(4) The Radar alerting system was possibly muted due to its nuisance alerts from other regular inputs.

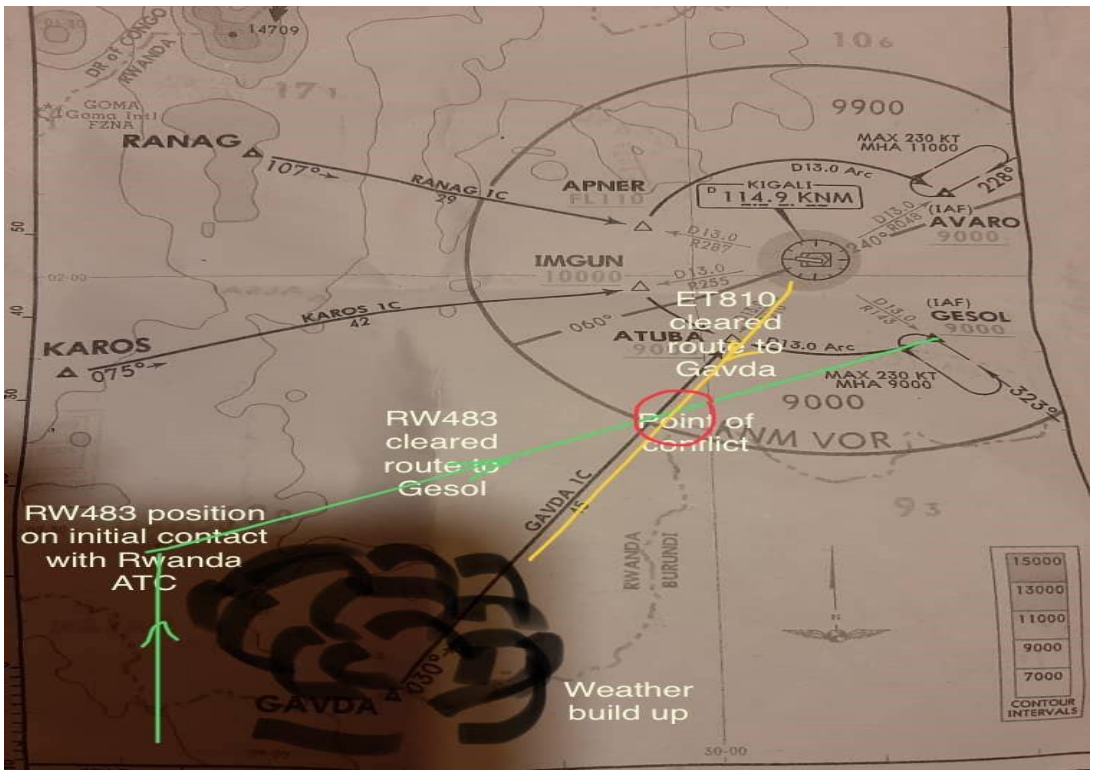


Figure 1: Incident Routing

1.2. Injuries to Persons

There were no injuries due to this serious incident.

1.3. Damage to aircraft

No damage to the aircraft

1.4. Other damage

There was no damage due to this serious incident.

1.5. Personnel information

1.5.1. Description of qualifications, experience and history of Crew of Flight WB 483:

A. Captain

Age:	37
Licence type:	Airline Transport Pilot Licence (ATPL)
Date of issue:	14th September 2021
Valid until:	30th September 2023
Medical certificate	Valid
Total flying experience	6019 Hours
Total flying experience on type	3840 Hours
Total flying hours in last 90 days	165 Hours
Previous rest period	Day-off on 21st January 2022

B. First Officer

Age:	54
Licence type:	Airline Transport Pilot Licence
Date of issue:	07th September 2021
Valid until:	30th September 2023
Medical certificate:	Valid
Total flying experience	7914 Hours
Total flying experience on type	4949 Hours
Total flying hours in last 90days	132 hours
Previous rest period	Day-off on 21st January 2022

1.5.2. Description of qualifications, experience and history of Crew of Flight ET 810:

A. Captain

Age:	56
Licence type:	Airline Transport Pilot Licence (MPL)
Date of issue:	16th July 2018
Valid until:	22nd March 2022
Medical certificate valid until:	Valid
Total flying experience	2852:14
Total flying experience on type	2852:14
Total flying hours in last 90 days	188:11
Previous rest period	13Hours 50mins

B. First Officer

Age:	26
Licence type:	Airline Transport Pilot Licence (MPL)
Date of issue:	15 September 2021
Valid until:	30th August 2022
Medical certificate :	Valid
Total flying experience	198:52
Total flying experience on type	198:52
Total flying hours in last 90 days	162:20
Previous rest period	20hours 54 minutes

1.5.3. Description of qualifications, experience and history of Air Traffic Controller

Age:	37
Licence type:	Aerodrome Control, Approach procedural Control, Approach Surveillance Control
Date of issue:	16th April 2021
Valid until:	30th September 2023
Function	Approach Radar Controller/ Supervisor
Medical certificate:	Valid
Work days before the day of the incident	1 day
Start of duty on the day of incident	13h00 UTC

1.6. Aircraft Information

1.6.1. 9XR-WH—WB483

Manufacturer	Bombardier Aerospace
Type	CL-600-2D24 (CRJ 900NG)
Manufacturer's Serial Number	15286
Registration as marked on the exterior	9XR-WH
Registration as marked on identification plate in cockpit	9XR-WH
Engines	GE CF34-8C5
Date of Manufacture	October, 2012
Certificate of airworthiness	Issued by CAA of Rwanda Date of issue: October 31st 2021 Date of expiry: October 31st 2022
Last maintenance check	100 Flight Hours Check done on 20th January 2022
Total Airframe cycles	15472

1.6.2. ET- AQN—ET810

Manufacturer	BOEING
Type	B737-800
Manufacturer's Serial Number	40967
Registration as marked on the exterior	ET-AQN
Registration as marked on identification plate in cockpit	ET-AQN
Engines	Left Hand Engine: CFM56-7B27E, S/N: 660973 Right Hand Engine: CFM56-7B27E, S/N: 960914
Date of Manufacture	24 June 2014
Certificate of airworthiness	Issued by CAA of Ethiopia Original issued on 26-06-2014 Latest renewal date:02-06-2021 Date of expiry: 01-06-2022
Last maintenance check	1A2 and MNIB Check done on 27-12-2021
Total Airframe cycles	9790 of 17 February 2022

1.6.3. Airborne Collision Avoidance System[4]

Functioning collision avoidance systems (traffic alert and collision avoidance system - TCAS) were fitted to both aircraft; they provided traffic information (traffic advisories-TA) and instructions for conflict resolution (resolution advisories - RA).

Both crews reacted to the system commands without delay. ET 810 descended whilst WB 483 climbed.

1.7. Meteorological information

The reported weather for the time of incident was METAR HRYR 221330Z VRB02KT 9999 FEW023CB BKN025 24/16 Q1017NOSIG

The incident took place at 14:00 (UTC). It was day time conditions with good visibility. Weather is not considered a factor in this incident.

1.9. Communications

1.9.1. Separation Clearance

WB 483 was cleared to descend enroute from Bujumbura to Kigali International Airport at flight level 190 to flight level 110 direct to GESOL and at the same time, ET 810 was climbing from Kigali international airport to Bujumbura via GAVDA. The audio transmissions from the Approach control were not clear and difficult to grasp while transmissions from the aircraft were clear.

When the Pilot for WB 483 realized the danger of a possible conflict, he called out on the communication radio frequency to the controller to stop further climb

[4] Airborne collision avoidance system (ACAS) is the designation of the basic concept. The International Civil Aviation Organization (ICAO) uses this term when drawing up the standards with which the system must comply. The traffic alert and collision avoidance system (TCAS) is a concrete implementation of this concept.

of the ET 810. In his transmission, the RwandAir pilot in error, requested “a stop descent” initially instead of “stop climb” for ET 810 but corrected his statement immediately. The controller therefore correspondingly instructed ET 810 to stop descent instead of climb. The controller transmissions were consistently muffled by air flow over the microphone which made it unclear and difficult to capture. The observation was that the microphone did not have any air mesh to prevent this interference. The transmissions were therefore not clear enough and WB 483 pilot had to call again and this wasted some precious time that would have been adequate for the separation.

Less than a minute thereafter, the TA audio call out was heard followed by RA where the TCAS provided a resolution advisory and both aircraft reacted appropriately to the prompts with the WB 483 climbing and the ET 810 descending to clear the conflict.

The ATC audio recordings showed that RwandAir pilots did not comply with TCAS phraseology for resolution advisories. Whereas the ET810 had a partial compliance, ET810 only stated “Clear of conflict” Either Aircraft did not call out “TCAS climb” or “TCAS descent” as required by TCAS Resolution Procedures.

1.10. Aerodrome information

The approach control at Kigali International airport handles arriving traffic and hands over the traffic to the aerodrome controller for landing. The Approach Controller also receives departing traffic from the tower for area separation.

The approach control office is located on the Ground floor of the control tower building and also has a console in the control tower. This enables both approach and Aerodrome control from the control tower especially at times of less traffic or failure of the system in the approach control centre. As at the time of the incident, the approach radar controller was working in the control tower and this is understood to be a Covid-19 control measure.

1.17. Organizational and management information

1.17.1. Procedures

The relevant basis for air traffic control procedures is defined in the Manual for air traffic Services (MATS) in Rwanda.

1.17.2. Notification of occurrence

Air Traffic control procedures Manual requires the reporting of occurrences to the management for the safety management system implementation. This incident was neither reported to the management nor recorded in the logbook.

RCAR Part 19, Regulation 19.025 (a) (8) requires Service providers to report any of such incident to AAID. This incident was not reported.

1.17.3. Air Traffic Controllers' Duty Roster

The Manual of Air Traffic Services specifies the number of Controllers to be on the shift. At Kigali International Airport, the Manual requires ATC to assign four (4) controllers to each shift that composed of Two (2) aerodrome controllers, One (1) Procedural Approach and One (1) Approach Radar Controller. However, at the time of incident, only three controllers were on duty: Two (2) Aerodrome controllers and one (1) Approach controller.

1.18. Additional Information

1.18.1. Radar Alerting System.

Kigali International Airport Air Traffic Control is equipped with Aircon 2100 Radar System. Among other features of this system, the alerting system is included. The Radar Alerting system alerts the user under specific circumstances during system operation. The Alerts are of two types: Visual alerts (Change of colour of the image displayed) and audio through area loudspeakers. According to Radar System Engineers, all alerts generated by this system differ in their sounds and duration. However, Controllers stated that there is no

difference in sounds between alerts generated by The System. There is no information in Radar System documentation provided regarding difference between audio/aural alerts generated by the system.

Short term Conflict Alerting system[5] is among the alerting systems of the Radar to the air traffic controller.

The Radar System is also equipped with a monitoring system that logs inputs and events and are retained for three months.

Playback of the retained recorded video information of the system at the time of the incident showed the imminent collision that was averted by TCAS, via a change in colour of the representations of both aircraft on the system.

During the investigation, all Air Traffic Controllers on duty stated that they did not hear any form of audio alerts and also the approach controller didn't see visual alert of the imminent possible conflict.

[5] **Short Term Conflict Alert System** is ground-based safety net that assists the controller in preventing collision between aircraft by generating, in timely manner, an alert of a potential or actual infringement of separation minima.

2. ANALYSIS

2.1. Technical Aspects

2.1.1. Aircraft systems

During the conduct of this investigation, AAID established that there were no indications of any pre-existing technical defects for both aircraft involved in the incident which might have caused or influenced the serious incident.

Without the proper functionality of the TCAS equipment in both aircraft, the result, would have been a mid-air collision with grave fatalities and disastrous consequences. Both TCAS can then be said to be fully operational.

2.1.2. Air Traffic Control Systems

The Approach Surveillance Radar system of Kigali International Airport, was equipped with a Short Term Conflict Alert System (STCAS). This includes both visual and Audio Alert Systems. According to the Radar System Experts, the Proximity Alert System was configured to activate when separation between aircraft falls below 10 nautical miles and the Audio Alert System is loud enough to capture the attention of any controller within the control tower. Based on the information obtained through Interviews and field visit, investigation confirmed that the radar and all related facilities were fully functional with no defect reported in the Radar Technical Log book. However, it seems unlikely that the alerts that were consistent for every input in the Radar System appears more like a malfunction than a norm.

During Interview, Controllers confirmed that audio alerts from Radar System are the same which is considered as a nuisance to users. However, System engineers confirmed that the radar audio alerts are different and differ in sound and duration. AAID was provided with system documentation dated 2011 related to the radar system and there was no clear information describing aural alerts and alarms that the system generates. On the other hand, visual alerts differ in colours and there is a system provision to inhibit all audio alerts.

The only possibility of averting the alerts is by muting the alert systems using provisions provided for that purpose. Investigation by AAID identified that the Approach Surveillance Radar system was equipped with Short term collision alert System which was properly configured and the Audio Alert System is loud enough to draw the attention of any controller within the Tower console.

The Audio transmission from the control tower was unclear and noisy. This was observed to be caused by air that ensued while the controllers speak into the microphone. In other words, there is no foam mesh to dampen the air from the controllers while they spoke into the microphone. Consequently, difficulty in understanding Kigali Tower transmissions resulted in repetitions and a dire waste of precious time that would have been used to provide adequate clearance between both aircraft.

2.2. Human factors and operational aspects

2.2.1. Air Traffic Control

The traffic situation in connection with the serious incident involved two aircraft in which one aircraft was cleared to descend from FL 190 to 110 and another one was climbing to FL 180 on a bi-directional route opposite each other on L432[6] and ended up in traffic conflict.

RwandAir Flight 483 was left of track due to bad weather and was subsequently cleared to proceed to GESOL[7] position which required the aircraft to cross the L432 route where the near mid-air collision incident occurred. Besides lacking situational awareness, the controller did not heed the calls from WB483 to provide separation. This should have drawn his attention to the ensuing situation. However, he persistently continued saying “No conflict”.

[6] L432 is Air Traffic Service route from Kigali to Bujumbura and vice-versa
[7] GESOL is an arrival waypoint into Kigali

3. CONCLUSIONS

3.1. Findings

3.1.1. The near mid-air collision incident was neither reported to AAID nor entered into Safety Management System as required by RCARs part 19 and ATC Procedures manual.

3.1.2. The ATC procedures manual requires recording of accidents and incidents in a logbook. However, the near mid-air collision incident was not recorded.

3.1.3. The ATC Procedures Manual does not specify the qualification and experience requirements for the position of the approach radar controller supervisor.

3.1.4. The radar approach controller communication was not clear and the WB483 was asking for further confirmation which wasted precious time.

3.1.5. Radar Approach controller stated that audio alerts generated by Radar System have similar sounds. However, Radar Engineers stated that the audio alerts differ in their sounds and duration.

3.1.6. In the Radar System documentation dated 2011, there is no information describing difference between audio/aural alerts generated by the System.

3.1.7. Within the RAC air traffic control services the function of clearing the aircraft and monitoring of the separation clearances with regard to possible conflicts was not done.

3.1.8. The investigation conducted did not reveal any pre-existing technical faults which might have caused the incident.

3.1.9. The TCAS generated a resolution advisory on both aircraft, the instructions of which were obeyed immediately and correctly by the pilots.

3.1.10. The RwandAir Pilots did not comply with TCAS RA Phraseologies “TCAS Climb” and “clear of conflict”) and ET 810 pilots partially complied with the “clear of conflict “phraseology.

3.1.11. The crews of the two aircraft involved in the serious incident were in possession of valid licenses required to exercise their assigned job functions and responsibilities.

3.1.12. The air traffic controller was in possession of valid licenses required to exercise his job functions.

3.1.13. The controller cleared WB 483 to descend from flight level 190 to flight level 110 and cleared ET 801 to climb to flight level 180.

3.1.14. The WB 483 reported left track for bad weather avoidance purposes on initial contact with Kigali ATC.

3.1.15. WB 483 pilots enquired if there was any possible traffic conflict with the climbing ET 810 from Air Traffic Controller and the controller replied there is no conflict.

3.1.16. An intervention by the air traffic controller came when it was late during RA and therefore no longer relevant since RA had priority.

3.1.17. There was only one radar-approach controller on duty. This does not provide for health and other necessary break in the course of 8hours duty.

3.1.18. TCAS Separated both aircraft successful and both aircraft continued their operations uneventfully.

3.2. Causal factor

The serious incident is attributable to the ATC inability to realize the traffic convergence in time and provide the requisite separation for the aircraft at a safe distance which continued degenerating until it finally culminated in a Resolution Advisory for both aircraft.

3.3. Contributory factors

The following factors contributed substantially to the cause of the serious incident:

- The controller erroneously instructed the ET810 to stop descending instead of stop climbing.
- The fact that air traffic controller failed to monitor the traffic
- The assumption that the Radar System audio alerts are the same for all events which therefore constituted a nuisance for which reason the audio was muted.
- Controller's loss of Situation awareness
- The fact that only one Radar Approach Controller was on duty without relief.

4. SAFETY RECOMMENDATIONS

To RAC:

4.1 The Rwanda Airport Company is recommended to ensure that all aviation incidents are reported to the AAID as laid down in RCAR Part 19 under mandatory reporting of accidents and incidents.

4.2 The Rwanda Airports Company to specify in the ATC procedures manual the required experience for the controller to qualify as supervisor (team leader) of the shift.

4.3 The Rwanda Airports Company to review the duty schedule to ensure relief of duty personnel by assigning not less than two Radar Approach controllers on duty at any given time.

4.4 Rwanda Airports Company to ensure that more trainings are conducted on Radar System in use as laid down in ATC procedures Manual.

4.5 Rwanda Airports Company to ensure that Short term conflict audio alerts are configured with a different sound to other annunciations of the Radar system and documented in ATC procedures Manual(MATS)

To: RwandAir

4.6 RwandAir to review flight operations training in the section of TCAS to ensure compliance with phraseology.

To: RCAA

4.7 To increase Oversight activities in order to ensure full compliance with the approved procedures and manuals.