THE REPUBLIC OF CROATIA

Air, Maritime and Railway Traffic Accident Investigation Agency

Air Traffic Accident Investigation Department

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Zagreb, 29 April 2020

F I N A L R E P O R T

ON SERIOUS INCIDENT OF THE AIRCRAFT
type LET-410,
registration OK-LAZ

Dubrovnik Airport, 29 November 2018

PUBLICATION OF REPORT AND COPYRIGHT

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The aim of the investigation relating to safety is in no case determination of guilt or liability.

Investigations are independent and separate from court or administrative proceedings and should not prejudice determination of guilt or liability of individuals.

The final report cannot be used as evidence in court proceedings whose aim is determining civil or criminal liability of individuals.

CONTENT

OCCURRENCE INFORMATION

Type of the occurrence:	Serious incident
Date:	29 November 2018
Local time:	12:43 LT
Place:	Dubrovnik Airport
Type of the aircraft:	Aeroplane
Manufacturer / model:	Let Kunovice / L-410
Registration:	OK-LAZ
Owner:	Van Air Europe
Operator:	Van Air Europe
Number of persons on board:	Ten (pilot, co-pilot, flight attendant and seven passengers)
Injuries:	No injured persons
Damage to the aircraft:	No material damage

INVESTIGATION

AIA received the first information about the serious incident on the same day from Dubrovnik Airport and the Croatia Control. AIA opened the safety investigation on the same day.

SUMMARY

On 29 November 2018 at 12:00 hours, the L-410 aircraft departed from Split Airport to Dubrovnik Airport. After landing on the runway, direction 12, they noticed that there are construction machines in front of them, and the air traffic controller informed them that they have landed on the closed portion of the runway where construction works were being performed. At the time of the serious incident, three crew members and seven passengers were on board the aircraft, none of whom were injured, and no material damage occurred.

The immediate cause of the serious incident in question was failure to identify the active portion of the runway and the closed portion of the runway by the commander of the aircraft.

AIA issued safety recommendations to Dubrovnik Airport, Croatia Control (CC), aircraft operator - company Van Air Europe, and Croatian Civil Aviation Agency (CCAA).

1. FACTS AND INFORMATION

1.1. FLIGHT INFORMATION

On 29 November 2018 the crew of the aircraft type LET L-410 of the Czech operator, the company Van Air Europe, had 6 flights scheduled between 6.00 hours in the morning and 17.00 hours in the afternoon. The flights took place between Osijek, Rijeka, Split and Dubrovnik. The flight in question was the third in a row, between Split Airport (LDSP) and Dubrovnik Airport (LDDU). During the morning preparation, by reviewing NOTAMs (Notice to Airmen), the aircraft crew noticed a wind information

on the LDDU whose strength exceeded the permissible limit for the aircraft in question, and noted the information on the construction works.

At 11:00 hours the aircraft departed from Split Airport (LDSP) to Dubrovnik Airport (LDDU), under flight number C3821, and call sign TDR821, in accordance with IFR flight rules. The crew decided to perform a visual approach considering a good visibility. During the approach, the first officer informed the captain of the aircraft (also the commander of the aircraft), who operated the aircraft, that the vehicles were located on the runway. The commander continued the landing, and the aircraft landed on the closed portion of the runway (Figure 01) where the construction works were being performed.

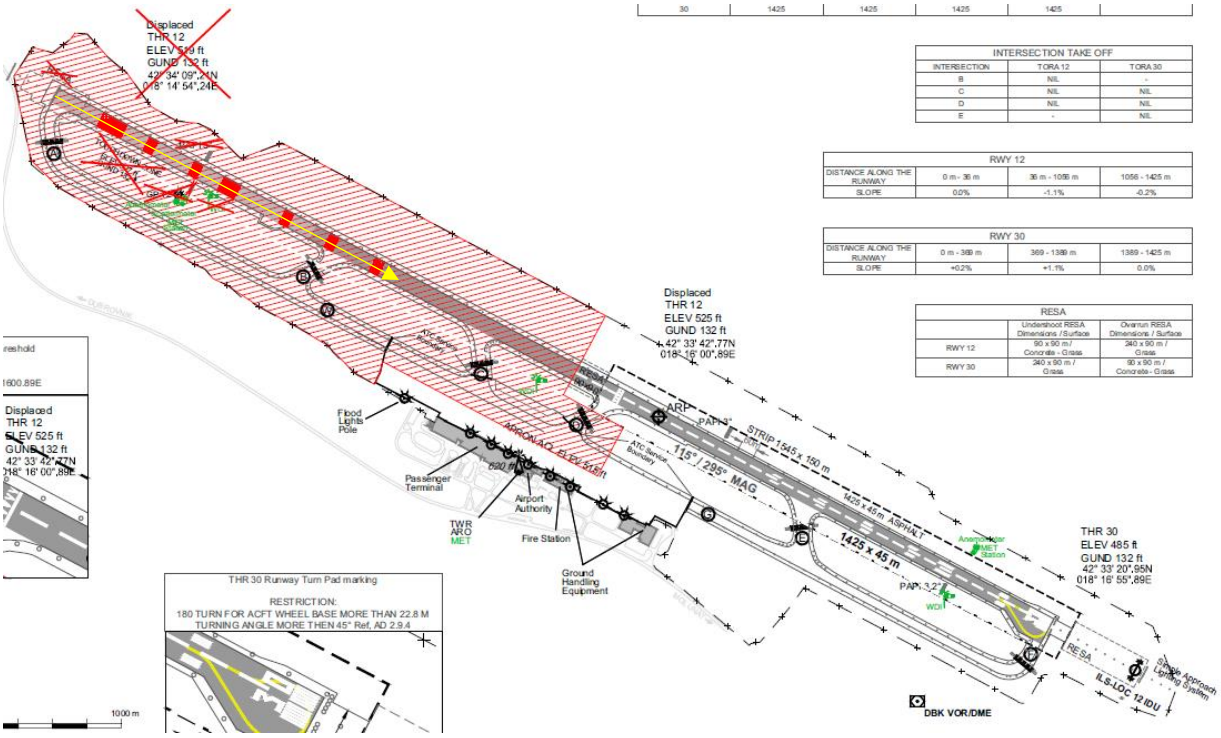

Figure 1 – Portion of the closed runway marked by yellow line (aircraft landing site)

1.2. INJURIES

Injuries	Crew	Passengers	Others
fatal	0	0	0
serious	0	0	0
minor / none	3	7	0

No persons were injured during the serious incident.

1.3. INFORMATION ON THE OPERATOR AND THE OWNER OF THE AIRCRAFT

The operator of the aircraft in question is the Czech company Van Air Europe, which has several LET L-410 aircraft. The company was founded in 2004 by the company Aeroservis, which provides aircraft maintenance services. The company started flight operations in 2006. The company specializes in ACMI (Aicraft, crew, maintenance, insurance) operations.

In the territory of the Republic of Croatia, the company Van Air Europe flies for the Croatian company Trade Air d.o.o, on domestic PSO (Public Service Obligation) routes between the cities of Osijek, Rijeka, Split and Dubrovnik.

In February 2017, the aircraft in question was involved in a serious incident. The investigation concluded that the crew decided to land in conditions of heavy wind with a lateral component twice of the permissible limit for the aircraft in question.

Following the mentioned incident, the UK Civil Aviation Authority suspended the authorization to the aircraft of the subject company to fly in the UK territory.

1.4. CREW INFORMATION

Captain

Male person, Slovakian citizen, born in 1959. At the time of the serious incident, he possessed a valid flight crew license, EASA ATPL(A), PPL(A), under number SVK.FCL.05100005, issued by the Civil Aviation Authorities of the Slovak Republic in March 2015. Let 410/IR rating is entered in the flight crew license. He has been flying as the captain for eight years. On the day of the serious incident, he had a total of 7110 flight hours, and on the type in question 5880 hours, over a period of 37 years. He spent 27 years in the military air force and flew military jets. Prior to the event in question, he flew to Dubrovnik Airport for 17 times between May and November 2018. He has an English language level 'Level 5' and has a valid medical certificate with the note of farsightedness.

On the flight in question, he was the PIC-Pilot in command and PF-Pilot flying.

First officer

Female person, Czech citizen, born in 1979. At the time of the serious incident, the person possessed a valid flight crew license, EASA CPL(A), PPL(A), under number GBR.FCL.CP.516329C.A., issued by the United Kingdom Civil Aviation Authority in June 2017. SEP, MEP, IR-SP-ME, Let410/IR authorisations are entered in flight crew license. She started with PPL training in 2013, and has been flying the subject aircraft type since August 2018. On the day of the serious incident, she had a total of 466 flight hours, and on the type in question 193 hours. Prior to the event in question, she flew to Dubrovnik Airport for 4 times in September, October and November 2018. She has an English language level 'Level 6' and has a valid medical certificate. On the flight in question, she maintained radio communication with competent flight control.

1.5. INFORMATION ON THE AIRCRAFT LET-410UVP-E (SN: 902504)

Manufacturer:	Let a.s.m. Kunovice
Type:	L-410-UVP-E
Capacity:	2 pilots and 17/19 passengers
Length:	14.47 m
Height:	5.83 m
Wing span:	19.48 m
Maximum take-off weight:	6400 kg
Maximum operating speed:	181 kts
Climbing speed:	4.2 m/s

Flight range: 770 NM

LET-410UVP-E is a twin-engine aircraft manufactured by the Czech company Let Kunovice (Figure 2). The aircraft is powered by two Walter M601 turbo-prop engines and has a retractable landing gear. The production of the UVP-E version of the aircraft in question began in 1986. Generally, this type of aircraft is used for the transport of passengers, cargo, mail, skydivers transport, etc. The aircraft may land on a paved and grassy runway. A total of 1150 pieces have been produced, while around 500 of LET-410 aircraft of various versions are currently flying around the world.

The subject aircraft, registration OK-LAZ, is registered in the Czech Republic. The Airworthiness Review Certificate was issued by the organization Van Air Europe (CZ.MG.OO17) on 26 October 2018. A valid Insurance Policy was issued for the aircraft. At the time of the serious incident, the aircraft was technically in order and there were no technical defects that could have affected the serious incident in question.

Figure 2 – The subject aircraft registration OK-LAZ in flight

1.6. METEOROLOGICAL INFORMATION

At the time of the serious incident (around 12:43 LT), sunny weather prevailed, with passing clouds. The air temperature was 14^0 C, the air pressure was 1020 mbar, and the wind was blowing with a variable direction of 7 knots. The humidity was 38%.

The meteorological conditions were satisfactory for the landing of the aircraft in question and did not affect the subject serious incident.

1.7. COMMUNICATION

During the subject flight, the first officer communicated with the air traffic control at the corresponding frequencies. For the purposes of the investigation, communication between the controller tower of Dubrovnik Airport and the crew of the aircraft in question were listened to. Communication was in order and with no difficulties.

1.8. AIRPORT INFORMATION

Dubrovnik Airport (LDDU) is located near the town Ćilipi, 22 km southeast of the city of Dubrovnik, at an elevation of 161 m. It started operating in 1962. Today it is the third busiest airport in Croatia. The annual traffic of this airport is about 2,000,000 passengers and it increases each year. It can accept wide-body aircraft such as B747 and A350.

The runway is asphalted, with length of 3300 m, width of 45 m and orientation 12/30.

At the time of the subject accident, certain construction works were performed in the area of Dubrovnik Airport for the purpose of expanding the capacity of the airport. These works affected the incident in question.

Figure 3 – Dubrovnik Airport

The runway is characterized by a curvature from the runway 12 threshold to the middle of the runway. At the time of the incident in question at the runway 12, the altitude was 519.46 ft (158.33 m), increasing to a maximum of 527 ft (160.62 m) in the runway 12 contact zone. Altitude at the runway 30 threshold was 485 ft (147.82 m).

1.9. FLIGHT DATA RECORDERS

The aircraft in question was equipped by a Flight Data Recorder and a Cockpit Voice Recorder.

1.10. INFORMATION ON THE IMPACT AND THE REMAINS OF THE AIRCRAFT

The aircraft landed at Dubrovnik Airport. The serious incident in question did not cause any material damage.

1.11. MEDICAL INFORMATION

In the incident in question, the crew and passengers were not injured.

1.12. RESCUE AND SURVIVAL ASPECTS

Considering that the aircraft landed at Dubrovnik Airport and that there were no injuries, there was no need for search and rescue activities.

1.13. ADDITIONAL INFORMATION

1.13.1. Construction works at Dubrovnik Airport (LDDU)

At the end of 2018, Dubrovnik Airport began with construction works on the reconstruction of the runway and taxiways. The aforementioned works were described in the document “Management on changes - reconstruction and construction of operational surfaces of Dubrovnik Airport development project" (SUS-UP-02, Rev 0 / 22.03.2018) and approved to the airport operator by the Croatian Civil Aviation Agency (CCAA). The said works at Dubrovnik Airport were also described in the official publications of the Croatia Control, among others AIP SUP 012/2018, which was in force from 8 November 2018 and was issued on 27 September 2018. It describes the reconstruction of the pavement of the runway 12/30 and the taxiways A, B, C, D and W at Dubrovnik Airport. The said construction works are divided into Phases I, II and III. At the time of the subject serious incident, Phase II works were being performed.

Phase I

Phase I - reconstruction works of the east central part of runway 12/30, length of 525 M and width of 45 M, and taxiway D. Phase I works were to be performed between the beginning of November 2018 and until the end of November 2018.

Phase II – reconstruction works of the west and central part of the runway 12/30, length of 1725 M and width of 45 M, and taxiways A, B, C, D and W. Phase II works were to be performed from the end of November 2018 until mid-December 2018.

Phase III – reconstruction works on the west part of runway 12/30, length of 1050 M and width of 45 M, and taxiways A, B and W. Phase II works were to be performed between mid-December 2018 and mid-March 2019.

Phases I and II of the construction works are shown in Figures 4 and 5 for easier understanding of the incident.

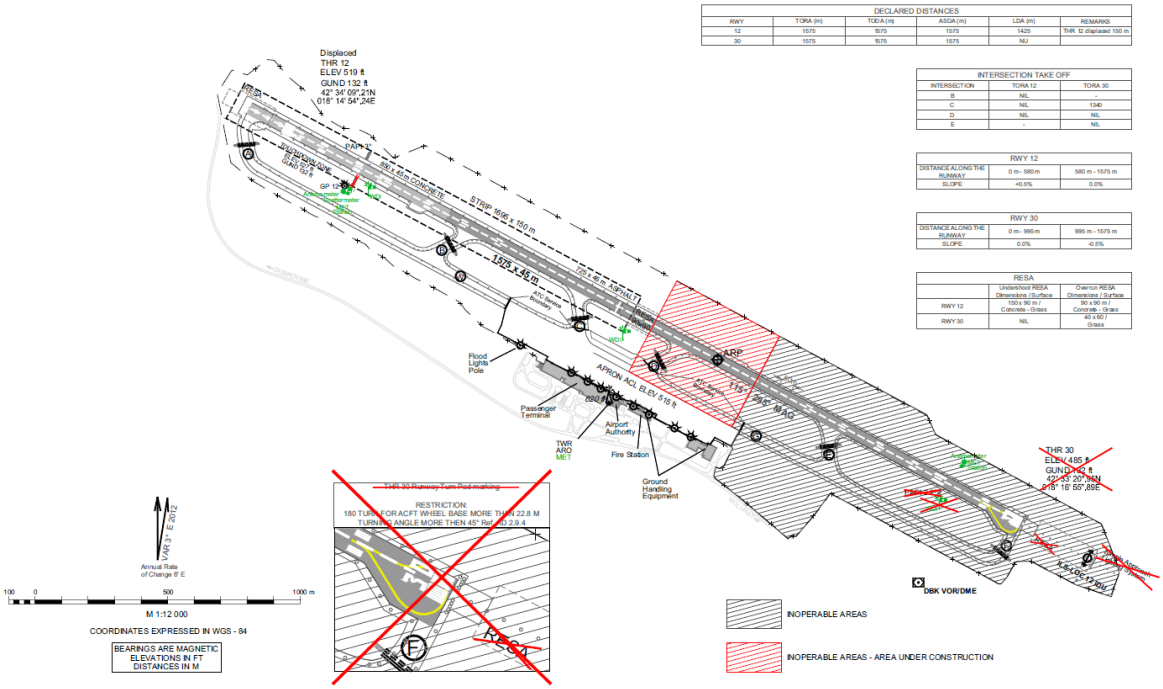

Figure 4 – Phase I of the construction works

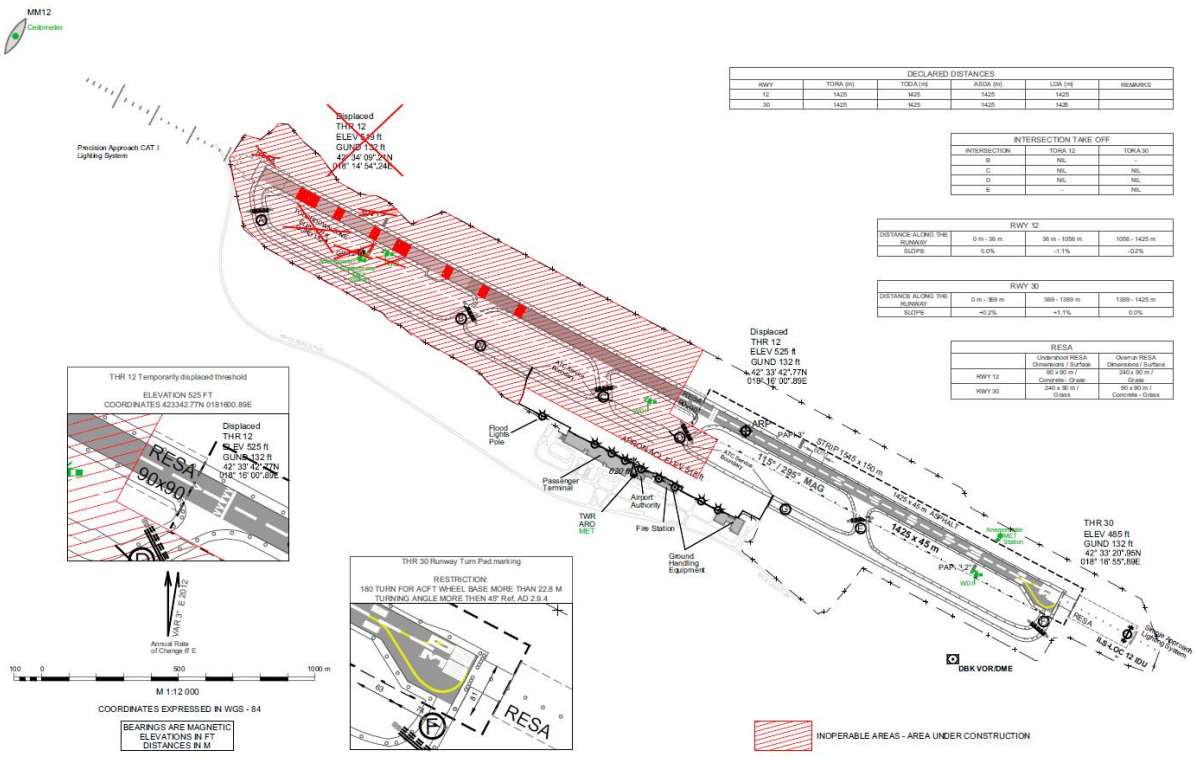

Figure 5 – Phase II of the construction works

The graphical representation of Phases I and II of the construction works shows that one of the differences between the said Phases was a displaced runway direction 12 threshold. A part of the runway used for landing in Phase I was closed in Phase II and the other half of the runway that was rebuilt during Phase I was used for operations.

All operational restrictions and activation of the various phases of the construction works were announced by timely announcement by NOTAM. Phase II, which was in force on the day of the serious incident in question was activated on 25 November 2018 by the following NOTAM:

A5151/18 NOTAMN
Q) LDZO/QPIXX/I /NBO/A /000/999/4234N01816E005
A) LDDU B) 1811250500 C) 1812090500
E) DUE TO ACTIVATION OF LDDU PHASE II RECONSTRUCTION WORKS ON RWY AND TWY (NOTAM A5125/18), AIP SUP 013/2018 IS IN FORCE FROM 25 NOV 2018 0500UTC.

The abovementioned NOTAM stated that due to the transition to Phase II of construction works, AIP SUP 013/2018 publication dated 25/11/2018 is in effect, which contains "Announcement of the provisional interim instrument approach procedures for the runway RWY12, VOR z RWY12 and LOC z RWY12" at Dubrovnik Airport.

1.13.2. ICAO Annex 14 (Aerodromes)

ICAO Annex 14, Aerodromes. Chapter 7 of the said contains standards for marking of temporarily closed runways

*7.1.2. Recommendation. — A closed marking should be displayed on a temporarily closed runway or taxiway or portion thereof, except that such marking may be omitted when the closing is of **short duration** and **adequate warning** by air traffic services is provided.*

Annex 14 does not define the term *"**short duration**", and does not define the term "**adequate warning**".*

1.13.3. ICAO Annex 11 (Air Traffic Services)

ICAO Annex 11, Air Traffic Services, contains standards relating to the service ATIS (Automatic terminal information service)

4.3.4.8 Recommendation.— The Voice-ATIS broadcast message should, whenever practicable, not exceed 30 seconds, care being taken that the readability of the ATIS message is not impaired by the speed of the transmission or by the identification signal of a navigation aid used for transmission of ATIS. The ATIS broadcast message should take into consideration human performance.

4.3.6.5 Recommendation.— Contents of ATIS should be kept as brief as possible. Information additional to that specified in 4.3.7 to 4.3.9, for example information already available in aeronautical information publications (AIPs) and NOTAM, should only be included when justified in exceptional circumstances.

4.3.7 ATIS for arriving and departing aircraft ATIS messages containing both arrival and departure information shall contain the following elements of information in the order listed:

…… g) the runway(s) in use; status of arresting system constituting a potential hazard, if any;
k) other essential operational information.

1.13.4. EU Regulative CS-ADR-DSN

At the time of the serious incident in question, a document CS-ADR-DSN, Issue 4, dated 8 December 2017, was in force at European Union level. The Chapter "R" of the aforementioned document describes the requirements related to marking of runways during construction works. The said document does not recognize the term of temporary closed runway for a shorter or longer period. The term used in the document is "permanently closed area".

CHAPTER R — VISUAL AIDS FOR DENOTING RESTRICTED USE AREAS

CS ADR-DSN.R.855 Closed runways and taxiways, or parts thereof

(a) Applicability:

A closed marking should be displayed on a runway, or taxiway, or portion there of which is permanently closed to the use of all aircraft.

(b) Location of closed markings: On a runway, a closed marking should be placed at each end of the runway, or portion thereof, declared closed, and additional markings should be so placed that the maximum interval between markings does not exceed 300 m. On a taxiway a closed marking should be placed at least at each end of the taxiway or portion thereof closed.

(c) Characteristics of closed markings: The closed marking should be of the form and proportions as detailed in Figure R-1, Illustration (a), when displayed on a runway, and should be of the form and proportions as detailed in Figure R-1, Illustration (b), when displayed on a taxiway. The marking should be white when displayed on a runway and should be yellow when displayed on a taxiway.

(d) When a runway, or taxiway, or portion thereof is permanently closed, all normal runway and taxiway markings should be obliterated.

(e) In addition to closed markings, when the runway, or taxiway, or portion thereof closed is intercepted by a usable runway or taxiway which is used at night, unserviceability lights should be placed across the entrance to the closed area at intervals not exceeding 3 m (see CS ADR-DSN.R.870(c)(2)).

Safety procedures during aerodrome works are described in Chapter AMC2ADR.OPS.B.070 of the said regulation. The said chapter is currently in the process of modification by EASA, which will further specify standards related to the publication of information on construction works and the marking of closed manoeuvring areas.

1.13.5. Ordinance on Aerodromes Official Gazette 58/14

At the time of the serious incident in question, the valid national Ordinance on Aerodromes, Official Gazette 58/14, was in force. The Chapter 7 of the aforementioned Ordinance defines standards for marking of temporarily closed runway in accordance with ICAO Annex 14.

Article 155

Closed runways and taxiways

»Closed« marking must be placed on a temporarily closed:

a) runway, or
b) taxiway, or
c) their portions.

*Such marking may be omitted when the closing of runway, taxiway or their portions is of **short duration** and adequate warning by air traffic services is provided.*

Ordinance on Aerodromes does not define the term "**short duration**", and does not define the term "**adequate warning**". Ordinance on Aerodromes also does not define procedures of marking when works are being carried out on a closed area which prevents placing of horizontal signalling in the above manner, e.g. when replacing the surface layer of the runway.

Article 156

Closed portions of runway and taxiway

1) *The »closed« marking on the runway must be placed on each end:*

a) of the runway, or
b) of the portion of the runway declared closed.

2) *Additional marking must be placed so that the maximum distance between markings is 300 m*
3) *On taxiways the »closed« marking is placed on each end of the closed taxiway or its closed portion.*

Article 157

Characteristics of the »closed« marking

1) *»Closed« marking which is placed on:*

a) the runway, must be of the shapes and dimensions described in the Figure 7-1, figure a), and
b) the taxiway, be of the shapes and dimensions described in the Figure 7-1, figure b).

2) *»Closed« marking must be:*

a) of white colour when placed on the runway, and
b) of yellow colour when placed on the taxiway.

3) *Where a certain portion of the manoeuvring area is temporarily closed, for marking of the closed areas the following can be used:*

a) fragile barriers, or
b) markings made of materials other than colour, and
c) other suitable means.

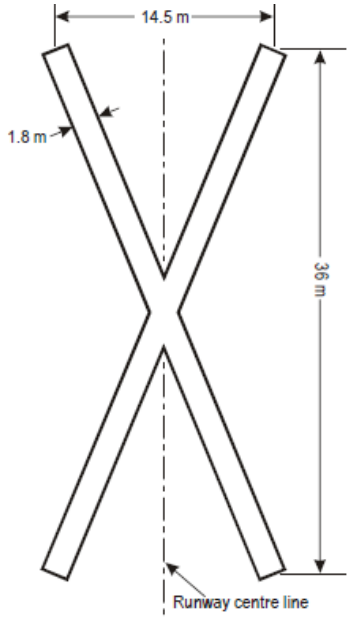

Figure 6 – Closed marking "X"

Figure 6 shows the marking of the closed manoeuvring area "X".

1.13.6. Ordinance of Rules of the Air and Air Traffic Services Official Gazette 32/18

At the time of the serious incident in question, the Ordinance of Rules of the Air and Air Traffic Services, Official gazette was in force.

Article 57 "Important information about the condition of the aerodrome", Paragraph 1 and 2 of the said Ordinance states:

(1) *Important information about the condition of the aerodrome is information relating to the condition of operating areas and associated means required for the safe operation of the air traffic. Important information about the condition of the aerodrome shall be issued whenever deemed necessary and in the interests of air traffic safety by the air traffic controller or at the request of the pilot of the aircraft.*

(2) *Important information about the condition of the aerodrome is forwarded in the following order:*

1. construction or maintenance works on or in the vicinity of the operating areas….

Article 58 "Information to departing and arriving aircrafts", Paragraph 1 of the said Ordinance states:

(1) *If automatic broadcasting of landing and take-off information is not available:*

a) for an aircraft on arrival upon establishment of the first communication, the air traffic controller shall forward the information in the following order:

…. 11. Condition of surface of runway in use when precipitation or other current hazards occur

12. Changes in the operational status of visual and non-visual aids which are important for approach and landing….

By reviewing of the ATIS records it was established that ATIS information at 11:25 read as follows:

ATIS,ATIS,ATIS,2018-11-29 11:25:06,0.000000,16,"This is Dubrovnik Information November. Time 1125. Runway 12 in use. Expect localizer Zulu approach. Landing distance available 1425 metres. Transition level 105. Wind, variable, 1 knot, varying between 240 and 020 degrees. CAVOK. Temperature 14. Dewpoint minus 3. QNH 1020. Trend NOSIG. Acknowledge Information November on first contact."

The automatic broadcasting of landing and take-off information (ATIS) in the period from 11:09 UTC until the time of the serious incident did not contain information about ongoing construction works in progress or the displaced runway. The information contained the direction of the active runway and the length of the runway for landing.

1.13.7. Statement of the aircraft commander

In his statement following the serious incident in question, the commander of the aircraft provided the following information.

In his standard morning flight preparation and NOTAM check, he concentrated on the information of strong wind at LDDU, which blew with strength which exceeded the aircraft operating limits. NOTAM provided information on permanent construction works and the shortened runway. By reviewing of large number of information and references in NOTAM, he failed to notice the information about the displaced runway threshold.

At Split Airport (LDSP), before the LDDU flight, he again concentrated on the information on strength of the wind at LDDU, which was finally within the operational limits of the aircraft. During the flight from LDSP to LDDU, as a pilot flying, he underwent a landing briefing for the runway direction 12 with the first officer. At the time of the briefing, he did not realize that the runway threshold had been displaced and which portion of the runway was being used.

By approaching LDDU, the air traffic controller offered him an option of landing on the runway 30 or 12, by which he chose the runway direction 12. The visibility was very good, so he decided to perform a visual approach to the runway 12.

During the approach, he was descending the aircraft at standard descent rate for the visual approach, without checking the procedure for the instrument approach to the runway 12. Such descent profile lowered the aircraft more than necessary and, due to the curvature of the runway and the construction machines in the middle of the runway, he failed to see the threshold or PAPI (Precision Approach Path Indicator) lights that would help him understand the situation.

After landing, the first officer said she see some activity on the runway, to which he replied that the situation was the same as last week without realizing that the working machines were much closer than before, and that they were operating in the middle of the runway.

During the entire approach there was no activity on the closed portion of the runway from which it could be concluded that something was different. Before landing, he saw that there were no marks on the runway, but thought this was because of current works.

After the landing, the controller informed the crew that they had landed on the closed portion of the runway and that they should wait for an airport vehicle (Follow me car). After the complete stop, the pilot informed the aircraft operator's operations centre about the event. After the last flight of the day, he also informed the operations centre of the company Trade Air about the event.

1.13.8. Statement of the first officer

In her statement after the serious incident in question, the first officer of the aircraft provided the following information.

During the approach to the runway 12, the captain was flying the aircraft. They both knew the runway was reduced to 1424 m in length. This information was also mentioned in ATIS. She mentioned to the captain in the final approach that there were vehicles around the middle of the runway. The area in front of the vehicles was completely clean, with no people, vehicles or visible obstacles. Considering that the captain assumed that this was the runway in use and considering that he had flown to LDDU a week before the event in question, they continued with landing. As they were getting closer to the runway, she again mentioned the vehicles on the runway but received a similar response as the first time, at which point she assumed that the closed portion of the runway was indeed the runway being used and she let the captain concentrate on landing.

The controller gave them no warning that they were landing on the wrong runway, and considering the good visibility and curvature of the runway, they did not see the lights of the active runway, the displaced threshold or the PAPI lights. After the landing, the controller informed them that they had landed on the closed portion of the runway. They waited about 10 minutes for the airport staff to clear the taxiway of smaller rocks so they could continue taxiing to the parking position.

1.13.9. Analysis of the subject event by the company Van Air Europe

After the subject event, the company Van Air Europe conducted an internal analysis with the aim of determining the cause of the serious incident and with the aim of defining corrective measures so as to prevent a recurrence of such event. The established risk index of the event itself was defined as 2D according to the Acceptable Risk Table (SCMM, Section 8.2).

The analysis consisted of three phases:

- Analysis of the serious incident.
- Identification of the cause of the serious incident.
- Establishing a corrective measures plan.

The following information were used during the analysis:

- Interview with crew members.
- Meteorological situation data.
- NOTAM and AIP-SUP data.
- Current status of Dubrovnik Airport

It was established that during the morning flight, by inspecting NOTAMs (Notice to Airmen) and meteorological reports, the crew noticed increased wind strength at the LDDU, which exceeded the permitted limits for the aircraft in question. The crew also noticed information on the construction works, but did not fully understand that there had been a change in Phases of works (Phase I to Phase II).

In their statement the crew stated that the runway and PAPI (Precision Approach Path Indicator) lights were off during landing. The crew considers that the ignited lights would maybe caught their attention. They also stated that ATIS contained information only on the shortened runway, without specifying

details of the displaced runway threshold. They stated that there were no activities on the closed portion of the runway during the landing.

The internal investigation of the company Van Air identified the following contributing factors:

- Insufficient analysis of NOTAM (Notice to Airmen) by the crew.
- Disadvantages of CRM (Crew Resource Management) - inexperienced first officer.
- Insufficient support from OCC (Operations Control Centre).
- Insufficient proactive approach of SMS (Safety Management System).
- Complex structure of NOTAM - due to references to AIP SUP.
- ATIS does not contain information on the displaced runway.
- ATC (Air Traffic Control) does not alert pilots of the current status of the runway during the approval for landing or the approach of the aircraft.

Operator's corrective measures include the following procedures:

- The flight crew involved in the event in question has been suspended until performing additional training and checks.
- SRB (Safety Review Board) meeting with the aim of analysing the event and establishing corrective measures plan.
- Informing all flight crews via NP (Notice to Pilot).
- Establishing guidelines for NOTAM processing through a SB (Safety Bulletin).
- Establishing a new duty of OCC staff regarding timely identification of emergency events.
- Presenting the analysis of the event in question to all crew members during the next upcoming training.

After the application of the corrective measures, the established risk index was 1D, according to the Acceptable Risk Table (SCMM, Section 8.2).

1.13.10. Analysis of the subject event by Dubrovnik Airport

After the subject event, Dubrovnik Airport conducted an internal analysis of the safety occurrence, with the aim of defining barriers for prevention of the occurrence consequences so as to prevent a recurrence of such event. The event is categorized as "Aircraft- and obstacle-related occurrences" according to EU Regulation 2015/1018. The identified risk index of the event itself is defined as 3A according to the Acceptable Risk Table (SUS-AD-MOR29NOV2018).

Considering the performance of the construction works during the serious incident in question, the analysis of Dubrovnik Airport covered in details the areas identified as being likely to have contributed to the occurrence of the event in question. The areas covered by the detailed analysis were:

- Horizontal signalling.
- Aeronautical ground lighting.
- PAPI 12 system.

Horizontal signalling

The analysis of Dubrovnik Airport established that during the construction works, the implementation document foreseen the drawing of new horizontal markings on the portion the operating area in use, and that the horizontal markings shall be covered on the parts which are out of use. It was further

established that covering of markings on the portion of the operating area out of use was done by coating them with a black bituminous emulsion.

By inspecting of the performed works during the transitional night (between Phase I and Phase II of the construction works) it was established that the works of covering of the markings on the portion of the operating area which was out of use were performed in accordance with the requirement stated in the implementation document. Due to heavy rain during the transitional night and the following two days, the black colour of the bitumen emulsion faded to a lesser extent, resulting in the partial sighting of the covered markings (Figures 7 and 8).

Figure 7 – Runway markings on the day of the incident

Figure 8 – Markings of the runway threshold on the day of the incident

Aeronautical ground lighting

The analysis of Dubrovnik Airport concluded that during the construction works, in accordance with the implementation document, the adaptation of the aeronautical ground lighting system should be performed in such a manner that the applicable aeronautical ground lighting system on the ground were enabled (temporarily displaced threshold 12, temporarily displaced end of the runway 30, runway edge lighting with yellow filters on the last third of the runway), including system powering and system management, and to shut down non-applicable aeronautical ground lighting systems (approach 12 lights, all operating lighting systems on the portion of the operational area out of use).

By inspection of the works performed during the transitional night (between Phase I and Phase II of the construction works) it was established that the adaptation works on the aeronautical ground lighting system were performed in accordance with the anticipated requirement specified in the implementation document.

In order to emphasize more intensively the portion of the runway in use during aircraft operations, a working instruction was issued to the personnel responsible for managing aeronautical ground lighting system, ordering that during all daily operations of the aircraft, lighting of the manoeuvring area with the highest intensity is used, which was the case during the subject event.

PAPI (Precision Approach Path Indicator) 12 system

The analysis of Dubrovnik Airport established that during the construction works, the implementation document provided for the installation of the new PAPI 12 system at the site in accordance with the technical calculation of the position of the PAPI units, and the removal of the PAPI 12 system from the old location.

Substitute temporary instrument approach procedures for Phase II of construction works were tested and published in AIP SUP no 013/2018, which entered into force on 8 November 2018.

In its analysis, Dubrovnik Airport defined the following possible sources of consequence (i.e. the consequence of the subject event):

a) Absence of adequate notices on closing of areas in the manner common to aviation (AIP, NOTAM).
b) Absence or failure of horizontal ground signalling with temporary solution for manoeuvring areas.
c) Absence or maladaptation of ground lighting (including vertical signs and PAPI system)
d) Inadequacy of navigation devices and navigation procedures with a temporary solution for manoeuvring areas.
e) Inadequate preparation of flight crew for the flight.
f) Bad weather conditions.

Dubrovnik Airport listed the following as barriers for preventing the consequences:

a) Performance of works in accordance with the prescribed measures of the Safety Plan.
b) Analysis of published information and publication of relevant/modified information on closing of areas in the manner common to aviation (AIP SUP, NOTAM).
c) Analysis of compliance with the basic conditions, and adjustment of horizontal signalling with temporary solution for the manoeuvring areas.
d) A working instruction on the obligation of use of aeronautical ground lighting at the highest intensity during each aircraft landing operation, to highlight the active portion of the runway and to increase the situational awareness of the flight crew on the position in space during landing operation.
e) Analysis of compliance with the basic conditions, and adaptation of the aeronautical ground lighting (including vertical signs and the PAPI system) with temporary solution for the manoeuvring areas.
f) Adaptation of navigation devices to the temporary solution for manoeuvring areas.
g) Publication of customized navigation procedures in accordance with the temporary solution for manoeuvring areas.
h) Control of the compliance of horizontal markings, aeronautical ground lighting (including vertical signs and the PAPI system) with a temporary solution for manoeuvring areas prior to their commissioning.

The analysis of Dubrovnik Airport identified two measures for risk mitigation for the most adverse consequence of an adverse event.

Measure 1 (M1)

Deadline: Each time during the switch between temporary solutions for manoeuvring areas.

Regardless of the published airport information in the manner common to aviation (AIP SUP, NOTAM), provide additional operational notice to aircraft operators conducting aircraft operations at Dubrovnik Airport during the relevant period, on the completion/entry into force of temporary solution for manoeuvring areas and its specifics.

Measure 2 (M2)

Deadline: Immediately and continuously.

Continuous control of the operational state of the operating surface in order to continuously ensure compliance of the temporary solution for manoeuvring areas with the requirements (all aspects of adjustment of horizontal signalling, aeronautical ground lighting, vertical signs, PAPI systems).

The risk assessment after the implementation of the measures was categorized as 2A. The analysis of the subject event by Dubrovnik Airport also stated that during the Phase I and II of construction works, other operators landed at the airport without reported deficiencies.

1.13.11. Study of the company Aeroports de Paris - safety of airport operations

During the safety investigation, available information related to the safety of airport operations during construction works at Charles de Gaulle Airport (CDG) were analysed. The findings were summarized in a 2015 study by the company Aeroports de Paris. The company Aeroports de Paris is an organization that manages 14 civilian airports and/or airdromes around the world.

The study was conducted in the period from 2011 until 2015, and included an analysis of safety-related events at Charles de Gaulle Airport itself during the performance of construction works during which runway thresholds were temporarily displaced. The study aimed to:

- Collect information on the type of performed construction works.
- Collect information on safety-related events during performance of construction works.
- Analyse the collected statistic information.
- Define hazards and assess risks.
- Define safety measures.
- Share the collected information with other entities in the aviation industry.

The aforementioned study stated factors that reduce the safety of airport operations such as:

- Insufficient or non-existent closed runway marking “X”.
- Types and ways of implementation of closed marking “X”.
- Insufficient content of aeronautical information.
- The complexity of aeronautical information.
- Wording used in aeronautical information.

All of the above factors in the analysis of the company Aeroports de Paris have been identified and covered in the subject safety investigation.

The conclusion of the said survey stated the following:

- Reconstruction of the runway is the most critical construction work in the area of the air side of the airport.
- Markings and lights of closed manoeuvring areas represent the first safety barrier in airport operations during performance of construction works.
- Pilots and controllers represent the last safety barrier in airport operations during the performance of construction works.
- The use of simple markings or the non-application of markings due to the short deadlines has to be considered with great attention.

- Daily inspections of the areas where construction works are performed are necessary to ensure the required level of safety.
- Compliance with the applicable regulations is not sufficient to satisfy the level of safety since often the regulation is incomplete or inapplicable to local conditions.
- Well-known assumptions such as that: NOTAMs never reaches the flight crew, approvals by the controller may be misunderstood, manoeuvring markings may be misunderstood, must be taken into account when assessing the risk of construction works.
- Considering the limited total number of airports that performed airport operations during the displaced runway threshold, it is necessary to share the experience with other organizations in the aviation industry.

1.13.12. Safety-related events during construction works

During the performance of construction works *"Reconstruction and construction of operational surfaces of Dubrovnik Airport development project"*, AIA received 8 safety related events related to the works in question. The received events describe:

- Failure to comply with construction works management protocols by the construction workers during the landing and take-off operations of aircraft. These events describe the movement of construction vehicles on aerodrome surfaces without the approval of the competent controller, and in accordance with defined procedures.
- Stopping the aircraft after landing behind the end line of the runway without material or other damage.

2. ANALYSIS

2.1. COURSE OF EVENTS

By reviewing all of the information gathered during the Safety Investigation, the analysis of the course of events was conducted.

It was established that on the day of the serious incident in question during flight preparation, by inspecting NOTAM information, the flight crew noted that construction works were being performed at Dubrovnik Airport and that the wind was blowing with the strength exceeding the permitted limits for the aircraft in question. The NOTAM in force contained information on the current Phase of the construction works (Phase II) and the information on issued AIP SUP Document (013/2018, in force as of 25 November 2018). The specifics of construction works and their impact on the flight operations were contained in the extensive AIP SUP documentation. The flight crew did not check the content of the AIP SUP document. More detailed information on the construction works were also contained in Jeppesen Airport Cards which the flight crew did not thoroughly examine.

On the day of the serious incident, the subject crew first actively flew on lines Osijek-Rijeka and Rijeka-Split, during which the wind intensity at Dubrovnik Airport decreased and fell within the range acceptable for the subject aircraft. On the subject flight, during the approach to Dubrovnik Airport, the crew was informed of its condition via ATIS (at a frequency of 118.425 Mhz). ATIS for Dubrovnik Airport contained information on the shortened runway (1,425 meters) but did not contain any other information on construction works.

The crew, after being offered approach possibilities by the controller, selected a visual approach for the runway direction 12. During the clearance for landing, the controller of Croatia Control did not provide information related to the construction works via radio link in any form, and therefore did not provide information on the displaced runway 12 threshold. During the approach itself, the first officer addressed the commander who operated the aircraft twice, informing him of presence of construction vehicles in the middle of the runway. Considering his recent experience of landing at Dubrovnik Airport, after the second addressing to the commander, she had no doubts regarding correctness of the aircraft flight path.

During the visual approach, the aircraft descended below the perfect approach path to the runway 12. From this position, due to the curvature of the runway, the crew was no longer able to see the lights of the active runway, the displaced runway threshold or the construction vehicles located at the end of the closed portion of the runway 12. The only markings on the closed portion of the runway that the flight crew from that position could see did not indicate, by their condition, that the runway was closed. The covered horizontal markings of the closed portion of the runway 12 became partially visible due to the fact bitumen emulsion has been washed out by rain. Also, on the closed portion of the runway there was no closed marking "X" which would indicate the closed status of the runway to the crew.

After landing and stopping, the flight crew noticed the construction vehicles at the end of the runway, and received information via radio link from the controller of the Croatia Control that they have landed on a closed portion of the runway and that they should wait for the airport vehicle.

2.2. FLIGHT PREPARATION

During the safety investigation, it was established that the crew in question had completed the flight preparation using NOTAM information. The information contained in the AIP SUP documentation were not used during the preparation. Also, the crew in question did not thoroughly review Jeppesen Airport Charts, which also contained information on the displaced runway 12 threshold.

2.3. HORIZONTAL RUNWAY MARKINGS

Standards of horizontal marking of a closed runway or its portion are included in the ICAO Annex 14, EU Regulation CS-ADR-DSN, and Ordinance on Aerodromes, Official Gazette 58/14. All three of these documents envisage a white closed marking "X" when a runway or its portion is closed for use. The said documents also state that the placement of the closed marking "X" is not necessary if the runway or its portion is closed for a short period of time and when the information on its closing information is published by an adequate warning issued by the aeronautical information provider (in this event, the Croatia Control). All three of these documents do not define the meaning of the terms "short duration" or "adequate warning". The documents set out standards related to the colour and dimensions of the marking, but not the manner in which the marking itself should be performed.

Considering the entire operating area (runway) was a construction site, the construction safety plan foresaw covering the existing markings on the portion of the operating area out of use until they are destroyed by the construction works. The closed marking "X" was not placed since the entire closed area was the construction site where the pavement surface was being removed.

The closed marking "X" is usually, in addition to drawing on the pavement, made by:

- Tailored fabrics with pavement fasteners that can be moved when necessary.

- Tailored fabric on a portable structure that can be moved when necessary.

The horizontal mark closed "X" serves as first visual safety barrier to prevent the aircraft from landing on the closed portion of the manoeuvring area, in the case in question, portion of the runway, direction 12.

2.4. AERONAUTICAL INFORMATION

Standards regarding aeronautical information are contained in ICAO Annex 11 and national Ordinance of Rules of the Air and Air Traffic Services Official Gazette 32/18. Both documents provide the possibility of informing an aircraft in approach on construction works through ATIS (ICAO Annex 11) or radio link (Ordinance of Rules of the Air and Air Traffic Services Official Gazette 32/18).

ATIS information that were broadcasted during the landing of the aircraft in question did not contain information on the displaced runway threshold which would additionally warn of the potential danger. During the approach, the controller of the Croatia Control did not provide the crew of the subject aircraft the information on the displaced runway threshold.

Providing information on the displaced runway threshold to an aircraft in approach, via ATIS and/or radio by the controller, can serve as a safety barrier during the last flight phase. Such information may be incorporated into ATIS in a concise and clear manner and shall further draw attention of flight crews during landing or may be part of the information transmitted by the controller to an aircraft during an approach.

2.5. ANALYSIS OF EVENTS OF THE ORGANIZATIONS INCLUDED IN THE SUBJECT EVENT

The analysis of the subject event was performed by Dubrovnik Airport and the operator, the company Van Air Europe. Both analyses contain the factors and cause of the event, and measures to mitigate or eliminate the risk in order to prevent the possibility of recurrence of the event.

2.6. ANALYSIS OF THE INFLUENCE OF LIGHT SIGNALIZATION OF THE RUNWAY AND PAPI SYSTEM ON THE EVENT

During the safety investigation, it was established that in the operator's analysis of the subject event it was stated that the runway and PAPI lights were not turned on at the time of the aircraft landing. In the analysis of the subject event by Dubrovnik Airport it was stated that the runway and PAPI lights were turned on at full intensity during the subject event in accordance with the prescribed procedures.

During the safety investigation it was not possible to determine with certainty whether the said lights were turned on or off during the landing of the aircraft. If the lights were on, the possibility that the flight crew could not have seen them due to the characteristic curvature of the runway, the lower approach angle of the aircraft to the runway and the construction machinery and vehicles that were located in the middle of the runway, could not be excluded.

3. CONCLUSION

Certain construction works at airports can compromise the safety of air traffic to some extent. Considering the speed of growth of air traffic in the Republic of Croatia, and therefore the speed of development of airport infrastructure, it can be expected that in the future, Croatian airports will face similar or same situations stated in this report during planning of construction works.

The regulatory standards applicable to the subject event are not precisely defined in certain areas, which leaves certain freedom to the organizations involved to define specific conducts, such as applying horizontal markings or defining information to be transmitted via ATIS or through controller via radio.

At the European level, at the time of issuing of this Final Report, EASA is in the process of amending Chapter AMC2ADR.OPS.B.070, which relates to safety during airport operations. The new amendments shall define more precisely the standards relating to informing via ATIS and marking of manoeuvring areas during construction works.

Flight preparation is an important segment when it comes to the safety of the flight itself. The information provided to the flight crew during preparation has a significant impact on flight decisions. In the present case, it was established that the preparation was inadequate for the subject flight. The level of complexity of documentation which flight crews reviews during flight preparation can make it difficult to understand certain information by the crew, especially if the flight crew operates several flights in a row. In such case, an additional role in preparation of the flight itself can be assumed by the operations centre of the operator, which by its action can alert the flight crew to certain risks and dangers.

Dubrovnik Airport and the operator, the company Van Air Europe, in their analyses of the subject event identified deficiencies within their processes as well as measures to eliminate or mitigate risks in the future.

3.1. FINDINGS

During the investigation, AIA established the following:

- The crew made flight preparations for the subject flight in the early morning.
- In the morning, the wind intensity at LDDU exceeded the operational limits of the aircraft.
- The crew did not fully review all information regarding Dubrovnik Airport listed in the AIP SUP document and Jeppesen Airport Charts.
- On the day of the subject event the crew performed two flights before the flight in question.
- The subject flight was conducted under IFR flight rules.
- The crew made a visual approach to the runway direction 12, with lower than the ideal approach angle.
- The crew communicated with each other during the flight regarding the approach Dubrovnik Airport and construction vehicles at the end of the runway 12.
- ATIS information did not contain information on construction works on LDDU or the displaced runway 12 threshold.
- During the approach, the controller of the Croatia Control did not provide to the aircraft the information on the displaced runway 12 threshold.

- Construction works on reconstruction of the runway and taxiways in three Phases were being performed at Dubrovnik Airport.
- On the day of the subject event, construction works were in Phase II.
- Curvature of the runway of Dubrovnik Airport.
- The closed portion of the runway was not marked with the closed marking “X”.
- The covered markings of the closed portion of the runway were partially visible due to the bitumen emulsion washed out due to rain.
- The analysis of the event by Dubrovnik Airport stated that the lights of the active runway and PAPI lights were on at full intensity during the subject event.
- The analysis of the event by the operator, the company Van Air, stated that the lights of the active runway and PAPI lights were not on at the time of the subject event.
- By the safety investigation it was not possible to determine with certainty whether the lights of the active runway and PAPI were turned on or off.

3.2. CAUSE

Immediate cause

The immediate cause of the serious incident in question was failure to identify the active portion of the runway and the closed portion of the runway by the commander of the aircraft.

Contributing factors

The factors that led to the immediate cause of this accident are:

- Inadequate flight preparation by flight crew.
- A visual approach below the ideal aircraft path.
- Non-marking of the closed portion of the runway with horizontal signalling closed marking (“X”) in accordance with the applicable standards.
- Partial visibility of the covered horizontal markings of the portion of the runway, which was out of use.
- Lack of information on the displaced runway 12 threshold in ATIS and/or in information published by the controller of Croatia Control to the aircraft in question.

4. SAFETY RECOMMENDATIONS

Safety recommendation shall in no case create a presumption of blame or liability for an accident, serious incident or incident.

During this safety investigation, AIA issued the following safety recommendations.

Recommendation to the operator, the company Van Air Europe

Considering the findings of this Safety Investigation, AIA issues to the operator, the company Van Air Europe, the following safety recommendations:

AIN04-SR-17/2019

The operator, company Van Air Europe, should define procedures that will enable flight crews to more easily review specifics of NOTAM information, especially when NOTAM information refers to other complex documents such as AIP-SUP.

AIN04-SR-18/2019

The operator, the company Van Air Europe, should implement all the corrective measures specified in its analysis of the subject event.

Recommendations to Dubrovnik Airport

Considering the findings of this Safety Investigation, and considering experience of other European airports, AIA issues to the Dubrovnik Airport, the following safety recommendations:

AIN04-SR-19/2019

For future works on manoeuvring areas, Dubrovnik Airport should introduce procedures which include the use of the horizontal closing marking "X" as the first safety measure, which would warn the pilots about the manoeuvring surface status. Such marking should be present until the manoeuvring area is activated.

AIN04-SR-20/2019

Dubrovnik Airport should include in its internal procedures the measures M1 and M2 defined in the document "Analysis of the event related to safety MOR29NOV2018" of the subject event. Such measures should become standard procedures at Dubrovnik Airport.

Recommendations to the Croatia Control (CC)

Considering the findings of this Safety Investigation, AIA issues to the Croatia Control the following safety recommendations:

AIN04-SR-21/2019

The Croatia Control should, in cases where a runway threshold is displaced, implement the term "displaced threshold" in information published via ATIS and/or information issued by the controller to the aircraft in approach.

Recommendations to the Croatian Civil Aviation Agency (CCAA)

Considering the findings of this Safety Investigation, AIA issues to the Croatian Civil Aviation Agency the following safety recommendations:

AIN04-SR-22/2019

When approving airport construction and reconstruction projects, the Croatian Civil Aviation Agency should fully verify the compliance of the project with the requirements of ICAO Annex 14 and of EU Regulation CS-ADR-DSN related to horizontal signalling of manoeuvring areas.

AIN04-SR-23/2019

The Croatian Civil Aviation Agency should, during the performance of construction works at airports, increase the number of supervisions, in order to verify compliance of construction works with the approved documentation which defines “Management of Airport Operations During Construction Works”.

Investigator in charge
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