MINISTÈRE DU DÉVELOPPEMENT DURABLE
ET DES INFRASTRUCTURES
Département des transports

Administration des enquêtes techniques

# FINAL REPORT
# ON THE COLLISION BETWEEN A CARGOLUX OPERATED BOEING 747-400F REGISTERED LX-OCV AND A MAINTENANCE VAN ON RUNWAY 24 AT LUXEMBOURG AIRPORT (ELLX) ON 21 JANUARY 2010, 11:53 UTC

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**ADMINSTRATION OF TECHNICAL INVESTIGATIONS**

CIVIL AVIATION – RAIL – MARITIME - RIVER

**Ministry of Sustainable Development and Infrastructure**
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**Administration of Technical Investigations**

**Report N° AET-2012/AC-01**

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# ON THE COLLISION BETWEEN A CARGOLUX OPERATED BOEING 747-400F REGISTERED LX-OCV AND A MAINTENANCE VAN ON RUNWAY 24 AT LUXEMBOURG AIRPORT (ELLX) ON 21 JANUARY 2010, 11:53 UTC

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## FOREWORD

In accordance with Annex 13 to the *Convention on International Civil Aviation*, Regulation (EU) No 996/2010 of the European Parliament and of the Council and Luxembourg law dated 30 April 2008 on technical investigations in relation to accidents and serious incidents which happened in the domains of civil aviation, maritime transport and railways, it is not the purpose of the aircraft accident investigation to apportion blame or liability.

The sole objective of the safety investigation and the Final Report is the prevention of accidents and incidents.

Consequently, the use of this report for purposes other than accident prevention may lead to wrong interpretations.

Note: All time indications are in Co-ordinated Universal Time (UTC) unless specified otherwise.

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## GLOSSARY

| | |
|---|---|
| ADD | Aerodrome Data Display |
| AET | Administration des Enquêtes Techniques – Safety Investigation Authority |
| AIP | Aeronautical Information Publication |
| ALPL | Association Luxembourgeoise des Pilotes de Ligne |
| ANA | Administration de la Navigation Aérienne – ANSP in Luxembourg |
| ANSP | Air Navigation Service Provider |
| APP | Approach control unit |
| A-SMGCS | Advanced Surface Movement Guidance and Control System |
| ATC | Air Traffic Control |
| ATCO | Air Traffic Controller |
| ATM | Air Traffic Management |
| ATS | Air Traffic Services |
| CAA | Civil Aviation Authority |
| CAT III | Category III Approach |
| CISM | Critical Incident Stress Management |
| CLX 793 | Cargolux flight nr 793 from Barcelona (LEBL) to Luxembourg (ELLX) |
| CNS | Communication, Navigation and Surveillance Department of ANA |
| CTR | Control Area |
| CVR | Cockpit Voice Recorder |
| CWP | Controller Work Position |
| DAC | Direction de l'Aviation Civile – Luxembourg CAA |
| DH | Decision Height |
| DME | Distance Measuring Equipment |
| EASA | European Aviation and Safety Agency |
| ELE | Electricity Department of ANA |
| ELE 23 | Maintenance vehicle nr 23 from the Electricity Department |
| ELLX | ICAO Code for Luxembourg Airport |
| FAA | Federal Aviation Administration |
| FDP | Flight Data Processor |
| FDR | Flight Data Recorder |
| FL | Flight Level |
| F/O | First Officer |
| FOD | Foreign Object Debris |
| GMC | Ground Movement Control |
| GPS | Global Positioning System |
| ICAO | International Civil Aviation Organisation |
| ILS | Instrument Landing System |
| IRS | Inertial Reference System |
| kHz | Kilohertz |
| Kts | Knots |
| LEBL | ICAO Code for Barcelona Airport |
| LVP | Low Visibility Procedures |

| | |
|---|---|
| LVO | Low Visibility Operations |
| MATS | Manual of Air Traffic Services |
| MHz | Megahertz |
| NDB | Non-Directional Beacon |
| NM | Nautical Mile |
| NSA | National Supervisory Authority |
| NTSB | National Transportation Safety Board |
| OJEU | Official Journal of the European Union |
| OM-A | Operations manual – Part A |
| OPS | Operations Department |
| PANS-ATM | Procedures for Air Navigation Services – Air Traffic Management |
| PF | Pilot Flying |
| PM | Pilot Monitoring |
| PNF | Pilot Not Flying |
| PTT | Push-to-talk |
| QAR | Quick Access Recorder |
| RDH | Reference Datum Height |
| ROC | Rate of climb |
| ROD | Rate of descend |
| R/T | Radiotelephony |
| RVR | Runway Visual Range |
| RWY | Runway |
| SARP | ICAO Standards and Recommended Practices |
| SIS | Service Incendie et Sauvetage de l'Aéroport – Airport Fire and Rescue Service |
| SMR | Surface Movement Radar |
| THR | Runway Threshold |
| TMA | Terminal Area |
| TWR | Aerodrome Control Tower |
| UBBB | ICAO Code for Heydar Aliyev International Airport near Baku, Azerbaijan |
| UTC | Coordinated Universal Time |
| VHHH | ICAO Code for Hong Kong International Airport |

# SYNOPSIS

**Notification of event**
The event has initially been notified as ‘accident’ to the NTSB, to EASA and to ICAO on the day of the occurrence. The initial classification was based on national law which has a different definition of an ‘accident’ than ICAO or EU provisions. Shortly before publication, the occurrence has been reclassified by AET as a ‘serious incident’ in accordance with prevailing ICAO Annex 13 and Regulation (EU) No 996/2010 definitions. In fact, the aircraft damage was limited to a tire which had to be replaced and which, as a non-structural part, does not fall within the scope of substantial damages.

**Identification of investigating authority**
The authority responsible for the safety investigation is the ‘Administration des Enquêtes Techniques (AET)’, which is the permanent and independent investigation body in Luxembourg. The NTSB has named an accredited representative and has selected the FAA and Boeing as technical advisers. Cargolux nominated a ‘Technical Pilot’ to participate as an adviser and the ‘Association Luxembourgeoise des Pilotes de Ligne (ALPL)’, a Luxembourg association representing the airline pilots, has been granted participation in the investigation on their request and have delegated a First Officer flying for Cargolux as a technical adviser.

At a later stage, external ATC experts were asked to provide assistance in the drafting of the final report.

**Organisation of safety investigation**
The AET was contacted shortly after the occurrence and reached the aircraft on apron P7 approximately one hour later. During the inspection of the airplane, the only damage that could be found were several cuts, including side cuts, on tire no 12 on the right hand body landing gear. Cargolux was instructed to quarantine the CVR and QAR data, as well as tire no 12 which had to be replaced due to the side cuts stemming from the collision with the van on the runway.

**Scope of the safety investigation**
In accordance with Annex 13 provisions, the final report may cover all safety relevant aspects which have been identified during the investigation, even if they are not linked directly to the main event. The investigation authority, after analysis of available data, has identified safety issues which are not in direct relation to the occurrence, but which will be addressed in the present report.

**Résumé of the circumstances**
On 21 January 2010, a Cargolux 747-400F was operating the scheduled freight flight CLX 793 from Barcelona to Luxembourg. On approach into Luxembourg, at 11:40:27 UTC, CLX 793 received information from Luxembourg approach control that Low Visibility Procedures (LVP) were in operation. It should be noted that Luxembourg Airport is not equipped with Surface Movement Radar (SMR) or any other means of ground movement surveillance. CLX 793 continued a Cat III(b) approach to the threshold of runway 24 where the PF briefly saw an object he believed to be a vehicle standing on the runway in the touchdown zone. CLX 793 completed an uneventful auto-landing at 11:53:51 UTC and after vacating the active runway, the crew informed Luxembourg aerodrome control about a car on the runway. A short time

before, the maintenance crew, carrying out preventive maintenance on the runway centreline lights, called the aerodrome control tower from a mobile phone and told the TWR coordinator/assistant that they had been working on the runway while an airplane was landing and that the aircraft damaged the roof of their van with the landing gear.

# 1. FACTUAL INFORMATION

## *1.1 History of flight*

The aircraft was operating a scheduled freight flight from Barcelona (LEBL), Spain to ELLX-Luxembourg. The aircraft's actual departure time in Barcelona was 10:13. At 11:40:27, CLX 793 contacted Luxembourg Approach (APP) for the first time and was advised by the approach controller that Low Visibility Procedures (LVP) were in operation. At that time, the aircraft was inbound waypoint AKELU, passing FL 154. Fog prevailed at Luxembourg airport with a cloud base at 100 feet overcast and a visibility of 100 meters, temperature and dew point were at 1°C. According to the tower logbook, LVP's were operational from 7:17 onwards.

The aircraft was instructed to descend to FL 80 for an ILS approach on Runway 24. RVR readings were 350/275/375 meters. At 11:49:34 the approach controller instructed CLX 793 'turn left heading 270 to intercept, cleared ILS 24, report established'. At 11:50:55, CLX 793 reported established on the localiser for Runway 24 and was transferred to Tower on 118,1 MHz. RVR readings had decreased to 350/250/350 meters.

After passing the fix 'ELU' NDB at an altitude of 3000 ft (5.38 NM from THR 24), CLX 793 contacted Luxembourg Tower (TWR) at 11:51:40 and reported established on the ILS 24. Part of that radio call was blocked out by a call from Luxair 4883 on apron P1 requesting a taxi clearance. Tower received the fragments 'Lux…93 established ILS 24' and, after clearing Luxair 4883 to taxi to the Cat III holding point runway 24, issued a landing clearance to CLX 793. At that time, CLX 793 was approximately 4.5 NM from the runway. The wind was calm and RVR readings were still at 350/250/350 meters.

At 11:52:26 CLX 793 completed the landing checklist and at 11:53:46, reaching decision height at 17 ft, the PF called out 'landing'. During the flare, the airplane impacted a maintenance van ELE 23 positioned slightly to the right of the centreline of runway 24 and about 340 meters from the threshold, with the front-end pointing into the opposite direction (060°). The roofline of the van was at a height of 2.54 m (8 ft). The right hand body landing gear of the Boeing 747-400F impacted the roof of ELE 23 with tire nr 12 slightly below the roofline of the van on a backward sloped roof section and rolled over it, damaging the roof on the whole length of the vehicle. The van's lightbar, as well as its R/T antennas, were ripped off on impact. The maintenance crew working on the centreline lights outside of ELE 23 ran off the side of the runway as soon as they noticed an increasing noise from a landing aircraft. The aircraft landed safely at 11:53:51.

After touchdown, at 11:53:59, the PF mentioned to the PM that there was a car in the touchdown zone. The PM, monitoring the instruments during landing in accordance with company procedures, didn't notice it.

The aircraft vacated RWY 24 at taxiway Echo and at 11:56:28, while taxiing to apron P7, the PF informed the TWR controller about a car in the touchdown zone. The controller asked if there was a problem and the PF denied. The aircraft continued to the parking position on apron P7 without further incident.

Up to that point, there was no indication that the crew was aware of the airplane's collision with the maintenance van which the PF saw during landing.

Damage to the aircraft was limited to tire nr 12 on the right land body landing gear, which sustained several cuts including side cuts and which had to be replaced.

## *1.2 Injuries to persons*

| *Injuries* | *Crew* | *Passengers* | *Others* |
|---|---|---|---|
| Fatal | | | |
| Serious | | | |
| Minor/None | 2 | 1 | 2 |

## *1.3 Damage to aircraft*

Damage to the aircraft was limited to cuts on tire nr 12 located on the right hand body landing gear, sustained from impact with the van's lightbar which was ripped off. The tire had to be replaced. It is unlikely that the damage to the tire could stem from a previous flight considering that the tires nr 11 and 12 had been replaced shortly before in Hong Kong and that the Barcelona-Luxembourg leg was the 3rd flight since the replacement.

Picture 1: Tire nr 12 (Source AET)

## 1.4 Other damage

The roof of the maintenance van was damaged on the whole length of the vehicle. The light-bar and the R/T antennas were ripped off on impact.

Picture 2: Van ‘ELE23’ (Source AET)

## 1.5 Personnel information

### 1.5.1 Flight crew

| | ***Captain*** | ***First officer*** |
|---|---|---|
| ***Function*** | PF | PM |
| ***Age*** | 47 | 38 |
| ***Nationality*** | Germany | Germany |
| ***License type*** | ATPL | ATPL |
| ***Total flight hours*** | 9125 | 6434 |
| ***Hours on type*** | 5793 | 4727 |
| ***Last 3 days*** | 13:31 hrs | 13:31 hrs |
| ***Last 28 days*** | 13:31 hrs | 30:41 hrs |
| ***Last 30 days*** | 13:31 hrs | 30:41 hrs |
| ***Day of event*** | 7:24 hrs | 7:24 hrs |
| ***Last proficiency check*** | 27.08.2009 | 11.11.2009 |
| ***Last line check*** | 15.07.2009 | 09.01.2010 |
| ***Last medical check*** | 02.09.2009 | 09.01.2010 |
| ***License valid until*** | 31.03.2014 | 25.06.2010 |
| ***Type rating valid until*** | 31.03.2010 | 30.06.2010 |

### 1.5.2 Aerodrome control tower

| | ***CWP 1*** | ***CWP 2*** |
|---|---|---|
| ***Position*** | TWR controller | TWR coordinator/assistant |
| ***Age*** | 47 | 36 |
| ***Nationality*** | Luxembourg | Luxembourg |
| ***Qualifications (TWR control positons as defined in MATS)*** | TWR controller & TWR assistant/coordinator | TWR controller & TWR assistant/coordinator |
| ***Last medical check*** | 25.06.2009 | 22.10.2009 |
| ***Experience since*** | 23.08.1984 | 19.01.2001 |
| ***Hrs on duty before occurrence*** | 1:24 hrs | 1:24 hrs |
| ***Hrs off duty before shift start*** | 19 hrs | 19 hrs |
| ***Last shift before day of occurrence*** | 20.01.2010 Morning | 20.01.2010 Morning |
| ***Hrs on duty during last shift before occurrence*** | 4:30 hrs | 4:30 hrs |

The TWR controller and the TWR coordinator/assistant both followed an emergency/refresher training course provided by DFS (Deutsche Flugsicherung) shortly before the occurrence (course id TWR-E09 on 16-19 November 2009 for the coordinator/assistant and TWR-E11 on 14-17 December 2009 for the TWR controller). The course was developed to comply with the provisions of the European Safety Regulatory Requirements ESARR5.

The content of the emergency/refresher training course was the following:

- Refreshing existing theoretical knowledge
- Building situational awareness
- Basic procedures for emergencies at the airport
- Increasing awareness for cockpit proceedings
- Practical application of procedures and the use of checklists
- Learning appropriate control and co-ordination procedures
- Learning appropriate standards according to the ASSIST principle

### 1.5.3 ELE 23 maintenance crew

| | ***Operator 1*** | ***Operator 2*** |
|---|---|---|
| ***Position*** | Electrician | Assistant |
| ***Age*** | 20 | 45 |
| ***Nationality*** | Luxembourg | Luxembourg |
| ***Experience since*** | 2008 | 1993 |
| ***Hrs on duty before occurrence*** | 04:24 | 04:24 |

## *1.6 Aircraft information*

### 1.6.1 Airframe

| | |
|---|---|
| ***Manufacturer*** | The Boeing Company |
| ***Aircraft designation*** | 747-4R7F |
| ***Serial Nr*** | 29731 |
| ***Year of manufacture*** | 1999 |
| ***Airworthiness certificate*** | |
| *Date of issue* | 16.03.2005 |
| *Date of expiry (ARC)* | 09.09.2010 |
| ***Flight hours*** | 55967 |
| ***Cycles*** | 10512 |

### 1.6.2 Engines

Manufacturer: Rolls-Royce
Number and type: 4 x RB211-524H2-T-19/15

### 1.6.3 Additional aircraft information

Cargolux summary regarding an incident at Hong Kong International Airport (VHHH) on 11 January 2010:

*‘ The Boeing 747-400F aircraft, LX-OCV, call sign, ‘Cargolux 759’, (CV759) was operating a scheduled flight. The flight was planned to depart Hong Kong International Airport on the 11th of January 2010 at 15:30 UTC with destination Baku, Azerbaijan.*

*After being pushed back from parking position ‘C22’, the aircraft started taxi under its own power via taxiway ‘L3’ and ‘K’ to holding position for runway ‘07R’.*

*During takeoff, the crew felt a minor ‘rolling/swaying’ followed by subtle vibration. As a precautionary measure, the crew decided to abort the take off at approximately 85 knots.*

*A fire on the right hand body landing gear (RH BLG) was extinguished by the fire brigade with water. The aircraft came to a stop on the runway. No events were reported by the crew until the take-off was aborted, due to indication of airframe vibration.*

*No persons were injured during this incident.’*

The wheel assemblies nr 11 and nr 12 were destroyed and some gear doors and fairings were damaged. The complete right-hand side body landing gear was subsequently replaced in Hong Kong and the airplane was back in service on 20 January 2010, one day before the occurrence at Luxembourg Airport. The airplane’s itinerary departing Hong Kong was Baku (UBBB) – Barcelona (LEBL) – Luxembourg (ELLX) and took a total of 15:38 flight hours. The crew of CLX 793 flew the legs Baku - Barcelona - Luxembourg, totalling 7:24 hours on the day of the occurrence.

## *1.7 Meteorological information*

### 1.7.1 Forecast

#### *1.7.1.1 Synoptic Situation*

A weak pressure gradient determined the weather over Luxembourg. The frontal system of weak activity situated over Germany, associated to the depression over the Mediterranean, was forecasted to dissipate during the day.

#### *1.7.1.2 Weather Forecast*

Overcast weather with light snow showers in the morning, followed by a misty overcast sky and possible freezing fog the next morning.

#### *1.7.1.3 Terminal Area Forecast (TAF)*

TAF (2106/2212)
12004KT 2000 BR SCT001 BKN004
BECMG 2106/2108 0300 FZFG BKN001
BECMG 2108/2110 3000 BR BKN003 BKN008
***BECMG 2110/2112 18003KT 6000 BKN008 BKN012***
BECMG 2112/2114 20002KT 8000 BKN012
BECMG 2203/2205 09002KT 0500 FZFG BKN002
BECMG 2208/2210 3000 BR BKN005=

The highlighted TAF for the date of occurrence, from 10:00 to 12:00, read as follows:
*Surface wind from 180° at 3 knots, visibility 6 km, broken cloud layer at 800 feet, broken cloud layer at 1200 feet.*

### 1.7.2 Weather Observations

#### *1.7.2.1 Meteorological Airport Report (METAR)*

ELLX 211120Z VRB03KT 0150 R24/0375N FG OVC001 01/01 Q1020 NOSIG
***ELLX 211150Z 12003KT 0100 R24/0350N FG OVC001 01/01 Q1020 NOSIG***
ELLX 211220Z VRB03KT 0100 R24/0275N FG OVC001 01/01 Q1020 NOSIG
ELLX 211250Z 13002KT 0100 R24/0250N FG OVC001 01/01 Q1019 NOSIG

The highlighted METAR closest to the time of occurrence read as follows:
*Issued at 11:50z, wind from 180° at 3 knots, visibi lity 100 m, visual range of 350 m at threshold runway 24, fog, overcast sky at 100 feet, temperature 1°, dew point 1°, QNH 1020, no significant change forecasted.*

#### *1.7.2.2 Runway Visual Range (RVR) Values*

The Manual of Air Traffic Services (MATS) defines the runway visual range as *"the range over which the pilot of an aircraft on the centre line of a runway can see the runway surface markings or the lights delineating the runway or identifying its centre line".* On the day of the occurrence, relevant RVR readings for runway 24 are shown hereafter:

| RUNWAY 24 | | | | |
|---|---|---|---|---|
| **Time (z)** | **Touchdown (m)** | **Midpoint (m)** | **Rollout (m)** | **Observation** |
| 1132 | 350 | 325 | 450 | ELE 23 entering runway 24 |
| 1133 | 350 | 325 | 450 | |
| ***1154*** | ***350*** | ***225*** | ***325*** | Time of occurrence |

## *1.8 Aids to navigation*

### 1.8.1 Aerodrome

The ILS CAT III radio navigation and landing aids available for runway 24 are:

- A non-directional beacon NDB (ELU/368.5 kHz) situated 5.38 NM from the threshold of runway 24;
- a VHF localizer (ILW/110.7 MHz) situated 2.31 NM from the threshold of runway 24;
- a UHF glide path transmitter (330.2 MHz) with a glide slope angle of 3° and an ILS reference datum height (RDH) of 52 feet;
- a distance measuring equipment DME (ILW/channel 44X) collocated with the glide path transmitter.

### 1.8.2 Aircraft

CLX 793 performed a Cat III(b) auto-land approach into ELLX. Passing 2500 ft, “Land 3” status became active, with all 3 autopilot channels engaged and working normally. The aircraft was “Fail Operational”, meaning that after the failure of 1 out of the 3 channels, the remaining part of the automatic system would still be able to carry out the approach, flare and landing.

The decision height (DH) for Cat III approaches is 17 ft and the minimum RVR for Cat IIIb approaches into ELLX (RWY 24) is 125 meters. OM-A defines the task sharing during Cat II/III approaches and states that the Commander shall be the PF for approach and landing or go-around, with the F/O acting as PM. The company procedure for final approach is the following:

- At 100 feet above DH, the Commander goes head-up and concentrates on expected outside visual cues, while the PNF (PM) stays head-down and monitors the auto-flight indications;
- When passing the DH and if visual reference is established, the PF calls out “Landing” and monitors the approach and landing by visual cues, while the PM stays head-down to monitor the landing roll;
- When passing the DH and if visual reference is <u>not</u> established, the PF calls out “Go-around”, starts the go-around and resumes the instrument scan, while the F/O stays head-down and monitors the go-around.

## *1.9 Communications*

### 1.9.1 General context

At the time of the event, CLX 793 was in contact with Luxembourg aerodrome control tower on 118.10 MHz. The communications between airplane and tower were recorded on the airplane’s CVR and on the ATC recording equipment. Both

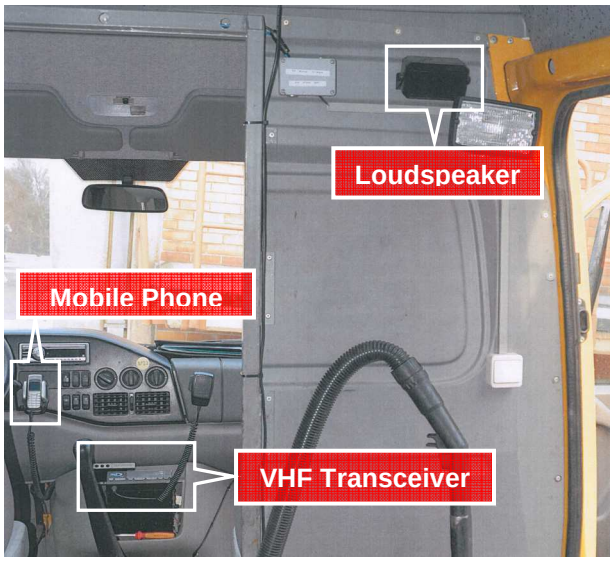
recordings were made available to the investigation authority and transcripts of the ATC recording were provided by ANA, the national ANSP.

The communication between Luxembourg aerodrome control tower and the maintenance crew was carried out on ground control frequency 121.90 MHz and was recorded on the ATC system. The investigation authority received an audio copy and a transcript of the ground communication from ANA. Phone conversations from the controller work positions were also recorded and made available to the investigation authority.

It should be noted that ground control frequency 121.90 MHz is not published in the AIP or on the navigation charts.

### 1.9.2 ELE 23 communication equipment

The radiotelephony (R/T) equipment available to the ELE 23 maintenance crew was a built-in VHF transceiver connected to an external loudspeaker located near the van's sliding door, enabling the ELE crew to maintain a listening watch on communications with TWR while working outside. Furthermore, the maintenance crew was equipped with a mobile phone and was provided with a list of important telephone numbers, including the one for the TWR unit, enabling them to contact TWR if needed (e.g. R/T equipment failure). The mobile phone number of ELE 23 maintenance crew was however not known to the TWR unit.




Picture 3: 'ELE23' R/T Equipment (Source ANA)

A handheld VHF transceiver was not part of the R/T equipment provided to ELE 23 as in some parts of the manoeuvring area, it was not possible with this type of equipment to maintain a communication link with TWR.

### 1.9.3 ATC Recordings

Relevant ATC related communications not recorded on the CVR or presented in paragraph *1.11.2 - CVR Recordings* are laid down hereafter.

Communications on ground control frequency 121.9 MHz and over the phone at the Controller Working Position 2 (CWP2) were mainly in Luxembourgish language and have been translated into English by AET for the purpose of the report.

#### *1.9.3.1 Ground control frequency 121.900 MHz*

At 11:33:15, ELE 23 called Luxembourg Tower on ground control frequency 121.9 MHz and asked for clearance to drive from apron P3 onto the runway and taxiways. ELE 23 was in direct contact with the TWR Assistant/Coordinator on that frequency.

At 11:33:23, ELE 23 was cleared to drive directly onto the runway and acknowledged the instruction.

No other communication was recorded on ground control frequency until after the occurrence.

At 11:55:21, a loud noise was heard for about one second.

At 11:55:26, more than a minute after the collision, ELE 23 called Tower.

During a telephone conversation, the electrician from ELE 23 asked the TWR coordinator/assistant to call ELE 23 on ground frequency to check if the van's R/T equipment was still in working condition. At 11:56:59, TWR coordinator/assistant called ELE 23 on ground control frequency 121.9 MHz but the transmission was not received by ELE 23, most probably because of the damage sustained by the communication antennas on the van. Subsequently the communication between ELE 23 and TWR was through the phone.

At 12:03:57, the SIS dispatcher called SIS 77, who was previously cleared and on his way to the occurrence site, on ground control frequency and told him that ELE 23 maintenance crew just called in to say that they were standing near the glidepath 24 and that numerous pieces from the roof of that small building were lying on the runway.

#### *1.9.3.2 Controller Working Position 2 (CWP2)*

There are two active controller working positions in the aerodrome control tower, one for the TWR controller (CWP1) and the second one operated by the TWR coordinator/assistant (CWP2). This paragraph relates to the phone conversations operated from and to CWP2.

At 11:45:02, Approach called TWR Assistant/Coordinator to know if there had been a new measurement of the braking action. The TWR coordinator/assistant gave a negative response and Approach asked to confirm that the last braking action was good, which TWR coordinator/assistant confirmed.

At 11:56:27, the electrician from ELE 23 called Tower unit from a mobile phone on the fixed line and informed the TWR coordinator/assistant about the collision, stating that the aircraft ripped off the lighting bar on the roof of their van, that debris was spread on the runway and that TWR should call the fire brigade for a runway check. Furthermore, he explained that the aircraft impacted the roof of the van with its landing gear and that the airplane should be inspected. The ELE 23 assistant in the background remarked that the lined-up aircraft should not be cleared for take-off. This remark was forwarded by his colleague to the TWR coordinator/assistant who acknowledged.

At 11:58:01, the TWR coordinator/assistant called the fire brigade and asked for a runway check of the first half of runway 24, indicating there might be pieces on the runway.

At 12:12:11, the electrician from ELE 23 contacted the TWR controller. The TWR controller explained that 'they' (the TWR controller and the TWR coordinator/assistant) called ELE 23 earlier on and that they got a carrier wave on return, which they thought was the confirmation that the van had left the sensitive area (had vacated the runway). The electrician replied that they didn't hear any communication coming from tower; otherwise they would have vacated the runway immediately. He added that they had been working all the time on the lighting in close proximity to their van and with the volume on the R/T speaker at high level. The TWR controller then assumed that there was either a problem with the microphone on the tower or with the van's R/T equipment. The electrician explained that the R/T equipment wasn't working anymore due to the damage to the roof of the van from the collision. The TWR controller continued by asking/inquiring about the damage on the van and remarked that the airplane didn't sustain any damage. The electrician stated that the airplane rolled over the whole length of the van's roof with what he assumed to be its front wheel and that the roof was completely dented. The TWR controller supposed that the damage to the van might have come from the air pressure generated by the aircraft or its engines and pointed at the fact that the CLX 793 crew hadn't reported any problem with the aircraft after the landing. He believed that the airplane crew should have noticed the impact and seemed dubious whether it happened the way described by the electrician. The electrician assured that he just ran for his life. The TWR controller finished by saying he was sorry and repeated that he and his colleague supposed that ELE 23 had vacated the runway because of the carrier wave on the frequency. He acknowledged that one should ask again but argued that due to the technical problem that wasn't possible.

At 12:17:16, the TWR coordinator/assistant called approach to inform them that Luxair 4883 was still lined up and that the fire brigade was removing pieces from the runway, so they would have to send the inbound Luxair 9304 back to APP. Approach inquired why Luxair 4883 couldn't depart and the TWR coordinator/assistant replied that there were pieces on the runway which had to be removed.

### *1.9.3.3 Tower frequency 118.100 MHz*

The tower frequency is monitored and operated by the TWR controller.

At 11:55:26, Luxair 4883 holding at the Cat II/III holding point on taxiway B1 was cleared by the TWR controller to line up on runway 24.

At 11:57:41, Luxair 4883 reported fully ready.

At 11:57:55, the TWR controller replied to stand-by and came back at 11:58:00 with the information that they had to do a runway check and that he would call back.

At 12:04:31, Luxair 4883 asked tower for an expected take-off time. The TWR controller replied that the fire brigade was removing pieces from the runway.

At 12:16:25, Luxair 9304 contacted tower at 8 miles final runway 24.

At 12:16:32, the TWR controller instructed Luxair 9304 to continue approach and indicated that wind was calm.

At 12:16:50, Luxair 4883, asked tower if there were any news for them. The TWR controller gave a negative reply and indicated that 'they' (the fire brigade) were still on the way to vacate the runway. He finished by expressing the hope to call back in 30 seconds.

At 12:17:16, the TWR controller asked Luxair 9304 if they were able to do a 360 at present position, which Luxair 9304 answered in the negative.

At 12:17:32, the TWR controller then instructed Luxair 9304 to continue on heading, climb to 3000 feet and call Approach on 118.9 MHz.

At 12:19:40, the TWR controller cleared Luxair 4883 for take-off. RVR readings had further decreased to 275/225/250 Meters.

## *1.10 Aerodrome information*

Luxembourg Airport has a single runway of 4000 m length and 60 m width, orientated 060°/240° true bearing. The runway designators are 06/24. Runway 06 is approved for Cat I approaches and runway 24 is approved for Cat III approaches. The aerodrome is not equipped with ground traffic control and surveillance equipment

The airport chart from the AIP is shown hereafter. The aerodrome control tower and the position of ELE 23 at the time of the occurrence are highlighted on the chart.

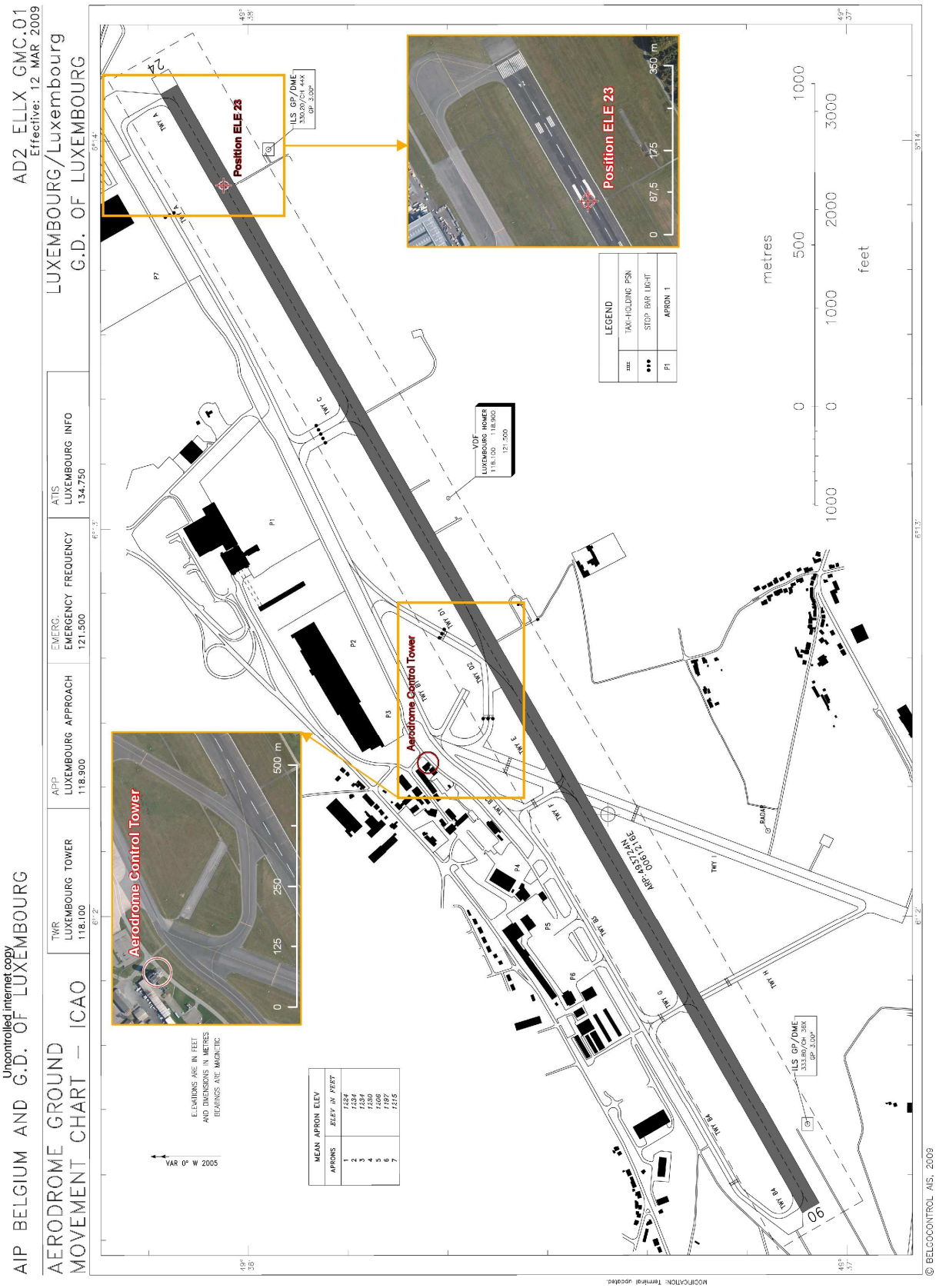



Figure 1: Aerodrome Ground Movement Chart (Source AIP Belgocontrol, ACT, AET)

## *1.11 Flight recorders*

The aircraft was equipped with a FDR, a CVR and a QAR. The day of the occurrence, the investigation authority requested Cargolux to quarantine both the CVR and the FDR. Cargolux proposed to download the QAR data and release the FDR from quarantine, considering that the data recorded on the QAR would be the same as on the FDR. The proposal was approved and the QAR data was provided to AET on 29 January 2010.

On a common agreement, the CVR was sent by Cargolux to a UK company on 25 January 2010 in order to transfer the audio files on to an optical storage device. AET received the recordings on a CD-ROM on 2 February 2010. The audio was of good quality.

### 1.11.1 QAR Data

#### *1.11.1.1 Relevant parameters*

The data retrieved from the QAR did not show any significant deviation from normal operation. This correlates with the fact that the crew did not notice the impact with the van during landing.

### 1.11.2 CVR Recordings

Communications between the crew and ATC were in English; communications between the PF and the PM were either in English or in German. The German dialogues have been translated into English.

The following relevant communications have been noted:

At 11:40:26, CLX 793 made initial contact with Luxembourg Approach on 118.9 MHz and received information that low visibility procedures were in operation. RVR readings of 350/275/375 m were provided.

At 11:44:31, the PF remarked that there didn't seem to be much traffic and that they should ask for the braking action, which the PM did. Approach, after checking with Tower, reported last braking action was good, that the measurement was done 2 hours ago, that the surface was wet and that there had been no precipitation since. No new measurement was requested by CLX 793.

At 11:49:43, the PF called for gear down.

At 11:50:53, the PM reported to Approach that they were established on the localiser for runway 24. Approach gave the RVR readings 350/250/350 meters and turned them over to Luxembourg Tower on 118.1MHz.

At 11:51:40, CLX 793 made initial contact with Luxembourg Tower on 118.1 MHz, reporting established for runway 24.

At 11:51:54, CLX 793 was cleared to land and received the RVR readings 350/250/350 meters. The wind was calm.

After reaching minimum decision height of 17 ft at 11:53:45, the PF called out landing.

Touch-down was at 11:53:51, the collision with the van occurred shortly before.

At 11:53:58, the PF asked the PM if he had seen the car on the runway. The PM inquired about what car and the PF repeated that there was a car precisely in the touchdown zone. The PM indicated that he couldn't see what was going on outside because he was monitoring the instruments at that time.

At 11:54:38, CLX 793 informed Tower that they were able to vacate the runway via taxiway Foxtrot.

At 11:54:43, the TWR controller indicated a landing time of 54 and instructed CLX 793 to report runway vacated by Fox or Echo if they liked.

At 11:55:31, CLX 793 reported runway vacated.

At 11:56:05, the PF exclaimed that visibility was really bad and the PM agreed.

At 11:56:28, the PF informed Tower that during landing, he saw a vehicle standing just before the touchdown zone on the runway.

At 11:56:39, the TWR controller replied that they would check and asked if there was a problem. The PF answered in negative but expressed his astonishment to see a car in that area, to which the TWR controller replied 'I believe you'.

At 11:56:53, the PM asked the PF what car it was and the PF replied it was a yellow car from the airport and assumed it was a Follow-Me vehicle.

At 11:57:11, the PF asked the PM again if he had seen the car and the PM replied that he was still looking inside at that time. The PF then continued by saying that it briefly flashed through his head to initiate a go-around.

At 11:57:39, the CLX 793 crew heard Luxair 4883 reporting fully ready, then being told by the TWR controller to stand-by and that a runway check had to be performed. Tower would then call back.

At 11:58:03, with regard to the previous conversation between Tower and Luxair 4883, the PF exclaimed that it had to do with the vehicle standing on the runway. He went on saying that in such foggy weather, one did not have any reference and it would be hardly possible to estimate a height.

At 11:59:35, the PM informed Tower that they were approaching the entrance of P7.

At 12:04:35, the TWR controller informed Luxair 4883 that the fire brigade was removing pieces from the runway.

At 12:04:52, CLX 793 inquired what kind of pieces were removed from the runway and he was told by the TWR controller that the pieces came from a house nearby.

The PM expressed his astonishment and the TWR controller replied that it wasn't the exact wording but they would keep him advised.

The CLX 793 crew was wondering how pieces from a house could end up on the runway and one crewmember suggested that debris might have been blown there by the wind.

The CVR recordings ended at 12:07:07.

## *1.12 Wreckage and impact information*

The impact of CLX 793 with ELE 23 took place during the flare at a height of approximately 8 feet above the touchdown zone of runway 24. The airplane impacted the roof of the van with wheel nr 12 on the right hand side body landing gear, below the roofline on the inclined front section of the van. Wheel nr 12 damaged the roof on the whole length of the vehicle, ripping off the lightbar and the R/T antennas. Wheel nr 12 sustained several cuts, including side cuts, and had to be replaced. No structural aircraft parts were damaged during the occurrence.

## *1.13 Medical and pathological information*

None

## *1.14 Fire*

No fire

## *1.15 Survival aspects*

Survivability was not an issue with regard to the limited damage to both the airplane and the unoccupied van.

The maintenance crew of ELE 23 ran off the side of the runway onto the grass when they heard the increasing noise from the landing aircraft. Immediately after the collision, they went back to their van, drove it off the runway to a nearby service road and contacted tower first on ground control frequency, then on a fixed line from a mobile phone and reported the occurrence.

## *1.16 Tests and research*

### 1.16.1 Aerodrome control tower R/T equipment issues

The TWR controller and the TWR coordinator/assistant both stated that ELE 23 was instructed to vacate the runway as soon as they saw CLX 793 approaching on the radar screens. The TWR controller estimated the aircraft at a distance of 16 to 18 NM from the airport at that time. After instructing ELE 23 to leave the sensitive area, both the TWR controller and the TWR coordinator/assistant indicated hearing a 'carrier wave' noise similar the one made by a VHF transceiver and interpreted that signal as the acknowledgment of ELE 23 that the sensitive area was vacated.

However, after the initial clearance by TWR at 10:33:23 to enter the runway, the maintenance crew of ELE 23 asserted that they never received an instruction from TWR to leave the runway. They had been working all the time on the runway centreline lighting close to their van, with the loudspeaker, located next to the sliding side door, activated and the sound at high level.

### *1.16.1.1 Tests and research by CNS Department*

CNS is the Communication Navigation Surveillance Department of ANA, responsible to provide electronic air navigation systems and maintain those systems in good working condition. After the occurrence, the CNS Department performed a number of tests and research to identify any potential technical issue with or malfunction of the R/T equipment.

#### 1.16.1.1.1 ATC recordings

The ATC recordings did not show any activity on the ground control frequency 121.9 MHz from the time when the van was cleared to drive onto the runway until after the occurrence. The recording system does not create an exportation file for a selected period of time if there is no audio signal (silence). When the CNS department selected the data export of the ground control frequency channel for a time period between 11:40 and 11:50 on 21 January 2010, the system displayed the following message:*'1 (one) exported channel does not contain data for the specified time period. No file created for this channel'*. On the recordings from 21 January 2010, no communication anomaly related to a defective microphone could be identified, either before or after the occurrence.

#### 1.16.1.1.2 Microphone on CWP2

On 22 January 2010, the CNS department examined the microphone (ID FG21) used on CWP2 during the occurrence by the TWR coordinator/assistant operating the ground control frequency, to identify any malfunction related to the cables, the transmission button (RTT switch) or any other defective component. No technical problem was detected during the verification.

#### 1.16.1.1.3 Aerodrome control tower R/T system

The R/T system generates one log-file per day which records data such as:

- system generated error messages;
- maintenance activities (e.g. adding phone numbers, changing layout, etc.);
- system generated acknowledge messages (e.g. after adding phone numbers or changing layout);
- selective ATCO actions (e.g. diversion from one CWP to another, switching from MAIN to STBY and vice-versa).

The log-file does not record standard ATCO actions performed on the control panel (e.g. Rx/Tx selection for a specific frequency, activation of 'runway incursion' function, etc).

When the 'runway incursion' function is activated on the R/T system, pushing the microphone transmission button triggers an aural warning on the loudspeaker of the

specific CWP. The CNS department examined if this warning sound would be recorded on the ATC recording system. The performed test showed that the sound could not be positively identified on the ATC recordings.

The CNS department contacted the R/T system manufacturer in order to assess if it could be possible for a selected frequency to shut down without any message. The R/T equipment problem described by the TWR control staff on the day of the occurrence could not be reproduced. Based on the description provided by the CNS department, the manufacturer came to the conclusion that:

- the event could not be described with any plausible technical explanation;
- such a failure had not yet been identified on any other similar equipment.

Based on the available data, it was not possible to establish whether the 'runway incursion' function had been activated by the TWR staff on duty prior to the occurrence. The archived log-file from 21 January 2010 did not show any technical failure related to the investigated occurrence.

#### *1.16.1.2 Aerodrome Data Display (ADD)*

The ADD tower information system provides the ATCO with all airport-relevant data: weather information, status of navigation aids, information on the runway, etc. It also has a manually activated 'runway blocked' function to mark an obstructed runway in red colour on the display.

The log file of the ADD system showed that the morning shift had used the 'runway blocked' function four times between 07:17 and 09:23, for periods ranging from 3:30 minutes to 24:00 minutes. After the shift-change at 10:30 and until the occurrence, the 'runway blocked' function had not been activated by the day shift. The ADD system had again been used at 12:50:06 when a vehicle entered the runway to look for remaining debris from the collision.

## *1.17 Organizational and management information*

### 1.17.1 Organisation of the Air Traffic Control Service

The ATC Service is divided into two control units:

- Aerodrome control
- Approach control

Aerodrome control is carried out from aerodrome tower and includes the following functions:

a) Aerodrome control (air and ground/manoeuvring area)
b) Coordination and assistance to aerodrome control

Approach control is carried out from the approach room and includes the following functions:

a) Radar approach control
b) Coordination and assistance to approach control

The minimum operational manning requirement per unit (aerodrome control / approach control) is two qualified agents during normal operating hours. During the

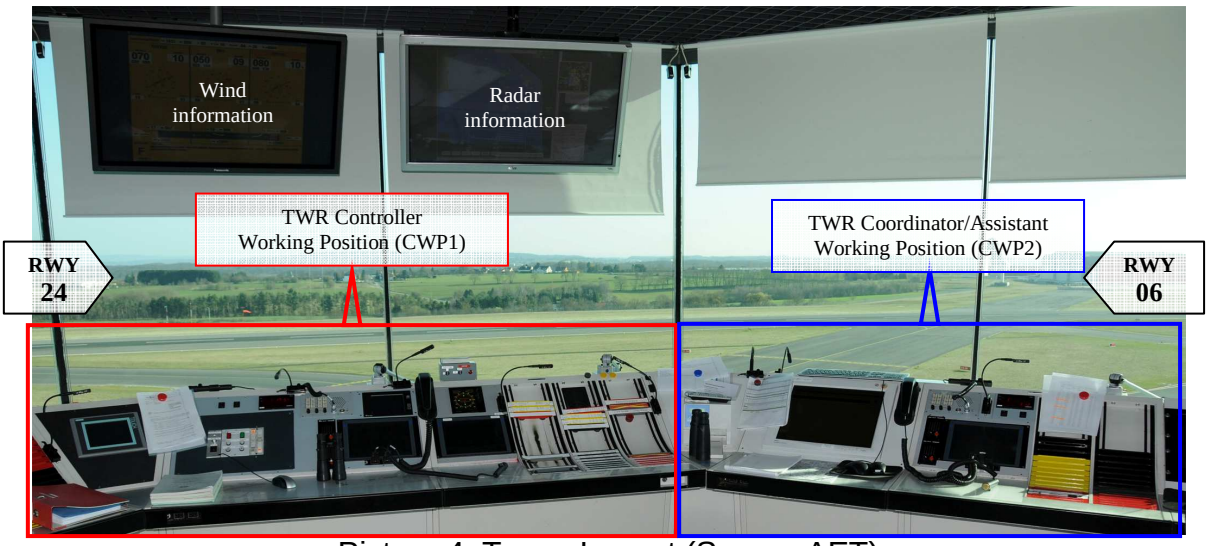
curfew (22:00h to 05:00h), if there are less than 3 movements per hour, the operation can be reduced to one qualified agent. However, a second ATCO (per unit) has to be available in the facility.

## 1.17.2 Aerodrome control tower

### *1.17.2.1 Tower layout*

The TWR controller working position (CWP1), in addition to the control console equipment, has two screens located above the working position. One screen is displaying the information from primary and secondary approach radar on a background image depicting the Luxembourg CTR and TMA. The other screen is providing wind information for the runway in use. The TWR control observation point is situated at a height of approximately 32 m above ground.

Aircraft sequencing is provided automatically by the Flight Data Processor (FDP) via a strip printer. The strips are generally printed out 20 to 30 minutes prior to the scheduled landing/departure time. If further coordination is needed between tower and approach, it is done over telephone between the respective coordinator/assistant positions.




Picture 4: Tower Layout (Source AET)

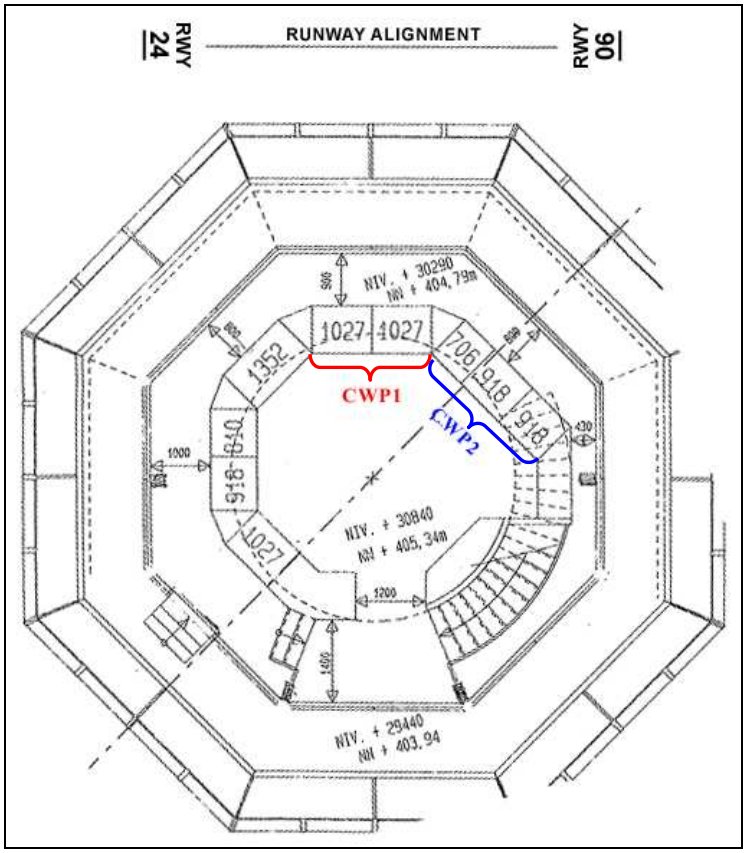


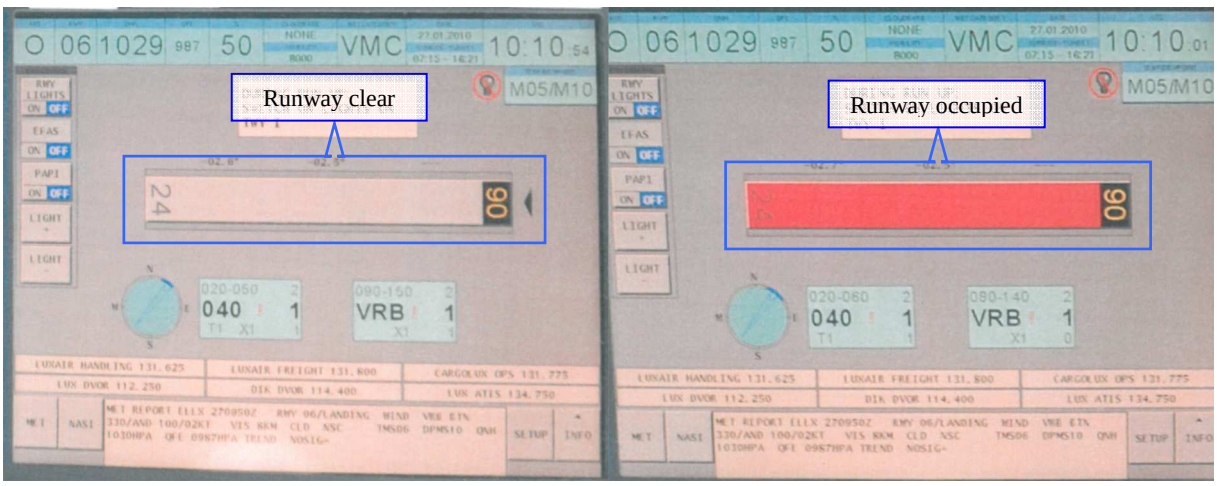
Figure 2: Tower Layout (Source ANA, AET)

### *1.17.2.2 Memorisation aids to mark an occupied RWY*

Both the TWR controller and the TWR coordinator/assistant have three different possibilities at their disposal as memory aids to mark the presence of authorised vehicles or personnel on the runway:

1) Aerodrome Data Display (ADD)

The ADD is available on both tower working positions and provides the ATCO with the possibility to visually mark the runway in red colour by means of manual activation when it is occupied or closed. The ADD can also be monitored in approach control unit, enabling the approach control staff to see the red runway marking when activated.

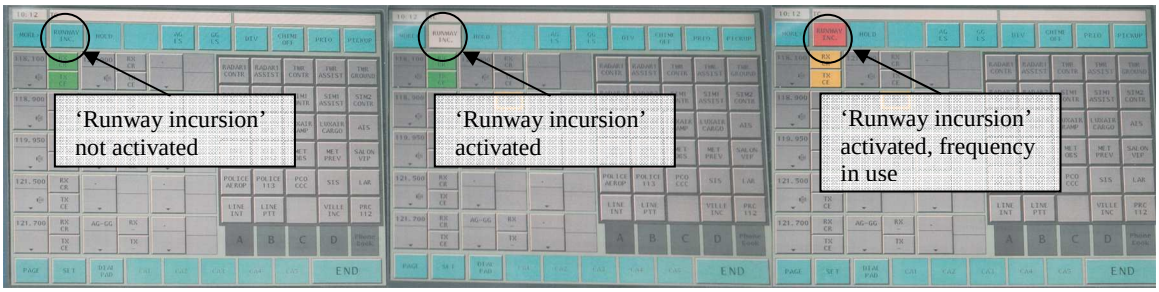


Picture 5: ADD (Source ANA)

The ADD was in an evaluation phase at the time of the occurrence and did not have operational status. The decision whether or not to use the system was left to the ATCO's on duty.

2) Radiotelephony (R/T) System

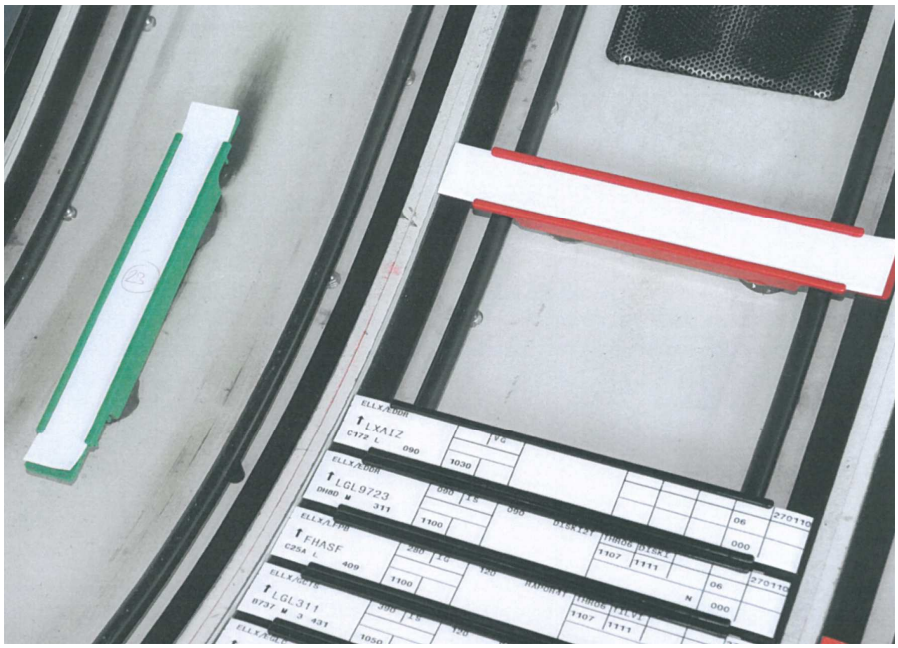
The command and frequency control touch screen of the R/T System on each CWP has a 'runway incursion' button on the upper left side. Upon manual activation of this button by the ATCO operating the CWP, its colour changes from blue to pink. When the selected frequency is used to transmit a communication, the colour of the 'runway incursion' button changes to red and an aural alarm activates on the specific CWP loudspeaker as a reminder that the function is active. It should be noted that the 'runway incursion' function only triggers an alarm for the active frequency on the specific position where it has been activated. This means that when the function is active on CWP2 for ground control frequency 121.9 MHz, a transmission from CWP1 on TWR frequency 118.1 MHz does not trigger the aural alarm.




Picture 6: R/T System (Source ANA)

3) Strip holder

A third memory technique is to mark a red strip holder with the information 'Runway occupied' and place it on the bay, either parallel or perpendicular to the other strips.



Picture 7: Strip Holder (Source ANA)

There were no published instructions in MATS regarding the marking of an occupied runway at the time of the occurrence. It was considered by ANA to be an elementary part of an ATCO's job to ensure that a RWY was unoccupied before issuing a landing clearance to an aircraft. Accordingly, the issue did not require to be addressed in MATS.

### *1.17.2.3 TWR control positions*

#### 1.17.2.3.1 TWR controller

As defined in MATS, the TWR controller is in charge of air traffic in the CTR, manages departures, arrivals, aerodrome circuits and airplane movements on the manoeuvring area and is responsible for flight information service and alerting service. He issues start-up and en-route clearances and monitors the tower frequency 118.1 MHz and the emergency frequency 121.5 MHz.

His function also includes:

a) to take note, at the beginning of his shift, of all relevant changes with regard to procedures, notes and instruction via dedicated information systems. To be familiar with meteorological forecasts and observations relevant to the aerodrome;
b) to ascertain the good working order of installations and equipment through ground verifications and flight crew information;
c) to communicate the latest information regarding the state of the aerodrome to its users and to inform approach control;
d) to disseminate meteorological messages containing information in accordance with MATS provisions;
e) to communicate the slots to the pilots, if necessary;
f) to maintain continuous surveillance of / watch on aerodrome traffic and to ensure its fast and safe expedition;
g) to transmit authorisations/clearances and messages in accordance to procedures and following prevailing phraseology
h) to arrange and amend the flight progression strips correctly on the progression bay;
i) to take all necessary measures in case of a diversion and to inform the appropriate services;
j) to report all occurrences in accordance with national provisions;
k) to report all equipment failures and malfunctions by applying the adequate distribution procedure;
l) between 24:00 and 06:00 local time, to verify together with the approach controller the good working order of the equipment. At 06:00 at the latest, the TWR controller communicates all operational equipment failures to approach.

#### 1.17.2.3.2 TWR coordinator/assistant

The function of the TWR coordinator/assistant described in MATS is to liaise between the TWR controller on one side and approach control or other external services on the other side. Furthermore, he has to monitor and operate the communication on the ground control frequency 121.9 MHz in accordance with the TWR controller instructions. All communications related to movements on the manoeuvring area other than aircraft movements are carried out on ground frequency.

In addition to assist the TWR controller as much as possible, his duties also include:

a) to take note, at the beginning of his shift, of all relevant changes with regard to procedures, notes and instruction via dedicated information systems. To be familiar with meteorological forecasts and observations relevant to the aerodrome;
b) to ensure that the *TWR controller* has all the flight progression strips processed by the computer at his disposal;
c) to prepare the flight progression strips in case of a computer failure;
d) to stock the flight progression strips from his shift in a chronological order;
e) to relay all flight plan or revision information to the TWR controller and adjacent units if necessary;
f) to receive, compile, disseminate and register, when needed, basic ATS information received verbally or in writing;
g) to answer all phone calls, to relay incoming information to the appropriate controller, to eventually pass on the communication to the controller or relay instructions received from him;
h) to process the ATC authorisation inquiry into the computer and to pass the flight progress strip to the TWR controller;
i) to ask the approach coordinator for ATC authorisations in case an FDP system failure and to mark them on the flight progress strips;
j) to execute all ATS instructions upon request of the TWR controller;
k) to report all occurrences in accordance with national provisions;
l) to report all equipment failures and malfunctions by applying the adequate distribution procedure.

#### *1.17.2.4 TWR control shift work*

The TWR controller and the TWR coordinator/assistant working the day shift took their positions at 10:30 UTC. Traffic at the Airport was low, with 5 arrivals and 6 departures between 10:30 UTC and the occurrence at 11:53 UTC.

Shift length on CWP's is usually 5 hours and at mid-shift the TWR controller and TWR coordinator/assistant positions are exchanged between the ATCO's on duty.

Shifts are overlapping in order to have a stand-by crew on hand, ready to relief the ATCO's on-duty, if needed (e.g. after an occurrence, emergency, etc..). After the occurrence, the TWR controller was relieved at 12:55 and the TWR coordinator/assistant at 13:02, both by the afternoon shift.

### 1.17.3 ATC Procedures – MATS

On 20 December 2005, the European Commission adopted the Commission Regulation (EC) No 2096/2005 "*laying down the common requirements for the provision of air navigation services*". One requirement set out in Annex I paragraph 3.3. relates to the operations manuals and states that:

*An air navigation provider shall provide and keep up-to-date operations manuals relating to the provision of its services for the use and guidance of operations personnel. It shall ensure that:*
*a) operations manuals contain instructions and information required by the operations personnel to perform their duties;*
*b) relevant parts of the operations manuals are accessible to the personnel concerned;*

*c) the operations personnel are expeditiously informed of the amendments to the operations manual applying to their duties as well as of their entry into force.*

With reference to the above requirement, the scope of the MATS is defined as follows:

*This document has been compiled to satisfy requirements for the certification of the Luxembourg Airport Administration as air navigation service provider according to Commission Regulation (EC) N° 2096 / 2005 of the Co mmission of 20 December 2005*
*laying down common requirements for the provision of air navigation services.*

The sections from the MATS which are considered to be of relevance to the investigated occurrence are listed hereafter. They address different areas which are being discussed in the analysis section of the report.

MATS SECTION 0
As laid down in *SECTION 0 GENERAL* under *PARAGRAPH 1*, the purpose of the MATS is to provide *"instructions and information for the guidance of air traffic controllers"*. The paragraph continues by stating that:

*Air traffic controllers are required to be familiar with the provisions of this manual. Nothing in this manual prevents an air traffic controller from applying purely local instructions duly issued by the person in charge of a particular ATS unit.*

MATS SECTION 2
Chapter 4 - Control of Traffic
*4.1. Air traffic control clearances*
*4.1.11 Read back of clearances*

*4.1.11.1 The flight crew shall read back to the air traffic controller safety-related parts of ATC clearances and instructions which are transmitted by voice. The following items shall always be read back:*
*a) ATC route clearances;*
*b) clearances and instructions to enter, land on, take off on, hold short of, cross taxi and backtrack on any runway; and*
*c) runway-in-use, altimeter settings, SSR codes, level instructions, heading and speed*
*instructions and, whether issued by the controller or contained in ATIS broadcasts transition levels.*
*Note. – If the level of an aircraft is reported in relation to standard pressure 1 013.2 hPa, the*
*words "FLIGHT LEVEL" precede the level figures. If the level of the aircraft is reported in relation to QNH the figures are followed by the word "FEET".*

*4.1.11.2 Other clearances or instructions, including conditional clearances, shall be read back or acknowledged in a manner to clearly indicate that they have been understood and will be complied with.*

*4.1.11.3 The controller shall listen to the read-back to ascertain that the clearance or instruction has been correctly acknowledged by the flight crew and shall take immediate action to correct any discrepancies revealed by the read-back.*

MATS SECTION 3
Chapter 1 – Approach Control Service
Paragraph 1.3.6 "Information for arriving aircraft" states under 1.3.6.5 that:

*during final approach, the following information shall be transmitted without delay: a) the sudden occurrence of hazards (e.g. unauthorized traffic on the runway)…*

MATS SECTION 3
Chapter 2 - Procedures for Aerodrome Control Service
Paragraph 2.1 "Unit and Objectives*"* sets out the objectives of Aerodrome control service as follows:

*a) prevent collisions between aircraft;*
*b) prevent collisions between aircraft on the manoeuvring area and obstructions on that area;*
*c) expedite and maintain an orderly flow of air traffic.*

Paragraph 2.2 "Functions of Aerodrome Control Towers" describes under 2.2.1.1 that

*Aerodrome control towers shall issue information and clearances to aircraft under their control to achieve a safe, orderly and expeditious flow of air traffic on and in the vicinity of an aerodrome with the object of preventing collision(s) between:*
*a) aircraft flying within the designated area of responsibility of the control tower, including the aerodrome traffic;*
*b) aircraft operating on the manoeuvring area;*
*c) aircraft landing and taking off;*
*d) aircraft and vehicles operating on the manoeuvring area.*

Under 2.2.1.2 the MATS states that:

*TWR controllers shall maintain a continuous watch on all flight operations on and in the vicinity of an aerodrome, as well as vehicles and personnel on the manoeuvring area.*
*Watch shall be maintained by visual observation, augmented in low visibility conditions by radar when available. Traffic shall be controlled in accordance with procedures set forth herein and all applicable traffic rules.*

2.2.1.3 describes the functions that may be performed by different control and working positions as follows:

*- TWR controller, normally responsible for operations on the runway and aircraft flying within an area of responsibility of the aerodrome control tower;*
*- ground controller, normally responsible for traffic on the manoeuvring area with the exception of runways;*
*- clearance delivery position, normally responsible for delivery of start-up and ATC clearances to departing IFR flights.*

Paragraph 2.4.1.3 sets out the scope of "*Essential local traffic information*" as follows:

*2.4.1.3.1 Information on essential local traffic shall be issued in a timely manner, either directly or through the unit providing approach control service when, in the judgement of the TWR controller, such information is necessary in the interests of safety, or when requested by aircraft.*

*2.4.1.3.2 Essential local traffic shall be considered to consist of any aircraft, vehicle or personnel on or near the manoeuvring area or traffic operating in the vicinity of the aerodrome, which may constitute a hazard to the aircraft concerned.*

Paragraph 2.4.1.4 describes the actions to be taken in case of a runway incursion or an obstructed runway:

*2.4.1.4.1 In the event the TWR controller, after a take-off clearance or a landing clearance has been issued, becomes aware of a runway incursion or the imminent occurrence thereof, or the existence of any obstruction on or in close proximity to the runway likely to impair the safety of an aircraft taking off or landing, appropriate action shall be taken as follows:*
*a) cancel the take-off clearance for a departing aircraft;*
*b) instruct a landing aircraft to execute a go-around or missed approach;*
*c) in all cases inform the aircraft of the runway incursion or obstruction and its location in relation to the runway.*

*2.4.1.4.2 Following any occurrence involving an obstruction on the runway or a runway incursion, pilots and controllers shall complete an air traffic incident report in accordance with the ICAO model air traffic incident report form.*

Paragraph 2.5 sets out the essential information on aerodrome conditions as follows:

*2.5.1 Essential information on aerodrome conditions is information necessary to safety in the operation of aircraft, which pertains to the movement area or any facilities usually associated therewith.*

*2.5.2 Essential information on aerodrome conditions shall include information relating to the following:*
*a) construction or maintenance work on, or immediately adjacent to the movement area;*
*…*
*f) other temporary hazards, including parked aircraft and birds on the ground or in the air;*
*…*
*h) any other pertinent information.*

Paragraph 2.6.3.2 sets out the guidelines for control of other than aircraft traffic. With regard to entry to the manoeuvring area, the MATS stipulates:

*2.6.3.2.1.1 The movement of pedestrians or vehicles on the manoeuvring area shall be subject to authorisation by the aerodrome control tower. Persons, including drivers of all vehicles, shall be required to obtain authorisation from the aerodrome control tower before entry to the manoeuvring area. Notwithstanding such an authorisation,*

*entry to a runway or runway strip or change in the operation authorised shall be subject to a further specific authorisation by the aerodrome control tower.*

The communication requirements for other than aircraft traffic are as follows:

*2.6.3.2.3.1 At controlled aerodromes all vehicles employed on the manoeuvring area shall be capable of maintaining two-way radio-communication with the aerodrome control tower, except when the vehicle is only occasionally used on the manoeuvring area and is:*
*a) accompanied by a vehicle with the required communications capability, or*
*b) employed in accordance with a pre-arranged plan established with the aerodrome control tower.*

*2.6.3.2.3.2 When communications by a system of visual signals is deemed to be adequate, or in the case of radio communication failure, the signals given hereunder shall have the meaning indicated therein.*

| *Light signal from aerodrome control* | *Meaning* |
|---|---|
| *Green flashes* | *Permission to cross landing area or to move onto taxiway* |
| *Steady red* | *Stop* |
| *Red flashes* | *Move off the landing area or taxiway and watch out for aircraft* |
| *White flashes* | *Vacate manoeuvring area in accordance with local instruction* |

*2.6.3.2.3.3 In emergency conditions or if the signals in 2.6.3.2.3.2 are not observed the signal given hereunder shall be used for runways or taxiways equipped with a lighting system and shall have the meaning indicated therein.*

| *Light signal from aerodrome control* | *Meaning* |
|---|---|
| *Flashing runway or taxiway lights* | *Vacate the runway and observe the tower for light signal* |

*2.6.3.2.3.4 When employed in accordance with a plan pre-arranged with the aerodrome control tower, constructional and maintenance personnel should not normally be required to be capable of maintaining two-way radio communication with the aerodrome control tower.*

Aerodrome surface and lighting inspections are addressed in paragraph 2.13 as follows:

*2.13.1 Aerodrome inspection are carried out*
*a) in the morning between 05.00 and 06.00h local time*
*b) in the afternoon in co-ordination with the tower controller. Delays to aircraft are to be avoided.*
*In case any object is reported by pilots, the tower controller shall request the fire brigade to remove the object.*

*2.13.2 The aerodrome lighting inspection is done by the responsible department in the morning between 08.00 and 09.30h local time.*

Paragraph 2.14 sets out the responsibilities of the aerodrome authority and the air traffic service unit in case of closure or restricted operation of aerodromes:

*2.14.1 Responsibility of the aerodrome Authority.*
*The aerodrome authority is entirely responsible for :*
*a) decisions regarding closure or re-opening of the aerodrome ;*
*b) withdrawal or return to use of runways (or taxiways) and associated lighting aids;*
*…*
*e) initiating NOTAM action to promulgate changes in serviceability*
*2.14.2 Responsibility of Air Traffic Service Unit.*
*On the occurrence of an incident or accident on the manoeuvring area or apron, or on receipt of a report of any hazard to the movement of aircraft on these areas, the controller should immediately inform the aerodrome authority.*
*Whilst awaiting a decision by this authority he should warn all aircraft intending to use the aerodrome of the nature and position of the obstruction or hazard. During this period pilots will be responsible for deciding whether or not the aerodrome is usable.*
*On receipt of instructions from the Aerodrome Authority (and for as long as the abnormal situation continues) he should pass to aircraft the decision of the authority regarding availability of the aerodrome and provide service accordingly.*
*LUXEMBOURG APP should be informed of any situation which may restrict operations of the aerodrome.*

Paragraph 2.15 defines the provisions for work on the manoeuvring area:

*When repair or installation work is to take place on the manoeuvring area the aerodrome authority will report to aerodrome control tower. The TWR shall brief the person reporting on the following points:*
*- the runway(s) in use and any likely changes;*
*- the area in which vehicles may operate;*
*- methods of obtaining permission to cross the runway-in-use;*
*- signals to indicate that vehicles and personnel must leave the manoeuvring area.*

MATS SECTION 3
Chapter 3 - Special Procedures on the Movement Area
Paragraph 3.2 relates to the access of vehicles to the manoeuvring area as follows:

*3.2.3. Before entering the manoeuvring area a clearance from the aerodrome control tower has to be obtained via radio-communication.*
*…*

*3.2.5 When on the manoeuvring area the following procedures have to be observed:*
*• maintain a two way listening watch on the ground frequency,*
*• follow the instruction of the TWR controller,*
*• if equipped show the anti-collision light on the vehicle,*
*• always give priority to aircraft and use precaution on other vehicles,*
*• inform the tower controller when the manoeuvring area is vacated.*

The provisions regarding the access of vehicles to the ILS sensitive area are laid down in Paragraph 3.4:

*3.4.1 The CAT II-III sensitive area as shown on page 3-51 shall be clear of aircraft and vehicles whenever ILS CAT II - III is in operation. Vehicles from the airport administration are allowed to park on the place marked with an X on the sensitive area map.*

*3.4.2 If necessary the access to the sensitive area is only possible after prior approval from the aerodrome control tower. A two way communication with ATC is mandatory.*

MATS SECTION 3
CHAPTER 5 - LOW VISIBILITY PROCEDURES (LVP)
*5.3. Procedures*
*5.3.1 At the preparation of CAT II and III operation*

*5.3.1.1. The TWR controller*
*• Clears - the sensitive CAT II-III area, as displayed on page 3-51, of vehicle and informs the approach controller when the sensitive area is clear. Cars from the airport administration are permitted to park on the location marked with a (x) on this map.*

*5.3.3.2. The TWR controller*
*• Clears aircraft off the runway at intersections C, D2, E or at the end;*

*5.3.4. ILS Critical and Sensitive areas protection*

*5.3.4.2. No vehicle (except those parked on authorised places) or aircraft (except L class aircraft between private area and B2) shall be permitted to infringe the ILS sensitive area from the time:*
*• when an arriving aircraft is 2 NM from touchdown until it has completed its landing run.*
*This means that no landing clearance must be issued and a go-around shall be initiated by the controller if the ILS critical or sensitive area is known to be infringed.*

MATS SECTION 6
Chapter 4 PHRASEOLOGIES
4.1. Communications Procedures.

*The communications procedures shall be in accordance with MATS 6. Ch.2 and pilots, ATS personnel and other ground personnel shall be thoroughly familiar with the radiotelephony procedures contained therein.*

4.2. General.
Note Requirements for read back of clearances and safety related information are provided in MATS 2 Chapter 4 § 4.1.11.

*4.2.1. Most phraseologies contained in the present Chapter show the text of a complete message without call signs. They are not intended to be exhaustive and when circumstances differ, pilots, ATS personnel and other ground personnel will be expected to use appropriate subsidiary phraseologies which should be as clear and concise as possible, to the level specified in the ICAO language proficiency requirements (Annex 1) in order to avoid possible confusion by those persons using a language other than one of their national languages.*

*4.2.2 The phraseologies are grouped according to types of air traffic service for convenience of reference. However, users shall be familiar with, and use as necessary, phraseologies from groups other than those referring specifically to the type of air traffic service being provided. All phraseologies shall be used in conjunction with call signs (aircraft, ground vehicle, ATC or other) as appropriate. In order that the phraseologies listed should be readily discernible in this Chapter, call signs have been omitted.*
*4.2.3. The § 4.3 of this section includes phrases for use by pilots, ATS personnel and other ground personnel.*
*4.2.4. Phraseologies for the movement of vehicles, other than tow tractors, on the manoeuvring area shall be the same as those used for the movement of aircraft, with the exception of taxi instructions, in which case the word "PROCEED" shall be substituted for the word "TAXI" when communicating with vehicles.*
*4.2.5. Conditional phrase, such as "behind landing aircraft" or "after departing aircraft", shall not be used for movements affecting the active runway(s), except when the aircraft or vehicles concerned are seen by the appropriate controller and pilot. The aircraft or vehicle causing the condition in the clearance issued shall be the first aircraft / vehicle to pass in front of the other aircraft. In all cases a conditional clearance shall be given in the following order and consist of:*

*i) identification*
*ii) the condition (specify)*
*iii) the clearance; and*
*iv) brief reiteration of the condition;*

MATS SECTION 9
Chapter 1 SERVICE D'ALERTE - CAS D'URGENCE - ACCIDENTS - INCIDENTS
Para. 1.2.6 of the MATS on an '*incident with an aircraft on ground'* describes the following procedure:

1. *activate the siren (for 5 seconds)*
2. *alert the SIS and provide them with the following information:*
    a. *type and position of aircraft*
    b. *type of incident*
    c. *number of passengers (if known)*
    d. *type of freight (if known)*
    e. *fuel quantity on board (if known)*
3. *alert APP*
4. *alert OPS indicating whether or not the aerodrome has to be closed to traffic*
5. *on order from the SIS leader, alert EMS and provide them with information under 2.a and 2.c*
6. *on order from the SIS leader, ask assistance from the stand-by crew through OPS file an incident report.*

## 1.17.4 Procedure on Luxembourg Language Phraseology

The procedure P-ATC-002 on Luxembourg Language Proficiency has been released by ANA in September 2009:

*Following a runway incursion incident investigation, the proposed remedial action and in addition to Avis ATC 07/2007, the following luxembourgish phraseology shall be used by ATCOs with luxembourg-only-speaking personnel involved in*

*ground operations associated with taxiways and runway.*
*a) instruction to drive to a holding point*
*"<callsign> Proceed to holding point runway 06 (24)"*
*shall be translated as*
*"<callsign> Fuhr ob den Haltepunkt Cap 06 (24)"*
*"<callsign> Proceed to holding point taxiway xx"*
*shall be translated as*
*"<callsign> Fuhr ob den Haltepunkt Taxiway xx"*
*The instruction implies that drivers must stop on the taxiway at the runway holding point.*
*b) instruction to enter the runway*
*"<callsign> Enter (cross) runway 06 (24)"*
*shall be translated as*
*"<callsign> kann elo ob (iwer) d'Piste fuhren"*
*It is important that drivers readback all the instructions they receive, including their callsigns. If there is any doubt about a received instruction, drivers shall ask for clarification.*

### 1.17.5 Low visibility procedures (LVP)

As published in the AIP and laid down in the MATS, the criteria for LVP's to become operative are an RVR falling below 800 meters or a ceiling/vertical visibility at or below 200 feet. Preceding the initiation of LVP's is a preparation phase which starts when the visibility drops below 1500 meters and/or ceiling is at or below 300 ft, with further deteriorating weather expected.

With LVP in operation, inbound traffic will be vectored to intercept the ILS at least 10 NM from the runway

Low visibility procedures were in operation the day of the occurrence, with an RVR of 350/250/350 meters at the time of the occurrence.

### 1.17.6 Common practice for vehicles to access the manoeuvring area

Access to the manoeuvring area was commonly granted by aerodrome control tower on an ON/OFF basis. A vehicle requesting entry to the manoeuvring area was required to call TWR on ground control frequency 121,9 MHz and ask for permission to drive onto the RWY or taxiways. Further information with regard to the type of intervention was not required. Based on the traffic situation, the TWR controller decided whether or not access was granted to the enquiring vehicle. When permission to drive on the manoeuvring area was granted, the vehicle was required to maintain a listening watch on ground control frequency and leave the manoeuvring area immediately when instructed to do so by the TWR coordinator/assistant. For each subsequent entry to the manoeuvring area, a new call on ground control frequency was required.

### 1.17.7 ICAO provisions on Air Traffic Services and Aerodromes

ICAO has issued a number of documents related to Air Traffic Services and aerodromes. In addition to the Annexes 11 and 14, ICAO published other supporting documentation which provides valuable guidance and recommendations to achieve a high level of operational safety.

### *1.17.7.1 ICAO Annex 11 – Air Traffic Services*

*3.8 Control of persons and vehicles at aerodromes*

*3.8.2 In conditions where low visibility procedures are in operation:*
*a) persons and vehicles operating on the manoeuvring area of an aerodrome shall be restricted to the essential minimum, and particular regard shall be given to the requirements to protect the ILS/MLS sensitive area(s) when Category II or Category III precision instrument operations are in progress;*
*…*

*3.10 Use of surface movement radar (SMR)*

*Recommendation.— In the absence of visual observation of all or part of the manoeuvring area or to supplement visual observation, surface movement radar (SMR) provided in accordance with the provisions of Annex 14, Volume I, or other suitable surveillance equipment, should be utilized to:*
*a) monitor the movement of aircraft and vehicles on the manoeuvring area;*
*b) provide directional information to pilots and vehicle drivers as necessary; and*
*c) provide advice and assistance for the safe and efficient movement of aircraft and vehicles on the manoeuvring area*.

### *1.17.7.2 ICAO Annex 14 – Aerodromes; Volume 1*

*9.8 Surface movement guidance and control systems*

*9.8.5 Recommendation.— The system should be designed to assist in the prevention of collisions between aircraft, and between aircraft and vehicles or objects, on any part of the movement area.*
*…*
*9.8.7 Recommendation.— Surface movement radar for the manoeuvring area should be provided at an aerodrome intended for use in runway visual range conditions less than a value of 350 m.*

### *1.17.7.3 Manual on the Prevention of Runway Incursions (ICAO Doc 9870, AN/463)*

ICAO has published a manual on the specific topic of runway incursions and included a chapter with recommendations aimed at reducing/mitigating the risk of such an occurrence. While an implementation is not mandatory, the recommendations contained in the manual constitute nevertheless valuable guidelines to prevent unsafe conditions. The following recommendations from Chapter 4 of the ICAO Manual on the Prevention of Runway Excursions are considered to be relevant to this investigation:

*Chapter 4*
*RECOMMENDATIONS FOR THE PREVENTION OF RUNWAY INCURSIONS*
*4.2 COMMUNICATIONS*

*4.2.2 Standard ICAO phraseologies should be used in all communications associated with runway operations*

*4.2.4 The read-back procedures in the 'Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM, Doc 4444)' should be used and should include communications with vehicles operating on the manoeuvring area.*

*4.2.5 All communications associated with runway operations should be conducted in accordance with ICAO language requirements for air-ground radiotelephony communications (Annex 10 – Aeronautical Telecommunications, Volume II, Chapter 5, and Annex 1 – Personnel Licensing, Chapter 1 and Appendix 1, refer). The use of standard aviation English at international aerodromes will improve the situational awareness of everyone listening on the frequency.*

*4.2.6 All communications associated with the operation of each runway (vehicles, crossing aircraft, etc.) should be conducted on the same frequency as utilized for the take-off and landing of aircraft.*

*4.5 AIR TRAFFIC SERVICE PROVIDERS AND AIR TRAFFIC CONTROLLERS*

*4.5.2 ATC should always use a clear and unambiguous method on the operating console to indicate that a runway is temporarily obstructed.*

*4.6 AERODROME OPERATORS AND VEHICLE DRIVERS*

*4.6.4 During construction or maintenance, information about temporary work areas should be adequately disseminated and temporary signs and markings should be clearly visible, adequate and unambiguous in all operating conditions, in compliance with Annex 14 provisions.*

*4.9 AERONAUTICAL INFORMATION*

*4.9.1 Time-critical aerodrome information that may affect operations on or near the runway should be provided to pilots in "real time" using radiotelephony communications.*

### 1.17.8 European Action Plan for the Prevention of Runway Incursions (EAPPRI)

A joint runway safety initiative, launched in 2001 by the Group of Aerodromes Safety Regulators (GASR), the Joint Aviation Authorities (JAA), ICAO and Eurocontrol, resulted in the '*European Action Plan for the Prevention of Runway Incursions (EAPPRI)*' which contains a number of recommendations divided into different areas.

The following recommendations from the EAPPRI are considered to be relevant in the context of this investigation:

4.3 Communications

…
*4.3.2 Verify the use of standard ICAO RT phraseologies*
*4.3.3 Use the ICAO read-back procedure (including Drivers and other personnel who operate on the manoeuvring area).*
*4.3.4 Improve situational awareness, when practicable, by conducting all communications associated with runway operations using aviation English.*
*4.3.5 Improve situational awareness, when practicable, by conducting all communications associated with runway operations on a common frequency.*

4.8 Aeronautical Information Management

*4.8.1 Significant aerodrome information which may affect operations on or near the runway should be provided to pilots 'real-time' using radio communication.*

## 1.17.9 Ground operations

### *1.17.9.1 ELE Department*

The ELE Department's main tasks are:

- to ensure the distribution and availability of electric energy within the premises of Luxembourg Airport;
- to ensure the maintenance of all aeronautical ground lights, cabling, etc.;
- to operate and maintain the Airport telephone system.

At the time of the occurrence, the ELE Department had a permanent staff of 7 operators. 2 operators were on sick leave due to a previous incident causing combustion of accumulated gas during maintenance work on the runway centreline lights. There was only one crew of two operators available for routine maintenance.

### *1.17.9.2 Runway Centreline Lighting Problems*

The background history of the maintenance task performed by the ELE Department at the time of the occurrence was a recurring problem with the type of lights installed on the runway centreline. In the month prior to the occurrence, several incidents related to the centreline lights occurred during maintenance.

In August 2009, a runway centreline light was ejected from its base due to an explosion caused by the infiltration of hydrocarbon into the base and an insulation defect in the electrical high voltage supply.

In October 2009, a technician from the ELE Department suffered a light electrocution while working on a runway centreline light, despite the fact that the primary power supply was disconnected.

After these two incidents, ANA called in a meeting with the equipment manufacturer in order to identify the risks related to the recurring problem with the centreline lights and to find a solution to it. Two main risk factors were identified at that meeting:

- Potentially lethal electrocution with high voltage equipment;
- Foreign object damage caused by ejected lighting parts during an explosion.

In the light of the results from the meeting, ANA decided to take the following corrective actions:

- Clean the bases of the runway centreline lights, verify their threads and lock (tighten) the lights;
- Insulate the secondary circuit;
- Replace the type of runway centreline lighting in use by another one with better electrical insulation and improved water tightness.

On 19 January 2010, during preventive maintenance on a runway centreline light, gas combustion occurred, causing temporary hearing perturbations to the maintenance personnel working on site. At that time, 114 out of the 161 trouble-prone lights had already been replaced.

That latest incident led ANA, in coordination with the Quality and Safety Managers, to give top priority to the replacement of the remaining 47 lights, without however hampering air traffic.

#### *1.17.9.3 Preventive maintenance work*

The replacement of the runway centreline lights was an ongoing process. With the temperature falling below 5° Celsius – the minimum operational temperature to install the new lights – the remaining 47 lights had to be cleaned on a regular basis to avoid the accumulation of gas and a possible explosion. The day of the occurrence, the crew of ELE 23 was scheduled to check and clean the runway centreline lights.

On 21 January 2010, prior to the occurrence, ELE 23 had already entered the runway once during the morning, but due to air traffic, they had to vacate the runway before finishing the task.

The collision between CLX 793 and ELE 23 took place in the touchdown zone on RWY 24 at approximately 341 m from the threshold. Immediately after the collision, the maintenance crew of ELE 23 drove the van off the runway to a service road outside the sensitive area.

## *1.18 Additional information*

### 1.18.1 Statements of the TWR control staff

Shortly after the occurrence, both the TWR controller and the TWR coordinator/assistant, accompanied by a legal counsel, were interviewed by DAC. The transcripts have been made available to AET for the purpose of the investigation. Several months later, AET also conducted interviews with the TWR control staff. The following relevant information comes from both sources.

#### *1.18.1.1 TWR controller*

The TWR controller stated that during the shift handover, he did not get any information with regard to the nature and the duration of the planned maintenance work on the centreline lights. In a more general context, he knew that due to an

explosion of a centreline light during maintenance, the electricians would proceed with the replacement of those lights.

On the day of the occurrence, ELE 23 was granted access to the RWY by the TWR coordinator/assistant after prior coordination with the TWR controller. The TWR controller said that he did not know the reason why ELE 23 asked to drive onto the RWY, nor did he know how long they intended to stay there.

The TWR controller remembers instructing the TWR coordinator/assistant to get ELE 23 off the RWY when CLX 793 was still 16 to 18 miles from the airport. He then heard a noise similar to one coming from a portable transceiver and interpreted that noise as a confirmation by ELE 23 that the sensitive area was vacated. At that time, there was also noise from an incoming telephone call.

The TWR controller further indicated that ELE 23 was usually operated by a specific crew which used to monitor both the ground control frequency and the TWR frequency when working on the runway. This simultaneous monitoring of two frequencies allowed them to react proactively to incoming traffic and vacate the RWY before necessarily being asked to do so by TWR. According to the TWR controller, this routine made him and the TWR coordinator/assistant believe that the return signal received in the TWR was an acknowledgement by ELE 23 that the RWY was vacated.

### *1.18.1.2 TWR coordinator/assistant*

The TWR coordinator/assistant said that he was informed during the shift handover of a possible intervention on the RWY, without however receiving information on the type and duration of the works to be carried out.

Usually, during CAT III operations no vehicle would be allowed in the sensitive area as it could deviate the ILS signals. After coordination with the TWR controller, ELE 23 was allowed to enter the RWY because there was no traffic at that moment. The TWR coordinator/assistant stated that he then activated the ‘runway incursion’ function on the R/T system console and marked the presence of the van on a strip.

When the TWR coordinator/assistant saw the inbound aircraft on the radar screen, he instructed ELE 23 to vacate the RWY. He then heard a noise, an audio signal on the frequency, and thought it was ELE 23 leaving the RWY. This assumption was also confirmed by the TWR controller. The TWR coordinator/assistant was then distracted by an incoming telephone call which he answered.

When the TWR coordinator/assistant transmitted on the ground control frequency for the first time after the occurrence, he was astonished to hear the audio alarm indicating that the ‘runway incursion’ function on the R/T system was still activated.

The TWR coordinator/assistant remembered noticing that when he pushed the PTT switch on the microphone on his working position, he heard two distinct ‘clicks’. The first ‘click’ was heard when the switch was being pushed down while a second ‘click’ was noticed when the switch was fully down. However, a communication was only transmitted in the ‘full down’ position. This malfunction made him think that his earlier instruction to ELE 23 to vacate the RWY might not have been transmitted if the PTT switch was not working correctly.

## 1.18.2 Advanced Surface Movement Guidance and Control System (A-SMGCS)

The objective of A-SMGCS is to provide the controller with information regarding the position of all known traffic and obstacles in a defined area on the ground. The system incorporates a primary non-cooperative surveillance sensor (e.g. SMR) and a secondary cooperative surveillance sensor (e.g. SSR, MLAT) which automatically and continuously transmits data, including identification, to the system. Known traffic identification (aircraft and vehicles) is achieved through the correlation of call signs with their corresponding targets on the system display.

Eurocontrol has defined four A-SMGCS implementation levels. Levels 1 and 2 have reached a mature status while Levels 3 and 4 are under development. Level 1 provides positive identification of aircraft on the movement area and vehicles on the manoeuvring area, while Level 2 adds an active defense by providing an alerting function for the infringement of runways and other pre-defined protection areas.

In 2010, ANA made a tender for the implementation of an A-SMGCS Level II at Luxembourg Airport. On 2 July 2010, a notice was published in the OJEU with a pre-qualification questionnaire available to candidates on request for a restricted tender. An invitation to tender was issued to qualified candidates on 4 October 2010 and the contract award was scheduled for 31 January 2011. However, for procedural reasons, the contract has not yet been awarded and the implementation has been put on hold.

## 1.18.3 Corrective actions taken after the occurrence

### *1.18.3.1 DAC Safety Orders*

The day of the occurrence, DAC issued the urgent safety order ('*consigne de sécurité*') nr 1-2010 to ANA, based on the results of their preliminary investigation. The content of safety order nr 1-2010 reads as follows:

- *no person and no vehicle, whose presence on the manoeuvring area or on the ILS sensitive area is not indispensable for runway operations, especially no maintenance crew, shall be authorised to enter or stay on the manoeuvring area or the ILS sensitive area during operations in CAT II/III meteorological conditions;*
- *in case of uncertainty regarding the presence of a vehicle or a person on the manoeuvring area or the ILS sensitive area, the air traffic controller shall immediately suspend all landing or take-off operations until positive confirmation that the runway is unobstructed;*
- *if the operational conditions require the intervention of a vehicle or the penetration of personnel on the manoeuvring area for an extended period of time, the runway shall be closed to all air traffic until positive confirmation that the vehicle or personnel have left those areas;*
- *all vehicles authorised to penetrate or to drive on the manoeuvring area shall maintain permanent radio contact with the aerodrome control tower on the ground control frequency.*

An additional urgent safety order (nr 03-2010 – modified) related to LVP was issued on 10 February 2010 and reads as follows:

*After notification of CAT II/III conditions by ATC service and as long as an aircraft is moving on the taxiways or the aprons, an additional aircraft shall not be authorised to taxi on the taxiways or the aprons as long as the preceding aircraft has not reached its parking position an the apron, respectively has not reached its holding point for the active runway.*

*In addition, the use of the taxiways for a 'push-back' shall not be authorised anymore.*

*The APP/TWR coordination necessary for the correct application of the present order shall be done in accordance with order nr 3 – 2008 from 15 January 2008, stating: ANA shall establish as soon as possible a coordination procedure, validated by a safety assessment, operational 24 hrs a day and 7 days a week, to be submitted to DAC for approval.*

It should be noted that the above safety order nr '03-2010 – modified' is not directly related to the investigated occurrence as it does not address runway operations. It rather deals with a more general concern of situational awareness during taxiway and apron operations in low visibility conditions.

### *1.18.3.2 ANA*

#### 1.18.3.2.1 Amendments to MATS

In 2010, ANA amended MATS Section 3, Chapter 3, para. 3.4. *'Access of vehicles to RWY and ILS sensitive area in LVP'.* The amendment restricts the access of vehicles to the sensitive area during LVP and defines the cases in which specific tasks can be considered after declaring the operational need and coordinating with aerodrome control tower in advance. Furthermore the amendment mandates the marking by the aerodrome controller of vehicles granted access to RWY and sensitive area by:

- *'introducing the 'RWY BLOCKED' strip holder on the active board;*
- *switching the 'RWY incursion' alarm function on VCS;*
- *tapping 'RWY blocked' visual aid on ADD.'*

Further to this amendment, extensive work on the review and reorganisation of MATS has brought about a new version in 2012 which is easier to consult by and readily available to ATCO's on duty.

#### 1.18.3.2.2 ELE Department

After the occurrence, an action plan aimed at improving safety and effectiveness of the ELE Department was set up and provisions were taken by ANA to engage external workforce on request to complement the ELE staff and carry out maintenance work at all times, including night hours. In addition, the operational staff of the ELE department has been increased.

## *1.19 Useful or effective investigation techniques*

### 1.19.1 System Occurrence Analysis Method (SOAM)

The ‘System Occurrence Analysis Method (SOAM)’, based on the Reason Model of organisational accidents, was specifically developed to assess ATM related events. It has been used in the investigation process to analyse the collected data and identify those factors and failed/missing barriers which are in direct relation to the event (Appendix B).

Guidance for the application of SOAM has been provided in the following Eurocontrol documents:

- EAM 2 / GUI 8 Guidelines on the Systemic Occurrence Analysis Methodology (SOAM);
- Systemic Occurrence Analysis Method – Quick Reference Guide.

# 2. ANALYSIS

## *2.1 Elements related directly to the event*

### 2.1.1 Standard phraseology procedures

Aerodrome control tower was operated by a control staff of two, one TWR controller and one TWR coordinator/assistant. At 11:33:08, when ELE 23 called TWR coordinator/assistant on ground control frequency and requested to enter the runway, the workload of both the TWR controller and the TWR coordinator/assistant was low. There has been no communication on ground control frequency for over 30 minutes and the last communication on tower frequency was at 11:26:10, almost 7 minutes before the request of ELE 23 to drive onto the runway. After clearing ELE 23 to enter the runway, the first activity on ground control frequency was a high pitch noise at 11:55:21 followed by a call from ELE 23 at 11:55:26 which was also accompanied by high pitch noise. The first communication on tower frequency was after more than 7 minutes at 11:40:12.

According to the TWR controller and the TWR coordinator/assistant, ELE 23 was instructed to vacate the runway while the inbound aircraft was 16 to 18 NM from the airport. Based on an average approach speed of around 150 kts, this would have been approximately 6 to 8 minutes prior to touchdown. However, the ATC recordings show no trace of a communication during that specific period of time. In fact, after the TWR coordinator/assistant cleared ELE 23 to drive onto the runway at 11:33:24, no communication was recorded on ground control frequency until after the occurrence, when at 11:55:26 ELE 23 called TWR (Rec LU-AC-2012/001).

When the TWR controller cleared the approaching Cargolux aircraft to land, it is reasonable to assume that he thought the runway was clear of obstacles and the sensitive area was unobstructed. In the prevailing weather conditions, the tower control staff had no possibility to maintain visual contact with the van. The area where the preventive maintenance was carried out was beyond the visual range of around 350 meters in the touchdown zone and 225 meters midpoint at the time of occurrence. The position of the van was approximately 341 meters from the threshold of RWY 24 and 1900 meters from the control tower. The only way of maintaining situational awareness was through appropriate R/T communications in accordance with operational procedures, supplemented by adequate memorisation aids.

According to procedures for ground communications with Luxembourg-only-speaking personnel and as observed in other communications on ground control frequency, at least four radio calls between TWR and ELE 23 should have been necessary to vacate the runway:

- a first call by TWR to instruct the ELE 23 to leave the RWY and clear the sensitive area;
- a read-back by ELE 23 of the TWR instruction;
- a third call by ELE 23 to confirm that the sensitive area was clear;
- a final fourth call by TWR to acknowledge.

The TWR controller stated that he was used to ELE 23 being operated by a crew which maintained a listening watch on both the ground control and TWR frequency and which reacted proactively to upcoming traffic by vacating the sensitive area

before being asked to do so. Subsequently, the number of required communications would be less than the mentioned four communications.

It should be pointed out that at the time of the presumed instruction to ELE 23 to leave the sensitive area, CLX 793 was still on APP frequency and first contacted TWR on 118.1 MHz at 11:51:40 after being established on the ILS.

Accepting a 'carrier wave' type signal as a confirmation that ELE 23 had vacated the runway and not requiring a proper read-back of the given instruction can be qualified as inappropriate, especially with LVP in force and no visual contact with the van. In low visibility weather conditions and without the augmentation capabilities of an ATS surveillance system, the primary control and surveillance means are procedural. The use of standardized voice communications between tower and ground operators (aircraft, vehicles, personnel, etc.) provides a safety barrier on the ATC side to prevent an unsafe condition. In the present case, not applying standard phraseology to confirm that the runway was effectively vacated rendered that safety barrier ineffective and the lack of additional 'engineered' defences (e.g. rec. LU-AC-2012/003) or 'soft' (e.g. rec. LU-AC-2012/004) defences opened the way to an unsafe condition. The fact that traffic was light and that the induced level of stress was low at that time may have contributed to a lack of attention with regard to phraseology procedures. To ensure a high level of compliance to phraseology procedures, AET issues recommendation **LU-AC-2012/001** to ANA.

The statements of the the TWR controller and the TWR coordinator/assistant regarding the instruction to ELE 23 to vacate the runway could not be corroborated by the evidence available to the investigation. It was not possible to objectively determine the course of events in the aerodrome control tower between the time ELE 23 was authorised to enter the runway and the time of the occurrence. The missing information relates mainly to the communication and co-ordination between the TWR controller and the TWR assistant/coordinator. In this context, it should be noted that ICAO Annex 11 contains a recommendation on recording devices for background communication and aural environment at air traffic controller work stations, which, had it been implemented at Luxembourg Airport, would have provided valuable factual information for the safety investigation. In order to enable an effective safety investigation of ATC related events, AET issues recommendation **LU-AC-2012/002** to ANA.

### 2.1.2 Ground traffic control and surveillance

#### *2.1.2.1 ATC perspective*

In low visibility operations, it can be impossible for the TWR control staff to maintain continuous watch by visual observation without the assistance of supplementary ground traffic control and surveillance equipment, such as an Advanced Surface Movement Guidance and Control System (A-SMGCS). A-SMGCS improves situational awareness by adding identification to known traffic and detecting potential intruders, typically through the SMR component of the system. Depending on the level of implementation, A-SMGCS can be a key element in the prevention of runway incursions. While a Level 1 implementation enables the identification and positioning of the different operators on the manoeuvring area, a Level 2 implementation adds an active defence to the system, alerting the controller of an arising unsafe condition. In the investigated case, an A-SMGCS Level 2 implementation at Luxembourg

Airport could have alerted the TWR controller of a potential unsafe condition, enabling him to take corrective actions.

Although a tender for the implementation of an A-SMGCS Level 2 at Luxembourg Airport has been published in 2010, the contract has not yet been awarded and the implementation process is still on hold. In order to stress the importance to provide aerodrome control tower with augmented ground traffic control and surveillance means, especially but not exclusively during LVO, AET addresses the recommendation **LU-AC-2012/003** to ANA.

### *2.1.2.2 Flight crew perspective*

CLX 793 was inbound to Luxembourg airport on a Cat III(b) auto-land approach in low visibility conditions. At 11:51:54, CLX 793 was cleared to land and continued its approach, while the crew were carrying out their respective duties according to company procedures. The RVR in the touchdown zone was 350 meters and decreasing. Shortly before landing, the pilot saw a vehicle in the touchdown zone and at approximately 11:53:47, the right hand body landing gear collided with the roof of the van on the runway. The flight crew did not notice the impact with the van and continued the flight to a successful landing at 11:53:51. Data from the QAR did not show any significant deviations from normal operation from flare to touch down.

The van was positioned at approximately 341 meters from the runway threshold and the aircraft had a groundspeed of approximately 150 kts (= 77 m/s) when crossing the threshold until shortly before touchdown. The horizontal distance travelled by the airplane over which the car could be seen was about 314 meters. Based on those numbers, the PF had an estimated 4 seconds to see the obstacle on the runway and to decide whether or not to take avoiding actions. The collision occurred half a second later. It should be noted that runway lights in the touchdown zone were at high intensity due to the prevailing fog, which made it more difficult for the pilot to identify any obstacle on the runway. Furthermore, when the pilot went head up during final approach, he was looking out for expected visual cues, not the unexpected presence of a runway obstruction.

In a conversation with the PM during taxi to the parking position, the PF mentioned that a go-around briefly flashed through his mind when he saw the car on the runway. The PF stated in the occurrence report that he saw the van in the touchdown zone for the first time after calling out ‘landing’ at 17 ft radar altitude. Initiating a go-around at that point would have resulted in an approximate altitude loss of 17 ft (= DH), accounting for the spool-up time of the engines and the subsequent recovery of a positive ROC. The roof of the van being situated 8 ft above the runway (nil runway slope on that portion), a collision with the van could not have been avoided. The landing sequence is illustrated in Figure 3.

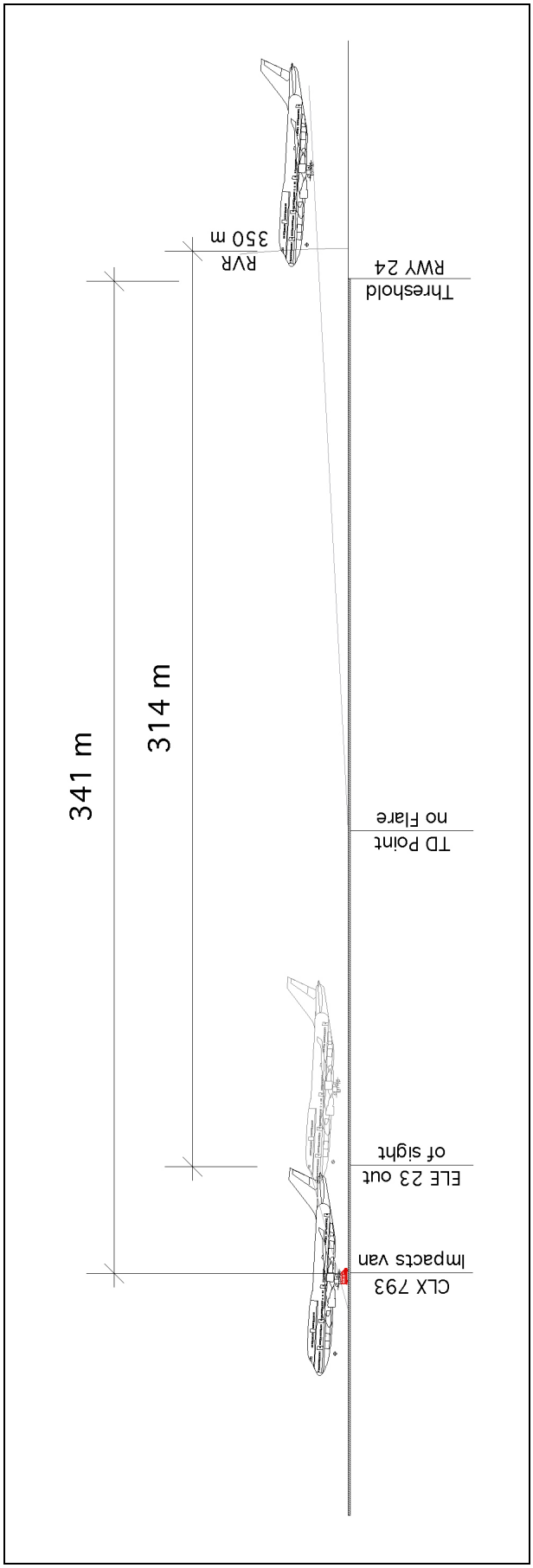



Figure 3: Landing Sequence: Source Boeing, VW, AET

## 2.1.3 Aerodrome control tower

### *2.1.3.1 Runway management*

The manoeuvring area is defined in ICAO Annex 11 as *'That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons'.* The manoeuvring area can be divided in 2 parts, one part consisting of the runway and the other part representing the taxiways.

The TWR controller is responsible, among other tasks, for all air traffic on the manoeuvring area and he issues start-up and en-route clearances. He monitors and operates the tower frequency 118.1 MHz and the emergency frequency 121.5 MHz. The TWR coordinator/assistant handles all traffic on the manoeuvring area other than air traffic, in accordance with the instructions by the TWR controller and he operates and monitors the ground control frequency 121.9 MHz.

The described runway management implies that communication between TWR and air traffic on the manoeuvring area is carried out on a different frequency than other ground traffic (vehicles/personnel) possibly operating on the same part on the manoeuvring area. The use of different channels creates two separate communication loops which have to be coordinated between the TWR controller and his coordinator/assistant in order to exchange relevant traffic information and disseminate it on the respective frequency to all traffic on the manoeuvring area to maintain an adequate level of situational awareness. In this configuration, the human involvement plays a major role in the co-ordination process and essential information can easily be lost in case of a communication breakdown..

The EAPPRI contains a recommendation in the 'Communications' section on the use of a common frequency for runway operations, which has also been adopted by ICAO. The ICAO 'Manual on the Prevention of Runway Incursions' (ICAO Doc 9870, AN/463) provides guidance for the implementation of runway safety programmes aiming to reduce the risk of runway incursions. One of the recommendations in Chapter 4, paragraph 4.2.6 states that '*all communications associated with the operation of each runway (vehicles, crossing aircraft, etc.) should be conducted on the same frequency as utilized for the take-off and landing of aircraft.'*

In the investigated case, ELE23 first contacted TWR unit on ground control frequency 121.9 MHz at 11:33:15. CLX 793 had the first contact on TWR frequency 118.1 MHz at 11:51:40 and received the landing clearance at 11:51:54. If all communications related to runway operations had been on the same frequency, it is likely that the ELE23 maintenance crew would have heard the communications between TWR and CLX 793, as they were to maintain a listening watch on the assigned frequency. Hearing the information that an aircraft was on final approach and subsequently cleared to land, the ELE23 maintenance crew would have been able to take avoiding action to prevent an unsafe condition, by informing TWR of their presence on the runway and/or by rapidly vacating the runway and leaving the sensitive area.

Communicating on the same frequency increases the situational awareness for all operators on the same part of the manoeuvring area by providing first hand access to all information transmitted on that frequency. Eurocontrol conducted five studies in 2008 *'relating to different runway management techniques to explore their impact on RT frequency loading, safety and capacity'*. One of those studies titled *'Study Area 442 - Airside Vehicle Drivers use the AIR Frequency when Entering or Crossing a*

*Runway'* concluded that, while R/T loading on the frequency was increased due to the additional ground traffic on the air frequency, the need for coordination between the ground and the air controller was significantly reduced. The safety benefits identified by the participating ATCO's in the simulation were:

- o *'The potential for errors in co-ordination between GMC-AIR Controllers was significantly reduced.*
- o *The situational awareness of both the AIR and GMC Controller was significantly increased.*
- o *Situational awareness of Pilots is improved regarding Tugs and vehicles crossing or operating on the runway.*
- o *Situational awareness of Tug and vehicle Drivers is improved regarding aircraft on approach, crossing or taking-off.'*

Although the above mentioned study refers to two separate controllers (ground and air), the need for coordination regarding air and ground traffic is comparable to the situation between the TWR controller and the TWR coordinator/assistant at Luxembourg Airport.

If all traffic operating on the runway should use the same frequency to increase situational awareness, the same argument can, for the specific situation at Luxembourg Airport, also be used for traffic on the taxiways. Assigning a designated frequency to all traffic on the taxiways should have the same benefit with regard to an increased situational awareness. To increase situational awareness for all operators on the manoeuvring area, AET issues the recommendation **LU-AC-2012/004** to ANA.

Current practice at Luxembourg Airport is that all communications on air frequencies TWR-118.1 MHz and APP-118.9 MHz are conducted in standard aviation English while the communications on ground control frequency 121.9 MHz are carried out mainly in Luxembourgish. It should however be noted that a pre-requisite to achieve the goal of recommendation LU-AC-2012/004 is that all communications conducted on a frequency should be in the same language and up to a common standard to ensure that everybody operating on the frequency understands the communications. ICAO and EAPPRI both issued recommendations related to the use of aviation English for all operations associated with RWY operations. In this context, AET issues recommendation **LU-AC-2012/005** to ANA**.**

### *2.1.3.2 Work procedures in low visibility operations*

At 11:33:15 ELE 23 contacted tower and asked if they could drive onto the taxiways and the runway. At 11:33:23, the TWR coordinator/assistant replied that they could drive directly onto the runway. ELE 23 acknowledged and entered the runway to carry out preventive maintenance work.

MATS Chapter 3 para. 3.4.2 states that '*if necessary the access to the sensitive area is only possible after prior approval from the aerodrome control tower*.' The initial request from ELE 23 to access the runway did not contain any specific information related to the type of intervention or an expected time in the manoeuvring area. This proceeding was common practice and it was the responsibility of the TWR controller to decide on an ON/OFF basis whether or not it was appropriate for vehicles to enter the manoeuvring area. Low visibility conditions did not have an influence on this practice and a prior coordination between TWR and ELE Department did generally

not take place. ELE 23 was granted access to the RWY because there was no traffic at that time.

As no specific information with regard to the intended work was provided by ELE23 during initial communication on ground control frequency – and not requested by aerodrome control tower, it was not possible for the ATCO's to evaluate the necessity for a vehicle to enter the manoeuvring area. Although the provisions laid down in MATS specify that an assessment should be made based on the necessity to access the ILS sensitive area, current practice demonstrates that this is not the case.

One primary goal of low visibility procedures is to protect the ILS sensitive and critical area in order to ensure the integrity of the signals sent out by the ILS ground equipment (localizer and glide slope) to guide the aircraft safely to the runway. In low visibility conditions, granting access to a vehicle to enter the manoeuvring area without knowing the intended destination or area of operation of the vehicle makes it impossible for the controller to assess whether or not the ILS sensitive or critical areas will be infringed. Subsequently, an effective protection of the ILS sensitive and critical areas is hardly possible.

According to ELE 23 maintenance crew, it took between 3 and 5 minutes to open, clean and close one centre line light and move on to the next one. On the day of the occurrence, more than 40 lights had to be serviced which adds up to a total time in excess of 2 hours working on the runway. With regard to the extent of this preventive maintenance, it is reasonable to consider it to be outside the scope of routine maintenance and checks, such as a runway check, a runway lighting check or a friction test. The provisions of MATS Chapter 2 para. 2.15 on the coordination between aerodrome authority and aerodrome control tower for repair or installation work should have been applicable.

The preventive maintenance work carried out on the RWY was not adequately reported to tower control staff. Both the TWR controller and the TWR coordinator/assistant said that during shift handover, they were informed of possible interventions on the RWY by the ELE department during the day, without being provided further details.

Reporting preventive maintenance work in advance to aerodrome control tower would have provided valuable information with regard to the area where the work was to be carried out and to the extent of the task, enabling an adequate co-ordination between TWR and ELE department. Furthermore, in the absence of visual contact with the RWY, it would have increased the situational awareness of the tower controllers. In order to achieve adequate co-ordination between ATC and other departments operating on the manoeuvring area during LVP, AET issues recommendation **LU-AC-2012/006** to ANA.

MATS has since been amended to restrict access to the ILS sensitive area when LVP are in force.

### 2.1.4 Organisational aspects

#### *2.1.4.1 Decision to carry out preventive maintenance work*

The recurring problems with the runway centre line lights led ANA to the assessment that FOD damage was a potentially high risk in case of a detonation such as experienced before. The preventive maintenance work, consisting of cleaning the lights on a regular basis, was judged to be of high enough priority to execute the task during normal operating hours and even with LVP in force. There was no further risk mitigation planned for that particular maintenance task during reduced visibility weather conditions, the existing MATS provisions were considered to offer an adequate level of safety.

While the decision to prioritise this preventive maintenance work can be considered as justified, for the aforementioned safety reasons, the provision to carry out the work without affecting air traffic should be seen more critically as it increased both the number of interventions by the ELE Department on an active runway and the time it would take to accomplish the task. Furthermore, interrupting the maintenance work for air traffic exposed this same traffic to the risk of FOD damage identified previously by ANA. To ensure an effective safety assessment of tasks which may affect airport operations, AET issues recommendation **LU-AC-2012/007** to ANA.

The reason for scheduling the task during normal operating hours instead of night hours was a staffing shortcoming within the ELE Department due to sick leaves related to a previous incident with the centre line lighting. With reduced capabilities of only one operative crew within the ELE Department and the lack of provisions to use external manpower as an alternative solution, night work would have impaired their operational capacity during the normal operating hours. In order to address the lack of operational readiness identified within the ELE department, AET issues recommendation **LU-AC-2012/008** to ANA.

The corrective actions taken in the context of the set-up action plan have increased the operational capacity and capability of the ELE department to address the daily workload with more flexibility and a higher efficiency.

#### *2.1.4.2 Compliance to MATS*

An essential part of the ATCO's job at Luxembourg Airport can be described as 'hands on' work, relying on undocumented knowledge and reflecting practices acquired during on-the-job training and based on experience built thereafter. This situation leads to a work environment where common practices were not always in line with provisions laid down in MATS. As previous paragraphs in the 'Analysis' section has shown, a number of existing provisions in MATS were not applied and common practices applied by ATCO's were not documented in MATS. To ensure a common standard among ATCO's at Luxembourg Airport, AET issues recommendation **LU-AC-2012/009** to ANA.

## *2.2 Other safety relevant elements*

### 2.2.1 Memorisation techniques

There was no formal procedure as to how the tower control staff should mark temporary RWY obstructions. The memory aids available to TWR unit, as described in para. 1.17.1.1.1, were:

- a magnetic strip with the ground vehicle ID to be placed on the active board;
- the 'runway incursion' function activated manually on the communication system;
- the ATCO operated 'runway blocked' visual aid (red bar) on the ADD. An important feature of the ADD is its availability in APP, providing a key tool to allow similar awareness about temporary RWY obstructions in both TWR and APP units. As stated before, the ADD was in an evaluation phase at the time of the occurrence and did not have operational status.

It could not be determined in the course of the investigation if the actions described by the TWR control staff to mark the presence of ELE 23 on the runway were effectively carried out:

- the R/T System does not log standard ATCO actions, such as the activation of the 'runway incursion' function, performed on the display;
- the warning sound generated by the CWP loudspeaker when transmitting on the active frequency with the 'runway incursion' function activated cannot be positively identified on ATC recordings;
- it is not possible to objectively confirm the marking of an occupied RWY on a dedicated magnetic strip without the use of video footage recording the CWPs.

In this context, it should be noted that ICAO issued a recommendation in the '*Manual on the Prevention of Runway Incursions (ICAO Doc 9870, AN/463)*' stating in para. 4.5.2 that '*ATC should always use a clear and unambiguous method on the operating console to indicate that a runway is temporarily obstructed*'. This highlights the importance to establish a common methodology for the marking of temporary RWY obstructions, applicable by all ATCO's in order to mitigate the risk of runway incursions. AET subsequently issues recommendations **LU-AC-2012/010** to ANA.

Shortly after the event, ANA issued an amendment with special procedures for the movement area to the MATS, Section 3, Chapter 3, 3.4, with, amongst others, instructions on how to mark the presence of a temporary obstruction on the runway. The use of the above mentioned three memorisation techniques has been made mandatory (Appendix A).

### 2.2.2 Situational awareness for ground operations during LVP

At 11:54:40, the PM of CLX 793 informed TWR that they were able to vacate via taxiway Foxtrot. TWR indicated a landing time of 54 and gave the instruction to report runway vacated via Echo or Foxtrot if they liked. The PM replied they would vacate via Foxtrot and report runway vacated. The analysis of the QAR data showed that the aircraft actually vacated the runway via taxiway Echo on a magnetic track of 20° to 22°, although the PM indicated to the tower controller that they would vacate via Foxtrot. This also coincides with the PM stating at 11:54:38 that they will take 'the next sharp turn', the angle between Runway 24 an Taxiway Echo being 140°.

The AIP states that with LVP in progress, *'arriving aircraft shall vacate the runway using exits C, D2, E or B4'*. The PM asking to vacate via taxiway Foxtrot instead of Echo is probably due to an inattention. The intention was to actually turn off the runway via Echo but the designators of taxiways Echo and Foxtrot were mixed up. This may partly be attributed to the fact that Echo and Foxtrot both have the same origin on the runway and that their depiction on the Jeppesen aerodrome chart could lead to confusion.

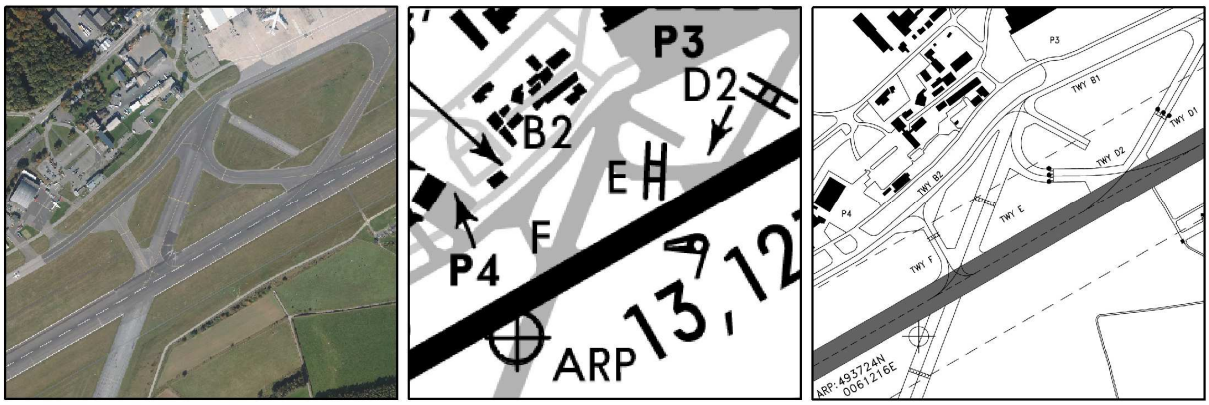


Figure 4: Aerodrome Chart (Source ACT, Jeppesen, AIP Belgocontrol)

With an RVR of 225 meters at midpoint, the tower control staff was not able to establish visual contact with the aircraft and their situational awareness relied solely on vocal radio communication. Reporting an erroneous aircraft position to ATC increases the potential for a safety hazard. It should therefore be stressed that aeroplane crews maintain a high level of attention with regard to their location until reaching the final parking position. In this context, it should be noted that providing flight crews with devices showing the own-ship position on digital airport charts would improve situational awareness during ground operations, especially in low visibility conditions.

### 2.2.3 Timely dissemination of information by CLX 793

CLX 793 landed at 11:53:51. At 11:55:16 Luxair 4883 reported fully ready at Cat III holding point and was cleared to line up runway 24 at 11:55:26. At 11:55:33, CLX 793 reported runway vacated. While taxiing to apron P7, the PF informed tower at 11:56:28 that during landing, he saw a vehicle standing just before the touchdown zone on the runway. More than 2:30 minutes had passed since touchdown of CLX 793 until the message to tower regarding a potential obstacle on the runway. It can be assumed that, at that point, the take-off clearance for Luxair 4883 was imminent.

Operating in low visibility conditions at an airport without supplementary means of ground traffic control and surveillance requires a high level of attention from all involved actors, such as flight crews, ground operators and ATC, with regard to vocal communication. When the PF of CLX 793 saw a vehicle on the runway during landing, he gained important information about a potential obstacle which, due to the prevailing visibility, was not visible to tower and which had not been reported before by tower. To improve situational awareness and prevent a potential unsafe condition for upcoming traffic, the presence of an obstacle on the runway should have been reported on the active frequency at the latest when reporting 'runway vacated', thus providing the information to TWR prior to an impending take off or landing clearance.

### 2.2.4 Confirmation bias

MATS Section 9 Para. 1.2.6 describes the procedure to be applied in the event of an '*incident with an aircraft on ground'*. However, the tower control staff did not apply this procedure after they were informed about the collision on the runway. To understand this behaviour, it is important to look at the situation from the TWR control staff perspective.

The first information related to the event was given to the TWR assistant/coordinator by one of the two electricians working on the runway besides ELE 23. The electrician correctly stated that the airplane collided with their van and damaged the roof. Shortly after that first communication, the PF of the implicated aircraft called tower to report a vehicle in the landing zone on the runway. The TWR controller asked if there was a problem and the PF replied in the negative, not knowing at that moment that his airplane effectively collided with the van. Although both the TWR controller and the TWR coordinator/assistant then realised that the van was still on the runway when CLX 793 landed, they had diverging information on the outcome of the event. Subsequent communications show that the TWR controller, based on what he was initially told by the PF, was reluctant to accept that there actually was a collision. At one point during a conversation with the electrician, the TWR controller evoked the possibility that the damage might have been caused by the aerodynamic blast from the aircraft. This hypothesis upset the electrician who vigorously replied that he just ran for his life. Additional confusing information was introduced after the occurrence when SIS dispatch called vehicle SIS 77 on ground control frequency and mentioned pieces on the runway coming from a house nearby.

During the period following the occurrence, the TWR controller stuck to his initial belief that a collision did not occur, based primarily on the information provided by CLX 793. He dismissed conflicting information which did not support his mental image and only retained supporting information (e.g. pieces from a house nearby). Without any visual information of what happened on the runway due to the prevailing weather, the TWR controller did not consider to apply the MATS provisions for an *'incident with an aircraft on ground'.*

### 2.2.5 Post-occurrence co-ordination issues

At 11:58:01, TWR informed the fire brigade about possible debris on the runway, without mentioning that the cause or origin of the debris was the collision between a landing aircraft and a maintenance van on the runway. APP was not informed about the occurrence. When, at 12:17:34, an approaching Luxair aircraft had to make a go-around because of the blocked runway, tower informed approach of the go-around mentioning as cause a lined-up Luxair aircraft on the active RWY and an ongoing runway check. APP then asked for the reason of the runway check and the TWR assistant/coordinator only gave an evasive answer, without passing on any information related to the occurrence on the runway.

The lack of information disseminated by TWR to other involved parties (SIS, APP, OPS), led to a situation of confusion and partial loss of situational awareness:

- In low visibility conditions, an inbound flight reporting 8 miles final, was instructed to continue approach while another aircraft was still lined-up on runway 24 and while SIS was cleaning up debris from that runway.
- At no point was the active runway formally closed.

- Air traffic was restored even though TWR control staff was informed by SIS of the presence of small debris which remained on the runway.

The actions performed by the TWR control staff in the aftermath of the safety occurrence indicate that situational awareness was impaired, probably due to a psychological reaction to the stress induced after realizing that ELE 23 was still on the runway when CLX 793 landed. For the TWR control staff, the outcome of the occurrence was uncertain for some time after the event due to the lack of visual contact with traffic on the RWY and conflicting information regarding the event from different parties involved (CLX 793, ELE 23, SIS). The TWR controller and the TWR coordinator/assistant remained on-duty for almost one hour after the occurrence and were not removed from their respective positions until around 13:00. The reason why they were not relieved earlier can be drawn to the fact that from the beginning, the TWR control staff did not identify the situation as an emergency. Subsequently, the occurrence was not reported to aerodrome authority and none of the emergency procedures contained in MATS were applied. The only action triggered after the event was a RWY check performed by SIS. To improve awareness and co-ordination of critical actions to be undertaken in the aftermath of a safety occurrence, AET issues recommendation **LU-AC-2012/011** to ANA.

### 2.2.6 Back-up communication means for ground operators

After the collision between CLX 793 and ELE 23, the van's R/T antennas were damaged and a two-way communication with TWR using the R/T equipment was not possible anymore. The use of visual signals by TWR, as specified in MATS, would not have been an adequate option due to the prevailing visibility. Flashing the RWY lights would have been the only remaining alternative to instruct ELE 23 maintenance crew to *'vacate the runway and observe tower for light signal'* (MATS 2.6.3.2.3.3), without TWR being able to assess the successful completion of this instruction.

Fortunately, ELE 23 maintenance crew was able to call TWR from a mobile phone and inform the TWR unit about the occurrence. It was however not possible for TWR control staff to contact ELE 23 as their mobile phone number was not available to TWR.

While radio communication failures between air and ground stations are addressed through specific procedures for IFR and VFR flights, communication failures between aerodrome control tower and ground operators only provide limited back-up solutions, mainly based on visual signals. In low visibility conditions, visual signals may prove to be inadequate and ineffective in case of a radio failure, thus interrupting the communication link and opening the way to an unsafe condition. To maintain two-way communications between TWR and ground operators in case of an R/T equipment failure, especially in low visibility conditions, AET issues recommendation **LU-AC-2012/012** to ANA.

A possible back-up solution, mobile phone network coverage permitting, could be to equip vehicles operating on the manoeuvring area with a dedicated mobile phone and provide a contact list of those vehicles to TWR unit. Said vehicles should be provided with the appropriate contact numbers for aerodrome control tower.

# 3. CONCLUSIONS

## *3.1 Findings*

- The flight crew members were licensed and qualified for the flight in accordance with existing regulations;
- The TWR control staff had valid qualifications to carry out the duty of air traffic controller in accordance with existing regulations;
- Recurring centerline lighting problems necessitated preventive maintenance work to be carried out on a regular basis until complete replacement of affected lights
- Preventive maintenance work was carried out during normal operating hours and with LVP in force;
- ANA decided to carry out preventive maintenance work on the active RWY without hampering traffic;
- Low visibility procedures were in force at the time of the occurrence. With the prevailing fog, the tower control staff was not able to maintain visual contact with traffic on the runway;
- The airport was not equipped with supplementary ground traffic control and surveillance equipment;
- ELE 23 was cleared to drive onto the runway;
- The investigation was unable to establish whether the TWR control staff made use of memorisation aids to mark the presence of ELE 23 on the RWY;
- The investigation was unable to establish whether ELE 23 was instructed by the TWR assistant/coordinator to vacate the RWY and sensitive area;
- According to both TWR controller statements, an audio signal described as a ‘carrier wave’ on ground control frequency made them assume that ELE 23 had vacated the sensitive area. The investigation was unable to establish the presence of the afore-mentioned audio signal on the ATC recordings;
- According to the statements of the TWR controller and the TWR coordinator/assistant, standard read-back procedures were not applied to positively confirm that the sensitive area had been vacated;
- There was no evidence of a technical problem of the R/T system prior to the occurrence;
- Flight CLX 793 was cleared to land by the TWR controller while ELE 23 maintenance crew was still working on the runway;
- The crew of CLX 793 was unable to take avoiding actions to prevent a collision due to the prevailing visibility;
- Flight CLX 793 collided with ELE 23 on the runway during flare;
- The crew of CLX 793 didn’t notice the collision with the van;
- The TWR control staff had no visual contact with CLX 793 or ELE 23 on the RWY and couldn’t see collision;
- Conflicting information by different parties (CLX 793, ELE 23, SIS) led to a wrong initial perception by the TWR control staff of what happened on the RWY, preventing them to apply appropriate emergency procedures.

## *3.2 Causal and contributory factors*

- The impaired operational readiness of the ELE department due to a manning shortcoming, combined with the lack of provisions to appoint external workforce if necessary, prevented ANA to schedule preventive maintenance work outside of normal operating hours (i.e. during the curfew);
- The decision to carry out preventive maintenance work in low visibility conditions without hampering air traffic gave priority to flight operations over safety aspects;
- The lack of adequate co-ordination between aerodrome control tower and ELE department with regard to the preventive maintenance work contributed to a reduced situational and organizational awareness of the TWR control staff;
- Inadequate procedures for the access of vehicles to the RWY and ILS sensitive area during LVP contributed to the development of an unsafe condition;
- Read-back procedures were not adequately applied by aerodrome control tower on ground control frequency, making this procedural safety net ineffective;
- Low visibility weather conditions, associated with the lack of supplementary ground traffic control and surveillance equipment, limited the capability of aerodrome control tower to identify and correct a developing unsafe condition;
- The use of different frequencies for air traffic and ground traffic on the manoeuvring area reduced the situational awareness of ELE 23 maintenance crew working on the RWY, preventing them to take avoiding action.

# 4. RECOMMENDATIONS

**LU-AC-2012/001 to ANA: Establish appropriate supervisory means to ensure the correct application of standard phraseology procedures by ATCO's. (SOAM 2.1)**

**LU-AC-2012/002 to ANA: Implement the recommendation by International Civil Aviation Organization (ICAO) Annex 11 Air Traffic Services, paragraph 3.3.3. stating that: '*air traffic control units should be equipped with devices that record background communication and the aural environment at air traffic controller work stations, capable of retaining the information recorded during at least the last twenty-four hours of operation.*'**

**LU-AC-2012/003 to ANA: Provide the aerodrome control tower with supplementary means of control and surveillance of ground traffic in accordance with the specifications for an A-SMGCS Level 2 implementation. (SOAM 2.2 & 5.1)**

**LU-AC-2012/004 to ANA: All communications associated with the operation of the runway should be conducted on the same frequency as utilized for the take-off and landing of aircraft and all communications associated with the operation of the taxiways should be conducted on a different designated frequency. (SOAM 2.3 & 5.2)**

**LU-AC-2012/005 to ANA: All communications associated with the operation of the runway and the taxiways should be conducted in standard aviation English and in accordance with ICAO language requirements for air-ground radiotelephony communications.**

**LU-AC-2012/006 to ANA: Amend work procedures for the access to the manoeuvring area during LVP:**

- **to establish the operational need for all access of vehicles and personnel to the manoeuvring area;**
- **to ensure an appropriate co-ordination between ATC and operators on the manoeuvring area. (SOAM 5.5)**

**LU-AC-2012/007 to ANA: Review the Safety Management System (SMS) to ensure an effective safety assessment of tasks which may affect the safety of airport operations. (SOAM 5.3)**

**LU-AC-2012/008 to ANA: Provide adequate operational means (manpower & equipment) to ELE department to ensure an appropriate level of operational readiness for aerodrome operations. (SOAM 5.4)**

**LU-AC-2012/009 to ANA: Review MATS to ensure that common practices and local instructions are contained in MATS and that they are not in contradiction with prevailing MATS provisions. (SOAM 5.6)**

**LU-AC-2012/010 to ANA: Establish written instructions in MATS and supervise their operational implementation to ensure the clear and unambiguous marking of a temporarily occupied runway by aerodrome control tower on all active work positions. The information on RWY occupation should also be provided to approach control to enhance operational awareness. (SOAM 2.4 & 5.2)**

**LU-AC-2012/011 to ANA and ELLX Aerodrome Operator: Review the emergency response plan and inform all concerned staff about the criticality of actions to be undertaken in the aftermath of safety occurrences with regard to:**

- **debris removal;**
- **staff response for alerting and co-ordinating with all interested parties;**
- **staff removal from position when involved in a safety occurrence;**
- **CISM (Critical Incident Stress Management).**

**LU-AC-2012/012 to ANA: Implement back-up communication means for ground operators on the manoeuvring area in low visibility conditions to maintain two-way communication with aerodrome control tower in case of an R/T equipment failure and establish appropriate procedures to support the operational implementation.**

# APPENDIX A – MATS Amendment

| LE GOUVERNEMENT DU GRAND-DUCHÉ DE LUXEMBOURG<br>Administration de la Navigation Aérienne | **Document "Amendement Special procedures on the movement area MATS Sect 3 CH 3 3.4"**<br>**P-ATC-010Document Amendement Special procedures on the movement area MATS Sect 3 CH 3 3.4** |
|---|---|

## Amendement
## Special procedures on the movement area
## MATS Section 3 Chapter 3, 3.4

3.4. Access of vehicles to RWY and ILS sensitive area in LVP

3.4.1. The RWY and CAT II/III sensitive area as shown on page 3-51 shall be clear of all vehicles, whenever LVP is in operation.

3.4.2. For operational needs the access to the RWY and sensitive area may be granted after prior approval from the aerodrome control tower. A two way communication with ATC Control Tower is mandatory. The operational need, as validated by QMS/SMS department of ANA, has to be declared to and coordinated with aerodrome control tower in advance of first radio contact and will only be considered by aerodrome control tower for the following:

- AGL inspection by Service ELE.

- AGL maintenance by Service ELE, when AGL does not meet safe guidance Under CatII/III conditions as required by ICAO Annex 14 (verified by ELE).

- Urgent Tarmac inspection by PCH, when previous landing and/or departure has reported hole or cavities in RWY.

- RWY FOD inspection by Service SIS as regulated in 2.13.1.

- Skidometer testing by Service SIS in case of icing and RWY contamination.

- Emergency intervention by Service SIS as per 2.6.3.2.2.1.

Tow trucks towing aircraft are considered as aircraft in operational need and should be granted access to RWY and sensitive area whenever CAT II/II traffic is allowing such incursion in respect of LVP 5.3.4.2.

3.4.3. In any case, vehicles granted access to RWY and sensitive area shall be marked by the aerodrome controller by :

- introducing the 'RWY BLOCKED' stripholder on the active board.
- switching the 'RWY incursion' alarm function on VCS.
- tapping the 'RWY blocked' visual aid on ADD.

3.4.4. The service road crossing the approach area RWY24 above the highway is automatically closed, upon LVP CAT II/III operations switch on, between Apron P7 and GP RWY 24, by red lights and barriers.

# APPENDIX B – SOAM Chart