ARAIB

Report No : ARAIB/AIR1005

AIRCRAFT SERIOUS INCIDENT REPORT

RUNWAY EXCURSION DURING LANDING ROLL
ACE AIR
L410UVP-E20, HL5234
MUAN INTERNATIONAL AIRPORT RUNWAY 19
3 SEPTEMBER 2010

30 November 2011

AVIATION AND RAILWAY ACCIDENT INVESTIGATION BOARD
MINISTRY OF LAND, TRANSPORT AND MARITIME AFFAIRS
REPUBLIC OF KOREA

According to the provisions of the Article 30 of the Aviation and Railway Accident Investigation Act of the Republic of Korea, it is stipulated;

The accident investigation shall be conducted separately from any judicial, administrative disposition or administrative lawsuit proceedings associated with civil or criminal liability.

And in the Annex 13 to the Convention on International Civil Aviation, Paragraphs 3.1 and 5.4.1, it is stipulated as follows;

The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability. Any investigation conducted in accordance with the provision of this Annex shall be separate from any judicial or administrative proceedings to apportion blame or liability.

Thus, this investigation report issued as the result of the investigation on the basis of the Aviation and Railway Accident Investigation Act of the Republic of Korea and the Annex 13 to the Convention on International Civil Aviation, shall not be used for any other purpose than to improve aviation safety.

In case of divergent interpretation of this report between the Korean and English languages, the Korean text shall prevail.

Aircraft Serious Incident Report

Aviation and Railway accident Investigation Board. Runway excursion during landing roll, Ace Air, L410UVP-E20, HL5234, Muan International Airport runway 19, 3 September 2010. Aircraft Incident Report ARAIB/AIR1005 Seoul, Republic of Korea

The Aviation and Railway Accident Investigation Board (ARAIB), Republic of Korea, is a government organization established for independent investigation of aviation and railway accidents, and the ARAIB conducts accident investigation in accordance with the Aviation and Railway Accident Investigation Act of the Republic of Korea and the Annex 13 to the Convention on International Civil Aviation.

The objective of the investigation by the ARAIB is not to apportion blame or liability but to prevent accidents and incidents.

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Ace Air L410 excursed from the runway of Muan International Airport

Ace Air

ET Aircraft Industries, Czech Republic

L410UVP-E20

HL5234

Muan International Airport runway 19

3 September 2010 around 09:31 (Korea time[1])

Synopsis

On 3 September 2010 at about 09:31, the L410UVP20 aircraft (hereinafter referred to as "HL5234") of Ace Air, Ltd. (hereinafter referred to as "Ace Air"), which was an unscheduled passenger airliner that departed Gimpo International Airport, excursed to the left of runway 19 during landing roll at Muan International Airport (hereinafter referred to as "Muan Airport"). Aboard the aircraft were one captain, one copilot and two passengers (including one free of charge), and there was no personnel injury nor damage to the aircraft.

The Aviation and Railway Accident Investigation Board (hereinafter be referred to as "ARAIB") determines as the cause of this incident that when the flight crew members moved both thrust control levers (TCL) to the reverse thrust position to use reverse thrust after aircraft touchdown, they did not set both propeller control levers (PCL) at the fine position as specified in the Flight Manual but moved them to the feather position, so reverse thrust was generated at the right propeller but not at the left propeller, thereby producing asymmetry between left and right thrust.

The ARAIB issues two safety recommendations to Ace Air on the basis of the findings from investigation.

1) All times in this report are the Republic of Korea standard time (KST, UTC + 9)

1. Factual information

1.1 History of flight

After HL5234 took off Gimpo International Airport on 3 September 2010 at about 08:25, it flew on airway B576 at 8,000 feet. Following the air traffic control instructions of Gwangju Approach Control, it approached Muan Airport runway 19 according to Muan Airport 'ILS/DME RWY 19' approach procedures.

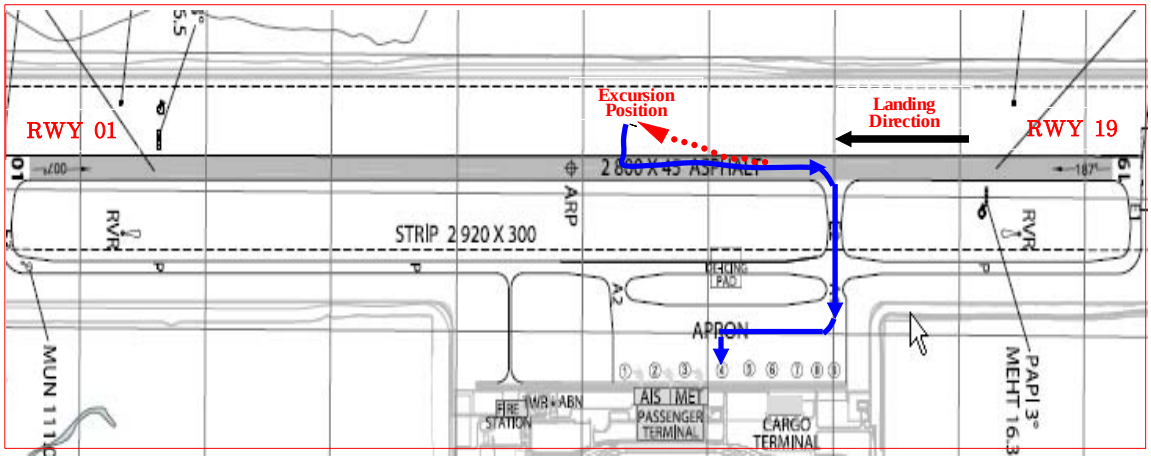
At the time of approach to and landing on runway 19, the copilot was 'pilot flying' and the captain was 'pilot monitoring.'

At 09:26:43, HL5234 contacted Muan Control Tower at 9 miles from the final approach course of runway 19 and was cleared to land and touched on the center of runway near the point of about 700 meters from the threshold of runway 19 at about 09:30.

After the aircraft touched down on the runway, the copilot operated the reverser, when the nose of aircraft turned right sharply (at a point of about 941 m from the threshold of runway 19).

The captain and copilot immediately stopped operation of the reverser and kicked the left rudder pedal to maximum, but the aircraft nose did not turn back to left. Eventually the aircraft veered off to right at an angle of about 20° and stopped on the grass at about 1,220 m from the threshold of runway 19 and about 48 m from the shoulder of runway.

When the aircraft stopped, the copilot deplaned to check the exterior of the aircraft and confirmed no damage, and with the permission by Muan Control Tower, the aircraft returned to the runway by its own power and moved to the parking spot 4 via taxiway E2, as shown in [Fig. 1].



[Fig. 1] Runway excursion and self-moved path

2. Injuries to persons

There were no injuries to persons due to this incident.

1.3 Damage to aircraft

There was no damage to aircraft due to this incident.

1.4 Other damage

There was no other damage due to this incident.

1.5 Personnel information

1.5.1 The captain

The captain (age 60) was employed by Ace Air in July 2008 and obtained L410 type rating, and has been flying as L410 aircraft captain since September 2008.

The captain held a valid transport pilot license[2], L410 type rating, Class 1 Medical Certificate[3], and Radio Operator Certificate[4].

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2) Qualification number: 1918 (issued on 5 September 2001)

The captain's total flying time was 7,486.5 hours including 244 hours as L410 captain, 56 hours for the latest three months and 8.6 hours for the latest one month. He completed a proficiency check in April 2010 and a line check in September 2009.

The captain was receiving treatment using splint due to damage to the ligament of left angle that occurred during athletic activity in June 2010, and was wearing support footwear[5] for activity improvement.

The captain did not take any alcoholic beverage or unpermitted medication before this flight, and stated his health normal.

1.5.2 The copilot

The copilot (age 44, male) held a valid commercial pilot license[6], L410 type rating, Class 1 Medical Certificate[7], and Radio Operator Certificate[8].

His total flying time was 1,782.9 hours including 262.8 hours on L410, 76.1 hours for the latest three months, and 30.7 hours for the latest one month. He completed a proficiency check in April 2010 and a line check in September 2009.

He did not take any alcoholic beverage or unpermitted medication before flight and stated his health normal.

1.6 Aircraft information

3) Date of check: 1 June 2009
4) Number 97-34-1-0280 (issued on 24 December 1997)
5) On 3 August 2010, the Flight Operation Chief submitted the opinion of the AME personally to the Seoul Regional Aviation Administration (Safety Section), and it was acknowledged that it would not affect his flight duty.
6) Qualification number: 12-002596 (issued on 16 February 2010)
7) Date of check: 6 October 2009
8) Number 96-34-1-0180 (issued on 5 April 2006)

1.6.1 General of aircraft

HL5234 is of a L410 UVP-E20 type manufactured[9] by LET Aircraft Industries of the Czech Republic for transport of passengers, mail and cargo. It can take off and land not only on a paved runway but also on an unpaved runway.

HL5234 is equipped with two turbo-prop engines[10] with a 5-blade V510 propeller each. Its specifications are as shown in [Table 1].

Classification	Specifications
Length	14 m 42 cm
Width	19 m 98 cm
Height	5 m 83 cm
Maximum operation altitude	4,250 m
Maximum zero fuel weight	6,060 kg
Maximum takeoff weight	6,600 kg
Maximum landing weight	6,400 kg
Cruising speed	136 KIAS at p.a. 3,600 m
Maximum fuel load	1,300 kg
Fuel consumption	0.790 kg/km at p.a. 3,600 m
Number of seats	2for crew, 19 for passenger

[Table 1] Aircraft specifications

Ace Air introduced the aircraft on 21 October 2007 and operated[11] for the purpose of aircraft using business. At the time of the incident, the total service time was 343 hours and the total number of takeoff and landing was 306 cycles.

When HL5234 was taking off from Gimpo International Airport, it had Jet-A1

9) Manufactured in July 2007 (Manufacturing number: 072628)
10) WALTER M 601E engine (takeoff: 750 horsepower, maximum sustainable: 657 horsepower)
11) Operation limit designation (Certification number: ISO7028/issued on 14 December 2007), airworthiness certificate (Certificate number: ISO7028/valid 2008.12.13)

fuel loaded to maximum (1,300 kg). There was no evidence that any defects were found in the aircraft system, airframe or engine or any problem with weight and balance.

1.6.2 Propeller feather system

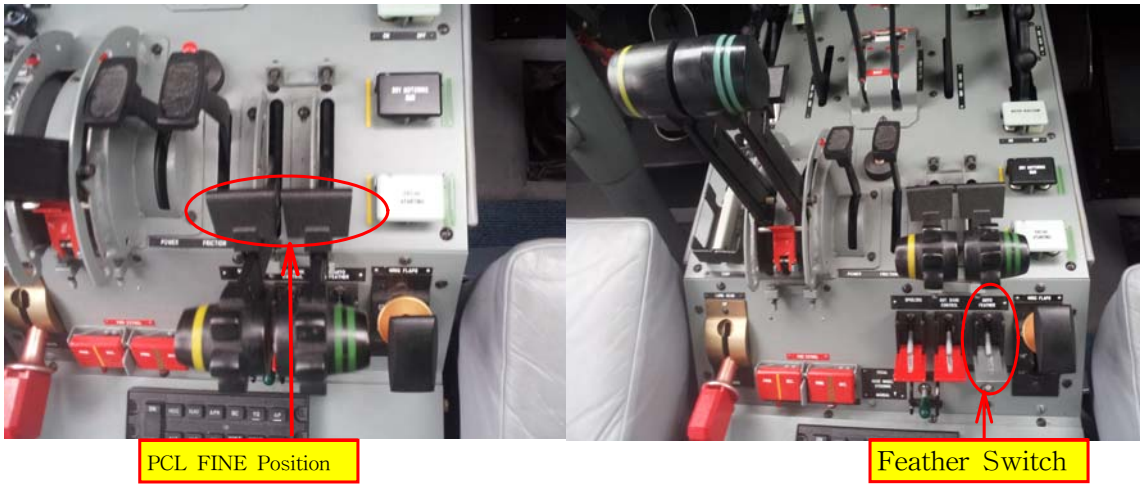
The propeller feather system of L410 aircraft consists of a constant speed mode that controls propeller speed by varying the propeller angle according to engine speed, a feather mode that does not let produce thrust by standing the angle of feather vertically in the same direction of aircraft heading and a reverse mode that produces reverse thrust by adjusting the propeller feather to reverse pitch. Such modes are set by propeller speed governor according to the positions of thrust control lever (TCL) and propeller control lever (PCL).

1.6.2.1 Propeller control lever

The propeller control lever is as shown in [Fig. 2]. The feather switch prevents the propeller from rotating by the effect of wind when the aircraft is standing on ground, and is used to reduce resistance when engine stopped in flight.

The fine position is used to minimize engine resistance during engine start-up and takeoff and maximize acceleration performance.

During cruising flight, the propeller angle is optimized by the propeller governor so as to produce a proper thrust.



[Fig. 2] Propeller control lever

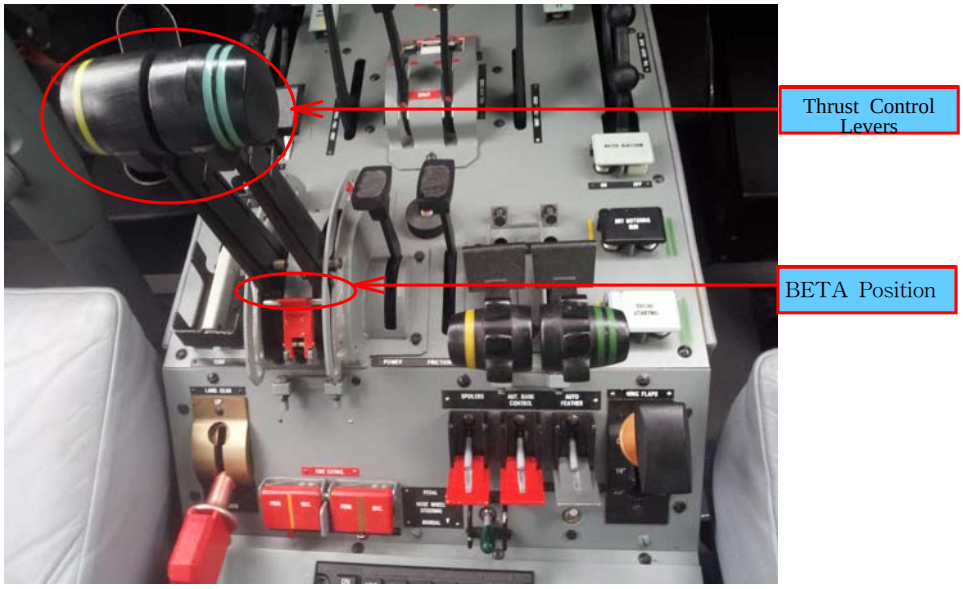
1.6.2.2 Thrust control lever

The thrust control lever (TCL) is used to control thrust and reverse thrust as shown in [Fig. 3].

For the flight crew member to use the reverser, he is to move the thrust control lever to BETA range after the aircraft touched down on the runway, and then he should confirm the lights[12] that come on when reverse thrust is ready to be used, and move the TCL to a desired BETA range smoothly.

Especially to operate reverse thrust, the PCL must be at the fine position.

12) The meaning of Beta range light



[Fig. 3] Thrust Control Levers

1.7 Meteorological information

The weather observed at Muan Airport at the time when HL5234 was landing i s as follows.

METAR 030000Z 20009KT 9999 SCT030 BKN130 28/24 Q1014 NOSIG =
(Surface wind 200 degrees at 9 knots, visibility 10 km or more, sky condition scattered clouds at 3,000 feet above ground, temperature 28 degrees Celsius)

The surface wind provided by Control Tower when HL5234 was cleared to land at 09:26:50 at 9 miles on the final approach course to runway 19 was 210 degrees at 7 knots.

1.8 Aids to navigation

HL5234 used the instrument landing system and ILS/DME to approach and land on the Muan Airport runway 19 and there was no record of malfunction of the system.

1.9 Communications

According to the cockpit voice recorder of HL5234 and the record of air traffic control communications, there was no two-way communication failure between pilot crew and Muan Control Tower controller.

1.10 Aerodrome information

The Muan Airport runway 01/19 is paved with asphalt, and 2,800 m long and 45 m wide, and the width of the runway shoulder is 7.5 m.

Both directions of runway 01/19 are equipped with ILS/DME, high-intensity runway lights, runway centerline lights), approach lights of an ALSF-Ⅰ[13] type, and PAPI, and CAT-I precision approach is possible.

The point where HL5234 started to veer off to right after touchdown on the runway was about 940 m from the threshold of runway 19, and the point where it excursed from the runway was about 1,034 m, and the trace and place of excursion are as shown in [Fig. 4] and [Fig. 5].

13) Approach Light System with Sequenced Flashing Lights

[Fig. 4] Tire marks and excursion direction shown on the runway

[Fig. 5] Trace on grass after runway excursion

1.11 Flight recorders

1.11.1 Flight data recorders

The HL5234 aircraft was equipped with a flight data recorder of an IC memory type, which was manufactured[14] by Speel Company of Praha in the Czech Republic and can record for at least 120 minutes. The parameters of the flight data recorder were 80 in all, and the major parameters used for analysis of the incident are as shown in [Table 2].

[Table 2] Major parameters of the flight data recorder

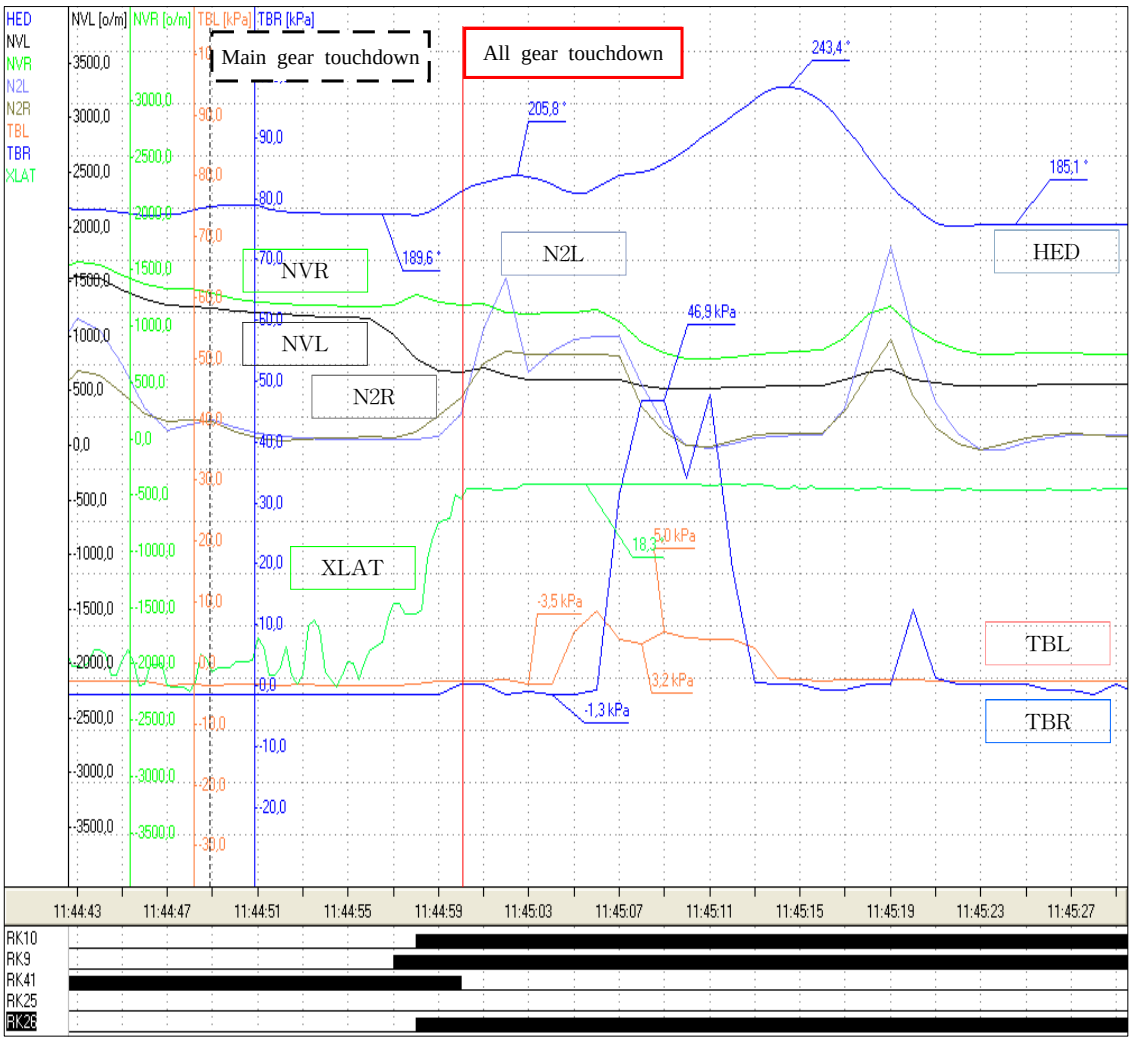
Parameter Name	Parameter Content
HED	Heading
NVL	L/H engine propeller RPM
NVR	R/H engine propeller RPM
N2L	L/H Generator speed
N2R	R/H Generator speed
TBL	L/H Brake pressure
TBR	R/H Brake pressure
XLAT	Rudder displacement
MKL	Left engine torque
MKP	Right engine torque
RK9	L/H Propeller control lever in position FEATHER
RK10	R/H Propeller control lever in position FEATHER
RK25	L/H Engine BETA CONTROL signaling on
RK26	R/H Engine BETA CONTROL signaling on
RK41	AIR/GROUND Sensor (active-AIR, inactive-GROUND)

On 11 September 2010, the ARAIB sent two investigators to the manufacturer Speel Company of the flight data recorder located in Praha of the Czech Republic. They took out the data of the flight data recorder and analyzed the data together with a newly appointed representative of the Czech accident investigation agency and the experts of the aircraft manufacturer.

And on 14 December 2010, the investigators of our ARAIB and the Czech accident

14) P/N ; FDR 59B-L, S/N : 51PP, Circuit part's S/N : 51SKM-B

investigation agency, and the experts of the aircraft manufacturer and propeller manufacturer held a technical meeting for the flight data recorder data analysis at the aircraft manufacturing company.



[Fig. 6] Major parameters of the flight data recorder

If we take a look at RK9 and RK10 in [Fig. 5], the left propeller control lever (PCL) went to the feather position at 11:45:57, and the right propeller control lever went to the feather position[15].

In the RK25 and RK26 parameters, we can see that the right BETA control signaling came on[16] at 11:44:58 and the left BETA control signaling did not come on from the

15) The left propeller control lever position was released at 11:53:16, and the right propeller control lever position was released at 11:53:17 (when movement started again).

16) The right reverse thrust operating signal was released at 11:53:17 (when movement started

beginning. And in RK41 parameter, the AIR/GND mode was changed to the GND mode[17] at 11:45:00.

In the XLAT parameter, from the time when the main landing gear touched down, the rudder began to be used to the right, and from the time when the front landing gear touched down to the time when the aircraft touched down, it was continuously used[18] to the left to maximum.

In the HED parameter, the initial touchdown was made in the direction of runway (189°), but when the reverse thrust was used, the aircraft nose turned to right, and immediately after the reverse thrust lever returned, but the aircraft nose continued to turn right again as the brake was working strongly.

In the TBL and TBR parameters, the left brake operated weakly from 11:45:04 to 11:45:14, and the right brake operated very strongly from 11:45:06 to 11:45:13.

In the N2L and N2R parameters, the left and right generator RPMs were maintained almost identically, which is evidence that the left and right thrust levers were moved together side by side.

In the NVL and NVR parameters, the left propeller RPM started to drop rapidly from 11:44:56, which is 7 seconds later after the main gear landing touched down, and when the front landing gear touched down, the left propeller RPM was 666 and the right propeller RPM 1190.

1.11.2 Cockpit voice recorder

The HL5234 aircraft was equipped with a cockpit voice recorder of an IC memory type, which was manufactured[19] in L3-Communications Company and can record for 30 minutes. The ARAIB dismounted to confirm the record from the time when the aircraft left the initial approach fix (IAF) to the time when it veered off and stopped on the runway.

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again.

17) The GND mode means all landing gear touched down, and the main landing gear touched down at 11:44:49.

18) It was used up to 18.3° and started to decrease at 11:53:13 (when movement started again).

19) Item: FA2100, P/N : 2100-1029-02, S/N 314366

1.12 Wreckage and impact information

In this incident, the aircraft moved on the runway and to the parking spot by its own power after it veered off the runway, and there was no physical damage to the aircraft.

1.13 Medical and pathological information

At the time, the captain was under treatment using splint due to damage to the ligament of his left angle that occurred during his exercise in June 2010, and he was wearing support footwear on his left foot for activity improvement.

According to the opinion of the aviation medical doctor in charge, it was judged that his flight duty performance was possible with support device worn to support muscle power since the damaged portion had no trouble in moving the control-related devices.

1.14 Fire

There was no fire in this incident.

1.15 Survival aspects

There were no facts relevant to survival aspects in this incident.

1.16 Tests and research

1.16.1 Ground tests

In the morning on the next day after the incident, the flight crew and maintenance personnel got on the aircraft to check the high-speed taxiing and reverser operating condition, and confirmed that there was nothing abnormal in the reverser.

On 20 October 2010. Ace Air conducted ground tests on 16 items related to the engine and propeller as recommended by the aircraft manufacturer under the supervision of the ARAIB as shown in [Fig. 7], and confirmed all the relevant functions were

within the operation limits. On 21 October, 2010, tests were conducted on the reverser and propeller feathering of the aircraft that was parked. There were no problems with operation and the test data are as shown in [Table 3].

■ Recommendation : perform check of engine and propeller control setting

◇ According procedures in the V510 MM:

- 061.00.10.C - Visual check of the feedback and compound linkage transfering system
- 061.00.10.D - Checking the clearance between carrier slide blocks and the thrust ring
- 061.00.10, PAGES 501-504 - Adjusting the speed governor by element 32
- 061.00.10, pages 519-522 - Checking the max. reverse propeller blade angle adjustment
- 061.20.01, pages 521-524 - Check adjustment of micro switch "V" on governor by elements 27, 38 and 62

◇ According procedures in the Walter M601E MM:

- 76.10.00.a - Checking and adjustment of basic position of the engine control lever on the LUN 6590.05-8 FCU
- 76.10.00.b - Checking and adjustment of the "V3" clearance
- 76.10.00.e - Checking and adjustment of the airframe pull rod length
- 76.10.00, pages 508 - Checking and adjustment of the coincidence of the double-lever mark with the mark on the double-lever bracket

◇ According procedures in the L410UVP-E20 aircraft MM:

- 076.10.00.A - Functional check of the TCL and PCL(POINT 3.1, 3.2)
- 076.10.00.D - Adjustment of engine control cable tension
- 076.10.00.F - Check fo the engine control kinematics adjustment, check of the calibration of the adjustable stop of take-off power

◇ According procedures in the V510 MM:

- 061.00.10, pages 601-603 - Checking the basic adjustment

◇ According procedures in the Walter M601E MM:

- 76.10.00.c - Functional check of the manual control lever for propeller blade adjustment on the propeller regulator

◇ According procedures in the V510 MM:

- 061.00.10, page 525-526 - Checking the secondary stop and the Beta-control system
- 061.00.10, page 537-542 - Ground test of the propeller unit
- 061.00.10, page 545-550 - Flight test

[Fig. 6] Aircraft manufacturer recommendations

[Table 3] Engine start test data

Classification	Propeller RPM		Torque	
	Left propeller	Right propeller	Left torque	Right torque
TCL Idle[20] and Prop Fine [21]	950	970	9.5	10
TCL Idle and Prop Idle[22]	950	980	11	10
TCL Idle and Prop Feather[23]	400	400	20	19
Prop Fine and TCL BETA[24]	1,100	1,150	20	19

1.16.2 Simulator tests

On 13 December 2010, the ARAIB investigator got on the L410 simulator in the L410 aircraft training center (LET'S FLY) located in Ostravar, the Czech Republic, to confirm how the "BETA RANGE" was displayed in the order of using the thrust control lever and propeller control lever when reverse thrust is used, and whether the pedal steering was operating continuously when the steering mode switch was cycled with the rudder pedal kicked to either side to maximum.

In this test were checked ① whether the "BETA RANGE" was displayed with the thrust control lever set first at the reverse thrust position and the propeller control lever set at the feather position, ②whether the "BETA RANGE" was displayed with the propeller control lever set first at the feather and the thrust control lever set at the reverse thrust position, and "BETA RANGE" lights came on.

20) Thrust Control Lever at idle position
21) Condition in which the propeller angle of attack is lowest
22) Condition in which the propeller angle of attach is highest
23) It takes 5 seconds for feathering
24) Position at which BETA signal comes on (Reverse thrust starts to work)

And when the steering mode switch brought to and back from the pedal steering position to manual steering position with the rudder kicked to either of the left and right sides to maximum, we confirmed that the pedal steering was continuously operating without interruption.

1.17 Organizational and management information

Registering aircraft using business and domestic air transport business, Ace Air is doing chartered transport and tour flight businesses and Gimpo/Muan domestic air transport business.

At the time of the incident, Ace Air had one aircraft of a L410 type and the flight crew for operation of this aircraft completed education and training in accordance with the Flight Crew Training Regulations (approved by Seoul Regional Aviation Administration on 17 November 2009).

1.18 Additional information

1.18.1 Flight crew statements

The captain stated, "Seeing that the aircraft nose started turning right, I immediately stopped operation of the reverser while kicking the left rudder pedal to maximum. But thinking a bigger problem could be caused if I tried to get into the runway by force as the aircraft nose did not turn back and the aircraft got out of the runway eventually, I feathered both propellers and did my best to stop the aircraft safely by using both brakes," adding, "Seeing the aircraft nose changing abruptly, I acted on it immediately by holding the rudder and reverse thrust lever, but I think I did not make it clear to the copilot that I should take over the controls."

The copilot stated: 「Seeing the aircraft nose turning right abruptly, I kicked the left rudder to maximum immediately, and stopped the operation of the reverser. As the

nose won't come back, I judged there should be something wrong with the nose steering switch so I quickly brought the nose steering switch that was at the pedal steering switch manually and returned it back again, but the nose did not come back.

The captain seemed to yell and touch the thrust lever, wheel and rudder pedal, so I thought he took over the control, and I kept only the left rudder kicked to maximum. When I used reverse thrust, I saw all the "BETA RANGE" lights on.」

2. Analysis

2.1 General

The HL5234 aircraft flight crew members held qualifications and certificates proper to the relevant flight, and the aircraft held a valid airworthiness certificate.

The flight had takeoff carried out within proper weight and balance limits, and any evidence that the flight crew fatigue, aircraft system trouble or meteorological factors that are judged to have affected the incident was not found.

2.2 FDR analysis

Both TCLs were moved to the reverse thrust position simultaneously to actuate reverse thrust, and at this time both PCLs were moved to the feather position as well.

The right reverse thrust worked but the left reverse thrust did not work. The analysis is that the reason for the left reverse thrust not working is because the feathering signal arrived sooner than the reverse thrust signal, and the reason for the right thrust working is because the reverse thrust signal arrived sooner than the feathering signal.

As the nose direction started to turn right, the left rudder was used to maximum immediately. But although the rudder was used to the right to maximum, the direction of aircraft nose did not return. It is judged that this is because the ability of pedal steering was not sufficient enough to prevent an asymmetric thrust.

The analysis is that after the aircraft got off the runway, the left brake rather than the right brake worked very strongly so that the aircraft heading continued to turn right.

2.3 Pilot performance

2.3.1 Operation of TCL and PCL

According to the results of analyzing the situation at the time when the HL5234 aircraft landed and the data of the flight data recorder, it is judged that almost at the same time when the thrust control lever went to the reverse thrust position after the aircraft landed both of the propeller control levers moved to the feather position, and as a result, different commands were given to the left/right propeller speed governor.

Therefore, the feathering signal arrived at the left propeller sooner, so it became feather condition, and because of this, the reverse thrust did not work. On the other hand, at the right propeller, the reverse thrust signal arrived sooner, so the reverse thrust worked. After all, reverse thrust worked only at the right side, so an asymmetric thrust was generated to cause the aircraft nose direction to change rapidly to the right side.

According to the reverse thrust using procedures of the Flight Manual, it is specified that「The flight crew member shall move the TCL smoothly to a desired reverse thrust position after he confirms the use of reverse thrust is all ready (when BETA Range cell comes on)」

At the time, the flight crew members saw the aircraft nose direction was turning sharply at the moment when they operated reverse thrust, so they immediately pushed the left rudder to maximum to return the TCL, but it is presumed because the ability of pedal steering was not sufficient enough to resist asymmetric thrust, the aircraft got off the runway eventually.

The Flight Manual specifies "When operating reverse thrust, the PCL must be at 'Fine Pitch'."

The captain stated that in order to prevent the aircraft nose from turning to right abruptly, he returned the TCL before he set PCL at the feather position.

But according to the flight data recorder data, almost at the same when the TCL moved to the reverse thrust position, the PCL was moved to the feather position, and this was analyzed to have affected non-operation of the left reverse thrust.

According to the data of the flight data recorder of the aircraft on which the captain flew before the flight concerned, it was confirmed that only feather was operated without reverse thrust operation on the runway after landing. Regarding this, the captain stated that he did so at normal times to reduce speed after landing and shorten the landing distance, and shorten the idling operation time for engine stop.

Therefore, it is reckoned from the flight data recorder data and captain's statement that the PCL's going to the feather position almost at same time when the copilot operated reverse thrust is an effect of the captain's usual landing habit.

In addition, that there was no discussion for operation of reverse thrust in the pre-landing briefing, and that there was no standard call-out procedures for the use of reverse thrust could have affected this, so it is judged to be necessary that relevant procedures are made and applied.

2.3.2 Directional control and control transfer

The copilot stated that the captain returned the thrust control lever kicking the left rudder as he saw the aircraft nose changing abruptly, but when the captain scolded him in a loud voice he thought the captain should have taken over the control, so he did not fly the aircraft any longer. And the captain stated that although he took countermeasures holding the rudder and thrust control lever immediately as he saw the aircraft nose changing abruptly, it seemed he did not make it clear that he should take over the control.

There should be no control vacuum in flight. For this, it should be made clear at

all times who is PF, and in case of an emergency, the captain should take over the controls. Especially when control is transferred, it is desirable that takeover/handoff of control should be made clearly by using the wording "You have control" or "I have control." But we could not find from the recording of the cockpit voice recorder any voice recording about control transfer between the flight crew members when the aircraft nose direction changed abruptly.

Seeing the aircraft nose direction was turning abruptly at the moment when the flight crew members were operating reverse thrust, they promptly returned the TCL lever by pushing the left rudder to maximum. But despite that the aircraft nose direction did not return, proper counteraction such as asymmetric brake operation using the left brake was not taken. This seems to be because there was an unexpected change of aircraft nose direction in a short time.

The ability of applying proper counteraction in time is different by pilot's personal experience and skill. Therefore, education and training of flight crew members at normal times could be helpful. Also, even if a copilot is in charge of flying, the overall responsibility for aircraft control rests with the captain, so the captain should be prepared at all times so as to promptly cope with an emergency situation.

The captain stated that he tried to stop the aircraft by using brake to maximum immediately before the aircraft got off the runway, but judging it would be safer to stop the aircraft than to make the aircraft get back into the runway as the aircraft got off the runway eventually, he concentrated on stopping the aircraft.

According to the flight data recorder data, the right brake worked much stronger than the left brake at the time, and because of this the aircraft nose direction did not return but turned to right more sharply. This is judged to be that because both brakes were used with the left rudder pushed to maximum relatively more load was applied to the right brake. Also, it is not excluded that it could be affected by the fact that the captain was wearing support footwear on the left foot at the time due to damage to his left ankle ligament portion.

3. Conclusions

3.1 Findings

1. The HL5234 flight crew members held qualification certificates proper to the flight, and the aircraft held a valid airworthiness certificate.

2. The flight had takeoff carried out within the limits of proper weight and balance, and any evidence that flight crew fatigue, aircraft system malfunction or meteorological factors that could have affected the incident was not found.

3. The Flight Manual specifies that "When using reverse thrust, the PCL must in the 'fine' position."

4. When the thrust control lever moved to the reverse thrust position, almost simultaneously the propeller control lever went to the feather position. When the left and right thrust control levers moved to the reverse thrust lever, both levers were moved in parallel.

5. The left reverse thrust did not work. This is because the feathering signal reached earlier than the reverse thrust signal. Also, the reason that the right reverse thrust worked is because the reverse thrust signal reached earlier than the feathering signal.

6. Because asymmetric thrust was generated between two engines the aircraft nose direction turned to right abruptly.

7. The flight crew members saw the aircraft nose direction turning abruptly at the moment when they used the reverse thrust, they kicked the left rudder immediately and returned the thrust control lever. But they did not take proper counteraction such as asymmetric brake operation that uses the left brake.

8. From the time when the aircraft nose direction started to turn to right, the rudder was used to maximum, but the aircraft nose direction did not return. This was because the steering ability was not sufficient enough to prevent an asymmetric thrust.

9. With an asymmetric thrust generated, while the right brake was working very strongly compared with the left brake, the aircraft nose direction turned to right all the more rapidly.

10. In an abnormal situation, the captain should fly the aircraft personally, and when he hands over the control, it is desirable to make handoff/handover of duty clearly by using the terms “You have control” or “I have control”, but we could not find the voice record from the cockpit voice recorder about handover of control between flight crew members when the aircraft nose direction changed abruptly.

11. The standard call-out procedures about using reverse thrust were not established.

12. In the morning on the next day after the incident, the flight crew members and a maintenance person boarded the aircraft and checked the high-speed taxiing and the reverse thrust operating condition on the Muan Airport runway, and in this check it was confirmed that there was nothing wrong with the reverser. Also it was confirmed by on-ground check on 16 items related to the engine and propeller as recommended by the aircraft manufacturer that all the relevant functions were within the operation range.

13. In the check on the simulator, when the propeller control lever was set at the feather first and the thrust control lever was set at the reverse thrust position, the "BETA RANGE" was displayed; and with the rudder kicked to maximum to either of the left and right sides, when the steering mode switch went to and came back from the manual steering position, it was confirmed the pedal steering operated without interruption.

14. At the time the captain wore support footwear on the left foot for treatment of the damage to the ligament of his left ankle, and the aviation medical doctor in

charge judged in his opinion that performance of flight duty was possible with the support device worn, and this fact was reported to the Seoul Regional Aviation Administration.

3.2 Causes

The ARAIB determines the causes of the incident as follows.

When the flight crew members moved both TCLs to the reverse thrust position to use reverse thrust after the aircraft touched down, they did not set both PCLs at the fine position as specified in the Flight Manual, but moved them to the feather position, so reverse thrust was generated at the right propeller but not at the left propeller, so asymmetry occurred between left and right thrust of the aircraft.

4. Safety recommendations

On the basis of the findings from the incident of the HL5234 aircraft that occurred at Muan Airport on 3 September 2010, the ARAIB issues safety recommendations as follows.

To Ace Air

1. Reinforce education so that the flight crew members are fully familiarized with the contents of the L410 aircraft systems and Flight Manual. (AIR-1005-1)

2. Establish and implement detailed procedures for standard call-out about reverse thrust operation and hand-over of control between flight crew members. (AIR-1005-2)