United Arab Emirates

الهيئة العامة للطيران المدني
GENERAL CIVIL AVIATION AUTHORITY

Air Accident Investigation Sector

Serious Incident

- Final Report -

AAIS Case No. AIFN/0009/2013

Prolonged Runway Closure Due to Disabled Aircraft

Operator: Air Ukraine International
Type: Boeing 737-800
Registration: UR-PSA
Location: Dubai International Airport
State of Occurrence: United Arab Emirates
Date of Occurrence: 14 September 2013

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Serious Incident Brief

GCAA AAI Report No.:	AIFN/0009/2013
Operator:	Air Ukraine International
Aircraft Type and Registration:	Boeing 737-800, UR-PSA
MSN	29658
No. and Type of Engines:	Two, CFMI CFM56-7B26, Turbofan Engines
Date and Time (UTC):	14 September 2013, 2331
Location:	Runway 12L at Dubai International Airport
Type of Flight:	Passenger
Persons On-board:	173
Injuries:	None

Investigation Objective

This Investigation is limited to the aspects related to the tire burst and runway closure due to disabled aircraft.

This Investigation is performed pursuant to the UAE Federal Act No. 20 of 1991, promulgating the Civil Aviation Law, Chapter VII, Aircraft Accidents, Article 4. It is in compliance with the UAE Civil Aviation Regulations, Part VI, Chapter 3, in conformity with *Annex 13 to the Convention on International Civil Aviation* and in adherence to the *Air Accidents and Incidents Investigation Manual*.

The sole objective of this Investigation is to prevent aircraft accidents and incidents. It is not the purpose of this activity to apportion blame or liability.

Investigation Process

The occurrence involved a Boeing 737-800 passenger Aircraft, registration UR-PSA, and was notified to the General Civil Aviation Authority (GCAA) by phone call to the Duty Investigator (DI) Hotline Number +971 50 641 4667.

After the Initial/On-Site Investigation phase, the occurrence was classified as an 'Incident'.

An Investigation Team was formed in line with the ICAO Annex 13 obligations of the United Arab Emirates (UAE) being the State of Occurrence.

The Investigation into this Incident is limited to the events leading up to the occurrence; no in-depth analysis of non-contributing factors was undertaken.

Notes:

1 Whenever the following words are mentioned in this Report with the first letter Capitalized, it shall mean:

- (Aircraft)- the aircraft involved in this Incident.
- (Investigation)- the investigation into this Incident
- (Incident)- this investigated Serious Incident
- (Report)- this Serious Incident Report

2 Unless otherwise mentioned, all times in this Report are Coordinated Universal Time (UTC), (UAE Local Time minus 4).

3 In this Report, the word 'Cockpit' and 'Flight Deck' are synonyms.

4 Photos used in the text of this Report are taken from different sources and are adjusted from the original for the sole purpose to improve clarity of the Report. Modifications to images used in this Report are limited to cropping, magnification, file compression, or enhancement of colour, brightness, contrast or insertion of text boxes, arrows or lines.

Abbreviations and Definitions Used in this Report

AEP	*Airport Emergency Plan*
AFM	*Airplane Flight Manual*
AFT	Aftward
AGL	Above Ground Level
AOC	Air Operator Certificate
ARM	*Aircraft Recovery Manual*
ASDA	Accelerate-Stop Distance Available
ATS	Air Traffic Service
ATPL	Airline Transport Pilot
CAS	Computed Air Speed
CoA	Certificate of Airworthiness
CoR	Certificate of Registration
CVR	Cockpit Voice Recorder
DI	Duty Investigator
ECCAIRS	European Co-Ordination Centre for Aviation Incident Reporting Systems
FDR	Flight Data Recorder
EK	Emirates Airlines
FCTM	*Flight Crew Training Manual*
fpm	Feet per minute (climb-descent speed measurement unit)
ft	Feet (distance unit)
FWD	Forward
GCAA	General Civil Aviation Authority of the United Arab Emirates
HOAO	Head of Airside Operations
HOCA	Head of Compliance Assurance
HP	Handling Pilot
hPa	Hectopascal (Pressure unit. 1 hPa = 100 Pa),
ICAO	The International Civil Aviation Organization
IFR	Instrument Flight Rules

INBD	Inboard
Kts	Knot(s) (airspeed/wind speed unit)
Km	Kilometre (distance unit)
KPI	Key Performance Indicator
lb	Bounds (mass unit)
LH	Left hand
MCC	Maintenance Control Centre
MHz	Mega Hertz (Frequency unit)
MoU	Memorandum of Understanding
MLG	Main Landing Gear\
MSN	Manufacturer Serial Number
NDT	Non Destructive Test
No.	Number
NOTAM	Notice to airmen
NRW	Net Recoverable Weight
OAT	Outside Air Temperature
OCC	Operations Control Centre
ODMA	Airside Operations Duty Manager
OM-B	*Operations Manual- Part B*
P/N	Part Number
RH	Right Hand
QNH	Barometric pressure adjusted to sea level
REW	Recoverable Empty Weight () and the associated moments.
SLA	Service Level Agreement
S/N	Serial Number
UAE	The United Arab Emirates
UTC	Coordinated Universal Time
VPAO	Vice President of Airside Operations

Synopsis

On 14 September 2013, at about 2200 UTC, a Boeing 737-800, registration UR-PSA, operated by Air Ukraine International, arrived at Dubai International Airport following a flight from Kiev, Ukraine. As the aircraft touchdown on runway 12L, both port main landing gear tires failed producing vibration and causing the aircraft to drift.

The aircraft had taken off from runway 36R at Boryspil International Airport, Ukraine, at approximately 1727 UTC. During the takeoff, a tire had sustained damage. This was noticed by the crew but they were unable to identify which tire had been damaged.

The crew decided to continue the flight to the planned destination. The flight was uneventful until landing at Dubai when the two post main landing gear tires fragmented and vibration was felt by the crew and the aircraft tended to drift to the left.

The aircraft continued its deceleration until it reached high speed exit Mike 09. As the aircraft vacated the runway, it stopped and was disabled as the left main gear tires had been completely destroyed, with the aircraft rolling on the wheels' rims. At that position, the aircraft nose gear was on the taxiway centreline and the tail was overhanging runway 12L.

The Airside Operations Duty Manager (ODMA) called the 'disabled aircraft recovery service provider' informing them that runway 12L was obstructed by an aircraft. A recovery team was dispatched to the site to remove the disabled Aircraft.

After the passengers and crew had disembarked, and with the cargo still on-board, the recovery team attempted to jack the aircraft and replace the affected tires. Despite several attempts, the recovery team was unable to jack the aircraft. The aircraft was then moved forward on the taxiway and the team succeeded in jacking the left side by using bedding platforms.

Some 10 hours were spent after the aircraft landing to move it to the stand for damage evaluation and repairs.

The Investigation, conducted by the Air Accident Investigation Sector (AAIS), determined that the causes of the prolonged runway closure were the destruction of the two port main landing gear tires, the inadequate disabled aircraft recovery plan, and the lack of training and insufficient decision-making of the ODMA and the disabled aircraft recovery team.

Contributing Factors to the Incident were the insufficient communication network available to the departure airport, the operations control centre (OCC), the maintenance control centre (MCC), and the Aircraft. The lack of cockpit tire pressure indications, which deprived the crew of the ability to identify which tire had burst and thereby allow the crew to devise a possible mitigating landing technique.

A total of 10 safety recommendations are included in this report and addressed to the operator, the departure airport, the State Aviation Administration of Ukraine, the arrival airport, and to the General Civil Aviation Authority of the United Arab Emirates.

CONTENTS

1. Factual Information

1.1 History of the Flight

On 14 September 2013, at 1719 UTC, following a 1 hour and 30 minute transit stop at Boryspil International Airport, Ukraine, Air Ukraine International Boeing 737-800, registration UR-PSA, informed the Tower that the Aircraft was ready to taxi for departure, to Dubai International Airport, UAE as scheduled flight AUI3526. The Tower instructed AUI3526 to taxi to the holding point for runway 36R along taxiways Charlie and Bravo.

At 1724:48, the Tower instructed AUI3526 to line up on runway 36R and wait.

At 1726:12, the Tower issued running take-off clearance advising 040°/11.7 knots (kts) wind direction and speed.

The calculated V_1, and V_R were 153 and 159 kts respectively. The gross take-off weight was 74,298 kg (163,800 lb).

At 1726:25, AUI3526 entered runway 36R, with no mechanical anomalies or abnormal flight deck indications.

At 1726:32, AUI3526 takeoff commenced and was uneventful until the airspeed reached about 140 kts when the crew heard a loud bang, described by the captain as 'like a car accident sound', and by the co-pilot as being similar to the 'flight simulator having engine failure'.

The takeoff was continued, the nose landing gear was raised at 160 kts computed air speed (CAS) and the Aircraft lifted off at 1727:24, CAS was 172 kts.

At 1727:45, during the initial climb, passing 1,270 ft altitude, and after completing the *After Take-off Checklist*, AUI3526 requested the *Delivery* (Departure) ATC to check the departure runway. After two minutes, ATC asked 'what exactly to check on the runway'. AUI3526 replied: 'Exactly, after reaching speed V_1 at take-off moment it seemed that we have driven wheel on the central lantern. We know to be on the safe side, it is better to check if there is nothing on the runway'. ATC acknowledged the request. Later, the Senior Cabin Crew Member (SCCM) came to the flight deck and informed the captain that some passengers were worried about the sound.

At 1736 ATC called AUI3526 informing the crew that pieces of tire(s) had been found on the runway and advising the crew to check the Aircraft. The crew replied that they had the *same impression* and that they would contact ATC later and that they would switch frequency.

At 1740, the ATC called AUI3526 asking if 'you [the crew] believe that you had lost the hubcap or that the found pieces were belonging to the Aircraft'. AUI3526 replied that 'it was most likely that the pieces were belonging to the Aircraft's tires and we had that impression because it happened with before but not like that'.

After consulting the *Flight Crew Training Manual (FCTM)*[1] and the *Quick Reference Handbook* (QRH), the captain, who was the handling pilot (HP), decided to continue the flight to Dubai.[2]

The crew informed Kiev ATC of their decision to continue the flight and ATC gave instructions to climb to flight level (FL) 330. After confirming the target flight level, the crew requested ATC to advise whether 'it was the nose landing gear or not?'. There was no reply to this query from ATC.

After about 4 hours 17 minutes of uneventful flight time, at about 21:45:16 during its approach towards Dubai International Airport, AUI3526 requested the Approach Controller to check the right hand (RH) main landing gear (MLG) *for any blown tire*. The Controller replied: 'there is a vehicle holding at holding point there and they [the Airside Operations personnel] will help us [the ATC and Aircraft] to see also'.

The Controller called the Airside Operations Duty Manager (ODMA) informing him of the situation.

At 2148:22, the Airside Operations advised the Tower that all wheels were down. The Tower advised AUI3526 to climb and maintain runway heading 4,000 ft.

Several minutes later, AUI3526 landed at runway 12L with three green landing gear lights. On touchdown, a vibration was felt by the crew and the aircraft tended to drift to the left. AUI3526 continued its deceleration until it reached high speed exit Mike 09. As the aircraft vacated the runway it stopped and was disabled as the port main gear tires were completely ruptured with the Aircraft rolling on the wheels' rims. At that position, the Aircraft nose wheel was on the taxiway centreline and the tail was overhanging runway 12L.

At 2244, the ODMA called the disabled aircraft recovery service provider[3] informing them that runway 12L was obstructed by an aircraft. Subsequently, a team was dispatched to the site to remove the disabled Aircraft.

About 30 minutes elapsed before an aircraft jack requested from a third party[4] operator arrived. The recovery team tried to position the jack underneath the LH MLG support point but the jack could not be positioned due to insufficient height being available.

About 45 minutes after the first attempt to jack the Aircraft a bottle jack and one main axle wheel jack were supplied to the recovery team. The axle wheel jack was also higher than the available space. Accordingly, the recovery team had no other alternative than to use the bottle jack to raise the LH MLG in order replace the wheels.

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[1] FCTM is not a flight document since it is only used for training and not frequently revised

[2] As the captain stated in his interview

[3] The disabled aircraft recovery service provider in Dubai International Airport is a department within Emirates Airlines

[4] The third party was Fly Dubai Airlines located in Dubai International Airport

The recovery team positioned the bottle jack underneath the LH MLG support point and started to lift the gear but, due to the concentrated load of the bottle jack on the tarmac, the latter could not withstand the pressure and the taxiway surface was damaged allowing the base of the jack to sink. The recovery team discontinued the attempt and tried to find another solution.

At this time, except for the passengers who had been disembarked earlier, the Aircraft was still loaded with cargo and the remaining fuel.

After more than one unsuccessful attempt to jack the Aircraft and change the affected wheels, the recovery team requested main Boeing 737 jacks from the same third party operator. About another 45 minutes were spent waiting for the main jacks to arrive. Upon the arrival of the jacks the recovery team positioned the LH jack at its location on the lower surface of the LH wing and began to lift the Aircraft. However, instead of lifting the LH side of the Aircraft, the nose started to lift. The recovery team repeated the attempts with no success until 0248 when the ODMA gave instructions to move the Aircraft immediately and by any means possible.

Subsequently, the recovery team connected the tow bar to the Aircraft nose gear and towing tractor and then waited about 40 minutes for the tractor driver who was employed by the Airport's Ground Handler. Later, the Aircraft was towed on its deflated LH MLG wheels' tires for about 200 meters to vacate the runway.

At about 0400, the recovery was handed over to the morning recovery team shift. At that time, the cargo was offloaded after towing the Aircraft.

The team leader of the recovery team decided to use the main jacks to lift the Aircraft and replace the two LH MLG wheels. The recovery team used some foam bedding under the LH jack stand in order to make the Aircraft even. After lifting the LH MLG for a height of about 12-14 inches, the recovery team used the normal wheel removal tools and replaced the wheels. The Aircraft was lowered and then towed at 0823 to the stand.

1.2 Injuries to Persons

Table 1. Injuries to persons

Injuries	Flight Crew	Cabin Crew	Other Crew On-board	Passengers	Total On-board	Others
Fatal	0	0	0	0	0	0
Serious	0	0	0	0	0	0
Minor	0	0	0	0	0	0
None	2	4	0	167	173	0
TOTAL	**2**	**4**	**0**	**167**	**173**	**0**

1.3 Damage to Aircraft

Due to the disintegration of the tires, the Aircraft sustained varying levels of localized damage to the following LH side parts:

- MLG lower side strut doors control fitting broke
- No.1 and 2 wheels and brakes
- No.1 leading edge flap
- Wing to body fairing
- Wing lower inboard trailing edge
- Missing MLG doors
- No. 6 spoiler
- MLG tubes and hoses
- No.1 engine fire extinguisher tube
- No.1 engine thrust reverser cowl
- Wheel well bonded panel
- Trailing edge inboard flap
- Fuselage skin panels at different locations.

1.4 Other Damage

The airport taxiway sustained localized ground breakup and groves due to the loading bottle jack concentrated load.

Shallow groves were drawn on the runway and taxiway due to the No.1 and No.2 hard rolling after the tires had separated from the wheels rims.

1.5 Personnel Information

The flight crew comprised: the captain and co-pilot. Table 2 illustrates the qualifications of both.

Table 2. Qualifications of the flight crew

Crewmember	Captain	Co-pilot
Age	51	48
Gender	Male	Male

License	ATPL	ATPL
Validity	27 November 2013	30 April 2014
Issuing State	Ukraine	Ukraine
Medical certificate/expiry	Class 1, 27 November 2014	Class 1, 6 June 2014
Flight experience	Not available	Not available

1.6 Aircraft Information

1.6.1 General

Table 3 shows general information about the Aircraft.

Table 3. General information about the Aircraft	
Make and Model:	Boeing 737-800
MSN:	29658
Registration:	UR-PSA
State of Registry:	Ukraine
Certificate of Airworthiness (CoA)	
Issuing Authority:	The State Aviation Administration, the Ministry of Transport and Communication, Ukraine
Issuance date:	10 September 2013
Valid until:	10 September 2014
Engines:	Two Turbofan, GE/Snecma, CFM56-7B26 Engines are not relevant to this Incident
Engines are not relevant to this Incident	

According to the records provided to the Investigation, there were no reported significant defects prior to the Incident. Neither there was any mechanical anomaly prior to the take-off.

1.6.2 LH MLG Tires History

The Aircraft records and the pieces of tire collected from the take-off runway revealed that the burst H44.5X16.5-21 sized tire had Part Number (P/N) APS06015 and, Serial Number (S/N) 411YC654-R3, and was installed on No.2 (LH inboard) wheel assembly (figure 1).

Figure 1: Collected tire piece from the departure airport

Table 4 illustrates general information about No.2 tire.

Table 4. No.2 tire general information	
Size: H44.5X16.5-21	**PR:** 28
S/N: 411YC654	**Manufacturing Date:** April 2011
Flight Cycles Since	**Manufacturer:** Bridgestone

Installation: 49	
Construction: N14-2BR-2RF	**Qualification:** TSO-C62d[5]
Casing P/N: APS06015	**Rated Load:** 44,700lbs
Re-tread Level: R-3	**Remaining Skid:** 8 mm

Nothing in the Aircraft technical logbook revealed any tire problems.

The tire/wheel assembly records revealed that the wheel was installed with zero Cycles Since New (CSN) on 6 October 2011 on another aircraft, and continued operation until 7 December 2011 when it was removed with 704 hours' Time Since New (TSN) and 225 CSN. The wheel assembly was stored until 10 May 2012 and then re-installed on the same aircraft.

The wheel assembly remained installed until 25 June 2012 when it was removed at 1,197 TSN and 412 CSN. On 11 December 2012, it was installed on another aircraft and continued until 5th March 2013 when it reached 2,086 TSN and 681 CSN.

On 6 May 2013, the tire was 3-layers re-treaded at Bridgestone.

In July 2013, the wheel assembly was removed from the No.3 (RH inboard) position of another aircraft due to low (60psi) pressure after landing.

The tire was assembled with P/N 3-1558, S/N 5451 wheel assembly on 10 August 2013.

The wheel was installed on the Aircraft on 3 September 2013 when it was at 168 hours Time Since Overhaul (TSO), 49 Cycles Since Overhaul (CSO), 8,641 TSN and 2,922 CSN, to replace S/N 5452 wheel and continued in service until the Incident date.

1.7 Meteorological Information

Table 5 shows the actual weather and the forecast for the departure Airport between 1700 and 1730 UTC on 14 September 2013.

Reviewing the 14th September 2013 data contained in the METAR and TAF reports between 1630 and 1800 UTC, there were no records of SIGMET reports neither were weather reports transmitted from other pilots indicating any significant meteorological events in the vicinity of the departure airport.

The Forecast Report issued at 1421 and valid from 1400 of 14 September 2013 to 1200 of 15 September 2013 contained the following information:

[5] TSO: Technical Standard Order, is the minimum performance standard issued by the United States Federal Aviation Administration for specified materials, parts, processes, and appliances used on civil aircraft. Articles with TSO design approval are eligible for use on the United States type certified products

Wind direction 030º, wind speed 10 kts, gust 19 kts, visibility 6,000 m, broken cloud at 500 ft, overcast cloud at 1,500 ft m temporarily between 1400 and 1800.

Wind direction was variable wind speed 19 kts, gust 29 kts, visibility 1,000 m, thunderstorm moderate shower rain mist, broken cloud at 300 ft, broken cumulonimbus cloud at 1,000 ft, temporarily between 1800 UTC of 14 September to 0600 of 15 September.

On 14 September 2013, Kiev sunrise and sunset were at 0632 and 1914 respectively. The day length was 12 hours 42 minutes and 2 seconds.

Table 5. METAR[1]

	1700 UTC	1730 UTC
Wind:	040°/12kts	040°/12kts
Visibility	6,000 meters	7,000 meters
Precipitation	Light shower rain	Light shower rain
Clouds [2]	Scattered at 600 ft, 1,100 ft, cumulonimbus cloud at 1,400 ft	Few cloud at 700 ft, scattered cloud at 1,400 ft, broken cumulonimbus cloud at 1,800 ft
OAT	15 °C	15 °C
Dew Point	15 °C	14 °C

1 METAR is a format for reporting weather information (Aviation Routine Weather Report)

2 According to the ICAO *Document 8896*, the following nomenclature is used to identify the clouds formation:

SKC: Sky clear

FEW (few)= 1-2 oktas

SCT (Scattered)= 3-4 oktas

BKN (Broken)= 5-7 oktas

OVC (Overcast)= 8 oktas.

Oktas: is a unit of measurement used to describe the amount of cloud cover at any given location. Sky conditions are estimated in terms of how many eighths of the sky are covered in cloud, ranging from 0 oktas (completely clear sky(SKC)) to 8 oktas (completely overcast (OVC))

1.8 Aids to Navigation

Ground-based navigation aids, on-board navigation aids, aerodrome visual ground aids and their serviceability were not a factor in this occurrence."

1.9 Communications

All communications between ait traffic services (ATS) and the crew were recorded by ground based automatic voice recording equipment for the duration of the flight. The quality of the aircraft's recorded transmissions was good."

1.10 Aerodrome Information

1.10.1 Boryspil International Airport

Boryspil International Airport, ICAO Code UKBB, 50°20'42"N, 03°05'34"E, is located 6 kilometres west of Boryspil, and 29 kilometres from Kiev, Ukraine. The elevation is 410 ft.

The airport has two runways: 36R/18L and 36L/18R, with lengths of 4,000 meters and 3,500 meters, respectively.

1.10.2 Dubai International Airport

Dubai International Airport, ICAO code OMDB, 25°15'10"N 55°21'52"E,, is located 4.6 kilometres east of Dubai, the UAE. The elevation is 62 ft.

The airport has two asphalt runways: 30R/12L and 30L/12R, with lengths of about 4,000 meters and 3,500 meters, respectively.

1.11 Flight Recorders

Both Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) were found intact and at their original place.

The recorders were brought to the Flight Recorders' Laboratory in the Air Accident Investigation Sector (AAIS), Abu Dhabi, the UAE.

The recorders were downloaded and analysed to depict the inter- and intra-flight deck communications and the various flight parameters pertinent to the Incident.

1.12 Wreckage and Impact Information

The Aircraft was intact. Scar marks were engraved on the runway of the arrival airport.

1.13 Medical and Pathological Information

No medical or pathological investigations were conducted as a result of this occurrence, nor were they required.

1.14 Fire

There were no signs of fire.

1.15 Survival Aspects

The airport fire brigade and emergency services arrived within two minutes. Aircraft evacuation was carried out by disembarking the passengers via mobile airstairs provided while the Aircraft was standing at the taxiway and its tail was obstructing the runway.

None of the passengers or crewmembers sustained any injury.

1.16 Tests and Researches

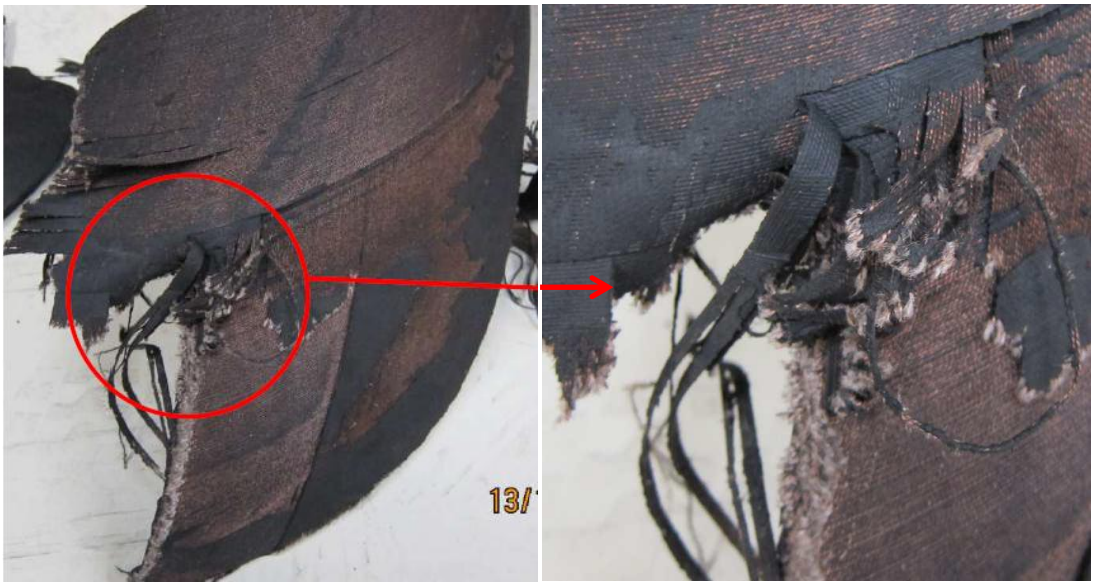
The damaged tire was shipped to the tire's manufacturer for laboratory examination. The examination revealed the following:[6]

The tread crown and casing plies examination revealed that:

- Two main pieces were recovered from the departure airport and one from the arrival airport
- All pieces showed a diamond shape
- The recovered pieces showed a separation at the casing plies. The separation occurred at about 30% of the casing total plies from the outside
- The casing separation could be explained by a sudden mechanical rupture
- The tread was still bonded to the casing which could give an indication that the tread separation was not caused by any production anomaly
- An identified suspected cut at the casing plies was observed on the debris which could be caused by an external impact (figure 2).
- The footprint of the remaining tire debris shows signs of overload which was mainly the result of an underinflated condition.

[6] Reference: Bridgestone Aircraft Tire (Europe), S.A. Tire Inspection & Analysis Report N° UIA 01.13, dated 7 February 2014

Figure 2: Sharp cut on the No.2 tire piece



There was no external sidewall, bead or inner liner pieces recovered.

The production records revealed no anomalies, and the shearographic re-tread processes were reviewed by the tire's manufacturer with no revealed anomalies in the casing structure or the tread crown area.

The manufacturer's report concluded that the tire rupture was due to contact with a foreign object leading to sudden tire burst. The first debris casing pieces were thrown at the departure airport while the remaining pieces disintegrated at the arrival airport.

1.17 Organisational and Management Information

The Operator (Ukraine International Airlines (UIA)), was established on 1 October 1992, and started operations on 25 November 1992 as per Air Operator Certificate issued by the State Aviation Administration of Ukraine to operate scheduled domestic and international passenger flights and cargo services to Europe, Middle East, Asia and the United States. The principal place of operation is Boryspil Airport, Kiev, Ukraine.

The Investigation could not obtain information related to the Operator's management and structure.

1.18 Additional Information

1.18.1 Boeing 737-800 Tires

The AAIS had issued investigation Final Report No. 05/2009 on 22 March 2010 concerning tire de-capping on a Boeing 737-800 during take-off roll. The No. 2 tire deflation had led to an aborted takeoff while the aircraft was about at 147 kt groundspeed.

Report No. 05/2009 stated that in Boeing 737-800, and as per Industry, the No.2 and 3 Main wheels are more affected than the other wheel locations due to that these tires are more prone to the shoulder wear problem (Step Wear) phenomenon that Industry is facing. Accordingly, Boeing issued a recommendation to operate at higher inflation pressures.

As per information received from Boeing, many operators of Boeing 737-800 model airplanes have reported low tire tread lives and high varying levels of tire shoulder wear on the main gear tires and that the wear is worse on No.2 and 3 wheel positions. Although shoulder wear is sometimes witnessed on both tire types, tires that are designed to the 'H' profile, such as the H44.5X16.5-21 tire, were observed to be affected more than type VII or radial tires.

Tire suppliers acknowledge that the Boeing 737NG[7] tire life is below expectation and they are studying and/or implementing design changes intended to improve tire life and reduce shoulder wear. In some cases, changes are being made to the re-tread processes since these can be implemented into service quicker than design changes to the carcass itself.

Bridgestone Company, the supplier of the de-capped tire on the Incident Aircraft, implemented a new tread compound across all of their tires lines which has shown an improvement in tread life and has also developed an increased skid depth version of their H44.5X16.5-21 tire.

Report No. 05/2009 stated that Boeing has recommended the following based on their studies on tires:

1. Inflate tires to the high end of the allowable range shown in *Aircraft Maintenance Manual* (AMM) 12-15-51. This reduces the sidewall deflection of the tire and therefore reduces the heat generated by the tire
2. It is important to check tire inflation pressures frequently
3. If a tire is identified as leaking, as evidenced by two successive pressure checks where the pressure is more than 5% low, it should be removed from the airplane immediately

[7] Boeing 737NG: is the Boeing 737 Next Generation as a name given to the −600/-700/-800/-900 series of the Boeing 737 aircraft

4. Operators should require that their tire maintenance agencies perform the more complete bead-to-bead Non Destructive Test (NDT), holography/shearography test, on their tires as opposed to just checking the crown area. This appears to be especially important on Boeing 737NG tire sizes and is most critical when the tires reach high re-tread levels. An example of a minimum NDT program may be as table 6 illustrates.

Table 6. Minimum NDT program for re-treaded tires

Re-tread Level	Inspection*
R-0	Crown area (shoulder-to-shoulder)
R-1	Crown area (shoulder-to-shoulder)
R-2	Crown area (shoulder-to-shoulder)
R-3 and beyond	Crown and sidewall (bead-to-bead)

* Using Shearography

Notes (by Boeing):

- The above NDT program is just a sample and should be adjusted based on individual operator's experience. Boeing Service Letter 737-SL-32-128 has been released on this subject.
- For aircraft tires, the term 're-treading' refers to the methods of restoring a used re-treadable tire by renewing the tread alone or by renewing the tread plus the reinforcing ply(s) or protector ply.
- Full re-capping is the recommended procedure for tires with evenly worn tread, tires with flat spotted tread, or tires with numerous cuts in the tread area. The new tread material extends around and over the shoulder of the tire for several inches.
- Re-tread Level (R-Level) Escalation is the process used to verify that a population of re-treaded tires is suitable for an additional service life.

5. There is a correlation between tire failure and the re-tread level of the tire. Several Operators affected by these tire failures found that their tread losses only occurred on tires at high re-tread levels. As a result, they elected to limit the number of times their tires are re-treaded.

1.18.2 The Operator's *Technical Procedures Manual*- General Storage Conditions for Components and Materials

According to the Operator's *Technical Procedures Manual*, both new and re-treaded tires should be stored in a cool, dry place out of direct sunlight. Temperatures should be between 32 °F (0 °C) and 85 °F (30 °C). Particular care should be taken to store tires away from fluorescent lights, electric motors, battery chargers, electric welding equipment, electric generators and similar equipment. These items create ozone, which has a deteriorating effect on rubber.

Care should be taken that tires do not come into contact with oil, gasoline, jet fuel, hydraulic fluids or similar hydrocarbons. Rubber is attacked by these in varying degrees.

All tires and tubes should be inspected immediately upon receipt for shipping and handling damage.

Whenever possible, tires should be stored vertically on tire racks. The surface of the tire rack against which the weight of the tire rests should be flat and wide to minimize distortion.

Axial (circumferential) rotation of un-mounted, vertically stored tires should not be required. With respect to the effect of storage time on rotation, strongly suggest the use of first-in first-out (FIFO) storage. This helps to avoid storage-related field issues.

Stacking of most tires is permissible; however, care must be used to prevent distortion of the tires on the bottom of the stack.

According to the same Manual, age is not an indicator of tire serviceability. Aircraft tires have no 'expiration date' as long as all service criteria, visual criteria, or individual restrictions are met.

1.18.3 Flight Continuation

During their interviews, the crew stated that the captain decided to continue the flight to the planned destination for the following reasons:

- *Adverse weather condition*. [At the departure airport]
- *FCTM[8] and OM-B recommended that the flight crew continue the flight.*

[8] FCTM: the Flight Crew Training Manual. This Manual shall not be used by the crew as an operation reference; it is a training manual that does not require frequent changes to any changes in the aircraft or operation. The recognized reference for crew in operations in the Flight Crew Operating Manual (FCOM) or any equivalent document.
The Investigation did not go to an in-depth analysis into this aspect.

- *Damage was limited to a single tire.*
- *Company advice.* [Operator's advice].
- *The take-off weight was very high.* [Weight is higher the Maximum Landing Weights].
- *There was no problem indicated in the cockpit.* [No adverse cockpit indications].

1.18.4 Communication among the Departure Airport, Operator's Operations Control Centre (OCC), Maintenance Control Centre (MCC), and the Aircraft

After the request from the crew to check the departure runway for any foreign object left by the Aircraft, the departure airport passed the information to ATC who in turn informed the crew of the pieces of tire found on the runway.

Neither the OCC nor the MCC was involved in the identification of the pieces through Operator's internal network. Referring to the serial number shown in the main left chunk could have identified the tire's position after consulting the Aircraft records.

1.18.5 Inspection by Fly-Past[9]

When the crew requested the Dubai Airport Approach Controller to check the RH MLG for a blown tire, the Controller replied that a vehicle was standing at the runway holding point and the persons on-board that vehicle would help in checking the gear.

Later, the Tower Controller called the ODMA to inform him that traffic is at three or four miles and will be low at about 500 ft. The ODMA replied that they, i.e. the Airside Operation, were standing by at the holding point.

The ODMA did not notice any abnormal condition on the RH MLG. The LH MLG was not inspected since the crew had not requested this.

1.18.6 International Standards of Disabled Aircraft Recovery

Part 5 of the International Civil Aviation Organization (ICAO) *Document (Doc) 9137 Airport Services Manual- Removal of Disabled Aircraft gives guidance for removal of disabled aircraft*. The document stresses on that 'disabled aircraft that interfere with normal activity of an aerodrome require prompt removal actions'.

Annex 14 to the Convention on International Civil Aviation specifies that each aerodrome should draw up a comprehensive plan for the removal of a disabled aircraft on or adjacent to the movement area and a coordinator designated to implement the plan, when necessary. The removal plan should include certain lists of equipment and personnel available on or in the vicinity of the aerodrome, additional equipment available from other aerodromes

[9] Fly-past inspection is defined as that: the aircraft is flying over an observation point (e.g. tower) to permit ground personnel to inspect the aircraft. Often used to determine whether the landing gear has been properly extended.

on request, nominated agents acting on behalf of each operator at the aerodrome, a statement of the airlines arrangements for the use of pooled specialist equipment, and local contractors able to supply heavy removal equipment on hire. The plan must also contain the responsibilities of the different parties in removing disabled aircraft, the notification of the occurrence to the investigation authority, preservation of aircraft, mail, cargo and records.

Responsibilities for the removal of a disabled aircraft are shared among the aircraft operator, the aerodrome operator and other parties. Doc 9137 states that for an aircraft removal operation to begin and be completed as quickly as possible, all parties must be expeditiously facilitated and already have the proper procedures in place. An efficient removal operation requires sufficient planning and readily accessible recovery equipment.

The aerodrome operator should have an officer designated to coordinate the aircraft recovery operation and a disabled aircraft removal plan available. In addition, a copy of the aircraft operator's removal plan should be on file for every regular user of the aerodrome. Among other things, the aerodrome authority is responsible also for: issuing the required notice to airmen (NOTAM) as may be appropriate; coordinating all aerodrome operations with the air traffic services units for continuation of aircraft operations, when possible; determining any obstacles in accordance with clearance criteria and to consider whether any section of the movement area should be closed; provide for security of the accident site and coordinate with the aircraft accident investigation authority on measures to be taken before the aircraft removal operation is initiated; providing advance vehicles and personnel to escort airline equipment to the site; establishing a removal command post at the site, if considered necessary; and convening a removal operation debriefing of all interested parties. The debriefing may include a review of aircraft accident investigation authority requirements, the coordinator's chronological report, and a discussion of the procedures and equipment used during the recovery operation. It may be desirable that all aircraft operators, especially those operating the same type of equipment, be invited to attend.

Among other things, the aerodrome coordinator of disabled aircraft removal operations shall convene a meeting with the aircraft operator representative, aircraft accident investigation authority, and other parties to discuss the most appropriate removal operation and agree upon a broad plan of action; supervise the aerodrome personnel and equipment assigned to the removal operation; make decisions on behalf of the aerodrome authority, as necessary, to expedite the removal of the disabled aircraft; maintain a chronological summary of the removal operation; and have photographs of the removal operation taken where possible.

The aircraft operator, or his ramp handling agent, is responsible, among other things, for arranging for portable stairs and removal of mail, baggage and cargo and to designate one representative with the authority to make all technical and financial decisions necessary to remove the aircraft.

Depending on the size of the airline and the area to be covered, more than one team leader may be required. Doc 9137 suggests that team leaders have experience as an aircraft maintenance production team leader or foreman; have good technical and leadership qualities; have experience and knowledge of aircraft recovery; have knowledge of equipment such as jacks, pneumatic lifting bags, cranes and their general operation; and supervise any on-site recovery processes.

The recovery team shall possess a level of experience, training and proficiency that allow them to control a successful aircraft removal operation without causing secondary damage.

To assure a continuous readiness, the ICAO suggests that the aerodrome operator and aircraft operators hold regular tabletop exercises in order to anticipate various aircraft removal scenarios and their projected outcomes.

As a specific approach to an aircraft type, the aircraft manufacturers usually publish *aircraft recovery manual* (ARM) that provides details on the specific aircraft related to weight and balance information, maximum loads for lifting and towing operations, locations for lifting bags and associated skin pressures, the location and numbering of fuselage frames and stringers, the location and type of composite materials, the size and location of all doors and openings, ground clearances, ground connections, grounding points, etc. The ARM is to be accessible by the recovery team through the aircraft operator, the aircraft manufacturer, the contracted recovery company or a copy held by the aerodrome operator.

It is essential for any recovery procedure to determine the weight and centre of gravity location of the aircraft thus the recovery team will be able to decide the levelling/lifting technique to be used, the type and capacity of the selected equipment, the expected loads, any anticipated changes to the stability of the aircraft, and that the lateral and longitudinal balance limits not be exceeded during the recovery operation. The ARMs provide worksheets to assist in calculating the net recoverable weight (NRW) and/or recoverable empty weight (REW) and the associated moments.

Managing the aircraft weight and related centre of gravity is essential for safe recovery but 'effort must be made to reduce the weight of the aircraft to the minimum possible. Fuel and cargo are generally the easiest way to remove large amounts of weight quickly'. For this purpose, the ARM contains information on where to find the fuel loads. In certain conditions, the magnetic sticks can be used to measure fuel. If the aircraft records are available, a good estimate of the expected fuel on board at landing will be available. In cases where the electrical system is serviceable, the on-board computer can also provide these details.

Reduction of aircraft weight is beneficial in that it brings the aircraft to a lower NRW, more straightforward soil stabilization, and the ability to use equipment of lower ratings such as cables, slings, etc.

It is the responsibility of the recovery team leader to determine the necessity for weight reduction by cargo removal since a number of factors need to be considered such as the need to level the aircraft prior to unloading. Otherwise, if the recovery team decides to remove the cargo prior to levelling, certain precautionary procedures are to be followed to prevent any further damage to the aircraft or any possible personal safety threats.

To lift a disabled aircraft, bottle or wheel type jacks can be useful for initial levelling and lifting in constricted areas. They have the same limitations as the standard maintenance jacks. But for Jack stability, the area on which the jack rests must be properly stabilized by gravel base, steel plates and plywood in order to support the anticipated loads.

1.18.7 UAE National Standards of Disabled Aircraft Recovery

Part IX of the UAE Civil Aviation Regulations-*Aerodromes*, prescribes the requirements for aerodromes certification and oversight.

Paragraph 2.10- *Disabled Aircraft Removal*, in appendix 2- *Aerodrome Data***,** to the regulations**,** states that:

'

Note: See ICAO Annex 14, Volume 1, Chapter 9, 9.3 for information on disabled aircraft removal.

2.10.1 The telephone/telex number(s) of the office of the aerodrome coordinator of operations for the removal of an aircraft disabled on or adjacent to the movement area should be made available, on request, to aircraft operators.

2.10.2 Information concerning the capability to remove an aircraft disabled on or adjacent to the movement area should be made available.

Note: The capability to remove a disabled aircraft may be expressed in terms of the largest type of aircraft which the aerodrome is equipped to remove.'

Paragraph 3.3.3.16- *Disabled Aircraft Removal Plan*, in appendix 3- *Particulars to be Included in an Aerodrome Manual***,** states that:

'

a) the telephone/telex/facsimile numbers and e-mail address of the aerodrome coordinator for the removal of a disable aircraft on or adjacent to the movement area; and

b) information on the capability to remove a disabled aircraft, expressed in terms of the largest type of aircraft which the aerodrome is equipped to remove.'

Paragraph 3.5.19 in appendix 3- *Disabled Aircraft Removal,* states that:

'

3.5.19.1 The Aerodrome Operators arrangements and implementing plans that ensure the integrated management of aircraft recovery and business continuity following an aircraft incident/accident. These arrangements should take account of the complexity and size of the aircraft operations and based on the largest aircraft using the aerodrome.

3.5.19.2 The GCAA Regulations for the full provision of Rescue, Fire-Fighting and Emergency Planning for all categories of aerodrome shall be in accordance with

CAR Part XI - Aerodrome Emergency Service, Equipment and Facilities.

3.5.19.3 The Aerodrome Operator shall provide aeronautical data regarding disable aircraft removal in accordance with Appendix 2, Section 2.10.'

Section 17 in the GCAA's *Emergency Planning Audit Checklist* contains check items pertinent to disabled aircraft recovery plan concerning: the documentation of the recovery plan; list of recovery equipment and if the equipment are provided by aerodrome or third party; mutual to use other airports recovery equipment; documented list of agents acting on behalf of each aircraft using the aerodrome; Memorandum of Understanding (MoU) in the use of recovery equipment at the aerodrome; documented list of local contractors with suitable recovery equipment; are those persons nominated to use the recovery equipment fully trained in its use; and who is the designated coordinator for aircraft removal and where is this documented.

The above checklist was followed during the last *Airport Emergency Plan (AEP)* audit done on Dubai Airport in 2013.

After the audit, in February 2014, Dubai Airports drafted a new *Disabled Aircraft Recovery Plan*[10] to supersede the current *SOP-01-24-v3.*

The new procedures consider the operator responsible for removing disabled aircraft and require them to have adequate planning that *guarantee* rapid response for the removal. Such a plan shall be made available to Dubai Airports by each airline or handling agent.

The draft contains a clause that from 1 January 2014, all operators are required to have a written disabled aircraft recovery plan in agreement with the airport operator. But, in case the operator or his agent fails to remove the aircraft, Dubai Airports will request EK to recover and remove it, the removal results and costs are binding to the operator.

The draft covers: the responsibilities of each concerned party; notes on documenting the aircraft and evidence before recovery work starts; health and safety of the involved persons present at the site; actions required by main parties; and five generally accepted major principles which are: site survey, planning, preparation, recovery and reporting processes.

1.18.8 Recovery of Disabled Aircraft at Dubai International Airport

Aerodrome Manual

The procedures that describe the disabled aircraft recovery operations in Dubai International Airport are contained in the *Aerodrome Manual* (DXB-2010-HOCA- *Aerodrome Manual*- March 2013-Version 8.1).

[10] A GCAA audit is planned to be done in May 2014 to check the adequacy of the revised Disabled Aircraft Recovery Plan

In the *Aerodrome Manual*, paragraphs 4.24, 5.20 and 5.21 refer to the Disabled Aircraft Removal Plan and Procedures. *SOP-01-24* contains disabled aircraft recovery outlines. *SOP-01-24* highlights that Dubai Airports has agreed arrangements with Emirates Airlines (EK) for the services of disabled aircraft recovery at Dubai International Airport under a Service level Agreement (SLA) signed by both parties.

The purpose of the *SOP* was stated as 'in order that the aerodrome can recommence operations, or remove an aircraft after it has become disabled, there is a requirement to ensure that its removal is undertaken in a controlled manner'.

The 'call out procedure in paragraph 4.1 of *SOP-01-24* states that: 'in the event of an incident which requires an aircraft to be removed, the ODMA will contact the Head of Airside Operations (HOAO), Head of Compliance Assurance (HOCA) and the VPAO. The ODMA will inform the Dubai Civil Aviation Authority (DCAA) and GCAA 'if necessary'. Paragraph 4.2 mentions that: 'only those three persons [VPAO, HOAO or HOCA] or their nominated deputies may authorize the request to EK to provide the recovery service under the SLA'.

Paragraph 5.2 of *SOP-01-24* states that: 'after the aircraft and any passengers or crew are made safe, the ODMA is to assess whether the aircraft penetrates any of the Obstacle Limitation Surfaces and whether any aerodrome operations are affected. In conjunction with ATC, taxiways, aprons, stands and roads should be taken out of use. If required, ODMA is to ensure that a NOTAM is issued and that all aerodrome users are informed of any changes to operations'.

If the location of the aircraft is such that operations on the runways are affected and the aircraft cannot be simply removed with a tug, the ODMA should contact VPAO, HOAO and HOCA to request EK to provide recovery under the agreement made in the SLA.

Neither the *Aerodrome Manual* nor *SOP-01-24* refers to a comprehensive plan for the removal of a disabled aircraft. In addition, the responsibilities of the different parties in removing disabled aircraft are not defined in the applicable procedures. There is nothing in the procedures that calls for regular tabletop exercises in order to anticipate various aircraft removal scenarios and their projected outcomes.

The procedure does not contain a reference to the manufacturer ARM and how such ARMs are to be acquired.

Service Level Agreement (SLA)

The disabled aircraft recovery is subcontracted by Dubai Airports Company, as of being the operator of Dubai International Airport, to EK, Base Operational Maintenance and Recovery through the aforementioned SLA that was signed by both parties on 2 June 2010 and amended for revision 3 in November 2012.

According to the SLA, EK shall provide the appropriate response to recover and remove the aircraft to an agreed location.

EK shall supply the manpower, equipment and materials working under the direction and supervision of EK Engineering Service Department and under the overall control of the Incident Commander nominated by Dubai Airports.

The 'call out procedure' in the SLA states that the individuals authorized to call for the aircraft recovery equipment to be mobilized is the VPAO, HOAO, or HOCA or their nominated deputies**.**

1.18.9 Response of the National Bureau for Incidents and Accidents Investigation of Civil Aircraft (NBIAICA), Ukraine, to the Draft Final Report of the AAIS

In its response to the draft Final Report forwarded on 6 April 2014, the NBIAICA contained the following comments:

(a) The damage of the Aircraft was significant to be a reason for upgrading the occurrence from 'incident' to 'serious incident'.

(b) The cause to be re-determined as:

- Unreasonable recommendations to the crew for the decision-making to continue the flight to the destination airport of Dubai after the tire damage at Borispol airport without having determined:
  - Which wheel was damaged;
  - On which landing gear stand;
  - What are special features of landing at Dubai airport,

Which resulted in:

- Significant damages to the aircraft structure;
- A long-term close-up of the RWY of Dubai airport

(c) The Chapter "Analysis" should be supplemented with the point that upon giving recommendations to the captain as for the flight continuation to Dubai airport, there had not been identified the tire remnants by numbers and, as per the technical documents, the location of their installation.

The AAIS agreed with the first comment and accordingly amended the draft Final Report in changing the classification of the occurrence from 'Incident' to 'Serious Incident' but the AAIS did not concur with the second and third comments.

A letter was sent to the NBIAICA containing the AAIS's opinion on the NBIAICA's comments.

After some discussion on the draft Final Report, the NBIAICA requested to append the contents of their initial response letter to the Final Report. Accordingly, appendix C was made to this Report which contains a quote of the NBIAICA's response letter submitted on 28 May 2014 and extract of the subsequent AAIS-NBIAICA communication**.**

1.19 Useful or Effective Investigation Techniques

No new investigation techniques were used during this investigation.

2. Analysis

2.1 The Tire Burst

The shape of the recovered pieces of the No.2 tire showed indications of sharp cuts due, most probably, to contact with a foreign object. The Investigation believes that the foreign object was on the departure runway as evidenced by the crew's request to ATC to check whether there was debris left after the departure. Moreover, the recovered pieces showed a separation at the casing plies at about 30% of the casing total plies from the outside. The tire manufacturer's laboratory examination concluded that, it is, most probably, that casing separation was caused by a sudden mechanical rupture. The identified suspected cut of the casing plies that was observed on the debris supported the probability of foreign object impact. The tread was still bonded to the casing which provided an indication that the tread separation was not caused by any production anomaly.

The Boeing 737-800 No.2 and 3 'H' profile tires, H44.5X16.5-21, are known for a 'shoulder wear problem' (step wear) which leads to shorter tire lives below expectations.

The recommendation by the Aircraft manufacturer was to operate at higher inflation pressures. Therefore, tire pressure audits were required by operators to check the tires pressure and then inflate to the maximum limit.

The laboratory examination of No. 2 tire showed that the footprint of the remaining tire debris had signs of overload which was mainly the result of an underinflated condition. Although the underinflated No. 2 tire did not contribute to the tire burst, the Investigation believes that the Operator did not have an adequate system to monitor the tire pressure leading to an undetected underinflated tire.

The Investigation was unable to obtain information relevant to the Operator's tire storage conditions, but the Investigation believes that, if followed properly, the tire storage conditions and procedures as laid down in the Operator's *Technical Procedures Manual* are efficient in keeping tires reliable.

2.2 Communication between the Departure Airport, OCC, MCC and the Aircraft

After the request by the crew to Kiev ATC to check the departure runway for any foreign debris left by the Aircraft, the crew were advised that pieces of tire had been found on the runway.

Neither the OCC, nor the MCC, had a role in identifying the collected tire pieces and then relaying the information relative to the position of the burst tire to the crew. This information would have enabled the crew to manage the landing by employing an effective modified landing technique.

The Investigation believes that the communication network between the departure airport, the OCC, the MCC and the Aircraft was not effective.

The decision of the captain to continue the flight was justified in that, "There were adverse weather conditions at the departure airport; the FCTM and OM-B recommend flight crew to continue the flight; the damage was confined to a single tire [according to the captain's

assumption]; the company had advised to continue the flight; the take-off weight was very high; and there was no problem indicated in the cockpit". Although there is nothing in the standards that can limit the captain's judgment of continuing the flight to the destination airport, the Investigation believes that the decision to continue the flight had introduced an operational hazard at the destination airport.

The light shower of rain and low wind at the departure airport, and the forecast temporary broken cloud at 500 ft and overcast cloud at 1,500 ft during the time period 1400-1800, which contains the estimated time of return to the departure airport, was not sufficiently significant to prevent the return to base where adequate support would have reduced any prolonged runway closure.

The limited information provided by the OCC/MCC to the captain, and the lack of cockpit tire pressure indication, prevented the captain from determining a possible landing technique that may have prevented the No.1 tire from being damaged due to overload generated by the axle-mate No.2 tire loss.

2.3 Inspection by Fly-Past

The crew mistakenly requested visual inspection of the RH MLG due to their inadequate appreciation of the state of the damaged MLG.

The ODMA did not notice any abnormal condition on the RH MLG nor did he inspect the affected LH MLG since the crew had not requested this.

According to international standards an 'Inspection Fly-Past' is usually requested by the crew and an external visual check is carried out by Airport Operations personnel[11]. The erroneous message that was transmitted by the captain to the Tower Controller deprived the Airside Operations personnel of paying any attention to the affected LH MLG. It is probable that the damage to the tire could have been identified.

2.4 Disabled Aircraft Recovery at Dubai International Airport

An aircraft recovery operation is a type of emergency operational activity that is required to begin and successfully complete the removal as quickly as possible with the engineering critical path key steps identified in advance. Accordingly, all parties must be prepared and with suitably trained personnel and have in place the procedures, manpower, training and equipment. An efficient removal operation requires effective, detailed planning and readily accessible recovery equipment.

One recognized recovery team leader should be assigned to the operation. This person should be an engineer familiar with the ARM’s.

[11] According to the events taxonomy of the European Co-Ordination Centre for Aviation Incident Reporting Systems (ECCAIRS), the Fly-past inspection is defined as: the aircraft is flying over an observation point (e.g. tower) to permit ground staff to inspect the aircraft. Often used to determine whether the landing gear has been properly extended

One of the criteria of an efficient recovery plan is to assure that effective communication networks are available among the various recovery parties.

On the day of the Incident, two communication networks were established: a narrow (intra-site) network and a wider (inter-site) network.

The intra-site network was established among the ODMA, recovery team, and the ATC. The inter-site network was among the ODMA, HOAO, HOCA, VPAO, and DCAA and GCAA.

The *SOP-01-24* specifies that the recovery team shall work under the direction and supervision of the service provider and under the overall control of the Incident Commander, nominated by Dubai Airports. The SLA does not specify whether the Incident Commander is the ODMA or not.

The *SOP* assigns several critical responsibilities to the ODMA such as ensuring that the aircraft and any passengers or crew are made safe, the assessment of the aircraft situation relative to the aerodrome operations and ensuring that a NOTAM is issued, if required.

According to the assessment of the ODMA, if the location of the aircraft is such that operations on the runways are affected, and the aircraft cannot be simply removed with a tug, the ODMA should contact VPAO, HOAO and HOCA to request the disabled aircraft recovery service from the airport recovery service provider.

Considering these responsibilities, the ODMA needs to be adequately authorized to make on-the-spot decisions. The *SOP* and the SLA introduced, to a certain extent, issues in managing an Incident.

The ODMA did not have the authority to directly call the recovery service provider requesting use of equipment. On the contrary, such requests were only made by managerial level personnel to Operations. Management personnel are not required to be present at the Incident site nor do their responsibilities require them to function at an emergency operational level. The Investigation believes the ODMA was not fully authorized to make decisions on behalf of the aerodrome authority in relation to removing the Aircraft within an efficient time and with the least amount of damage.

The inter-site network could be optimized if the ODMA obtains the necessary training and empowerment]. There should be no restrictions in the *SOP* that impedes the ODMA since, as the Incident Commander, he is the most appropriate person to assess the situation and come up with effective recovery plan decisions after referring to the factual information available at the incident site.

Neither the *Aerodrome Manual* nor the *SOP* specifies a comprehensive plan for the removal of a disabled aircraft. In addition, the responsibilities of the different parties in removing disabled aircraft are not defined in the applicable procedures. There is nothing in the procedures that calls for regular joint tabletop exercises in order to anticipate various aircraft removal scenarios, and their possible outcomes. The *SOP* does not require referring to the manufacturer ARM and how such ARMs are to be acquired.

The lack of availability of the ARM to the recovery service provider deprived the latter of managing the Aircraft removal in an organized manner. Problems were introduced due to the trial-and-error methodology followed by the recovery team.

The Investigation believes that the recovery team was not able to determine the aircraft weight or to determine the location of the C.G. Therefore they could not determine whether a weight reduction was required. The reluctance in managing the recovery was partially due to the difficulty in off-loading cargo from the Aircraft while it was obstructing the runway.

There was no adequate risk assessment exercise made on the Incident site to determine whether the reduction of the Aircraft weight was possible or necessary. In the same manner, there was no sufficient effort made to offload the Aircraft. Although it was the responsibility of the ODMA to control the process, the ODMA did not establish sufficient communication with the recovery team to discuss the issue of offloading the Aircraft. The ODMA insistence of towing the Aircraft without weight reduction resulted in several unsuccessful attempts to move the Aircraft confirmed that such a reduction was required. The Investigation believes that the risk of offloading the Aircraft while it was at its first stop point would be less than the risk of keeping it obstructing the runway for a long time and potentially leading to several unsuccessful trial-and-error jacking practices.

The stress concentration generated by the bottom of the jack onto the taxiway ground caused the jack to sink into the taxiway pavement. The Investigation believes that the phenomenon of stress concentration caused by excessive load on narrow areas was not considered by the recovery team, and consequently, stabilizing the jack by gravel base, steel plates and/or plywood in order to support the anticipated loads was not practiced by the recovery team.

The recovery team attempt to jack the Aircraft by using the type applicable aircraft jacks supplied by the third party was not successful. The reaction of the Aircraft after installing the LH wing jack was not predicted by the recovery team. The Investigation believes that the recovery team leader did not possess a level of experience, training and proficiency to anticipate the Aircraft reaction as the jack lifted the Aircraft, nor he had an applicable ARM that would have presented adequate guidance information relevant to determine the C.G and thus follow proper jacking technique. [12]

Since the Aircraft type in question was not operated by the recovery service provider, communication and arrangements had to be made with a third party who possessed the required jacking equipment applicable to the Boeing 737. Obtaining the requested tools, equipment and material consumed a considerable amount of time since the logistics stores were located some distance from the incident site and the routing was mandatory via airside roads. The Investigation believes that the time taken during transport of the equipment from the third party was longer than it should have been in such a demanding situation.

[12] During their interviews, both recovery team leaders revealed that they had gone through short recovery training with no attention to the aircraft load sheet and CG shifting

The Investigation believes that, in this case, the 10 hours consumed in removing the Aircraft and recommencing the runway operation could have been significantly reduced if the removal was undertaken in a controlled manner.

2.5 UAE National Standards of Disabled Aircraft Recovery

The requirements for disabled aircraft recovery, as prescribed in the Civil Aviation Regulations, lack reference to the recovery team competency and training needs. Although the regulations refer to the *Annex 14* to the Convention on International Civil Aviation and ICAO *Document (Doc) 9137,* the regulations neither enforce the competency of the recovery personnel nor it clearly require frequent exercises to assure the adequacy of the recovery plan.

Accordingly, the GCAA's *Emergency Planning Audit Checklist*, did not contain check items relevant to the competency of the recovery personnel or frequent exercises. Instead, the checklist was limited to check the that persons nominated to use the recovery equipment are fully trained in its use whereas the training needs exceed the equipment users to the recovery team leader who shall be a qualified person who has adequate know how on aircraft recovery management such as C.G control, load reduction requirements, aircraft handling safety, etc. and more than knows how to use the aircraft recovery manual specific to the type of the disabled aircraft.

The Investigation believes that should the regulations are enhanced and the checklist are re-designed; the objectives of aircraft recovery plan will be more achievable for less delays in re-commencing the airport normal operations and minimised damage to the aircraft during its recovery work.

3. Conclusions

3.1 General

From the evidence available, the following findings, causes and contributing factors were made with respect to this Incident. These shall not be read as apportioning blame or liability to any particular organisation or individual.

To serve the objective of this Investigation, the following sections are included in the conclusions heading:

- **Findings-** are statements of all significant conditions, events or circumstances in this Serious Incident. The findings are significant steps in this Serious Incident sequence but they are not always causal or indicate deficiencies.
- **Causes-** are actions, omissions, events, conditions, or a combination thereof, which led to this Serious Incident.
- **Contributing factors-** are actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident or incident occurring, or mitigated the severity of the consequences of the accident or incident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

3.2 Findings

3.2.1 The flight crewmembers were licensed and qualified for the flight in accordance with the existing requirements of the State Aviation Administration, the Ministry of Transport and Communication, Ukraine.

3.2.2 The Aircraft was certified, equipped and maintained in accordance with the existing requirements of the State Aviation Administration, the Ministry of Transport and Communication, Ukraine.

3.2.3 The Aircraft was airworthy when dispatched for the flight.

3.2.4 Examination of the maintenance records did not reveal any evidence of pre-existing Aircraft structural or mechanical anomalies that could have contributed to the Incident.

3.2.5 The No.2 wheel tire sustained damage during the take-off roll.

3.2.6 There is no evidence to the Investigation of deficiencies in tire storage or tire re-tread procedures and conditions.

3.2.7 'H' profile tires, H44.5X16.5-21, are known to Industry for a 'shoulder wear problem' (step wear) phenomenon which leads to shorter tire lives.

3.2.8 The No.2 tire was underinflated when it was damaged.

3.2.9 The No.2 tire was, most probably, damaged due to impact with an object.

3.2.10 The meteorological conditions at the departure airport would not have prevented the crew returning to base.

3.2.11 The Airport, the Operator's MCC, OCC and Aircraft communication networks were not well integrated.

3.2.12 The MCC did not identify which tire had failed and therefore did not convey the information to the Aircraft.

3.2.13 The crew were not aware which side of the MLG tire had been damaged.

3.2.14 The crew requested the arrival Approach ATC to inspect the incorrect (RH MLG) undercarriage unit.

3.2.15 The crew were unable to determine an appropriate tire burst landing technique.

3.2.16 The No.1 tire burst had occurred sometime after landing and was consequent to the No.2 tire damage.

3.2.17 The Aircraft stopped and was unable to continue while vacating runway 12L via taxiway M 09.

3.2.18 The disabled aircraft recovery personnel response time was 30 minutes.

3.2.19 The responsibilities of the different parties in removing disabled aircraft are not defined in the applicable procedures.

3.2.20 The Incident Command and Control were improperly implemented due to time-consuming inter-site communication.

3.2.21 The recovery service provider was not sufficiently having the necessary equipment since the Aircraft type is not within his fleet.

3.2.22 The recovery team was not provided with access to the *Aircraft Recovery Manual*.

3.2.23 The recovery team did not consider the necessary engineering requirements related to jack stabilizing, C.G identification and determining the need for weight reduction.

3.2.24 The supply of Boeing 737 equipment from the third party store took longer than expected.

3.2.25 The permission given by the ODMA to the recovery team for offloading the Aircraft from cargo was provided late.

3.2.26 Neither the procedures in the possession of the recovery team nor their training was adequate.

3.2.27 The disabled aircraft recovery was not implemented in a controlled manner.

3.2.28 There have been no previous disabled aircraft recovery exercises nor is it required by the applicable *SOP* and *Aerodrome Manual*.

3.2.29 The requirements of disabled aircraft recovery, as prescribed in the UAE Civil Aviation Regulations, lack standards for competency of the recovery personnel and the need for frequent exercises to assess the adequacy of the recovery plan.

3.2.30 There was no damage to the Aircraft caused by the recovery.

3.2.31 The meteorological conditions at the arrival airport were not relevant to the Incident.

3.3 Causes

The Air Accident Investigation Sector determines that the causes of the prolonged runway closure by this disabled aircraft were:

3.3.1 The No.2 wheel tire burst on takeoff leading to the No.1 tire burst after landing.

3.3.2 The tire burst on takeoff, was most probably, due to impact with an object on the take-off runway.

3.3.3 The inadequate disabled Aircraft recovery plan.

3.3.4 Lack of training and inefficient decision-making.

3.4 Contributing Factors to the Incident

Contributing factor to the Serious Incident was the insufficient communication network between the departure airport, the OCC, MCC, and the Aircraft, and lack of cockpit tire pressure indications, which deprived the crew from identifying which tire had burst and then practice a possible mitigating landing technique.

4. Safety Recommendations

4.1 General

The safety recommendations listed in this Report are proposed according to paragraph 6.8 of *Annex 13 to the Convention on International Civil Aviation*[13], and are based on the conclusions listed in heading 3 of this Report; the GCAA expects that all safety issues identified by the Investigation are addressed by the receiving States and organizations.

4.2 Final Report Safety Recommendations

The Air Accident Investigation Sector recommends that:

4.2.1 The Operator to:

Establish new procedures or enhance existing procedures to:

SR 12/2014

Enhance his operational airport, Operations Control Centre (OCC), Maintenance Control Centre (MCC) and aircraft communications network to ensure that safety related data are transmitted to the flying crew on proper time.

SR 13/2014

Provide advanced policy and guidelines to flight crews on return to base criteria.

SR 14/2014

Although it was not proven to the Investigation that the low pressure of No.2 wheel tire had contributed to its damage; the Investigation recommends that the Operator establishes a tire pressure monitoring system to ensure that the pressure of the H44.5X16.5-21 tires are inflated up to the upper permissible limits as recommended by the Aircraft manufacturer.

4.2.2 Boryspil International Airport to:

SR 15/2014

Although No.2 tire damage due to impact with an object on the departure runway was a probability revealed by laboratory examination of the tire; the Investigation

[13] Paragraph 6.8 of *Annex 13 to the Convention on International Civil Aviation* states: 'At any stage of the investigation of an accident or incident, the accident or incident investigation authority of the State conducting the investigation shall recommend in a dated transmittal correspondence to the appropriate authorities, including those in other States, any preventive action that it considers necessary to be taken promptly to enhance aviation safety'.

recommends that Boryspil International Airport enhance the applicable runway inspection procedure.

SR 16/2014

Establish new procedures or enhance existing procedures for communicating safety information to operators' OCCs/MCCs.

4.2.3 The State Aviation Administration of Ukraine to:

SR 17/2014

Assure that, all operators who possess Air Operator Certificates issued by the State Aviation Administration of Ukraine, establish new procedures or enhance their existing procedures for:

(a) Enhancing their airport, OCC, MCC and aircraft communications network to ensure that safety related data are transmitted to the flying crew in proper time.

(b) Enhancing risk management capabilities

(c) Monitoring the pressure of the H44.5X16.5-21 tires.

SR 18/2014

Ensure that the Airport operator:

(a) Enhances the applicable runway inspection procedure for foreign object inspection.

(b) Establishes new procedures or enhance existing procedures for communicating safety information to operators' OCCs/MCCs.

4.2.4 Dubai Airports to:

SR 19/2014

Although Dubai Airports had drafted new disabled aircraft recovery procedures, later to the Incident, that contain some of the facts discussed in this Report. The draft is to be improved to ensure that:

(a) Sufficient and clear empowerments are made to the various disabled aircraft recovery role players.

(b) Common frequent exercises are conducted to test the effectiveness of the recovery plan.

(c) Efficient communication network is supplemented to the Service Level Agreement (SLA).

(d) Effective training of Airside Operations Duty Managers (ODMA) to sufficiently assume their roles in aircraft recovery.

(e) The ODMA is vested with sufficient power in decision-making on aircraft recovery actions.

(f) Operators given rights to operate from/to Dubai International Airport, provide continuous access to their applicable aircraft recovery manuals for use by the disabled aircraft recovery team.

(g) Frequent pre-planned exercises, in collaboration with all concerned parties, especially the disabled aircraft recovery service provider, are conducted for the purpose of testing the disabled aircraft recovery procedures.

4.2.5 The Disabled Aircraft Recovery Service Provider to:

SR 20/2014

Amend the disabled aircraft recovery procedure to ensure:

(a) Prompt access to the necessary recovery tools, equipment and materials through direct acquirement or loan/pool agreements.

(b) Effective training of the recovery team to ensure adequate competency in performing recovery operations in reference to the applicable aircraft recovery manuals.

(c) Sufficient empowerment of the recovery team leader in decision-making in relation to the technical requirements for removal of disabled aircraft.

(d) The possession of list of all aircraft types that currently operate into Dubai International Airport and current list of all technical and ramp handling agent of all operators.

4.2.6 The General Civil Aviation Authority of the United Arab Emirates to:

SR 21/2014

Improve the Civil Aviation Regulations and the associated checklists to include requirements and check items pertinent to the competency of the recovery personnel and frequent exercises to assess the adequacy of the recovery plan.

Accordingly, and during aerodromes initial certification, renewal, or oversight; the GCAA is to assure that all UAE aerodrome operators have sufficient disabled aircraft recovery procedures that contains all requirements laid down in *Annex 14* to the Convention on International Civil Aviation and part 5 of ICAO *Document (Doc) 9137*.

Air Accident Investigation Sector
General Civil Aviation Authority
The United Arab Emirates

Appendix A. Kiev International Airport- Runway Layout

Кроки составил инженер АС А.В. Шукало

Инженер-инспектор СКБП и АНО С.А. Сухов

Дата: 14.09.2013 г.

Условные обозначения:
- Крупные фрагменты резины от пневматика - 2 шт.
- Мелкие фрагменты резины от пневматика - до 10 шт.

Appendix B. Dubai International Airport- Runway Layout

Appendix C. The NBIAICA Response to the AAIS Draft Final Report

Response letter submitted by the NBIAICA, on 28 May 2014, on the AAIS draft Final Report stated that:

"In accordance with i.6.3 of ICAO Annex 13, as for the classification and the causes of the occurrence with Boeing-737 aircraft in Dubai airport, we would propose to introduce some amendments into the draft of the Final Report

1. Our point is that the classification of the event involving multiple structural damages, as per Annex 13 Addition C, should be classified as a serious incident ("Events of aircraft structural damages or damages to the power plants, including non-localized defaults of gas turbine air engines, which are not classified as air incidents").
2. The cause, which you had described in the drafted Report, as we think, is the outcome of the serious incident, not being its cause, the cause had turned out to be:

- Unreasonable recommendations to the crew for the decision-making to continue the flight to the destination airport of Dubai after the tire damage at Borispol airport without having determined:
- Which wheel was damaged;
- On which landing gear stand;
- What are special features of landing at Dubai airport,

Which resulted in:

- Significant damages to the aircraft structure;
- A long-term close-up of the RWY of Dubai airport

3. We believe the Chapter "Analysis" should be supplemented with the point that upon giving recommendations to the captain as for the flight continuation to Dubai airport (the record of ATC-crew communications, the record of ATC phone conversations with the aviation company executives), there had not been identified the tire remnants by numbers and, as per the technical documents, the location of their installation This remark is confirmed by your conclusions in i.i.3.2.9- 3.2.16.

   Taking into account the above said, we suggest that the cause of the incident should be described as per i.2 of the present letter."

Relevant AAIS- NBIAICA communication:

The AAIS responded to the NBIAICA comments, by its letter dated 15 June 2014, stating that:

"With our utmost appreciation for your contribution to safety made in the course of this investigation.

Kindly find below our responses to the points mentioned in your letter dated 28 May 2014:

1. Re-classifying the occurrence as a "Serious Incident":

   The occurrence was re-classified as a "Serious Incident". Accordingly, the Final Report has been amended.

2. Re-determining the causes of the occurrence:

   The scope of the investigation was the 'Prolonged Runway Closure' categorised as per the European Co-Ordination Centre for Aviation Incident Reporting Systems (ECCAIRS), which has been adopted by the Air Accident Investigation Sector (AAIS). Accordingly the causes were determined within this scope.

3. Analysis-Flight continuation recommendation:

   Paragraph 2.2 in the 'Analysis' section mentions the same idea. We believe that this paragraph and other statements in the report adequately cover your comment.

Kindly note that should you disagree with any of our responses to your comments, you have the right to append your opinion to the Final Report."

On 22 June 2014, the AAIS followed its letter by e-mail forwarded to the Accredited Representative of the NBIAICA stating that:

"Kindly be advised of our [AAIS] opinion on your comment concerning the determination of the causes and contributing factors as:

Unreasonable recommendations to the crew for the decision-making to continue the flight to the destination airport of Dubai after the tire damage at Borispol airport without having determined:

- *Which wheel was damaged*
- *On which landing gear stand*
- *What are special features of landing at Dubai airport*

Which resulted in:

- *Significant damages to the aircraft structure;*
- *A long-term close-up of the RWY of Dubai airport".*

When the AAIS determined to open an investigation case into the occurrence, the decision was made due to the 'pro-longed runway closure' and the causes of the long time consumed whereas the movement of the disabled aircraft could have taken much less time if proper procedure and insight situation assessment were taken provided proper SOP, tools, Equipment, manuals, and trained staff are existing.

The objective of the investigation as depicted in the draft Final Report is:

"This Investigation is limited to the aspects related to the tire burst and runway closure due to disabled aircraft….".

We linked that objective to the ICAO 'cause' definition: "Actions, omissions, events, conditions, or a combination thereof, which led to the accident or incident…" and determined the causes mentioned in the draft Final Report.

Kindly note that should you disagree with any of our responses to your comments, you have the right to append your opinion to the Final Report."

A response e-mail was received from the Accredited Representative, on 26 June 2014, stating that*:*

"We [the NBIAICA] *have received your notification as for the amendment of the Final Report, and we would express our gratitude for your contribution to the flight safety enhancement in the field of prevention of air accidents and incidents, as well as for your professional consideration of our remarks as to the Final Report draft in the part of re-classification of the occurrence into a serious incident.*

However, we understood from your message, that the causes of the serious incident described in the Final Report had remained the same;

therefore we are deeply convinced, insisting on the need to mention the causes of the serious incident as they were described in our letter of May 28, 2014.

In this connection, and in accordance with i.6.3 of Annex 13 to the Convention on International Civil Aviation, we are forwarding to you our argumentative final remarks about the causal link of the given serious incident, which we would kindly request you to attach to the Final Report.

As per ICAO Annex 13, the main purpose of an investigation is to prevent an air accident and not to repeat its causes in the future.

In its turn, air accidents and incidents causes are those actions, omissions or combinations thereof, when eliminated, an occurrence will not take place.

Being based on these definitions, and using the actual data of the investigation, we have determined the casual link of the occurrence:

a) after reaching V1 during the run, the crew heard a blast, and, correspondingly, it was obliged:

- *not to retract the landing gear;*
- *to report to the ATC (FC);*
- *to perform the flight above the airdrome to check the condition of the landing gear;*
- *to determine the methodology of the landing with a damaged tire;*
- *to consume the fuel and to land on the airdrome of departure,*

thus excluding the risks related to the damaged landing gear retraction/release;

b) through: having not fulfilled the actions, described in i.a), and having not received

the information from the Maintenance Center of "Ukraine International" airlines about the location of the damaged tire (on which wheel and on which LG stand), the PIC took a decision to proceed to Dubai airport (OAE), being recommended by the airlines CEO, thus increasing a risk of an in-flight emergency situation;

c) having had no information about the condition of the main landing gear stands, the PIC performs landing with a load on the left main LG stand, where the damaged tire was located (thereby, there arose a threat of the aircraft airframe destruction, and increased a risk of dangerous outcomes of this occurrence), which had led to the tear of the both tires on the left main LG stand, resulting in the AC loss of capability to move, being the cause of the RWY prolonged closure.

Proceeding from the said above, we believe that:

- *the tire rupture of the wheel #1 was caused by a wrong technique of landing with one damaged tire (unsafe action);*
- *the choice of the wrong technique landing was the outcome of PIC's having no information about the condition of the main landing gear stands;*
- *the absence of the true information was the result of PIC's wrong decision-making to continue the flight to the destination airport with all the existing damages of the AC;*
- *PIC's wrong decision was the result of the unjustified recommendations of the Operations Centre and the Maintenance Centre of "Ukraine International Airlines»*
- *to continue the flight, which did not contained the information about the position of the damaged tire;*
- *the unjustified recommendations turned out to be a result of ineffective interactions of the departure airport services and the airline (Operator), of the bad-quality*
- *analysis for flight safety risk factors (low level assessment of the consequences severity), as well as of the LG stands retraction with the wheel #2 damaged tire made by the crew after the take-off.*

In this way, the occurrence, this was considered during the investigation as a prolonged RWY closure at Dubai airport, turned out to be the result of the intermediate occurrences at Borispol airport.

Therefore, we had made a conclusion that this occurrence should be considered as a serious incident:

- *destruction of the AC structure, which is not classified as an air accident, and*
- *a prolonged RWY closure*."

An e-mail was forwarded by the AAIS, on 26 June 2014, stating that:

"Pursuant to our earlier email and your kind below email; please advise whether you like to append the contents of the below email to the Final Report?"

Finally, on 27 June 2014, the Accredited Representative requested, by e-mail, to append the comments mentioned on the NBIAICA's initial letter to the Final Report.