AIRCRAFT SERIOUS INCIDENT REPORT

MULTI TIRE DISINTEGRATION DURING TAKEOFF ROLL
SOUTHERN AIR INC.
B747-300SF, N749SA
INCHEON INTERNATIONAL AIRPORT
4 MAY 2010

14 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, Multi Tire Disintegration during Takeoff Roll, Southern Air Inc., U.S.A. B747-300SF Freighter, N749SA, Incheon International Airport, 4 May 2010. Aircraft Serious Incident Report ARAIB/AIR-F1001. 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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Multi Tire Disintegration during Rolling Takeoff

Southern Air Inc., U.S.A.
B747-300SF Freighter
N747SA
Incheon International Airport, Republic of Korea
4 May 2010 at about 23:21 (14:21 UTC)[1)]

Synopsis

On 4 May 2010 at about 23:21, a Southern Air B747-300SF (Registration N749SA, Freighter, hereinafter referred to as "Flight 720 Freighter") performing flight SO720 from the Incheon International Airport, the Republic of Korea to Anchorage International Airport, the United States, had two tires of the left main body gear disintegrated[2)] at a speed of about 150 knots during takeoff rolling, so the captain rejected the takeoff immediately just before the V1 speed[3)].

A total of three flight crew including the captain were aboard the Flight 720 Freighter but there was no injury to personnel. But by the fragments of damaged tires, the left body gear door was damaged, the number 1 hydraulic return line was cut, a part of left fuselage skin was slightly dented, and while the Flight 720 Freighter was holding on taxiway M5 after vacated the runway, the thermal fuse plugs of the wheels[4)] were activated, so the twelve (12) main body and wing gear tires were deflated.

The ARAIB determined as probable causes of this incident that 「The number 5 tire ruptured as the tire pressure increased due to the heat originating from the accumulated high temperature and an additional load caused by an imbalance of the diameter between number 5 tire and number 6 tire while the flight 720 freighter was moving a long distance for takeoff, and the number 6 tire ruptured because it could not bear all the load that the number 5 tire had to receive after it had ruptured.」

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1) Unless otherwise indicated, all times in this report are the Republic of Korea standard time (KST, UTC + 9)
2) This aircraft was installed with a total of 18 tires (two for nose gear, four each for left and right wing gear, and four each for left and right main body gear), of which the forward two (number 5 and 6) of the left main body gears were damaged.
3) Takeoff decision speed (V1): 164 knots, actual rejected takeoff speed: 160 knots
4) The wheel has six thermal fuse plugs; when the tire temperature increases to more than 146 ℃, the fuse melts to reduce pressure so as to prevent the tire from rupture.

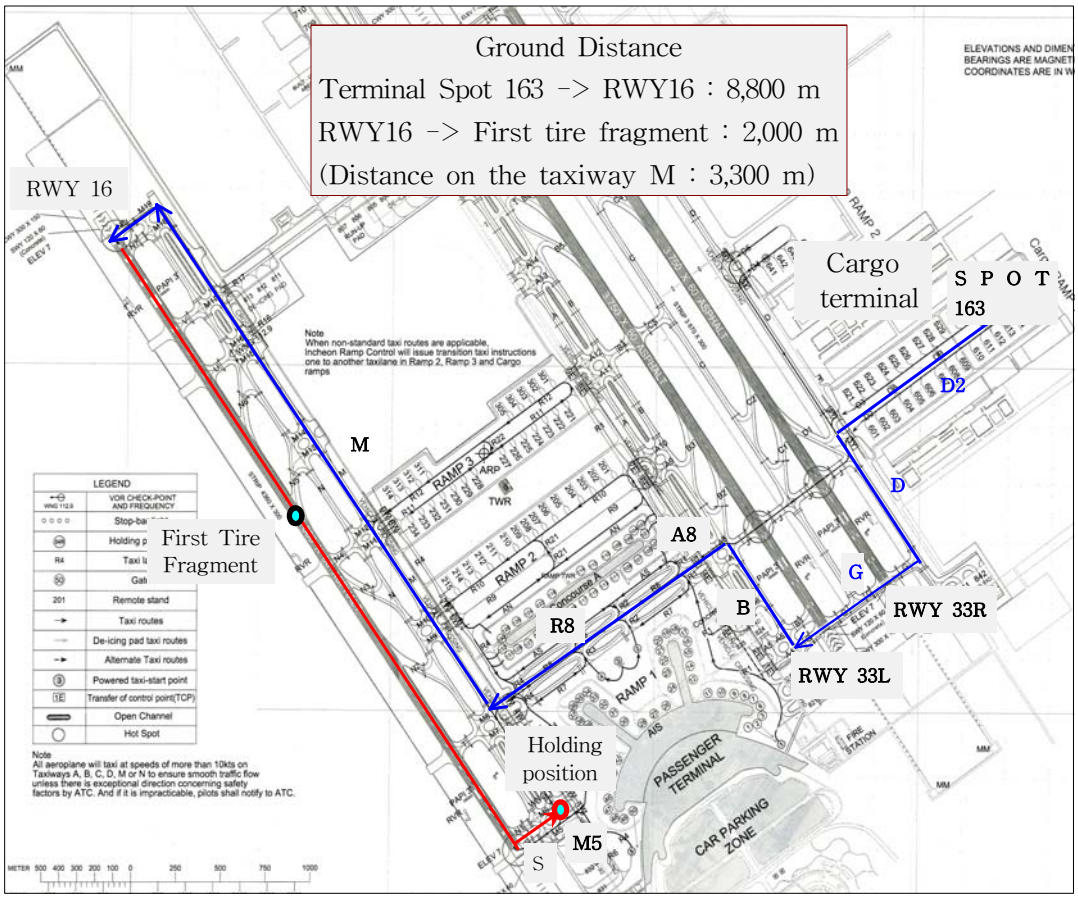
And the contributing factors are that「① Because the number 6 tire tread was worn out relatively more than that of the number 5 tire it had the load added. ② The flight crew members were not aware of the relevant information that the tire could suffer a serious heat damage when the aircraft makes a long-distance landing roll.」

On the basis of the findings, the ARAIB issued safety recommendations to the Southern Air Inc. and the Boeing Company.

1. Factual Information

1.1 History of Flight

The Flight 720 Freighter with three flight crew[5] departed[6] the spot 163 in the cargo terminal of the Incheon International Airport at about 22:55, arrived at the takeoff position of the runway 16 via taxiways D2, D, G, B, A8, R8 and M as shown in [Fig. 1], and then started takeoff rolling at about 23:21.



[Fig. 1] Taxi route and distance

The first officer was PF (pilot flying) and the captain was PM (pilot monitoring). The captain was holding the thrust levers while the first officer was executing takeoff according to the Flight Manual. At the time of the takeoff rolling, the aircraft was in a condition of almost maximum allowable takeoff weight.[7]

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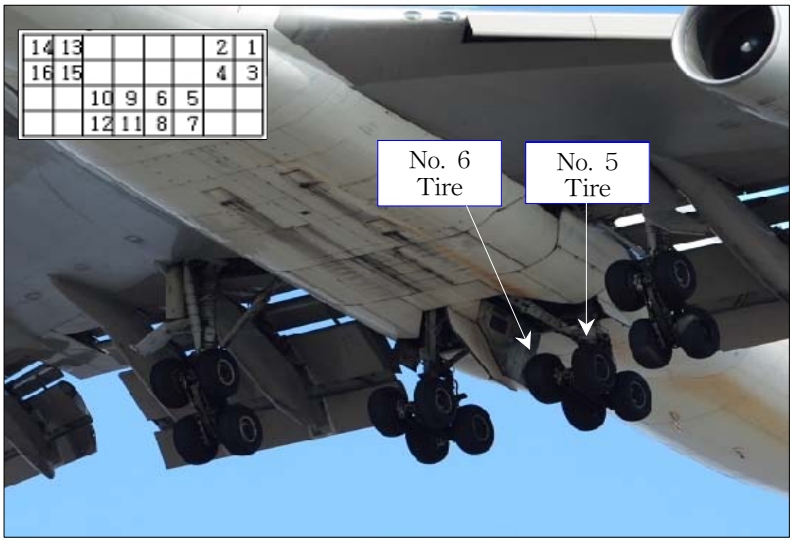
5) Captain, first officer, flight engineer
6) The Flight 720 Freighter arrived at Incheon International Airport at 07:10 a.m. on that day.
7) Maximum Allowable Takeoff Weight: 833,000 lbs, Actual Takeoff Weight: 832,063 lbs

At about 23:22, when the airspeed passed about 150 knots during the takeoff roll, two of the left main body gear tires blew out and the flight crew felt the aircraft shaking up and down severely. The captain decided to reject the takeoff right away, and taking over the control, reduced the thrust levers to idle position at 159.6 knots, and slowed the airspeed by using maximum manual brake and reverse thrust.



[Fig. 2] positions of the damaged two tires

After vacating the runway through taxiway S connected to the end of the runway, the captain stopped the aircraft on taxiway M5. While the aircraft was holding, the tire temperature rose to activate the thermal Fuses mounted on the wheels, and due to this, air leaked out completely from 12 tires except two tires[8] out of the remaining 14 tires. The Flight 720 Freighter was towed to the parking ramp after all of the damaged tires were replaced.

1.2 Injuries to Persons

Injuries	Crew	Passenger	Others
Fatal	0	0	0
Serious	0	0	0
Minor / None	3	0	0

8) Number 2 and 4 tires

1.3 Damage to Aircraft

The Flight 720 Freighter had the forward two tires (number 5 and 6) of the left main body gear failed as shown in [Photo 1], and the left wheel well door was damaged by the collision with the damaged tire fragments, and number 1 hydraulic return line was cut out, and the number 5 and 6 wheels were abraded by friction with the runway. And the thermal Fuses of the wheels were activated so pressure leaked out from 12 tires.

[Photo 1] Damaged number 5 and 6 tires

1.4 Other Damage

In the process of vacating the runway after the rejected takeoff, five (5) taxiway centerline lights were broken.

1.5 Personnel Information

1.5.1 The Captain

The captain (age 57, male), an American, held a valid Airline Transport Pilot License[9], B747-300 Type Rating, Class 1 Medical Certificate[10], and Radio Operator Certificate[11].

9) Qualification number: FAA, 2122680(24 February 2008)
10) Date of check: 26 April 2010

The captain's total flying time was 20,909 hours including 3,680 hours on B747-300, 878 hours as captain on B747-300, 131 hours for the latest three months, and 33 hours for the latest one month. He completed a proficiency check and a line check in January 2010.

1.5.2 The First Officer

The first officer (age 30, male), an American, held a valid Airline Transport Pilot License[12], B747-300 Type Rating, Class 1 Medical Certificate[13], and Radio Operator Certificate[14].

The first officer's total flying time was 16,641 hours including 641 hours as first officer on B747-300, 183 hours for the latest three months, and 64 hours for the latest one month. He completed a line check in May 2008 and a proficiency check in October 2009.

1.5.3 The Flight Engineer

The flight engineer (age 62, male), an American, held a valid Flight Engineer License[15], Aircraft Maintenance Mechanic License[16], Type Rating[17], Class 2 Medical Certificate[18].

The total flying time of the flight engineer was 22,002 hours including 16,713 hours on B747-300, 174.2 hours for the latest three months, and 54.3 hours for the latest one month. He completed a line check in June 2008 and a proficiency check in September 2009.

1.6 Aircraft Information

1.6.1 Aircraft History

The Flight 720 Freighter was manufactured[19] by the Boeing Company in October

11) Issued by the Federal Communications Commission of the United States
12) Qualification number: FAA, 552763658
13) Date of check: 22 April 2010
14) Issued by the Federal Communications Commission of the United States
15) Qualification number: FAA, 561555150 (9 June 2008)
16) Airframe, Powerplants
17) Turbo Jet
18) Check date: 2 September 2009

1988, and was operated by the Korean Air and the Cargo 360 before the Southern Air operated it since 31 December 2009.

The Flight 720 Freighter held a valid airworthiness certificate[20]. The total service time was 74,598 hours, and the number of takeoff and landing was 13,209 cycles. A C-CHECK was carried out in December 2009, and a D-CHECK was planned for June 2014.

1.6.2 Weight and Balance

The weight and balance data of the Flight 720 Freighter are as follows:

- Basic Operating Weight (BOW).... 350,231 lbs (including 240 lbs for crew)
- Payload..... 224,832 lbs
- Zero Fuel Weight (ZFW)..... 575,063 lbs (max. 590,000 lbs)
- Total Ramp Fuel..... 260,000 lbs
- Taxi Gross Weight..... 835,063 lbs (max. 836,000 lbs)
- Taxi-out fuel ..... 3,000 lbs
- Takeoff Weight (TOW)..... 832,063 lbs (max. 833,000 lbs)
- Trip Fuel (TIF)..... 215,978 lbs
- Landing Weight (LDW)..... 616,085 lbs (max. 630,000 lbs)
- Takeoff Weight Center of Gravity..... 20.2 % MAC

1.6.3 Takeoff Performance Data

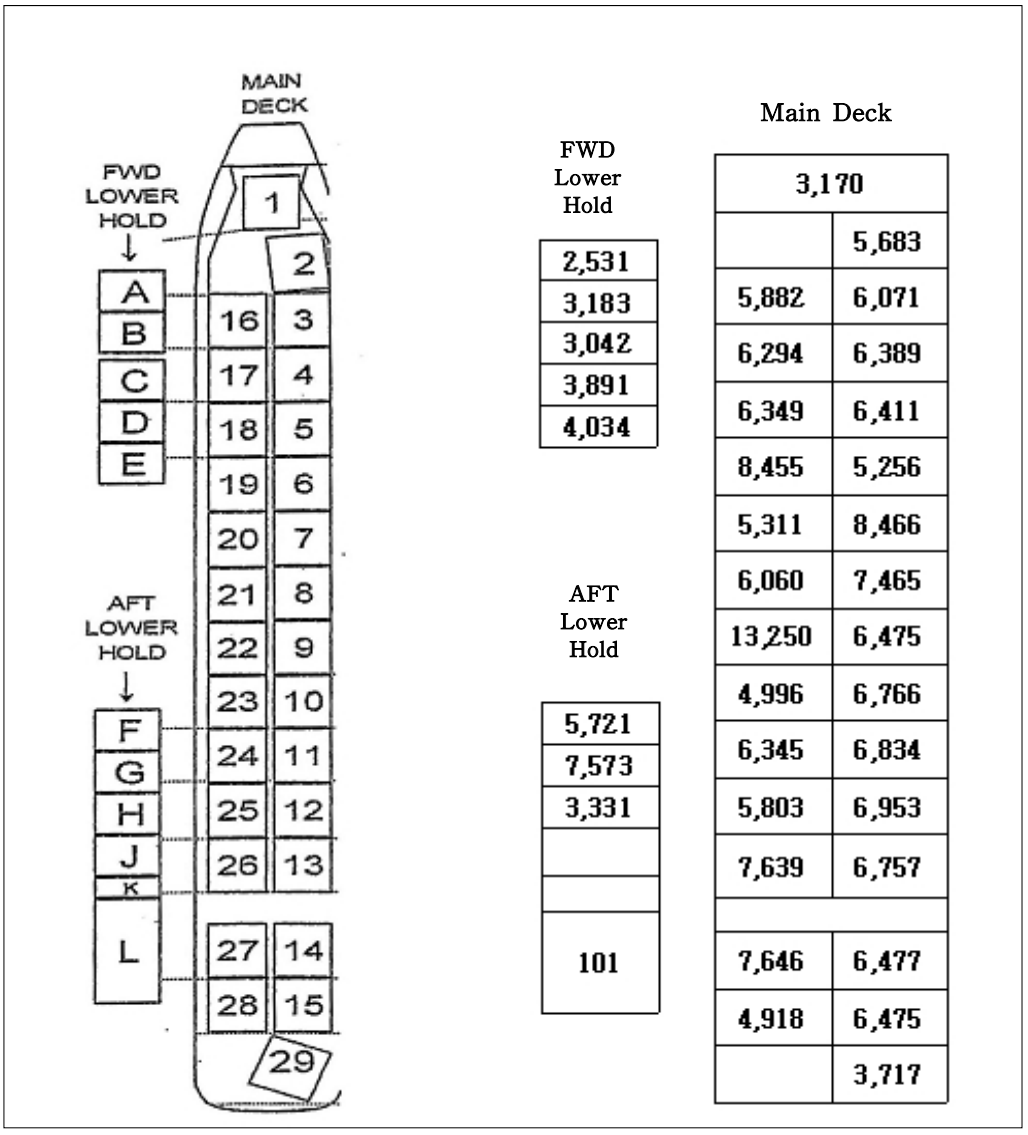
The takeoff performance data of the Flight 720 Freighter are as follows:

- Takeoff runway..... Incheon International Airport (Runway 16)
- Takeoff weight..... 832,063 lbs
- Takeoff thrust..... 1.540 (Max EPR)
- Takeoff flap..... FLAP 10
- Takeoff speed ..... V_1: 164 knots, V_R: 177 knots, V_2: 188 knots

19) Manufacturing number: 24194
20) Number: EA-FSDO-63 (issued on 18 March 2006)

1.6.4 Cargo Loading

The cargo loading position and payload of the Flight 720 Freighter are as shown in [Fig. 3]. On the Flight 720 Freighter were loaded dangerous goods of Class 2.1[21] and Class 9[22] [23] in the main deck and lower deck, and the flight crew confirmed this.



[Fig. 3] Cargo loading position and payload (lbs)

21) Aerosols (Flammable Non-Radioactive)

22) Engines (Internal combustion, flammable liquid powered), vehicles (flammable liquid powered)

23) Dangerous goods are classified into nine (9) classes.

1.6.5 Damaged Tires and Wheels Information

1.6.5.1 Damaged Tires

The damaged two wheels/tires were of the number 5 and 6 tires mounted on the forward of the left main body gear. According to the Southern Air's maintenance records, the related information is as shown in [Table 1].

Classification		No. 5 Tire	No. 6 Tire
Original	Part Number	491K49G2	491K49G2
	Serial Number	80935005	81151132
	Size, Number of ply	49x19-20, 34 Plies	49x19-20, 34 Plies
	Place Mfg.	Thailand	U.S.A.
Retread	Year Retread	November 2009	March 2009
	Place Retread	Goodyear (Kingman, Arizona)	Goodyear (Atlanta, Georgia)
	Times of Retread	1	1
	Date mounted	17 April 2010	5 December 2009
	Number of landings after mounted	42	222
	Tread groove	14/32 inches	9/32 inches

[Table 1] Information of the number 5 and 6 tires

1.6.5.2 Damaged Wheels

The number 5 and 6 wheels information are as shown in [Table 2].

Classification		No. 5 Wheel	No. 6 Wheel
Assembly part number		2603561-52	2607081-3
Inboard half	Part Number	2613555-1	2613555-1
	Serial Number	B-H4598	B-H4414
	Mfg. date	February 2007	December 2006
Outboard half	Part Number	2614195-1	2609114-1
	Serial Number	B-H1569	B-H3889
	Mfg. date	April 1995	August 2003

[Table 2] Information of the number 5 and 6 wheels

1.6.5.3 Tire Specification and Inflation

According to the "Aircraft Tire Data Book" of Goodyear Company, the specifications of the tire (size 49×19.0-20, 34PR, part number 491K49G2) are as follows.

- Tread design: 4 groove, C/L RIB
- Wheel rim designation: 49×17
- Rated Load : 55,700 lbs
- Rated Speed : 245 mph (235 mph for retread)
- Rated Pressure : 215 psi (14.8 bar, at 68°F)

According to the maintenance records of the Southern Air, 195 ~ 200 psi was specified as normal pressure, and the tire inflation data of the Flight 720 Freighter were as shown in [Fig. 4].

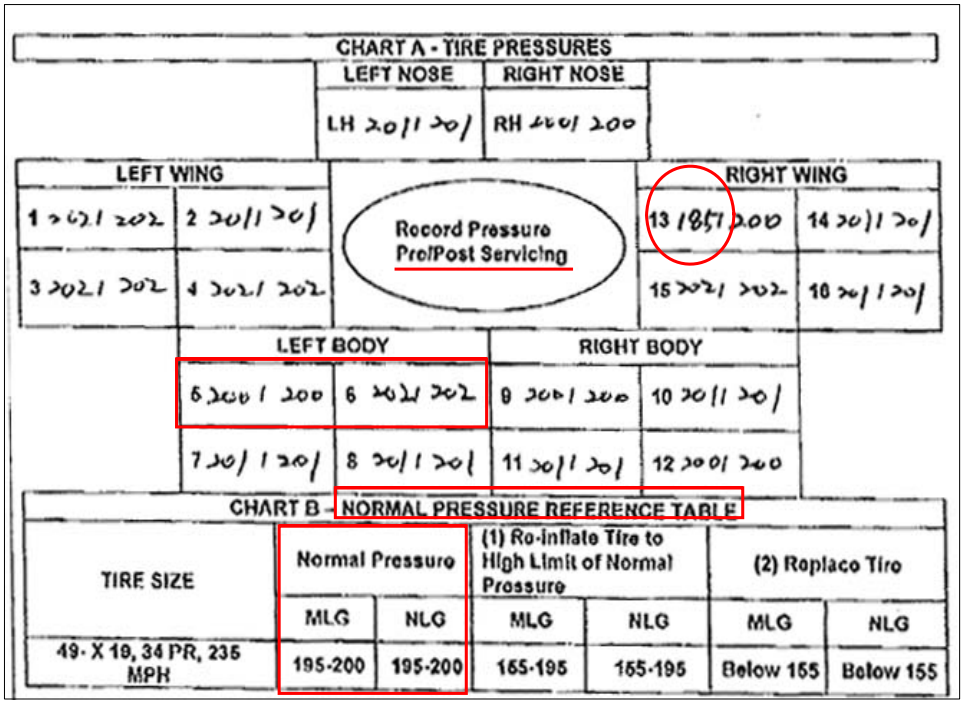


CHART A - TIRE PRESSURES

	LEFT NOSE	RIGHT NOSE
	LH 200/200	RH 200/200

LEFT WING			RIGHT WING	
1 200/200	2 200/200	Record Pressure Pre/Post Servicing	13 185/200	14 200/200
3 200/200	4 200/200		15 200/200	16 200/200

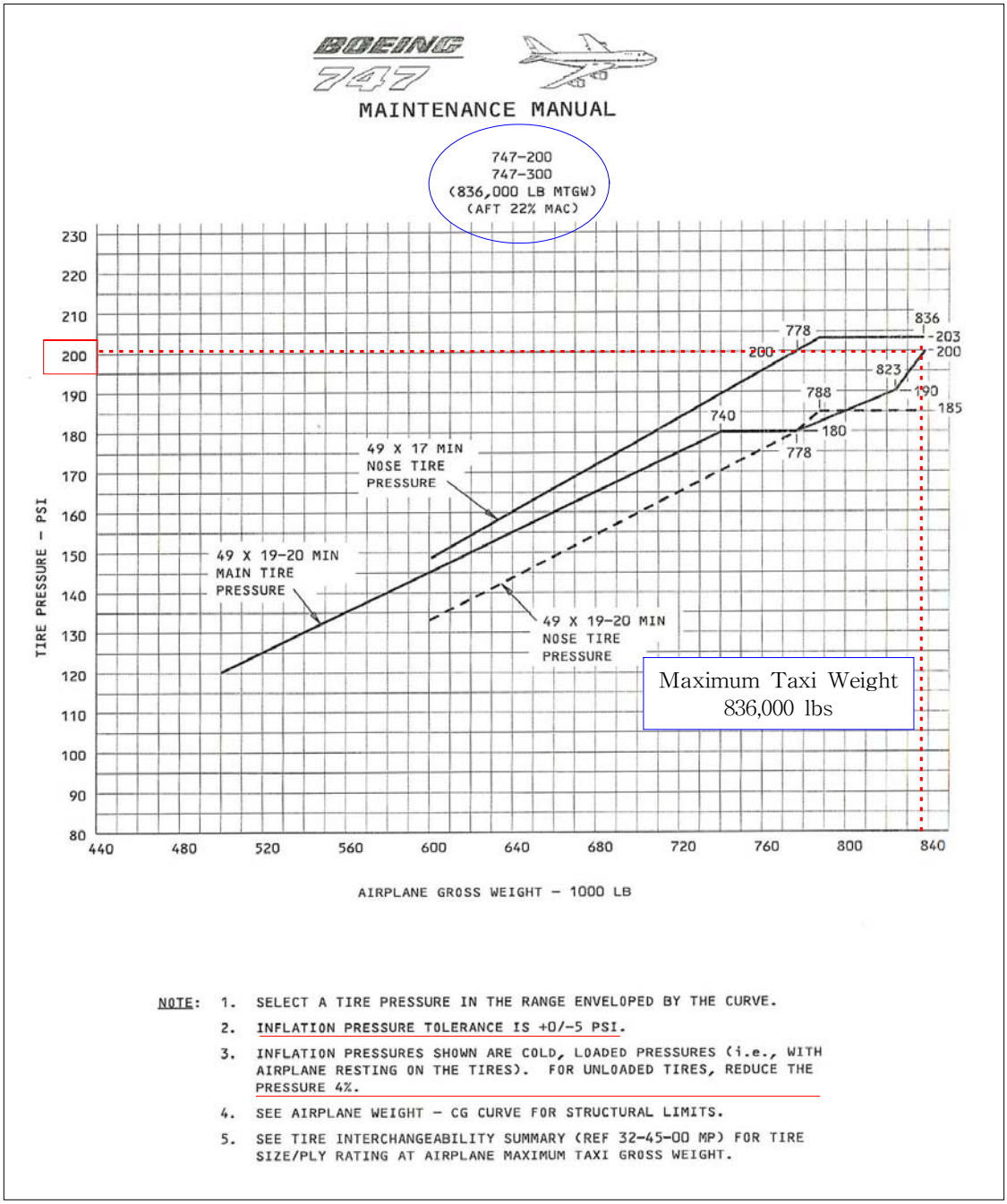
LEFT BODY		RIGHT BODY	
5 200/200	6 200/200	9 200/200	10 200/200
7 200/200	8 200/200	11 200/200	12 200/200

CHART B - NORMAL PRESSURE REFERENCE TABLE

TIRE SIZE	Normal Pressure		(1) Re-inflate Tire to High Limit of Normal Pressure		(2) Replace Tire	
	MLG	NLG	MLG	NLG	MLG	NLG
49- X 19, 34 PR, 235 MPH	195-200	195-200	165-195	165-195	Below 165	Below 165

[Fig. 4] tire inflation reference and actual injection pressure

According to the "Boeing 747 AMM (Aircraft Maintenance Manual)", the minimum service pressure of the 49×19.0-20 tire was as shown in [Fig. 5].



[Fig. 5] Minimum service pressure (12-15-06)

1.7 Meteorological Information

The METAR at the time when the Flight 720 Freighter left the cargo terminal of Incheon International Airport for takeoff was as follows:

METAR RKSI 041400Z 10001 KT 8000 FEW030 BKN150 17/14 Q1012 NOSIG= (Incheon Airport weather observed at 23:00 on 4th: Wind 1kt at 100 degrees, FEW cloud at 3,000ft, BKN cloud at 15,000ft, temperature 17°C / dew point 14°C, sea level pressure 1012 hectopascal, No Significant Change)

1.8 Aids to Navigation

Not applicable

1.9 Communications

After the Flight 720 Freighter was cleared for takeoff, the communications between the air traffic controller and flight crew is as shown in [Table 3].

Time	Communicator	Contents
23:19:12	Pilot	LINE UP AND WAIT RWY 16, SOO 720.
23:20:44	Controller	SOO 720 WIND 140 DEGREES 4 KNOTS RWY 16, CLEARED FOR TAKEOFF.
23:20:51	Pilot	CLEARED TAKEOFF RWY 16, SOO 720 HEAVY.
23:22:25	Pilot	SOO 720, IT'S ABORTING TAKEOFF.
23:22:31	Controller	SOO 720 ROGER.
23:23:03	Controller	SOO 720, VACATE VIA S, HOLD SHORT OF M5.
23:23:08	Pilot	VACATE VIA S, HOLD SHORT OF M5, SOO 720 HEAVY.
23:23:22	Controller	SOO 720 VERIFY. DO YOU HAVE ANY CRITICAL PROBLEM?
23:23:30	Pilot	AFFIRMATIVE, WE'VE LOST OUR HYDRAULICS.
23:23:33	Controller	ROGER, SAY YOUR INTENTION.
23:23:36	Pilot	WE NEED TO HAVE GROUND COME AND CHECK THE AIRPLANE FOR US.
23:23:40	Controller	ROGER, STAND-BY.
23:24:15	Controller	SOO 720 VERIFY, YOU WANNA BACK TO GATE IN?
23:24:18	Pilot	NEGATIVE, WE GONNA NEED TOW BACK INTO THE GATE. WE NEED TUG.
23:24:23	Controller	COPY THAT. I'LL SUMMON TOWING TRAFFIC. REMAIN THIS FREQUENCY.
23:24:27	Pilot	REMAIN WITH YOU, SOO 720.
23:26:55	Pilot	TWR, SOO 720.
23:26:56	Controller	STAND-BY.
23:27:26	Pilot	TWR SOO 720.
23:27:31	Controller	SOO 720 STAND-BY.
23:27:35	Pilot	CAN YOU SEND FIRE DEPARTMENT, PLEASE? WE WANNA CHECK THE AIRPLANE.
23:27:36	Controller	OK, VERIFY STAND-BY, STAND-BY, JUST A MOMENT.
23:28:00	Controller	SOO 720, ICN TOWER, GO AHEAD.
23:29:06	Pilot	WE'RE REQUESTING THE FIRE EQUIPMENT TO CHECK THE LANDING GEAR AND CHECK FOR HYDRAULIC LEAKS UNDER THE AIRPLANE.
23:29:13	Controller	ROGER.
23:29:33	Pilot	SOO 720 ALSO REQUIRE MAINTENANCE BECAUSE WE BELIEVED TO HAVE FLAT TIRES.
23:29:40	Controller	SOO 720, GOOD INFORMATION. WE‘RE JUST ASKING FOR THE TECHNICIAN AND TOWING TRAFFIC.
23:29:47	Pilot	THANK YOU VERY MUCH.

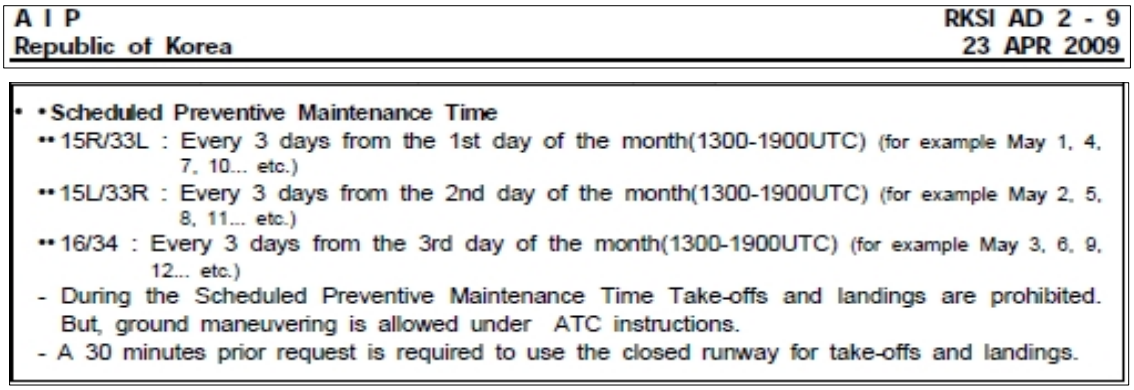
[Table 3] Communications between pilot and controller

1.10 Aerodrome Information

1.10.1 Runway Information

At the time when the Flight 720 Freighter left the cargo terminal, the runway 15R / 33L was closed according to the Incheon International Airport runway 'scheduled preventive maintenance' plan, and the runway 15L / 33R was closed due to runway surface repavement work. So at the Incheon International Airport, only the runway 16/34 was in use for takeoff and landing.

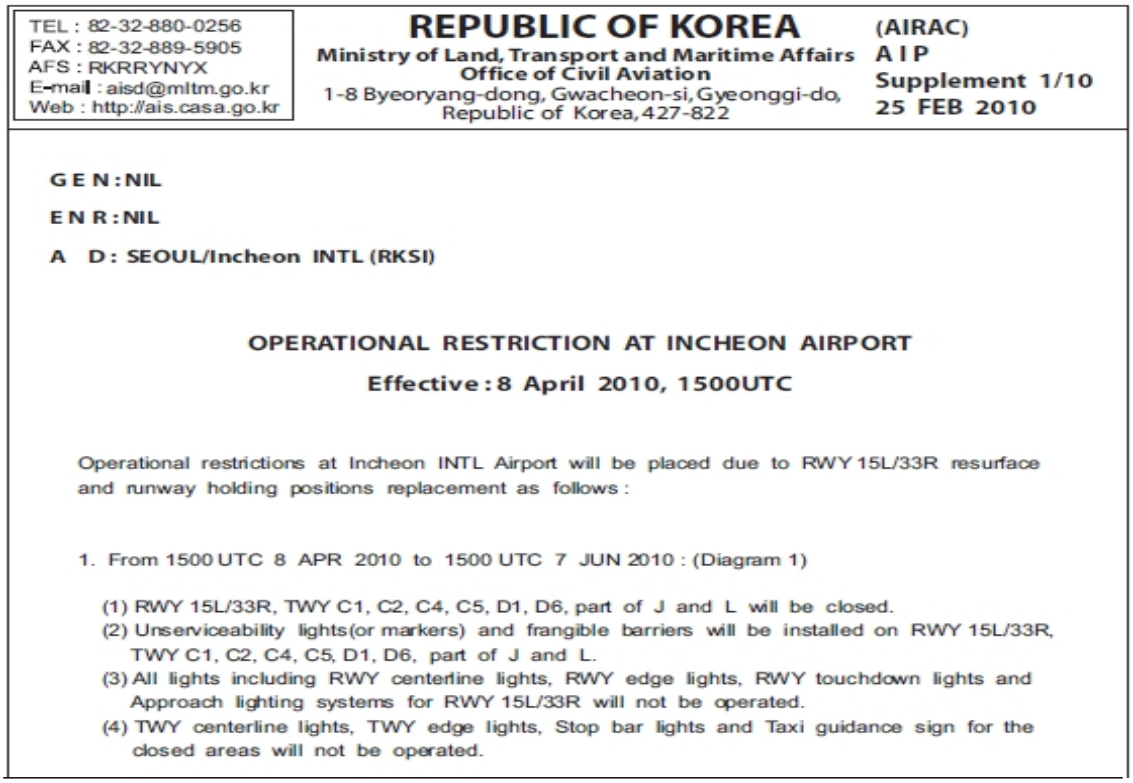
As shown in [Fig. 6] ~ [Fig. 8], such information was contained in the Aeronautical Information Publication (AIP) Amendment of the Republic of Korea (Incheon International Airport pages 2-9) dated 23 April 2009 and in the AIP Supplement of the Republic of Korea issued on 25 February 2010. The information for the runway surface repavement work of the runway 15L / 33R was also contained in the TRIGGER NOTAM issued on 30 March 2010.



A I P — RKSI AD 2 - 9
Republic of Korea — 23 APR 2009

- Scheduled Preventive Maintenance Time
  - 15R/33L : Every 3 days from the 1st day of the month(1300-1900UTC) (for example May 1, 4, 7, 10... etc.)
  - 15L/33R : Every 3 days from the 2nd day of the month(1300-1900UTC) (for example May 2, 5, 8, 11... etc.)
  - 16/34 : Every 3 days from the 3rd day of the month(1300-1900UTC) (for example May 3, 6, 9, 12... etc.)
- During the Scheduled Preventive Maintenance Time Take-offs and landings are prohibited. But, ground maneuvering is allowed under ATC instructions.
- A 30 minutes prior request is required to use the closed runway for take-offs and landings.

[Fig. 6] Information for the scheduled preventive runway maintenance



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Republic of Korea, 427-822

(AIRAC)
AIP
Supplement 1/10
25 FEB 2010

GEN : NIL

ENR : NIL

AD : SEOUL/Incheon INTL (RKSI)

OPERATIONAL RESTRICTION AT INCHEON AIRPORT

Effective : 8 April 2010, 1500UTC

Operational restrictions at Incheon INTL Airport will be placed due to RWY 15L/33R resurface and runway holding positions replacement as follows :

1. From 1500 UTC 8 APR 2010 to 1500 UTC 7 JUN 2010 : (Diagram 1)

(1) RWY 15L/33R, TWY C1, C2, C4, C5, D1, D6, part of J and L will be closed.
(2) Unserviceability lights(or markers) and frangible barriers will be installed on RWY 15L/33R, TWY C1, C2, C4, C5, D1, D6, part of J and L.
(3) All lights including RWY centerline lights, RWY edge lights, RWY touchdown lights and Approach lighting systems for RWY 15L/33R will not be operated.
(4) TWY centerline lights, TWY edge lights, Stop bar lights and Taxi guidance sign for the closed areas will not be operated.

[Fig. 7] Information for the runway 15L / 33R closer

```
1003030008 RKRRYNYX
(C1253/10 NOTAMN  A0290/10 NOTAMN
Q)RKRR/QMRTT/IV/BO/A/000/999/3728N12626E005
A)RKSI B)1004081500 C)1004221500
E)TRIGGER NOTAM - AIRAC AIP SUP 1/10 WEF 8 APR 2010 TIL 23 JUN 2010.
RWY 15L/33R RESURFACE AND RWY HOLDING POSITIONS REPLACEMENT.)
```

[Fig. 8] NOTAM related to the Runway 15L / 33R closer

1.10.2 Inspection of the Movement Area

According to the check records of the aircraft movement area in the Incheon International Airport dated on 4 May 2010, the last check of the runway 16/34 was carried out at 22:30, and the check of the taxiways, which the Flight 720 Freighter used for taxiing, was carried out at 16:40 and 23:40. And no foreign object were found from these checks.

In accordance with the Article 22 of the Airport Operation Standards (Ministry of

Land, Transport and Maritime Affairs Notice No. 2010-413), the airport operator shall regularly check the runways, taxiways and apron for the movement area safety, and the minimum inspection cycle is set according to the airport operation category.

The Incheon International Airport Corporation also made the movement area safety guidelines in accordance with the Airport Operation Standards, setting the daily minimum inspection cycles as four times for the runway, two times for the taxiway and the apron. The inspection is conducted with one or two vehicles in daytime and three vehicles in night time moving in parallel simultaneously.

1.11 Flight Recorders

1.11.1 Cockpit Voice Recorder

The Flight 720 Freighter was equipped with a cockpit voice recorder of a magnetic tape media type, which was manufactured[24] by the Sunstrand Data Control Inc. and can record for 30 minutes. But 30 minutes passed without the protection of the recording after the rejected takeoff, so the voice recording at the time of the incident was not preserved.

1.11.2 Flight Data Recorder

The Flight 720 freight was equipped with a flight data recorder of a metal tape media type, which was manufactured[25] by Sunstrand Data Control Inc. and can record for at least 25 hours. The ARAIB investigated the recording from the time when the aircraft started takeoff rolling to the time when it came to stop after rejected takeoff.

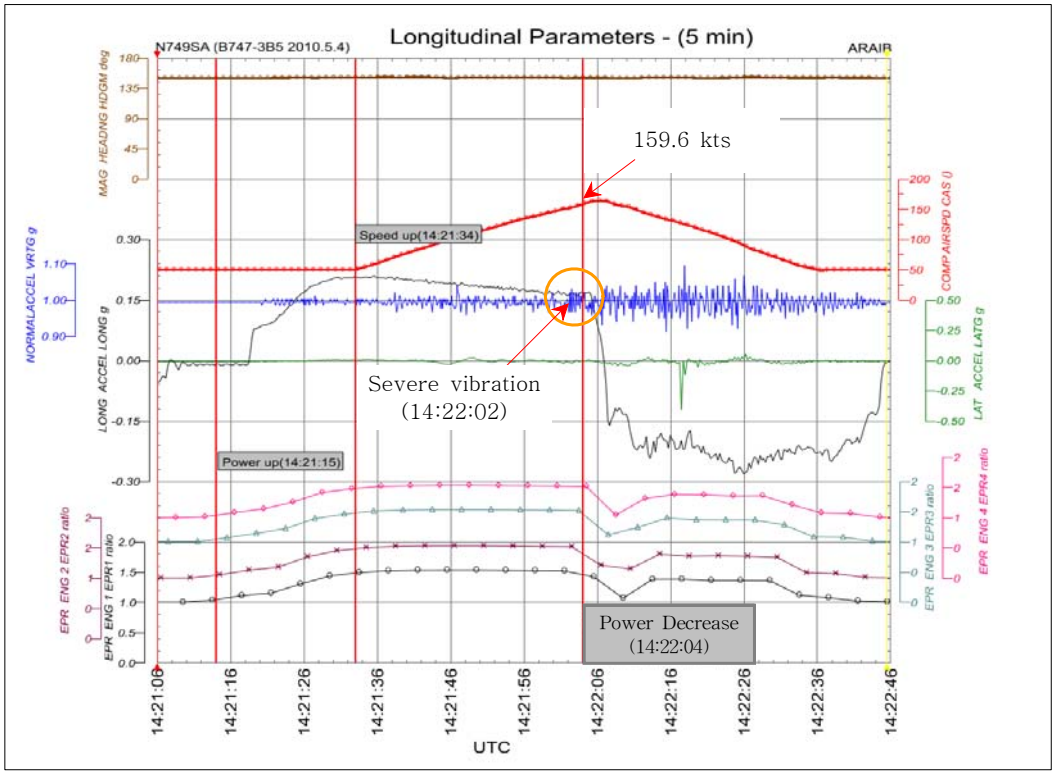
24) Part Number: 980-6005-055, Serial Number: 7110
25) Part Number: 981-6009-011, Serial Number: 2182

/ER TIME CL(GMT hhmm	AIRSPD CAS kts	EPR ENG 1 EPR1 ratio	EPR ENG 2 EPR2 ratio	EPR ENG 3 EPR3 ratio	EPR ENG 4 EPR4 ratio	T/R DEPLO TRD1	VHF 1 KEYIN VHF1
14:21:59	140.6		1.525				
14:22:00	144.4			1.529			
14:22:01	146.8				1.525		
14:22:02	150.5	1.523					
14:22:03	152.2		1.522				
14:22:04	155.5			1.521		Reject T/O	
14:22:05	159.6				1.518		
14:22:06	163.1	1.427					
14:22:07	164.5		1.216				
14:22:08	163.5			1.119		Max Speed	
14:22:09	158.6				1.047		
14:22:10	155.7	1.074					
14:22:11	154.1		1.158			Reverse Thrust	
14:22:12	149.4			1.244			
14:22:13	144.6				1.321		
14:22:14	141	1.384					
14:22:15	137.6		1.4				
14:22:16	133.7			1.401			KEYED
14:22:17	131.5				1.386		KEYED
14:22:18	127.5	1.387					KEYED
14:22:19	124.2		1.365				
14:22:20	120.3			1.369			

[Fig. 9] FDR parameters-1

As shown in [Fig. 9] and [Fig. 10], four thrust levers were increased for takeoff at 14:21:15, and at 14:22:02 the aircraft was vibrating up and down. At 14:22:04 four thrust levers were reduced to abort the takeoff, and subsequently reverse thrust levers were used. The speed at which the aircraft started to abort the takeoff was 159.6 knots, and the airspeed was increased to maximum 164.5 knots. According to the FDR data, it took about four (4) minutes and fifteen (15) seconds[26] for the Flight 720 Freighter to travel straight up to the end of the taxiway M after entering the taxiway M.

26) Its taxing speed corresponds to an airspeed of about 25 kts because the distance is 3,300 m.



[Fig. 10] FDR parameters-1

1.12 Wreckage and Impact Information

The Flight 720 Freighter had the forward two tires (number 5 and 6) of the four left main body gear failed during takeoff roll, and the door rod was damaged by collision with fragments of the damaged tire, and the number 1 hydraulic return line was cut, and the number 5 and 6 wheels were abraded by friction with the runway.

At about 2,000 meters from the takeoff position, debris, which come apart from the number 5 tire, were collected, and subsequently tire fragments were scattered down to 4,000 meters along the runway. While the aircraft was holding on the taxiway after vacated the runway, the safety devices were activated so that 12 tires deflated.

1.13 Medical and Pathological Information

The flight crew of the Flight 720 Freighter held valid Medical Certificates, and stated that they had not taken any medication or alcoholic beverage which could have adverse effects on the flight.

1.14 Fire

Not applicable

1.15 Survival Aspects

1.15.1 Rescue Activities

Not applicable

1.15.2 Mobilization of the Fire Engines

At 00:29:24, the local controller of the Incheon Control Tower requested a mobilization of fire engines, notifying the Incheon International Airport Rescue and Fire Fighting Watch Room (hereinafter referred to as "ARFF") that 「At about 23:23, after a Southern Air's B747 aircraft rejected takeoff due to a hydraulic failure in the runway 16, it vacated the runway and was holding now, it is unable to move due to its burst tires.」

At 00:31:28, on receiving the request for mobilization, a personnel on duty of the ARFF ordered its branch B office a mobilization of fire engines and notified the relevant organization[27] of this. The branch B office reported to the ARFF that all vehicles[28] were standing by around the aircraft at 00:35:56.

At 01:54:20, the personnel on duty of the ARFF contacted the ARFF's Main Station to issue an order to mobilize the ambulance and search light truck of the Main Station, at 02:32:48, the Main Station reported that the ambulance and search light truck arrived near the aircraft. At 02:32:48, the fire fighting unit commander withdrew all vehicles from the scene except the water tank and search light truck, judging there would be no more adverse situation to occur.

According to the statement made by the fire fighting unit members who were present at the scene, 「When we arrived at the scene, the aircraft was holding on the taxiway with the tires of the left forward landing gear ruptured, and the hydraulic liquid

27) Incheon International Airport Authority (Status Management Center), Seoul Regional Aviation Administration, Incheon Fire Prevention and Safety Department
28) Three fire fighting vehicles, one foam tender vehicle, and three water tender vehicles

was leaking due to the damage to a hydraulic line. There was no fire and there were grooves on the surface of the runway.」

1.16 Tests and Research

From 29 September to 1 October 2010, the investigators and experts from the ARAIB, NTSB, FAA, Boeing Company and Goodyear gathered at the Development and Research Center[29] of the Goodyear to conduct tests on the damaged tires and wheels.

The damaged tire fragments and wheels, which collected at the scene of the incident, were moved to the Goodyear and kept in a condition sealed in two boxes, and they were opened in the presence of the investigations of the ARAIB and NTSB.

The damaged tire fragments were reconstructed to the maximum possible extent with the fragments available under the control of the NTSB investigator and the facts found from these tests are as follows.

1.16.1 Tire Examination

○ Number 5 tire

- As shown in [Photo 2], the fragments from the number 5 tire were generally larger than those of tire number 6 tire, and about 90% of them were collected to be used for reconstruction.

- The tread fragments from the number 5 tire included plies, but those from the number 6 tire did not include them. Visible wrinkles[30] were seen on the number 6 inner liner but not on the number 5 inner liner.

29) It is located in Akron, Ohio, U.S.A.
30) Wrinkles are potential indications of operation while deflected beyond design limits.

[Photo 2] Reconstructed number 5 tire

- No tire manufacturing defects were found nor traces of FOD.

- The conditions of the casing and tread package suggested that the casing rupture occurred while the tire was pressurized.

- Nearly the whole beads remained on the wheel, and the beads remaining on the inboard were worn out much more seriously than those on the outboard or the number 6.

- The color of rubber had blue tinting and the nylon fibers were stiff. There was no rubber reversion.

○ Number 6 tire

- As shown in [Photo 3], a quantity of fragments sufficient enough for reconstruction of the number 6 tire was not collected except for about 75% of tread.

- The size of fragment of the number 6 tire was much smaller than that of the number 5 tire, and the edge was lengthened like a string or ripped.

- The tire beads were separated from the casing and remained attached to the wheel assembly, and both beads had severe mechanical damage and heat damage.

- The casing broke apart into many pieces, and most of the casing pieces had severe mechanical and heat damage.

[Photo 3] Number 6 tire fragments

- There was head damage to the shoulder, casing and tread pieces as evidenced by a blue color. But It was weaker than that of the number 5 tire.

- The tread was separated primarily from the top of ply, casing materials remained attached on many liner pieces. The collected portions of the shoulder and inner liner had wrinkles on the inside of both shoulders.

- There were no signs that the tire was broken away from the wheel or had the pressure lost by FOD.

1.16.2 Wheel Examination

○ Number 5 wheel

- As shown in [Photo 4], the inboard and outboard bead areas were still attached

to the wheels. The remaining beads had extensive mechanical and heat damage.

[Photo 4] Number 5 wheel

- The half rim of wheel had extensive abrasion damage due to contact with the concrete runway surface after the main portion of the tire casing was broken away from the wheel assembly.

- Air leak tests were conducted on the thermal fuses and inflation valves by air test block and soapy water solution to find no air leaks from any part.

- Tests were not conducted on the overpressure relief plug because the test equipment owned by Goodyear at the time was not adequate for the tests. Subsequently tests were conducted in the Boeing Company, but no malfunction was found.

○ Number 6 wheel

- As shown in [Photo 5], the inboard and outboard tire bead areas were still attached to the wheels. The remaining tire beads had extensive mechanical and heat damage.

[Photo 5] Number 6 wheel

- The wheel half rim had extensive abrasion damage due to contact with the concrete runway surface after the main portion of the tire casing departed the wheel assembly.

- Air leak tests were conducted on the thermal fuses. inflation valves and overpressure relief plugs using air test block and soapy water solution to find no air leaks from any part.

- The inflation valve stem was installed but was found to be barely tighter than hand tight.

1.17 Organizational and Management Information

Southern Air provides a wide range of services including long-term ACMI (Aircraft, Crew, Maintenance, Insurance), etc. Its Global Headquarters Hub centered in Norwalk, Connecticut, U.S.A, it transports Korean Air's cargo in accordance with a long-term contract with Korean Air, and for this purpose it has its own maintenance personnel[31] at the Incheon International Airport.

31) It operates two B777-200LRFs and 14 B747 Freighters (B747-200F, B747-300F). In accordance with a contract with Korean Air, part of maintenance work is supported by Korean Air.

When a Southern Air aircraft arrives at Incheon International Airport, tire pressure check is made based on the maintenance job card, and the actual tire pressure check and inflation is carried out by Korean Air maintenance personnel. The maintenance job card specifies the normal tire pressure as 195~200 psi as shown in [Fig. 11].

SOUTHERN AIR

MAINTENANCE JOB CARD	STA:	LP:	DATE:	WORK NO: A110202

JOB ORDER NO	JOB NO/PAGE	A/C TYPE	JOB	REVISION	A/C REG
	JOB 1 3 OF 6	747	RAMP CHECK	Rev 9	

COST CENTER	CREW	DOWNTIME	MAN HRS	DATE REVISED	EVENT/PAGE
	1			05-Mar-09	110202 3 OF 6

TASK	ITEM	ZONE	JOB DESCRIPTION	MECH	INSP

FIGURE 1 (sheet 1 of 2)

AIRCRAFT TIRE SERVICING PROCEDURES T-107, Chapter 5.4 & AMM 12-15-06

General

1. See Figure 1, Sheet 2 for tire pressure limits.
2. Annotate the pre / post service pressures in the spaces provided in Chart A.
3. Service tire pressure to the high limit of normal pressure range in Chart B using calibrated tire pressure gauge and dry nitrogen ONLY.

CHART A - TIRE PRESSURES

	LEFT NOSE	RIGHT NOSE
	LH /	RH /

LEFT WING			RIGHT WING	
1 /	2 /	Record Pressure Pre/Post Servicing	13 /	14 /
3 /	4 /		15 /	16 /

LEFT BODY		RIGHT BODY	
5 /	6 /	9 /	10 /
7 /	8 /	11 /	12 /

CHART B – NORMAL PRESSURE REFERENCE TABLE

TIRE SIZE	Normal Pressure		(1) Re-inflate Tire to High Limit of Normal Pressure		(2) Replace Tire	
	MLG	NLG	MLG	NLG	MLG	NLG
49- X 19, 34 PR, 235 MPH	195-200	195-200	155-195	155-195	Below 155	Below 155

(1) See Figure 1, Sheet 2 for continued service limits.

(2) If tire is below minimum pressure, replace both main wheel assemblies on the same axle.

MECHANIC: _____

[Fig. 11] Tire service procedures

1.18 Additional Information

1.18.1 Aircraft Tire Construction

As shown in Fig. 12, a tire is composed of three main parts of tread, sidewall and carcass (or cord body), and the detail part names are as shown in Fig. 13.

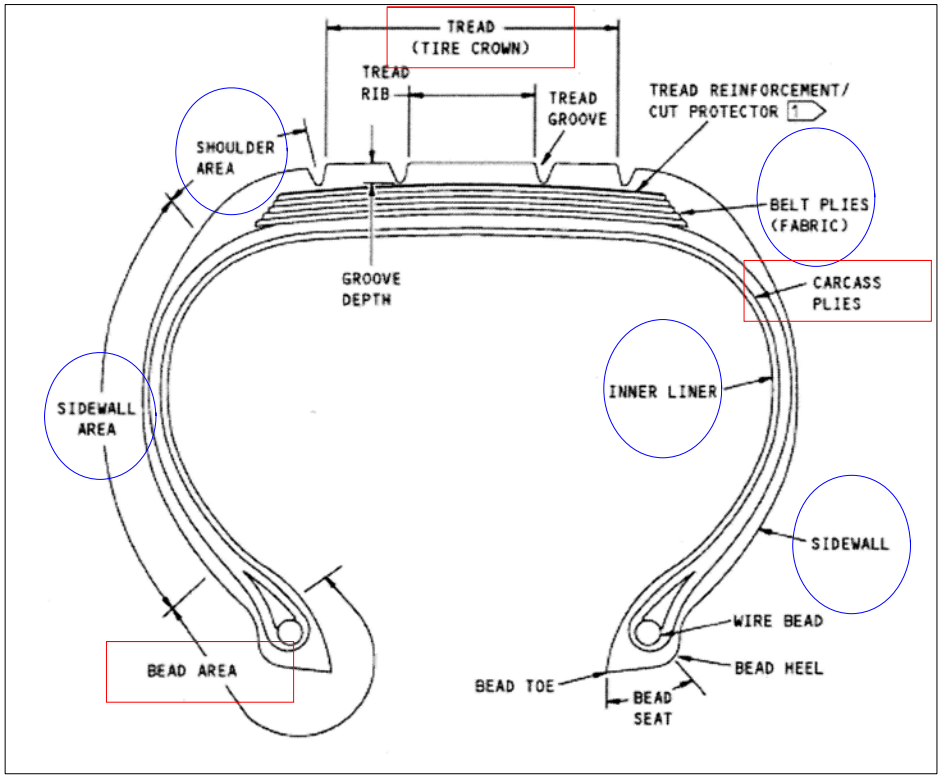
· Tread: The tread is a part in contact with the surface, and is made of rubber, compounded for toughness, durability and wear resistance to protect the carcass inside of the tire.

· Shoulder: The shoulder is located between tread and sidewall, it is designed to radiate heat generated from inside during rolling because the thickness of rubber is thickest.

· Sidewall: The sidewall is a protective layer of flexible, weather-resistant rubber covering the outer casing ply, extending from tread edge to bead area. This part is marked with various letters showing the type, specification, structure, pattern, manufacturer, trademark, etc. of the tire.

· Bead : The beads or bead wires anchor the tire to the wheel. Beads are fabricated from steel wires layered together and can be embedded with rubber to form a bundle. The bead heel is the outer bead edge that fits against the wheel flange. The bead toe is the inner bead edge closest to the tire centerline.

· Casing plies: As an important portion that frames the tire, it refers to the whole of the alternate layers of rubber-coated fabric (running at opposite angles to one another) which provide the strength of the tire.



[Fig. 12] Construction of Tire

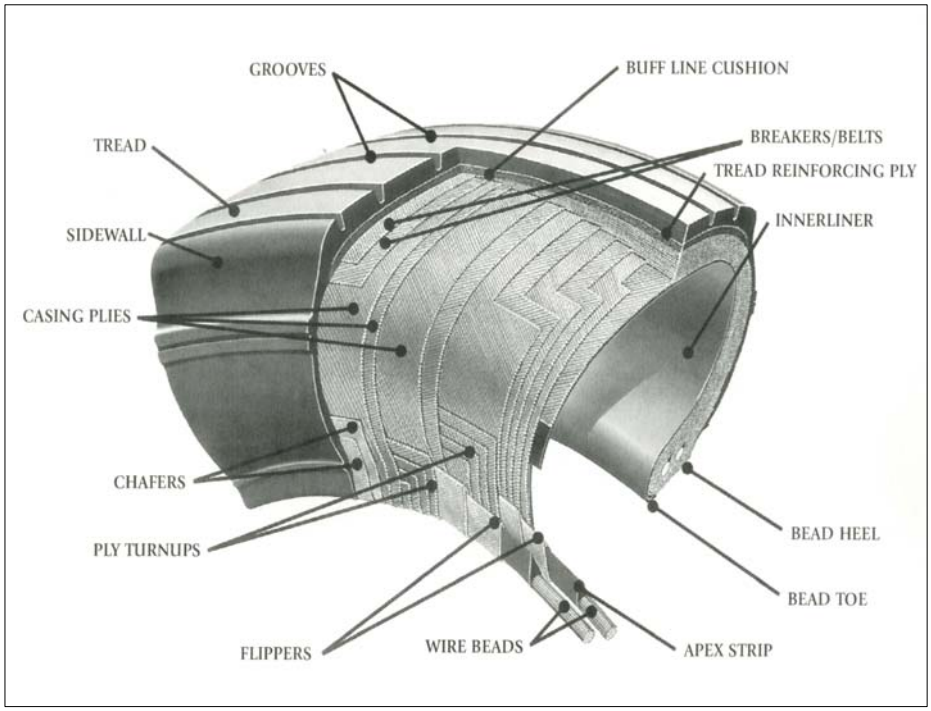


Fig 24

[Fig. 13] Construction of Bias Ply Tire

. Belt plies: They are layers inserted between tread and carcass. They relieve shock received from outside during takeoff and prevents the cracking of or external injury to the tread from reaching the carcass directly. They play the role of improving the safety by widening the tread portion in contact with the road surface.

· Inner liner: In tubeless tires, this inner layer of low permeability rubber acts as a built-in tube and restricts the air from diffusing into the casing plies.

1.18.2 Tire Inflation

1.18.2.1 Importance of Proper Inflation

In the Goodyear's "Aircraft Tire Care and Maintenance" handbook, it is specified that it is most important to maintain tire inflation properly in the tire preventive maintenance program. The problem brought about by inaccurate inflation is very serious.

The effects of overinflation on tire are as follows.

· The area of tire tread is reduced to increase the load per unit area so that the middle portion of tire is worn down much more quickly.

· Fatigue is increased on the tire cord body[32] to eliminate elasticity sufficient to absorb landing shock, and the side is apt to be damaged more than when properly inflated.

· The rubber of tire tread or sidewall is in a pulled condition so it is easily cut and worn quickly. The cut portion grows bigger and bigger.

The effects of underinflation on tire is as follows.

32) Composed of plies made of nylon or rayon

- If tire is underinflated, it is apt to skid sideward or forward when landing or braking. It is rapidly worn asymmetrically along the edge of tread.

- During landing there are many possibilities that the sidewall or shoulder of tire is mashed. The body could be bruised, broken or ruptured.

- An underinflated tire could bend the flange of wheel to the extent that it could damage the bead portion. A severely underinflated tire could make the cord fall out or the tire useless because of heat and strain generated when deflexing is repeated.

1.18.2.2 Proper Inflation Procedures

The proper inflation procedures specified in the Goodyear's "Aircraft Tire Care and Maintenance" handbook are as follows.

You should check daily in a condition of tire temperature lowered. Tire inflation should always be checked at outdoor air temperature. Tire temperature could rise exceeding 200°F(95℃) higher than outdoor air temperature during flight operation. A change of 5°F(3℃) in outdoor temperature causes a change of about 1% in tire pressure. It could take three hours for tire air temperature to return to outdoor air temperature after flight.

The tire/wheel assembly could have pressure dropped by 5% in 24 hours and this can be regarded normal. This is because the tire pressure changes daily. The tire that does not lose pressure normally could be damaged by FOD or other external factors that could decrease pressure suddenly. Because of such reason, it is important to check tire pressure every day or before every flight.

The tire should be inflated based on the worst weather conditions. If it is anticipated that the tire is exposed to a ground temperature change exceeding by 50°F(27℃) because of flying to another place with different weather conditions, the tire pressure should be

adjusted to fit the worst weather conditions before take-off.

The pressure should be adjusted to fit a low temperature so as to maintain the minimum required pressure and the pressure should be adjusted again in a warm climate. Before returning to a low-temperature area, the pressure should be adjusted to fit a low temperature. A change of 5°F(3℃) in outdoor air temperature causes a change of about 1% in tire pressure.

Dry nitrogen gas should be used. Nitrogen is incombustible, so it prevents the performance of the liner material, casing plies and wheel from lowering due to oxidation.

If a tire manufacturer specifies by distinguishing between loaded pressure and unloaded pressure, it should be followed. In loaded condition, the gas chamber volume decreases because of tire contraction. Therefore, if a tire pressure is specified for unloaded condition, the pressure should be increased 4% to get a tire pressure equivalent to the loaded condition, and it should be decreased 4% otherwise.

1.18.3 Cold Pressure Setting

The "cold pressure setting" recommended by the manufacturer Goodyear is as follows.

- The minimum service pressure for safe flight is the pressure measured at low temperature without cargo loaded as specified by the aircraft manufacturer.

- Loaded pressure should be specified 4% higher than that of unloaded pressure. The recommended operation range is -0 % ~ +5 % of minimum service pressure.

- If the in-service tire pressure is less than the minimum service pressure, Table 5 should be applied.

Cold Tire Service Pressure	Recommended Action
100 to 105 percent of loaded service pressure	None - normal cold tire operating range.
95 to less than 100 percent of loaded service pressure	Reinflate to specified service pressure.
90 to less than 95 percent of loaded service pressure	Inspect tire/wheel assembly for cause of pressure loss. Reinflate & record in log book. Remove tire/wheel assembly if pressure loss is greater than 5% and reoccurs within 24 hours.
80 to less than 90 percent of loaded service pressure	Remove tire/wheel assembly from aircraft (See NOTE below).
Less than 80 percent of loaded service pressure	Remove tire/wheel assembly and adjacent tire/wheel assembly from aircraft (See NOTE below).
0 percent	Scrap tire and mate if air loss occurred while rolling (See NOTE below).
NOTE: Any tire removed due to a pressure loss condition should be returned to an authorized repair facility or retreader, along with a description of the removal reason, to verify that the casing has not sustained internal degradation and is acceptable for continued service.	

[Table 4] Action to take in case tire pressure is not sufficient

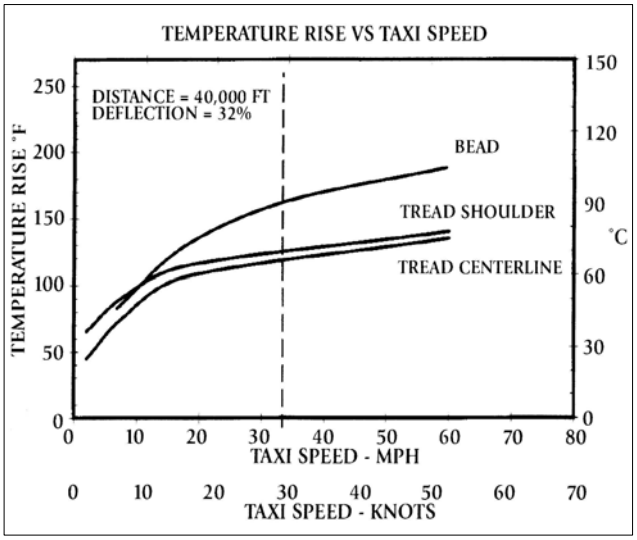
1.18.4 Taxiing and Heat Generation

In [Fig. 14], the vertical dotted line at 35 mph (30 knots) indicates the recommended maximum taxi speed. On this chart, the curves constantly slope upward with higher taxi speeds. In other words, the faster an aircraft travels over a given distance, the hotter the tires will become.

Many people would expect the shoulder area to generate the most heat. In reality, the bead and lower sidewall area are the hottest. There are two major reasons for this:

- All forces, in or acting on a tire, ultimately terminate at the bead. This is an area of high heat generation.

- Rubber is a good insulator; or said another way, it dissipates heat slowly. The bead area, being the thickest part of the tire, retains the heat longer than any other part of the tire.

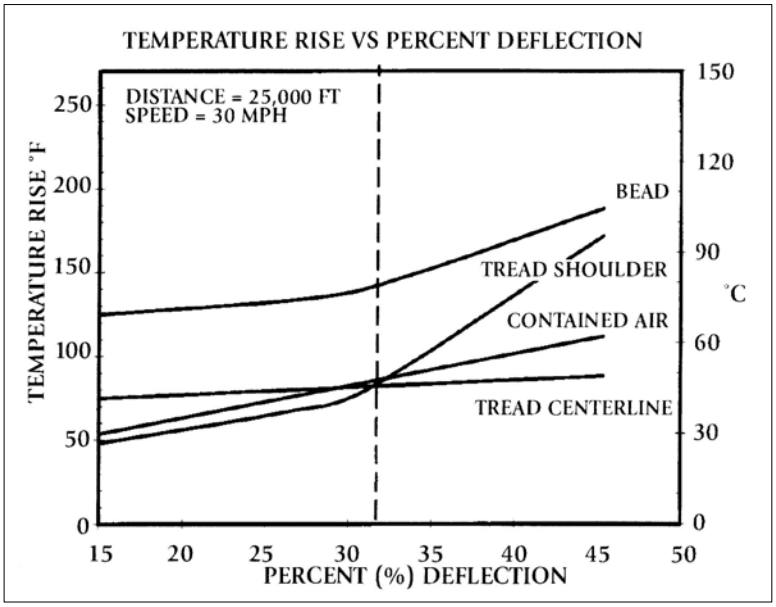


[Fig. 14] Tire temperature rise vs taxi speed

As the vertical dotted line indicates in [Fig. 15], the tire was designed to be operated at 32% deflection[33]. Left of this line designates overinflation, and to the right underinflation.

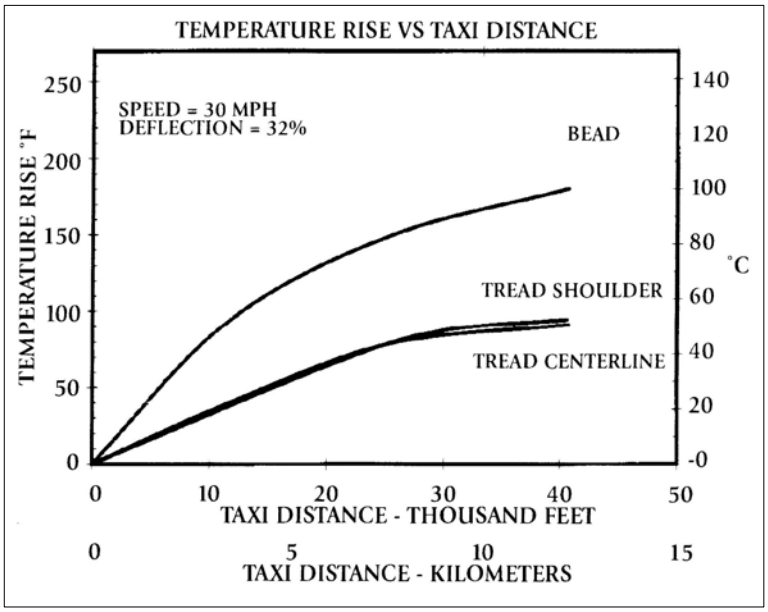
When the speed and the distance traveled are constant, the more a tire is under inflated the hotter it becomes. The rate of temperature rise versus underinflation is the highest in the shoulder area due to increased flexing. The bead area, however, still remains hottest.

33) % Deflection = $\frac{\text{Free Height - Loaded Free Height}}{\text{Free Height}}$



[Fig. 15] Tire temperature rise vs percent deflection

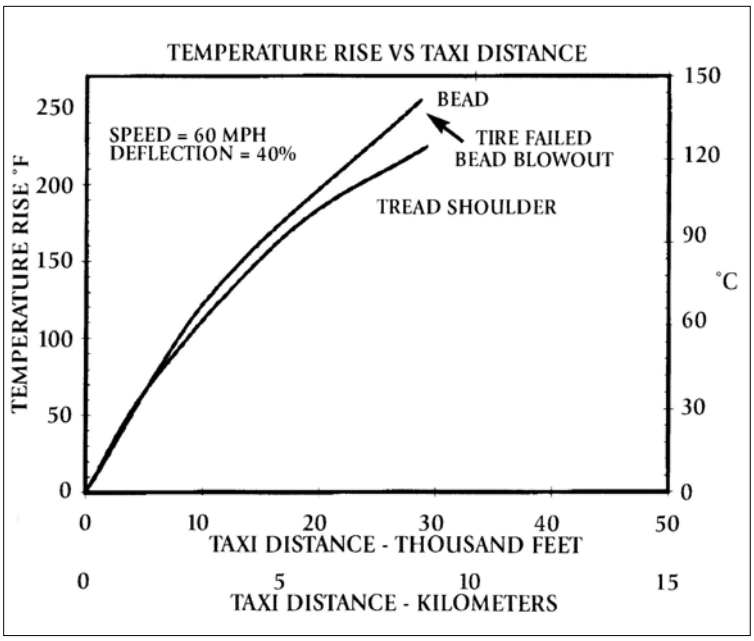
Even when an aircraft tire is properly inflated and operated at moderate taxi speeds, the heat generation will always exceed the heat dissipated. (This is indicated by the ever increasing slope of the lines.). As shown in [Fig. 16], the farther the taxi distance, the hotter the tires will be at the start of the takeoff.



[Fig. 16] Temperature rise vs taxi distance-1

On the [Fig. 17], the effect of underinflation (higher deflection) is coupled with the high speed taxiing. A comparison is made between a tire run at 32% deflection and

one run at 40% deflection. Not only is the slope of the 40% deflection curves much steeper (due to higher rate of heat generation) than the 32% curve, but the 40% deflection tire blew out in the lower sidewall after traveling about 30,000 feet.



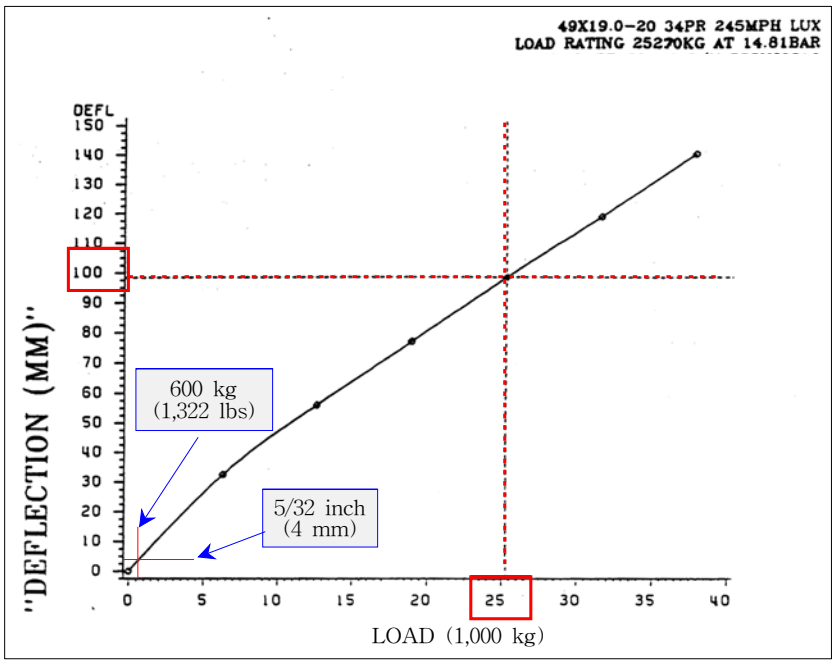
[Fig. 17] Temperature rise vs taxi distance-2

The carcass or body of the tire is usually made up of rubber-coated layers of nylon fabric. As good as nylon is, there is a reduction in strength when exposed to high temperatures. And the physical properties of rubber compounds are also susceptible to degradation by high temperatures. Both strength and adhesion are lost when the rubber reverts to the uncured state, and the effect of temperature on rubber compounds are as shown in [Table 5].

Appearance of blue color	210 - 230°F (100 - 110 ℃)
Rubber reversion to uncured state	280 - 320°F (140 - 160℃)
Rubber becomes hard and dry	355 - 390°F (180 - 200℃)
Melting point of nylon	＞ 400°F (200℃)

[Table 5] Tire temperature and color

[Fig. 18] shows the relationship between the tire deflection and load under the rated pressure in case of the 49×19.0-20, 34 PR, 245 mph tire.



[Fig. 18] Deflection vs load under the rated pressure

2. Analysis

2.1 General

The Flight 720 Freighter's crew had qualifications and certification proper to the flight, and there was no evidence that fatigue and/or medical factors of the flight crew or meterological factors could have affected the incident.

The aircraft held a valid airworthiness certificate, and the flight was conducted within the regulatory limitations of weight and balance.

No manufacturing defects or anomalies were found in either tire and there was no foreign object damage found in the fragments of the damaged number 5 and 6 tires.

2.2 Tire Inflation and Operation

The Goodyear's "Aircraft Tire Care and Maintenance" handbook specifies that tire pressure should be checked with the tire temperature lowered to an ambient temperature, snf that it could take 3 hours after flight for the tire temperature to return to the ambient temperature. The maintenance job card of Southern Air specifies that the tire pressure should be inflated at 195～200 psi within 3 hours before departure.

The "Boeing 747-300 AMM (Aircraft Maintenance Manual)" specifies that the minimum service pressure for safe flight operation is the pressure that the aircraft manufacturer specifies with the tire temperature lowered to the ambient temperature and the aircraft weight loaded on the landing gear. The minimum service pressure at 836,000 lbs., which was the weight at the time when the flight 720 freighter departed, was 200 psi.

The "Aircraft Tire Data Book" of Goodyear Company specifies the rated load of the relevant tire at 55,700 lbs., the rated inflation at 215 psi and the rated load of the relevant tire, and the recommended operation range of the tire is -0% ~ +5% of the minimum service pressure.

After the Flight 720 Freighter arrived at the cargo terminal of Incheon International Airport, it was parked for 15 hours and 45 minutes. Since the tire pressure was inflated

to 200～202 psi within 3 hours before departure, it is judged that the tire inflation procedures for the Flight 720 Freighter were properly taken based on the maintenance job card of Southern Air and the B747-300 Aircraft Maintenance Manual, with the tire air temperature lowered to the ambient temperature.

But the "Aircraft Tire Care and Maintenance" handbook specifies that the pressure of the landing gear with the cargo loaded on the aircraft should be 4% higher than the pressure with the cargo unloaded. This is because the gas chamber volume decreases due to tire contraction and the pressure increases when load is applied to the tires.

Therefore, there is a possibility that the pressure after the loading of the cargo (224,832 lbs) was completed could be higher than the initially inflated pressure although it was within the recommended operation range of -%0 ~ +5% of the minimum service pressure, because the pressure inflated into the tires of the flight 720 freighter at the time was the pressure with the cargo loading not completed.

As shown in [Fig. 1] above, the Flight 720 Freighter traveled 8,800 m (28,871 ft) at an average taxi speed of 25 kts to go to the takeoff position, and ran 2,000 m (6,561 ft) at a high speed for the takeoff roll. According to the [Fig. 16] and [Fig. 17] above, such a long distance taxi could have increased the temperatures of all tires of the flight 720 aircraft.

Meanwhile, because the depth of the number 6 tire tread groove was 9/32 inches (7 mm) and that of the number 5 tire tread groove was 14/32 inches (11 mm), there was a height difference of 5/32 inches (about 4 mm) between the two tires. According to [Fig. 18] above, this could have made deflection greater by making additional load apply to the number 5 tire, thereby making the temperature and pressure of the number 5 tire increase higher than the other tires.

If we put all these together, it can be judged that although the pressures and temperatures of all the tires of the flight 720 aircraft were within the operation range recommended by the aircraft manufacturer, they became very high while it moved a long distance for takeoff, and especially the number 5 tire was in a state of a relatively higher temperature and pressure compared to the other tires.

And in the course that the flight 720 freighter was making a takeoff roll at a high speed, the temperatures and pressures of all tires increased rapidly. At this time, the

number 5 tire burst as it was in overpressure condition earlier than the other tires. And it is judged that the number 6 tire also burst because it could not bear the load after it rolled with deflection becoming very large as it received the load after the number 5 tire burst.

2.3 Flight Crew Performance

According to the "Aircraft Tire Care and Maintenance Handbook" of Goodyear Company, the farther the landing roll distance is the hotter the tires become at the takeoff point. The rubber adhesive of tire tends to have its performance decreasing at high temperatures, and when the rubber becomes irrecoverable condition, it loses strength and adhesive force. Therefore, moving a long distance on ground could cause heat damage to tires and lower the performance of tires. But such information was not provided to the flight crew members before flight.

There are three runways in Incheon International Airport, but at the time when the flight 720 freighter left the cargo terminal, runways 15L/33R and 15R/33L were all closed, so only runway 16/34 was in use for takeoff and landing, and such information is carried in the aviation information publications of the Republic of Korea.

But because the flight crew members were not aware of the fact that landing roll of an excessively long distance could increase the temperature to the extent of tire burst, they did not consider change of departure time of the flight even though they knew runway 16 only was in use. Although the air traffic controller assigned runway 16 for takeoff, they accepted without any other request, and it is judged that they selected FLAP 10 instead of FLAP 20 for takeoff flap.

According to the flight manual, the captain has the sole responsibility for the decision to abort takeoff and the maneuver to abort takeoff should start before the takeoff decision velocity (V1). Also, if it is unsafe to fly between 80 knots and V1 during takeoff roll, it is specified that takeoff should be aborted. Therefore, it is deemed proper that the captain decided to abort the takeoff before V1, recognizing severe vibration.

At the time, the first officer was PF (pilot flying) and the captain was PM (pilot monitoring). The captain was holding thrust levers according to the flight manual while the first officer was executing the takeoff. The captain took over the controls from the first officer after he decided to abort the takeoff. And he commenced the aborted

takeoff maneuver before V1, and aborted takeoff successfully by using maximum reverse thrust and manual brake. So it is judged that the performance of the flight crew in taking procedures was proper.

2.4 Mobilization of the Fire Engines

Because the takeoff was aborted using the brake to maximum, the temperatures of tires / wheels were very high, and there was a high possibility of fire due to the leakage of the hydraulic liquid. But mobilization of fire engines was not conducted immediately. This is judged because the flight crew of the Flight 720 Freighter did not clearly request a mobilization of the fire engines, and the local controller, concentrating in control of the aircraft takeoff and landing, knew that maintenance personnel and a tow car were only necessary to resolve the problem at that time.

The mobilization of fire engines is made when the pilot requests, when actually a fire occurred, or when the controller judges it necessary, by requesting it to the Fire Fighting Unit. But while the Flight 720 Freighter came to stop on the taxiway, a fire did not occur actually, and it was a night time that it was impossible for a controller to have the aircraft in sight. And, as the local controller did not have any knowledge about a possibility of aircraft fire and did not clearly received a request for the fire engines from the flight crew, it is presumed that the local controller did not notify the Fire Fighting Unit of the mobilization of the fire engines without delay.

3. Conclusions

3.1 Findings

1. The the flight crew members of the flight 720 freighter held qualifications and certificates proper to the flight and any evidence that the fatigue and/or medical factors of the flight crew or meterological factors could have affected the incident was not found.

2. The aircraft held a valid airworthiness certificate, and the flight was conducted within the regulatory limitations of the weight and balance.

3. The captain's decision and maneuvers to abort the takeoff were made before the V1 speed and there were no problems in taking the aborted takeoff procedures.

4. According to the maintenance job card of Southern Air, the tire pressure was inflated to 195~200 psi before departure of every flight, the tire pressure of the flight 720 freighter was inflated to 200~202 psi with cargo loading not completed.

5. Traces of heat damage were found in the fragments of the shoulder, casing and tread. But there was no rubber reversion. The heat damage traces of the number 6 tire were weaker than those of the number 5 tire.

6. Visible wrinkles were see in the number 6 inner liner but not in the number 5 inner liner, and the casing was damaged with pressure existing in the tire.

7. No manufacturing defects or anomalies were found in either tire, and any evidence that the tire was separated from the wheel or FOD was not found.

8. When the aircraft taxiing distance is longer than a certain distance, the temperature of tire rises so high that it could result in heat damage to the tire. But the flight crew members of the flight 720 freighter were not aware of such information before the flight.

9. Communication between flight crew and air traffic controller was not clearly made with regard to the request for mobilization of fire engine.

3.2 Causes

The ARAIB determines the causes of the incident as follows.

The ARAIB determined as probable causes of this incident that 「The number 5 tire ruptured as the tire pressure increased due to the heat originating from the accumulated high temperature and an additional load caused by an imbalance of the diameter between number 5 tire and number 6 tire while the flight 720 freighter was moving a long distance for takeoff, and the number 6 tire ruptured because it could not bear all the load that the number 5 tire had to receive after it had ruptured.」

And the contributing factors are that 「① Because the number 6 tire tread was worn out relatively more than that of the number 5 tire it had the load added. ② The flight crew members were not aware of the relevant information that the tire could suffer a serious heat damage when the aircraft makes a long-distance landing roll.」

4. Safety Recommendations

The ARAIB issues safety recommendations as follows on the basis of the findings from investigation of the incident of the flight 720 freighter that occurred at Incheon International Airport on 4 May 2010.

To the Southern Air Inc.

1. Provide the flight crew members and air traffic controllers with the information that "If taxiing becomes longer than a certain distance the tire temperature rises so high that the tires could suffer heat damage and burst" and the operation limitations for taxiing. (AIR-F1001-1)

2. According to the current maintenance procedures, tire pressure is inflated to 195~200 psi regardless of aircraft weight. But if tire pressure is inflated before cargo loading, the pressure when cargo loading is completed could be higher due to volume contraction of tire chamber. Therefore, devise a proper scheme so as to inflate tire pressure adequate to the final aircraft weight condition before departure. (AIR-F1001-2)

3. Devise a proper scheme so as to prevent the imbalance in tire height due to abrasion of tire tread or pressure difference in case two tires are mounted in parallel. (AIR-F1001-3)

To the Boeing Company

1. Provide the flight manual with the information that "If taxiing becomes longer than a certain distance the tire temperature rises so high that the tires could suffer heat damage and burst" and the operation limitations for taxiing. (AIR-F1001-4)

2. The maintenance manual specifies the initial inflation pressure according to the final aircraft weight but does not specify the maximum pressure according to the aircraft weight at the time of tire pressure inflation. Actually in the front lines, tire pressure is inflated before cargo loading, so the pressure when cargo

loading is completed could become higher due to volume contraction of the tire chamber. Therefore, review a scheme for specifying maximum pressure according to the aircraft weight at the time of tire pressure inflation so as to maintain tire pressure adequate to the final aircraft weight. (AIR-F1001)