KOMITE NASIONAL KESELAMATAN TRANSPORTASI
REPUBLIC OF INDONESIA

FINAL

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Aircraft Serious Incident Investigation Report

PT. Wings Abadi Air

ATR 72-212A; PK-WFR

Sultan Hasanuddin Airport, Makassar

Republic of Indonesia

28 March 2014

2016

This final investigation report was produced by the Komite Nasional Keselamatan Transportasi (KNKT) 3rd Floor Ministry of Transportation, Jalan Medan Merdeka Timur No. 5 Jakarta 10110, Indonesia.

The report is based upon the investigation carried out by the KNKT in accordance with Annex 13 to the Convention on International Civil Aviation Organization, the Indonesian Aviation Act (UU No. 1/2009) and Government Regulation (PP No. 62/2013).

The final report consists of factual information collected until the final report published. This report includes analysis and conclusion.

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TABLE OF CONTENTS

TABLE OF FIGURES

ABBREVIATIONS AND DEFINITIONS

AAL	:	Above Aerodrome Level
A/C	:	Aircraft
ADC	:	Air Data Computer
AHRS	:	Altitude and Heading Reference System
ANS	:	Approach Non Stabilized
AOC	:	Air Operator Certificate
ARFF	:	Airport Rescue and Fire Fighting
ATC	:	Air Traffic Control
ATIS	:	Aerodrome Terminal Information Services
ATPL	:	Air Transport Pilot License
ATR	:	Avions de Transport Regional
ATS	:	Air Traffic Service
AWOS	:	Automated Weather Observation Services
BMKG	:	*Badan Meterologi Klimatologi dan Geofisika* (Metrological Climatology and Geophysical Agency)
°C	:	Degrees Celsius
CASR	:	Civil Aviation Safety Regulation
C/L	:	Check List
C of A	:	Certificate of Airworthiness
COM	:	Company Operation Manual
CPL	:	Commercial Pilot License
C of R	:	Certificate or Registration
CRM	:	Crew Resources Management
CSN	:	Cycles Since New
CVR	:	Cockpit Voice Recorder
DGCA	:	Directorate General of Civil Aviation
DME	:	Distance Measuring Equipment
ECU	:	Electronic Control Unit
EEC	:	Engine Electronic Control
EFIS	:	Electronic Flight Instrumentation System
ENG	:	Engine
EVAC	:	Evacuate
GPWS	:	Ground Proximity Warning System

FA	:	Flight Attendant
FCOM	:	Flight Crew Operation Manual
FCTM	:	Flight Crew Training Manual
FDR	:	Flight Data Recorder
FL	:	Flight Level
ft	:	Feet
GNSS	:	Global Navigation Satellite System
ICAO	:	International Civil Aviation Organization
ILS	:	Instrument Landing System
Kg	:	Kilogram(s)
Km	:	Kilometer(s)
KNKT	:	Komite Nasional KeselamatanTransportasi
kt	:	Knot (s) (nm/hours)
LT	:	Local Time
LTM	:	Long Term Memory
MAC	:	Mean Aerodynamic Chord
mbs	:	Millibar(s)
Nm	:	Nautical mile(s)
OTM	:	Operation Training Manual
PF	:	Pilot Flying
PIC	:	Pilot in Command
PNF	:	Pilot Non Flying
SCT	:	Scattered
SGU	:	Symbol Generator Unit
SIC	:	Second in Command
SID	:	Standard Instrument Departure
SSFDR	:	Solid State Flight Data Recorder
STM	:	Short Term Memory
T/O	:	Take off
UTC	:	Universal Time Coordinate
VOR	:	Very High Frequency Omni Directional Range

INTRODUCTION

SYNOPSIS

An ATR 72-500, registered PK-WFR, on 28 March 2014 was being operated by PT. Wings Abadi Air, as scheduled passenger flight. The aircraft departed Pomala Airport, Sulawesi Tenggara at 0710 UTC (1510 LT) to Sultan Hasanuddin Airport, Makassar, Sulawesi Selatan. On board in this flight were two pilots, two flight attendants and 73 passengers. The Second in Command (SIC) acted as Pilot Flying (PF) and the Pilot in Command (PIC) acted as Pilot Non Flying (PNF).

The pilot elected to fly via MKS VOR to avoid cumulonimbus cloud on the south east area from Makassar. The flight then vectored for Instrument Landing System (ILS) approach runway 03.

At 1500 feet, the Hasanuddin Tower controller and was provided the landing clearance with additional information of wind which was from 120° up to 23 knots. Refer to the information from the controller and considered the experience of the SIC, the PIC took over the control of the aircraft and the SIC performed the duty as PNF.

The PIC noticed that on the right side of the final course was dark and thick cloud, while on the left was clear.

At 08.00 UTC, the aircraft touched down normal on the touchdown zone. The pilot started to applied the brake and reverse the propeller. The FDR recorded that after touchdown, left rudder was applied gradually from 3° up to 27° and the aircraft heading was varied between 026° to 031°. The application of left rudder reduced and changed to right rudder up to 26° and the aircraft heading changed from 030° to 074°. The aircraft then run off to the right of the runway. The aircraft skid and veered to the right and stopped at 15 meters from the runway pavement.

No one injured in this serious incident. The aircraft suffer minor damage mainly on the landing gear doors.

The investigation concluded that the incorrect rudder application to compensate the crosswind affect had resulted in the aircraft exiting the runway. This might due to the pilot confusion to the crosswind effect as result of inadequate training.

At the time of issuing this final investigation report, the Komite Nasional Keselamatan Transportasi (KNKT) has been informed safety action of the PT. Wings Abadi Air.

Following this investigation, KNKT issued safety recommendations addressed to PT.Wings Abadi Air and the Directorate General Civil Aviation (DGCA).

1 FACTUAL INFORMATION

1.1 History of the Flight

An ATR 72-500, registered PK-WFR, on 28 March 2014 was being operated by PT. Wings Abadi Air, as scheduled passenger flight. The aircraft departed Pomala Airport, Sulawesi Tenggara at 1510 LT (0710 UTC[1]) to Sultan Hasanuddin Airport, Makassar[2], Sulawesi Selatan. On board the aircraft were two pilots, two flight attendants and 73 passengers.

The Second in Command (SIC) acted as Pilot Flying (PF) and the Pilot in Command (PIC) acted as Pilot Non Flying (PNF). The flight cruised on altitude of 14,000 feet. While approaching Makassar, the pilots received weather information from the Aerodrome Terminal Information Services (ATIS), contained information of the wind was from 230° and the velocity 8 knots, visibility 10 km, cloud scattered (SCT) with the cloud base 1,900 feet, temperature 32°C and dew point 25°C, and the aerodrome pressure 1,009 millibars.

The pilot elected to fly via MKS VOR to avoid cumulonimbus cloud on the south east area from Makassar. The flight then vectored for Instrument Landing System (ILS) approach runway 03. Ahead of the flight were two aircrafts on approach for landing and after those aircrafts landed, the flight was cleared for ILS approach runway 03. There was no report from pilots of both previous flights related to the weather condition on approach.

At altitude of 1,500 feet, the flight was transferred to Hasanuddin Tower controller and was provided the landing clearance with additional information of wind which was from 120° up to 23 knots. The PNF checked the wind indication on the Global Navigation Satellite System (GNSS) and found that the wind was from the right and slightly tail wind with velocity between 11 to 15 knots.

Refer to the information from the controller and considered the experience of the SIC, the PIC took over the control of the aircraft and the SIC performed the duty as PNF.

The PIC noticed that on the right side of the final course was dark and thick cloud, while on the left was clear.

At 0800 UTC, the aircraft touched down within the touchdown zone. The pilot started to applied the brake and reverse the propeller. The aircraft decelerated and when the aircraft speed was approximately 70 knots, the pilot felt that the aircraft suddenly veered to the right. The pilot attempted to recover the situation by applied differential rudder and nose wheel steering. The pilot felt that the nose wheel steering was heavier than normal.

The aircraft skid and veered to the right and stopped at 15 meters from the runway pavement. After the aircraft completely stop, the pilot notified the tower controller that the aircraft stopped outside the runway and requested assistance.

The Flight Attendant (FA) waited for the command from the PIC in case evacuation was required. After few seconds later and there was no command from the PIC, the

1 The 24-hour clock used in this report to describe the time of day as specific events occurred is in Coordinated Universal Time (UTC). Local time that be used in this report is Waktu Indonesia Barat (WIB) which is UTC + 7 hours.

2 Sultan Hasanuddin Makassar Airport will be named as Makassar for the purpose of this report.

FA-1[3], checked the outside condition. She found that outside area was grass and the aircraft tilted to the right. She then pressed the "EMERGENCY" button to call to the pilots. The FA-1 then announced to the passengers to keep calm. This announcement also triggered the FA-2 to start perform the duty.

After the engines shut down, the FA-1 contacted the pilot afterward the PIC went out the cockpit, then opened the crew entrance door and disembarked the aircraft to check the outside area. The PIC then commanded the flight attendant to evacuate the passengers.

The Airport Rescue and Fire Fighting (ARFF) team arrived on the site and ready to assist the passenger evacuation. After knowing that the ARFF has arrived, the flight attendants opened the passenger door and passengers disembark normally and transferred to passenger terminal.

No one injured in this serious incident. The aircraft was minor damaged, mainly on the landing gear doors.

1.2 Personnel Information

1.2.1 Pilot in Command

The PIC was 43 years old Indonesia pilot and has joined the company since 2008. The pilot held valid ATP License (Air Transport Pilot License) issued on 10 May 2010 and rated for ATR aircraft. The pilot held first class medical certificate which valid until 02 July 2014 with limitation of "*holder shall posses glasses that correct for near vision*". The pilot has performed line check on 19 January 2014 and last simulator proficiency check was performed on 30 October 2013.

The PIC flying experience

Total hours	:	7713 hours
Total on type	:	2579 hours
Last 90 days	:	262 hours 55 minutes
Last 60 days	:	176 hours 10 minutes
Last 24 hours	:	2 hours 15 minutes
This flight	:	45 minutes

1.2.2 Second in Command

The SIC was 24 years old Indonesia pilot and has joined the company since 2013. The pilot held valid CP License (Commercial Pilot License) issued on 27 November 2012 and rated for ATR aircraft. The pilot held first class medical certificate which valid until 22 July 2014 without limitation. The pilot has performed line check on 20 August 2013 and last simulator proficiency check was performed on 11 April 2013.

The SIC flying experience

Total hours	:	881 hours 1 minutes
Total on type	:	597 hours 15 minutes

3 Flight Attendant (FA) – 1 is the leader of the flight attendants, responsible for the safety of the passengers.

Last 90 days	:	249 hours 15 minutes
Last 60 days	:	183 hours 55 minutes
Last 24 hours	:	2 hours 15 minutes
This flight	:	45 minutes

During the interview both pilot described their confusion of the right crosswind effect to the fact that the aircraft veered to the right. In their opinion the aircraft would have been veered to the left as the effect of the cross wind from the right.

1.3 Aircraft Information

The aircraft was France manufactured ATR 72-500, registered PK-WFR. It has valid Certificate of Airworthiness (C of A) and Certificate or Registration (C of R) and has accumulated 7,666 hours and 58 minutes of total flight hours and 8,299 cycles since new.

The aircraft departed with the total takeoff weight of 21,620 kg which was 480 kg below the maximum allowable takeoff weight. The takeoff Mean Aerodynamic Chord (MAC) was 23.37 % which was within the range limit of 16 – 37 %. The aircraft was operated within the approve weight and balance limits.

The aircraft was airworthy prior to the occurrence.

1.4 Meteorological Information

The weather of Makassar reported on the Aerodrome Terminal Information Services (ATIS) at 0730 UTC was as follows:

Wind	:	230° / 08 knots
Visibility	:	10 km
Cloud	:	SCT 1,900 feet
Temperature	:	32°C
Dewpoint	:	25°C
Pressure	:	1,007 mbs

The Makassar was equipped with Automated Weather Observation Services (AWOS) and the data was displayed at Badan Meteorology Klimatology dan Geofisika (BMKG – The Agency of Meteorology, Climatology and Geophysics) office and Makassar Tower control station. The data indicated that at 0800 UTC, the wind changed from direction of 220° with velocity of 7 knots to direction of 130° with velocity more than 18 knots (figure 1).

	2' DD (Park 21/03) CAOBS	2' FF (Park 21/03) CAOBS kt	DD of max FF inst 10' (Park 21/03) CAOBS	Max FF inst 1' (Park 21/03) CAOBS
28/03/2014 07:55:00	220	7	250	7
28/03/2014 07:56:00	220	6	250	7
28/03/2014 07:57:00	220	5	250	7
28/03/2014 07:58:00	200	5	250	7
28/03/2014 07:59:00	170	7	130	18
28/03/2014 08:00:00	120	11	130	18
28/03/2014 08:01:00	100	13	120	19
28/03/2014 08:02:00	100	14	130	24
28/03/2014 08:03:00	100	15	130	22
28/03/2014 08:04:00	100	15	130	20
28/03/2014 08:05:00	90	13	130	18
28/03/2014 08:06:00	90	12	130	19
28/03/2014 08:07:00	80	13	70	25
28/03/2014 08:08:00	70	17	60	30
28/03/2014 08:09:00	70	21	60	28
28/03/2014 08:10:00	70	19	60	25

Figure 1: The wind information recorded on the AWOS at the time of the aircraft landing

1.5 Aerodrome Information

Airport Name	:	Sultan Hasanuddin Airport
Airport Identification	:	WAAA / UPG
Airport Operator	:	PT. Angkasa Pura I
Airport Certificate	:	017/SBU-DBU/VII/2010
Coordinate	:	05º 03’39”S 119º33’16”E
Elevation	:	47 feet
Runway Direction	:	13/31 and 03/21
Runway Length	:	2,500 meters
Runway Width	:	45 meters
Surface	:	Concrete Asphalt

1.6 Flight Recorders

The aircraft was equipped with a Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR). Both recorders were examined in the KNKT facility in Jakarta. Both recorders contained good quality data including the serious incident flight data.

1.6.1 Flight Data Recorder

The Flight Data Recorder (FDR):

Manufacturer : L3 Comm

Part Number : 2100-4043-00

Serial Number : 000677687

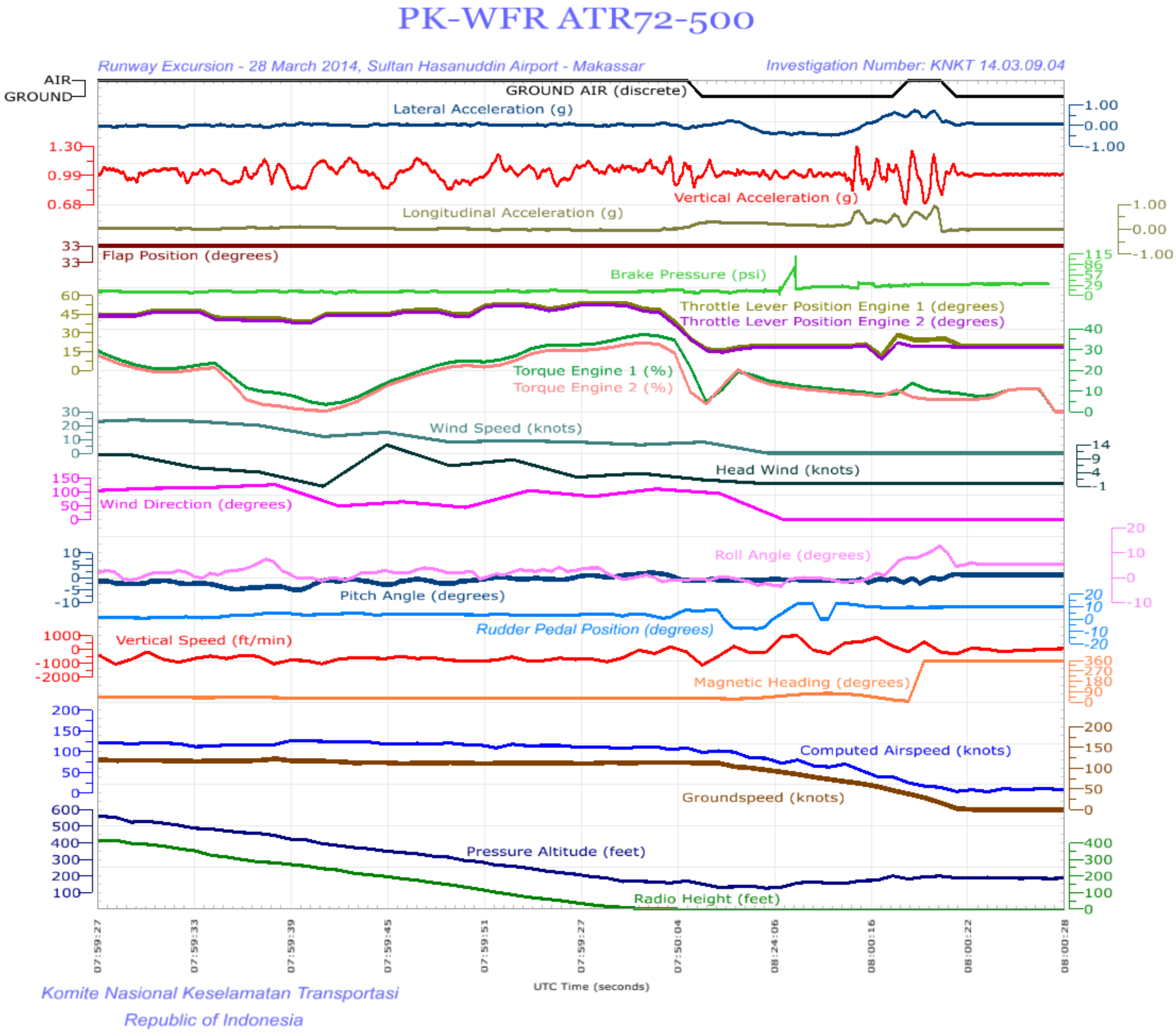


Figure 2: **Graph of the FDR data started from prior to touch down**

UTC Time (seconds)	Pressure Altitude (feet)	Radio Height (feet)	Groundspeed (knots)	Magnetic Heading (degrees)	GROUND AIR (discrete)	Computed Airspeed (knots)	Wind Direction (degrees)	Wind Speed (knots)	Head Wind (knots)	Throttle Lever Pos Engine 1 (degrees)	Torque Engine 1 (%)	Torque Engine 2 (%)	Brake Pressure (psi)	Rudder Pedal Pos (degrees)	Rudder Position (degrees)	Control Wheel Pos (degrees)
	167	10	113	32		108				53	36	32.5	7	4	4	3
	168	5	114	32		111		6	4	49	37	33.25	7	4	4	6
	165	2	114	31		112	110			48	36	32.5	7	1	-2	-19
7:50:04	158	0	114	31		105				38	34	28.25	12	5	6	-18
	171	-1	114	32	AIR	109				25	22	9.5	6	7	11	-23
	152	-1	113	31	GRD	98		8	1	17	5	3.75	5	8	15	-30
	133	-1	112	28	GRD	102	94			16	10	12.25	9	-1	-3	-21
7:50:08	135	-1	104	26	GRD	99				18	19	20.25	5	-8	-26	-31
	140	-1	100	30	GRD	85				19	18	15.75	11	-8	-27	-58
	127	-1	96	39	GRD	84		0	0	19	15	13.25	6	0	-5	-15
	133	-1	90	52	GRD	72	0			19	14	12	0	8	15	17
8:50:12	158	-1	85	63	GRD	80				19	12	11	112	12	26	7
	166	-2	78	72	GRD	66				19	12	10.25	22	0	26	5
	156	-2	73	74	GRD	63		0	0	19	11	9.5	22	13	26	-18
	156	-1	68	70	GRD	70	0			19	10	8.75	28	12	26	-17
8:00:16	172	-1	62	58	GRD	55				21	9	8.25	33	10	26	32
	174	-2	56	38	GRD	40				12	8	7.25	28	9	24	23
	201	-2	46	19	GRD	39		0	0	28	8	10.5	22	9	26	54
	182	-1	38	6	AIR	25	0			25	14	7	29	9	26	63
8:00:20	195	-1	28	359	AIR	17				25	10	6	27	9	26	0
	200	-1	16	358	AIR	14				25	10	6	26	10	26	62
	189	-1	2	358	GRD	4		0	0	20	9	6	28	10	26	58
	189	-2	0	358	GRD	8	0			20	8	6	27	10	26	54
8:00:24	192	-2	0	358	GRD	3				20	8	6.75	28	10	26	52

Table 1: FDR table data of significant parameters from prior to touchdown until the aircraft stop

The FDR data showed:

1. Prior to touchdown the wind was easterly with wind velocity up to 8 knots.
2. Aircraft touched down normally.

3. After touchdown, engine torque equally increased and then reduced.
4. The left rudder was applied (negative value on the FDR) then changed to right rudder.
5. Aircraft heading increased (turn right) in four seconds up to heading 074 or approximately 44 degrees from runway bearing.
6. No significant brake pressure recorded.
7. The aircraft stopped on heading north.

1.6.2 Cockpit Voice Recorder

The Cockpit Voice Recorder (CVR)

Manufacturer : L3 Comm
Part Number : 2100-1020-02
Serial Number : 000672133

The CVR did not record pilot conversation during the aircraft on descend. The CVR recorded pilot and ATC communication. The significant excerpts of the CVR data are as follows:

Time (UTC)	Communication
7:56:10	Flap selected to 30
7:56:24	Before landing checklist initiated
7:57:19	The PIC confirming that the wind was cross wind from the right
7:57:50	Controller issued landing clearance and informed that the wind was 120° up to 23 knots.
7:59:05	The aircraft touched down

1.7 Wreckage and Impact Information

The wheel tracks were found on runway 03, begin on the touchdown and were on the runway centre line. The marks turn to the right at approximately 45º from the runway direction.

Figure 3: **The marks of the wheel where started to turn right**

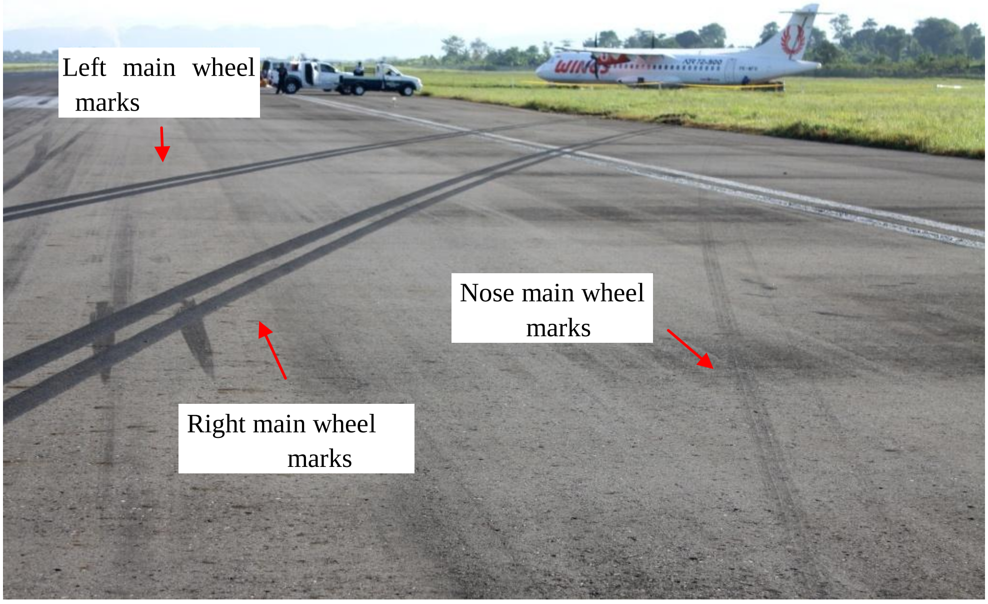


Figure 4: The marks of the wheel where started left the runway pavement

1.8 Organization information

1.8.1 Company Operation Manual

4.10.6 APPROACH AND LANDING

4.10.6.1 Crew Coordination during Holding, Approach and Landing

During these phases of flight, both pilots must be seated in their assigned cockpit seats. Careful planning of the approach and close cooperation between flight crews is necessary to achieve a safe approach and landing. The techniques and procedures to be used shall be discussed in advance, in order to avoid errors and misunderstandings. Both pilots shall therefore familiarize themselves thoroughly with the relevant data such as descent altitude restrictions, weather conditions, aircraft serviceability, ground facilities, holding and approach procedures runway data, missed approach procedures etc. The crew briefing should be completed well in advance of terminal area penetration and be updated if changing circumstances so require.

Normally the PF, programs and monitors the auto-pilot/flight director and autothrottle, and gives the necessary commands (e.g. checklist, gear down, flaps etc). The PNF, monitors the approach, keeps lookout, executes the allocated system operation on command of the PF and confirms its execution, does the radio communication and checks for visual reference. The PNF therefore, shall be fully familiar with the intentions of the PF, and shall have facts and figures ready when needed. The use of facilities shall be planned beforehand, and on passing one facility, the PNF shall inform the PF and be ready to retune to the next facility immediately. During the descent phase, at altitudes below approximately 10.000 feet, and during taxi, all flight crewmembers shall concentrate on cockpit procedures, cockpit monitoring and lookout, and refrain from non-essential matters.

1.8.2 Operation Training Manual (OTM)

The OTM Chapter 5.5 ATR 72-500 Pilot type rating training shows that the pilots had been trained for the cross wind landing twice which were on session 4 and session 5.

The OTM Chapter 5.5 ATR 72-500 Pilot type rating training

Type Rating Simulator Session 4

- Briefing .... 1 hour
- Exercises.. 4 hour

1. Internal inspection – Preliminary cockpit preparation
2. Final Cockpit Preparation – Before taxi – Taxi – before TO C/L
3. TAKE OFF – Climb sequence – After TO C/L
4. Climb on SID to FL 9000 feet
5. AFCS utilisation AP ON and AP OFF with FD
6. Configuration changes as needed
7. ARRIVAL preparation (weather, datacard, arrival briefing)
8. ILS APPROACH
9. GO AROUND – Radar Vector
10. VOR DME approach
11. Cross wind LANDING
12. After Landing – DYNAMIC ENG TEST, Parking, Leaving the A/C C/L

- Debriefing .... 1 hour

Session 5

- Briefing .... 1 hour
- Exercises.. 4 hour
    1. SHORT TRANSIT preparation – Final cockpit preparation – Before Taxi
    2. Eng 1: NO ITT DURING ENG START then start A+B – Taxi – Before TO
    3. Take Off – EFIS COMP (ROLL) – SID FL 8000 feet – Failure treatment
    4. ENGINE FLAME OUT no.2 on cruise – SINGLE ENG HANDLING
    5. RESTART IN FLIGHT
        Stall with Ice accretion WITHOUT ICING AOA ON
        Stall with Ice accretion WITH ICING AOA ON
    6. Ice accretion – ACW BUS 2 OFF (ADC disagreement) (reset)
    7. AHRS fail on PF side (reset)
    8. CREW MEMBER INCAPACITATION
    9. Radar Vector – ILS - Landing
    10. VOR DME approach
    11. Cross wind LANDING
    12. Take Off – SGU FAIL (reset) – normal procedure – SID FL 8000 feet –Failure Treatment
    13. Take off – climb straight ahead 3000' – ECU/EEC FAULT before acceleration altitude – radar vector.
    14. After failure treatment BOTH ECU/EEC FAULT
    15. Vector for ILS keeping HIGH SPEED (190 kts) up to 2000'
    16. ANS (Approach Non Stabilized) at 1000' AAL – GO AROUND to 2000' – Freeze at the end of the C/L
    17. Reposition A/C at TO to demonstrate BOT ECU/EEC FAULT effect on ground
- Debriefing .... 1 hour

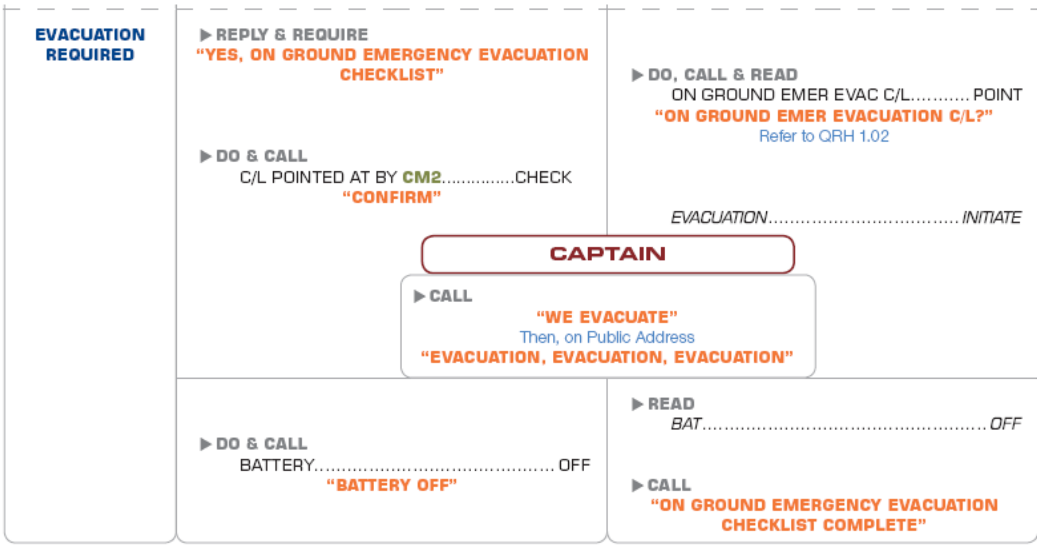
1.8.3 QRH (Quick Reference Handbook)

ON GROUND EMER EVACUATION

AIRCRAFT / PARKING BRAKE	STOP / ENGAGE
ATC (VHF 1)	NOTIFY
CL 1 + 2	FTR THEN FUEL SO
MIN CAB LIGHT	ON
CABIN CREW (PA)	NOTIFY
FIRE HANDLES 1 + 2	PULL
AGENTS	AS RQD
ENG START ROTARY SELECTOR	OFF / START ABORT
FUEL PUMPS 1 + 2	OFF
EVACUATION (PA)	INITIATE
● **Before leaving aircraft**	
BAT	OFF

1.8.4 FCTM (Flight Crew Training Manual)

FCTM ATR 72-500 ABNORMAL AND EMERGENCY PROCEDURE, 03.02.01, page 2 Sep 2012.



Part of the on ground evacuation procedure stated that evacuation command conducted by the captain through public address and afterward switch off the battery.

1.9 Additional Information

1.9.1 Crosswind During Landing

When an airplane is airborne it moves with the air mass in which it is flying regardless of the airplane's heading and speed. However, when an airplane is on the ground it is unable to move with the air mass (crosswind) because of the resistance created by ground friction on the wheels.

Characteristically, an airplane has a greater profile or side area, behind the main landing gear than forward of it. With the main wheels acting as a pivot point and the greater surface area exposed to the crosswind behind that pivot point, the airplane will tend to turn or "weathervane" into the wind (figure 5).

Though it is characteristic of most airplanes, this weathervaning tendency is more prevalent in the tail wheel type because the airplane's surface area behind the main landing gear is greater than in nose wheel type airplanes (see figure 6 and 7).

Wind acting on an airplane during crosswind landings is the result of two factors - one is the natural wind which acts in the direction the air mass is traveling, while the other is induced by the movement of the airplane and acts parallel to the direction of movement. Consequently, a crosswind has a headwind component acting along the airplane's ground track and a crosswind component acting 90º to its track. The resultant or relative wind, then, is somewhere between the two components. As the airplane's forward speed decreases during the after landing roll, the headwind component decreases and the relative wind has more of a crosswind component. The greater the crosswind component the more difficult it is to prevent weathervaning.

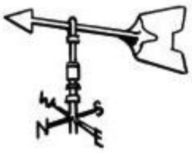


Figure 5: Weathervane

Figure 6: Tail wheel airplane

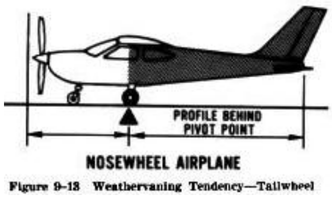


Figure 7 : Nose wheel airplane

In February 2014, the aircraft manufacturer issued the Safety Note "Be Prepared For Crosswind Landing" to provide guidance to the pilots to perform crosswind landing. This Safety Note particularly emphasizes the use of rudder during landing roll that must be smooth, mainly for any upwind input. The detail of the Safety Note available on the appendices of this report.

1.9.2 Situational Awareness and Decision Making

Relation between the Short Term Memory (STM) are the spatial orientation, ability to process information, and emotional/physical condition, and the Long Term Memory (LTM) is the experience, training, management skill, physical skill, and personal attitude refers the figure below shows the process and relation of the input cues assessment (diagnostic) includes the risk assessment decision making.

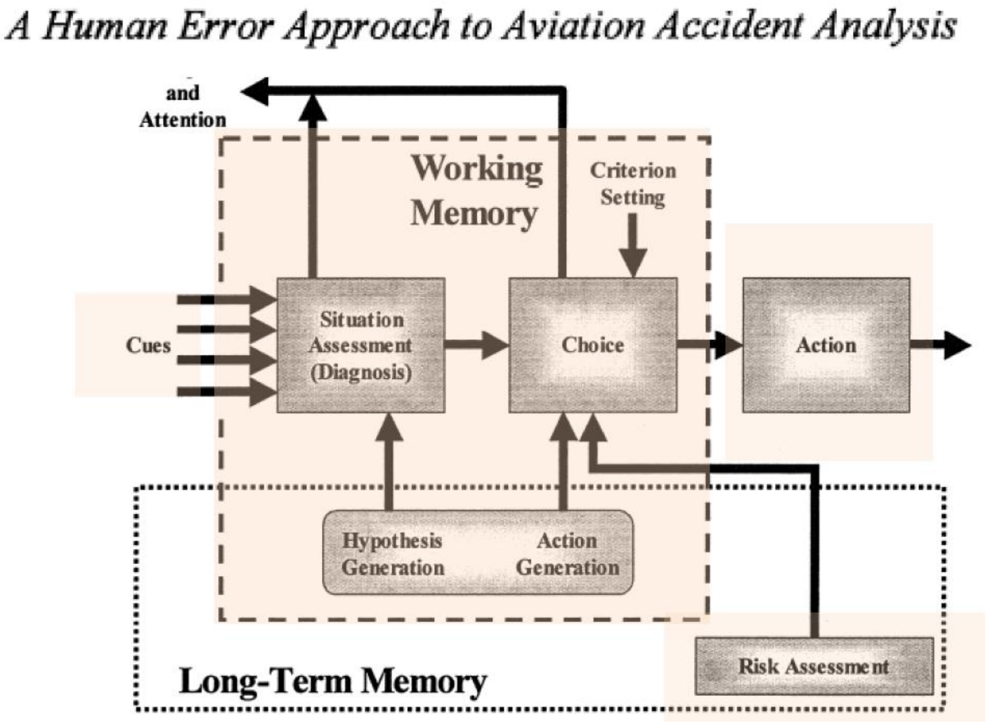


Figure 8: Decision Making Model Wickers and Flach (1988)

1.9.3 Thunderstorm formation

Generally, thunderstorms require three conditions to form:

1. Moisture
2. An unstable air mass.
3. A lifting force (heat)

All thunderstorms, regardless of type, go through three stages: the **cumulus stage**, the **mature stage**, and the **dissipation stage.** The average thunderstorm has a 24 km (15 miles) diameter. Depending on the conditions present in the atmosphere, these three stages take an average of 30 minutes to go through.

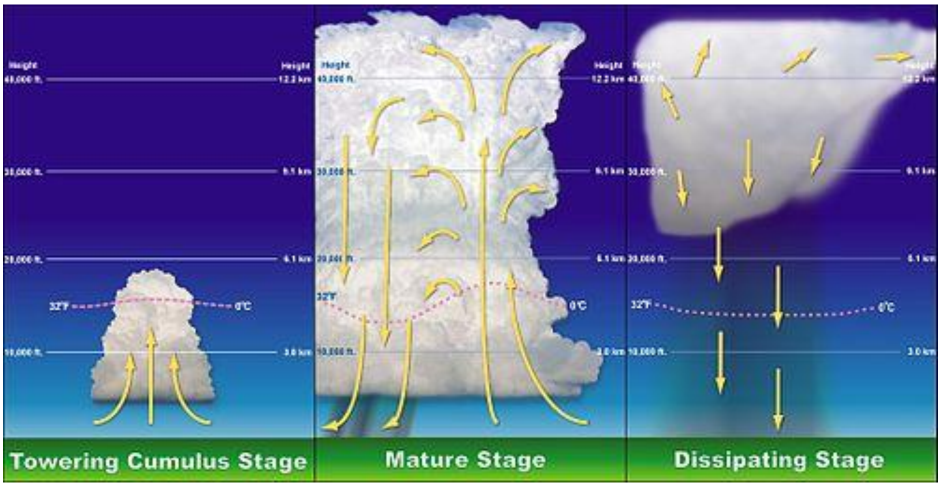


Figure 9: Stages of thunderstrom

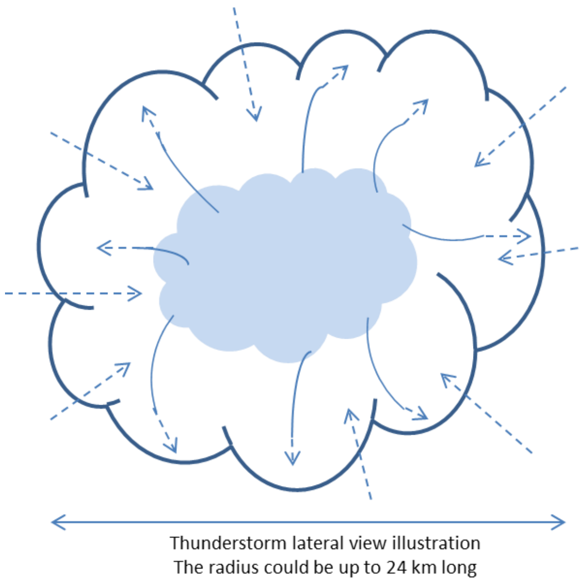


Figure 10: Lateral view illustration of thunderstorm

Cumulus Stage

The first stage of a thunderstorm is the cumulus stage, or developing stage. In this stage, masses of moisture are lifted upwards into the atmosphere. The trigger for this lift can be insolation heating the ground producing thermals, areas where two winds converge forcing air upwards, or where winds blow over terrain of increasing elevation. The moisture rapidly cools into liquid drops of water due to the cooler temperatures at high altitude, which appears as cumulus clouds. As the water vapor condenses into liquid, latent heat is released, which warms the air, causing it to become less dense than the surrounding dry air. The air tends to rise in an updraft through the process of convection (hence the term convective precipitation). This creates a low-pressure zone beneath the forming thunderstorm. In a typical thunderstorm, approximately 5×10^{8}kg of water vapor is lifted into the Earth's atmosphere.

Mature Stage

In the mature stage of a thunderstorm, the warmed air continues to rise until it reaches an area of warmer air and can rise no further. Often this 'cap' is the tropopause. The air is instead forced to spread out, giving the storm a characteristic anvil shape. The resulting cloud is called cumulonimbus incus. The water droplets coalesce into larger and heavier droplets and freeze to become ice particles. As these fall they melt to become rain.

Dissipating Stage

In the dissipation stage, the thunderstorm is dominated by the downdraft. If atmospheric conditions do not support super cellular development, this stage occurs rather quickly, approximately 20–30 minutes into the life of the thunderstorm. The downdraft will push down out of the thunderstorm, hit the ground and spread out.

2 ANALYSIS

The investigation considered that the aircraft was not a factor. Air traffic controller information of wind condition was a good practice to improve pilot awareness. Therefore, the analysis will discuss the cause of the aircraft veered to the right and the weather condition in the airport vicinity that might affect the aircraft and pilot decision while on the landing roll.

2.1 Flight Technique on crosswind landing

Prior to approach on runway 03, the pilot noticed cumulonimbus clouds on the east side of the airport and decided to avoid the area. During the approach the pilots also noticed black and thick cloud on the right side of the approach path, while on the left side was clear.

There was no report from any pilot related to the weather condition on approach area. The controller notified the pilot of wind which was from 120° up to 23 knots or perpendicular to the landing direction up to 23 knots. The wind indicated on the GNSS was from the right and slightly tail wind with velocity between 11 to 15 knots.

Considering the wind condition and the experience of the SIC, the PIC took over the control. The aircraft touched down normally.

The FDR recorded that after touchdown, left rudder was applied gradually from 3° up to 27° and the aircraft heading was varied between 026° to 031°. The application of left rudder reduced and changed to right rudder up to 26° and the aircraft heading changed from 030° to 074°. The aircraft then run off to the right of the runway.

Prior and during the approach, there were several significant information of cumulonimbus existence which were the visual view of the pilot to the cloud formation and controller information of significant cross wind condition. There was no pilot discussion recorded on the CVR to anticipate this condition. The only action was that the PIC took over control of the aircraft.

After touchdown, the pilot initially applied left rudder and able to manage the aircraft heading on runway bearing. The pilot then applied right rudder and the aircraft turned to the right.

During the interview, the pilots explained their confusion of the effect of the wind. They assumed that the aircraft would have been veered to the left as the effect of right crosswind.

The shape of the vertical stabilizer will have greatest effect to the crosswind condition. The vertical stabilizer and all part of the aircraft behind the main wheel will be pushed by the air, hence the nose will move into the wind (weathervaning). So, on a right crosswind, the aircraft will turn to the right. The right rudder application would make the aircraft veered more to the right.

Misinterpretation of the pilot to the effect of crosswind might have led to incorrect recovery action.

2.2 Decision Making

The Company Operation Manual on 4.10.6 APPROACH AND LANDING 4.10.6.1 Stated that; *Careful planning of the approach and close cooperation between flight crews is necessary to achieve a safe approach and landing. The techniques and procedures to be used shall be discussed in advance, in order to avoid errors and misunderstandings. Both pilots shall therefore familiarize themselves thoroughly with the relevant data such as descent altitude restrictions, weather conditions, aircraft serviceability, ground facilities, holding and approach procedures runway*.

In the dissipation stage of cumulonimbus, the thunderstorm is dominated by the downdraft. The downdraft will push down out of the thunderstorm, hit the ground and spread out.

The wind direction as recorded by AWOS changed from westerly to easterly and increased in velocity. This related to the cumulonimbus which was existed surrounding the airport.

Prior and during the approach, there were several significant information to the pilot related to the existence of cumulonimbus such as dark and thick cloud on the right side of the final course and strong crosswind condition.

The CVR recorded that the pilots noticed the crosswind condition, however there was no discussion recorded concerning the anticipation to this condition. The only action was that the PIC took over control of the aircraft.

The absence of pilot discussion related to the cumulonimbus existence as required by the COM, most likely had reduced or absence the important information stored as short term memory which might require for the pilot to make decision during the approach and landing roll.

The OTM Chapter 5.5 ATR 72-500 Pilot Type Rating Training shows that the pilots had been trained for the crosswind landing two times on session 4 and 5.

The FDR recorded that after touchdown, initially left rudder was applied and able to manage the aircraft heading on runway bearing and center line, afterward the right rudder applied up to maximum and the aircraft turned to the right.

The pilots opinion the aircraft would have been veered to the left as the effect of the cross wind from the right. An aircraft has a greater profile or side area, behind the main landing gear than forward of it. Characteristically the crosswind, will tend to turn or "weathervane" the aircraft into the wind and requires correct rudder application to counter it.

During the landing roll, the wind was from the right which would tend the aircraft to turn to the right, therefore left rudder application required. The right rudder application was not in accordance with the characteristic of countering crosswind effect on landing roll.

The rudder application might be caused by the pilot confusion to the crosswind effect as stated during the interview.

The pilots had been trained for crosswind exercise two times in aircraft simulator. However, the pilots were confused to the crosswind effect. The pilot confusion indicated inadequate training.

It can be concluded that the incorrect rudder application to compensate the crosswind effect had resulted in the aircraft exiting the runway. This might due to the pilot confusion to the crosswind effect as result of inadequate training.

3 CONCLUSION

3.1 Findings[4]

According to factual information during the investigation, the National Transportation Safety Committee founded any findings as follows:

1. The aircraft was airworthy prior to departure and there was no any aircraft systems problem reported.
2. All crew has valid licenses and medical certificates.
3. The OTM Chapter 5.5 ATR 72-500: Pilot Type Rating Training showed that the pilots trained for the cross wind landing twice, on session 4 and session 5.
4. The aircraft departed within the weight and balance operating limit.
5. The Second in Command (SIC) acted as Pilot Flying (PF) until on final approach when the Pilot in Command (PIC) took over control of the aircraft.
6. During approach, the pilot noticed dark and thick could which was cumulonimbus cloud formation.
7. Controller informed the pilot that the wind condition was easterly with velocity up to 23 knots.
8. The wind condition as recorded by AWOS changed to westerly wind and increasing speed that related to the cumulonimbus which existed surrounding the airport.
9. COM. 4.10.6.1 Crew Coordination during Holding stated that approach and landing techniques and procedures to be used shall be discussed in advance, in order to avoid errors and misunderstandings. Both pilots shall therefore familiarize themselves thoroughly with the relevant data such as weather conditions, holding and approach procedures runway.
10. The FDR recorded that after touchdown, initially left rudder was applied and able to manage the aircraft heading on runway bearing and center line, afterward the right rudder applied up to maximum and the aircraft turned to the right.
11. During the interview, the pilots explained their confusion of the effect of the wind. They assumed that the aircraft would have been veered to the left as the effect of right crosswind.
12. After the engines shut down the PIC went out the cockpit, then opened the crew entrance door and disembarked the aircraft to check the outside area. The PIC then commanded the FA to evacuate the passengers.
13. Part of the on ground evacuation procedure stated that evacuation command conducted by the captain through public address and afterward switch off the battery.

4 Findings are statements of all significant conditions, events or circumstances in the accident sequence. The findings are significant steps in the accident sequence, but they are not always causal, or indicate deficiencies. Some findings point out the conditions that pre-existed the accident sequence, but they are usually essential to the understanding of the occurrence, usually in chronological order.

3.2 Contributing Factors[5]

The investigation concluded that the incorrect rudder application to compensate the crosswind affect had resulted in the aircraft exiting the runway. This might due to the pilot confusion to the crosswind effect as result of inadequate training.

5 Contributing factors is defined as events that might cause the occurrence. In the case that the event did not occur then the accident might not happen or result in a less severe occurrence.

4 SAFETY ACTION

Following the occurrence, the PT. Wings Abadi Air management held a meeting to discuss the occurrence and the corrective action. The meeting was attended by the Director of Wings Air, General Manager Safety, Security and Quality, Safety Manager, Chief Operation Safety, QMR manager, Chief Pilot ATR, Chief Operation Training and Chief Analyst.

The meeting concluded that there was manual input from the cockpit that lead the aircraft veered off to the right, and after the aircraft stopped, the PIC did not command the flight attendant until the FA-1 called to the cockpit.

The meeting agreed to provide recurrent training for the flight crew and limiting the crosswind component for PIC as pilot flying to maximum of 25 knots and the SIC to maximum of 15 knots which was informed to pilot by a notice. (Detail of the notice available in the appendices of this report).

5 SAFETY RECOMMENDATIONS

The Komite Nasional Keselamatan Transportasi (KNKT) consider that the safety actions taken by the aircraft operator were relevant to improve the issued identified in this investigation.

In addition KNKT issued safety recommendations to address safety issues identified during this investigation. The safety recommendations are based on the factual information, analysis and findings of this investigation. However the operator shall consider that the condition possibly extends to other pilots and related supporting units within the company.

DGCA requested to ensure that the recommendations addressed to the relevant parties are well implemented.

The safety recommendations addressed to:

5.1 PT. Wings Abadi Air

- **04.O-2016-86.1**

  To ensure the pilot understand and consistently implement the company policies stated in the COM.

- **04.O-2016-87.1**

  To improve pilot skill and knowledge to the aerodynamic effects of crosswind condition including the recovery technique and to consider the additional training session of crosswind landing exercises.

- **04.O-2016-88.1**

  To improve pilot knowledge of weather effects to the flight characteristic including the cumulonimbus effect.

- **04.O-2016-20.2**

  To ensure appropriate coordination during emergency evacuation by improving the crew emergency training.

5.2 The Directorate General of Civil Aviation (DGCA)

- **04.R-2016-89.1**

  To oversight the operator training to ensure the achievement of the training objectives.

6 APPENDICES

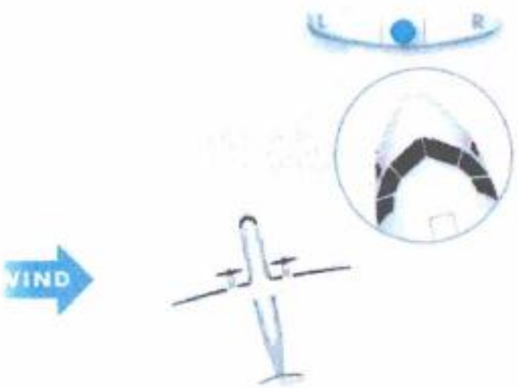
6.1 Notice to Pilot

Wings Air SSQ DIRECTORATE	SAFETY NOTICES	
	NO	002/SSQ/ SR-SN-SI/IV/2014
	EFFECTIVE DATE	4 April 2014
	DISTRIBUTION LIST	DO;OF; OT; OMPATR
	APPLICABILITY	All Pilots
	TITLE	***Safely Crosswind Landing Operation***

Due to recent serious incident PK-WFR which experienced runway excursion during crosswind landing operation. Hence SSQ directorate would rise some improvement for safely crosswind landing operation as follow:

1. As consideration the Pilots shall crosscheck wind information which broadcast by ATC as complement wind indicator in instrument as well as aircraft flight control status via DMI status list;
2. Prior decide to apply crosswind landing operation, the PIC shall communicate to ATC regarding wind condition as well as runway condition status;
3. For strong crosswind condition (above 20Kts) and/or contaminated runway, the PIC could request to change runway landing to ATC;
4. If the origin PF was FO and the result max crosswind component measurement above standard (***SSQ has recommended to reduce max crosswind component for Captain = 25Kts; FO = 15Kts***), then the Captain shall take over control at final approach phase (±1000ft AGL) in order adjusting the autopilot-disconnect altitude for prevailing conditions to provide time to establish manual control and trimming of the aircraft before do crosswind landing as well as brief the First Officer regarding Pilot Monitoring function in crosswind landing operation;
5. the ATR manufacture recommended crabbed approach as the most safely technique than sideslip technique;

Crabbed Approach



6. For landing roll technique, maintaining aileron input into the wind. In addition, rudder pedals shall be used to keep the airplane on runway axis;

7. Don't hesitate to make go around.

WINGS AIR SSQ DIRECTORATE

6.2 The ATR Safety Note

SAFETY NOTE # 1

BE PREPARED FOR CROSSWIND LANDING

When crosswind conditions are reported on arrival airport, it is essential to anticipate by reviewing the landing technique and to prepare an action plan before starting the approach. This "Be prepared for crosswind landing" provides an overview of operational factors involved in planning and conducting the approach and flare under crosswind conditions, as well as some recommendations regarding handling techniques.

Key points for a safe and successful crosswind landing

- Review and brief crosswind landing technique.
- Strictly adhere to computed Vapp.
- Ensure strengthened crew cooperation.
- Be prepared for a go-around.
- Look for a reduced air/ground transition.
- Keep aileron into wind during landing roll.

MAXIMUM RECOMMENDED CROSSWIND

The crosswind value given in the AFM performance section (6-01) as maximum demonstrated crosswind shall be understood as the maximum crosswind under which the capacity of the ATR aircraft for landing was demonstrated during flight tests. It shall be considered as the maximum recommended crosswind.

The operators may consider establishing operating conditions, based on crews experience or airfields specificities, for which the maximum crosswind would be reduced.

During the approach briefing the pilot flying shall evaluate his/her own ability to land in announced crosswind condition and get prepared for a go-around and/or a diversion.

The AFM 6-01 also provides maximum recommended crosswind applicable in case of contaminated runway.

APPROACH SPEED

The FCOM (3.08.02) defines the approach speed as Vapp = VmHB + wind factor where the wind factor is the maximum of either 1/3 of the headwind velocity or the gust in full (to be understood as the difference between the maximum reported wind and the steady wind, without considering wind direction). **In any case the wind factor to be added is limited to 15 kt.**

For example, when landing in Toulouse Blagnac airport on runway 14R, with a wind reported as 200° / 18 kt gusting at 30 kt, 1/3 of headwind component is 3 kt while the gust in full is 12 kt (30-18). Hence the wind factor to be considered for the approach speed computation will be 12 kt.

The wind factor shall not be increased further, even in strong crosswind conditions. An excessive approach speed increases the duration of the flare (while under crosswind conditions, it is preferable to shorten the transition from air to ground), , it also increases the risk of landing with nose landing gear first and it increases the landing distance . Long flare and "greased" landings are not recommended by ATR.

PREPARING THE APPROACH

The best defence against crosswind conditions is anticipation through a reminder of the landing technique before starting the approach. While preparing for the approach, the crew shall check the applicable maximum demonstrated crosswind, calculate the estimated drift on final, the approach speed and associated preset values (pitch and torque). The pilot flying shall evaluate his/her own ability to land in forecasted conditions and the crew shall review the available means to timely detect any change in wind conditions, and how changes will be communicated. **It is of utmost importance that the crew organizes their resources in order to build and maintain proper situational awareness on final approach.**

https://www.atractive.com

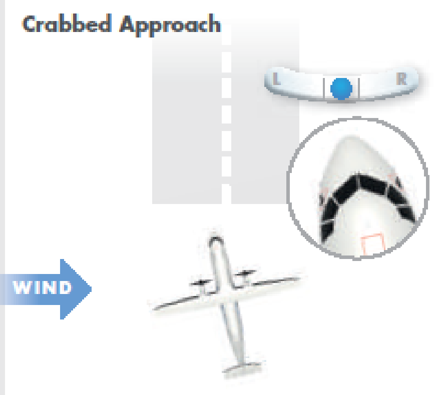
CONDUCTING THE APPROACH

ATR recommends performing a crabbed approach. : wings level and drift correction.

ATR recommends disconnecting the autopilot and yaw damper at the latest at 500 ft in order to have time to establish manual control.

Crosswind conditions are often associated with turbulence. In any case, the crew shall strictly adhere to the stabilized approach criteria in force within the applicable operator Standard Operating Procedures. Any deviation shall be called out and corrected. Performing a go-around is an option that shall be considered at any time until a safe landing is ensured.

During final approach, the crew shall pay particular attention to changes in wind direction and strength and maintain a high level of cooperation.



DECRAB AND FLARE TECHNIQUES

ATR recommends the standard decrabbing technique: the pilot flying decrabs the aircraft by coordinating downwind rudder input, with into wind aileron input. These actions enable to align the aircraft with runway axis.

This manoeuver shall be initiated at the latest at 20 ft but could be started earlier. The resulting aircraft position must be maintained up to the touchdown. Correction of flight path deviation, if necessary, will be performed around this new position.

Power reduction shall be initiated passing 20 ft. **The touchdown shall occur with power levers at Flight Idle.** In coordination with power reduction, the pilot flying progressively adjusts aircraft pitch to flare the aircraft, until upwind main landing gear contacts with the runway.

As wind intensity increases, manoeuvers dynamic should be implemented toward a faster executed set of simultaneous actions.

Aileron deflections are exaggerated for a better visual understanding.

AIRCRAFT HANDLING DURING LANDING ROLL AND DECELERATION

The upwind main wheels contact the ground first, followed by downwind main wheels. After both main landing gears contact, the pilot flying assists the nose landing gear towards the ground and selects the power levers to Ground Idle. Selecting power levers on Ground Idle causes an effective reduction of energy. If further deceleration is needed the crew could use reverse or brake to minimize landing roll.

During the landing roll, the pilot flying holds the control column in nose down position to increase directional efficiency, maintaining aileron input into the wind. In case of insufficient aileron input, crosswind gusts will lift the upwind wing and make the aircraft turn (accentuated by weather cock effect). To avoid that, the pilot flying must gradually increase the aileron input into the wind (up to maximum deflection if necessary). In addition, rudder pedals shall be used to keep the airplane on runway axis and **any heading deviation must be corrected smoothly, especially in upwind direction.**

In case of lateral deviation tendency, reverse shall be released and the pilot shall primarily use rudder pedals to regain lateral control. Asymmetrical braking can also be used to assist lateral control as rudder efficiency decreases with airspeed.

Below 70 kt, The Captain controls airplane alignment with nose wheel steering and the First Officer maintains aileron input into the wind until the aircraft comes to a complete stop.

Note: the use of reverse is more efficient at high speed and brake at low speed. Reverse shall be selected only after pilot monitoring has checked and announced the 2 low pitch green lights.

Any comment or question on this document can be sent to **flight-ops-support@atr.fr**

6.3 Direct Involves Parties Comments

Bureau d'Enquêtes et d'Analyses (BEA), France

NO	PAGE	COMMENTS			KNKT RESPONSE
		Extract of the Report	Proposed Changes	Justification	
1.	Cover	ATR 72-500	ATR 72-212A	"72-500" is a commercial name. The model, as identified in the EASA Type Certificate is "72-212A"	Accepted
2.	Synopsis Page vi	*There was no windshear alert from the Ground proximity Warning System (GPWS) during the approach*	Delete the sentence	There is no windshear alerting system on ATR 72-212A aircraft.	Accepted
3.	Synopsis Page vi	The investigation concluded that the contributing factors to this serious incident was inadequate Short Term Memory from the absence of discussion related to the weather condition and inadequate Long Term Memory from the training related to the input cues assessment (diagnostic) to the risk assessment and decision making might have led to the incorrect recovery action.	*The investigation concluded that the main contributing factor to this serious incident was* ***the full upwind rudder pedal application at relatively high speed, under crosswind conditions.***	Investigating human factors issues is very valuable. However, the conclusion expressed in the terms of lack of short term memory or inadequate long term memory can be confusing and not understandable by all the readers.	Accepted with rephrase
4.	§1.1	*There was no wind shear*	Delete the sentence	There is no windshear	Accepted

NO	PAGE	COMMENTS			KNKT RESPONSE
		Extract of the Report	**Proposed Changes**	**Justification**	
	Page 1	*alert from the Ground proximity Warning System (GPWS) during the approach*		alerting system on ATR 72-212A aircraft.	
5.	§1.7 Page 8	1.7 Wreckage and Impact Information	1.7 ~~Wreckage and~~ Impact Information	Considering the damages evidenced on the aircraft consecutive to the incident, and that the aircraft is back into operations, the term "wreckage" is not appropriate.	Rejected. This tittle is the standard KNKT format, even though no information of the wreckage.
6.	§1.9.1 Page 12	Complete paragraph "Thunderstorm formation"	Consider deleting the paragraph	The intent of this paragraph is unclear. If it aims at explaining the risk of encountering windshear, then it should be deleted as no windshear is evidenced through DFDR data analysis.	Rejected
7.	§1.9.2 Page 14	Extract from the ATR 72 FCOM 2.02.12 Page 1	Remove this extract and replace by the ATR Safety Note attached to this letter.	In February 2014, ATR has issued the Safety Note "Be Prepared For Crosswind Landing" to provide guidance to the pilots to perform crosswind landing. This Safety Note particularly emphasizes the use of rudder during landing roll that must be smooth, mainly for any	It is good information. However KNKT require confirming whether this ATR Safety Note has been received and understood by the pilots.

NO	PAGE	COMMENTS			KNKT RESPONSE
		Extract of the Report	**Proposed Changes**	**Justification**	
				upwind input.	
8.	§2.2 Page 17	*The thunderstorms formation, regardless of type, goes through three stages: …. to the cumulonimbus which was in view surrounding the airport.*	Consider deleting the paragraph	Refer to comment 6	Rejected
9.	§2.2 Page 17	*There was no pilot discussion recorded on the CVR to anticipate this condition. The only action was that the PIC took over control of the aircraft because of the crosswind landing.*	Add information in §1.2 or 1.8 about TEM training.	To potentially better understand why the pilot did not discuss the anticipated landing conditions, the report should highlight whether the airline organizes Threat and Error Management (TEM) training for the crew.	Accepted and additional information added to the report on chapter 1.6.2. Changed in the analysis.
10.	§2.2 Page 17	*It can be concluded that the incorrect recovery action was result of inadequate Short Term Memory from the absence of discussion related to the weather condition and inadequate Long Term Memory from the training related to the input cues assessment (diagnostic) to the risk assessment and decision making.*	*It can be concluded that the aircraft exiting the runway was the result of full upwind rudder pedal application at relatively high speed, under crosswind conditions.*	Refer to comment 3	Accepted and changed in the analysis.

NO	PAGE	COMMENTS			KNKT RESPONSE
		Extract of the Report	**Proposed Changes**	**Justification**	
11.	§3.1 Page 19	*15. There were combination of the lack of experience and information stored affected the pilot misinterpretation to the effect of crosswind which might have led to incorrect recovery action.*	Move to § 3.2	This should be considered as a contributing factor and not a finding.	Accepted
12.	§3.2 Page 19	*The absence of pilot discussion related to the significant information weather particularly on the cumulonimbus existence which was required by the COM, might had reduced/absence of the Short Term Memory and inadequate Long Term Memory from the training might have led to the misperception to the effect of crosswind and incorrect recovery action.*	Add at the beginning of the paragraph : *It can be concluded that the aircraft exiting the runway was the result of full upwind rudder pedal application at relatively high speed, under crosswind conditions.*	Before the contributing factors paragraph highlighting the absence of pilot discussion and potential effect on pilot memory, it is necessary to clearly indicate what physically led to the aircraft exiting the runway.	Accepted and changed in the conclusion.

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