State of Israel
Ministry of Transport and Road Safety
Aviation Accidents and Incidents Investigation

Safety Investigation Report - Final

(Final Investigation Report)

Accident File No. 31-18

Collision between two aircraft during pushback

Date	**28.3.2018**
Between	
Aircraft	**BOEING 767**
Registration	**4X-EAK**
And	
Aircraft	**BOEING 737**
Registration	**D-ABLB**
Location of event	**Taxiway M, LLBG**

For Safety Purposes Only

The Investigations conducted by the Israeli Investigation Office (AIAI) are in accordance with Annex 13 to the ICAO Convention on International Civil Aviation, and the Israeli Aviation Law 2011, chapter 7, and its respective Aviation regulations.

The sole objective of the investigation of an accident or incident under these Regulations is the prevention of future accidents and incidents. It is not the purpose of such an investigation to apportion blame or liability.

Accordingly, it is not appropriate that AIAI reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

This report has been translated to the English language for other parties' convenience, and should adhere to the Original report in the Hebrew language - In any case of abstruseness or miss-understanding, the original report in the Hebrew language is taking over.

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Summary

On Wednesday, March 28, 2018 at 06:22 the tails of two airliners collided while being pushed back to their engine start-up positions.

Both aircraft were cleared for pushback from their gates to their assigned start-up positions. An Elal Boeing 767 commenced pushback to its designated position and towards the end of the pushback, the second aircraft, a Germania Boeing 737 was cleared for pushback to another start-up position, which was altered by the ground controller during the pushback. When the Elal aircraft had 14 meters remaining to reach its start- up position, its tail and the Germania aircraft tail collided and both aircraft stopped.

Both aircrafts were damaged but there was no fire and no panic on board. There was no declaration of an emergency or of standby for emergency. The passengers were deplaned and transferred to the terminal.

The event was immediately reported, by Elal's director of aircraft maintenance to the Chief Investigator and within a short time, investigators from the Chief Investigator's office arrived at the scene and launched an investigation.

Both aircraft after the accident

Abbreviations and Acronyms

Abbreviation	Term
APU	Auxiliary Power Unit
ATC	Air Traffic Control
A-SMGCS	Advanced-Surface Movement Guidance and Control Systems
BFU	Bundesstelle für Flugunfalluntersuchung
CAVOK	Ceiling And Visibility OK
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
EASA	European Aviation Safety Agency
EFS	Electronic Flight Strips
FLARM	Flight Alarm system
FOD	Foreign Object Debris
GPS	Global Positioning System
HS	Hard Stand
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IGOM	IATA Ground Operations Manual
ISAGO	IATA Safety Audit for Ground Operations
NIGS	Nose In Guidance System
RAAS	Runway Awareness and Advisory *System*
RT	Radio Telephony Qualification
SMR	Surface movement radar
SMS	Safety Management System
SP	Start-up Position
TBL	Towbarless (a tow-truck without a tow-bar)
TCAS	Traffic Collision Avoidance System

1. Factual information

1.1 Synopsis of the accident

(Local times, rounded to the next full minute. The exact time is shown in the following transcript).

On Wednesday, March 28, 2018 at 06:22 the tails of two airliners collided and were damaged while being pushed back to their engine start-up positions. At that morning hour the weather was rainy, it was still dark, the aprons were wet and illuminated by floodlights. There was active traffic of departing airplanes, following the airport's opening for departures and arrivals.

The two involved aircraft were parked at adjacent gates near terminal 3.

Elal's Boeing 767-300 on flight 385 to Rome, with 240 passengers and crew on board (herewith "**the 767 a/c**") was parked at departure gate C9.

Germania's Boeing 737-700 on flight 4915 to Berlin, with 127 passengers and crew on board (herewith "**the 737 a/c**") was parked at the adjacent gate C8, to the west of C9.

At 06:09 the 767 a/c crew has first called on the ground west frequency 118.05 and requested departure clearance. The ground controller transferred them to freq. 129.2 for clearance. The pilots' ~~aircraft~~ then left the ground west frequency for several minutes.

At 06:13 Elal flight 314 first called on the ground west frequency after landing, and was cleared to taxi to gate C7 (located west of C8) and hold before intersection with taxiway M1, due to traffic.

At 06:14 the 737 a/c called and requested pushback and start up from gate C8. The ground controller asked them to standby for clearance due to traffic behind.

At 06:16, Elal flight 314 was cleared to continue taxiing to gate C7, located west of the 737 a/c's gate. Taxiing was conducted through taxiway ~~1M~~ M1 and taxiway M, behind the 737 a/c.

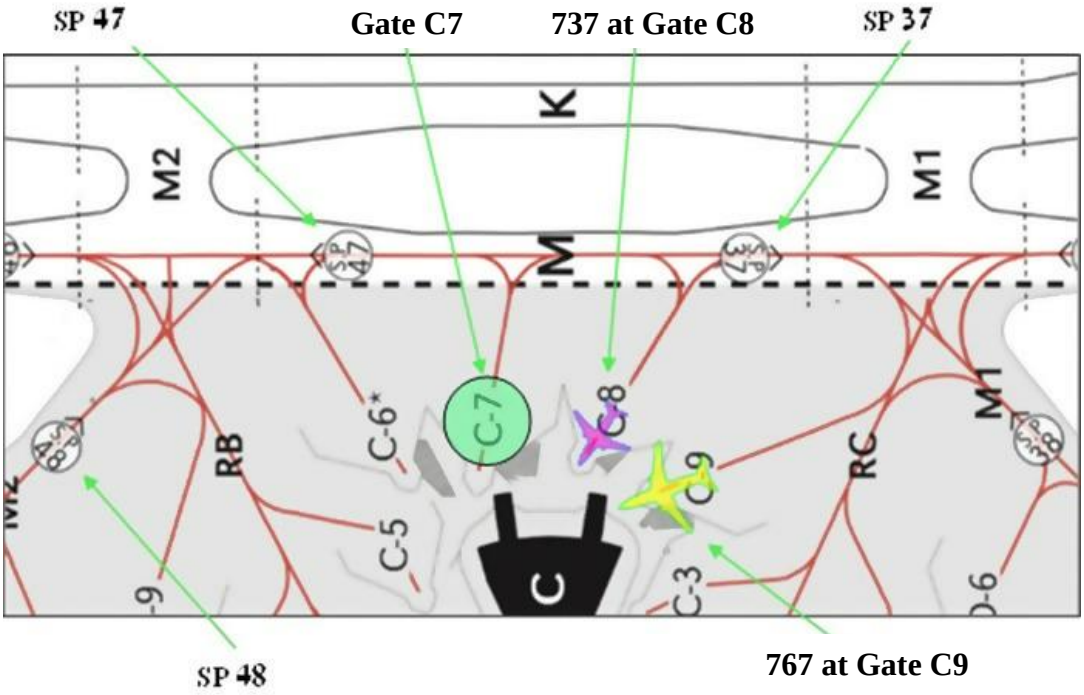
At the same time, the 767 a/c crew called and requested pushback from gate C9. The ground controller asked him to standby for pushback clearance.

At 06:17, about a minute later, the 767 a/c was cleared for pushback from gate C9 to start-up position 37, facing east.

At 06:19, when the 767 a/c completed its tail turnabout, from taxiway M1 to taxiway M where start-up position 37 is located, the 737 a/c was cleared for pushback from gate C8 where it was parked. This clearance was given about 5 minutes after it was requested. When issuing the pushback clearance, the controller did not specify the parking position. The pilot confirmed by read back. The 737 a/c was cleared to be pushed back to start-up position 48, facing east.

About 1.5 minute after obtaining the pushback clearance, while the 737 a/c was already far to the north of the parking gate, its start-up position was changed by the ground controller to position 47, facing west.

Accident site



The 767 a/c was slowly pushed back along taxiway M and at the same time the 737 a/c was slowly pushed back towards taxiway M in order to line up on it with its tail directed to the east, and subsequently be towed westbound to start-up position 47, facing west.

When the 767 a/c had 14 meters remaining to start-up position 37 the tails collided, and both airplanes stopped with their tails intertwined. The 767 a/c's horizontal stabilizer and elevator penetrated the 737 a/c's vertical stabilizer and rudder.

The airplanes were damaged but there was no fire and no panic on board.

About 45 seconds after the collision, a “Follow me” car arrived at the accident site. The 737 a/c's pilot reported to the ground controller that they stopped the pushback due to an airplane behind them, and the controller responded that there is an airplane to their east and requested the pilot to confirm that the pushback cannot be continued. The 737 a/c pilot confirmed. By about two minutes after the collision, no one has yet reported that a collision has occurred, neither the “Follow me” car operator who was at the accident site, nor the towing crews. The ground controller informed the 737 a/c pilot that the traffic to their east is not a factor, but if they have a problem, he will assign another start-up position. The 767 a/c pilot reported to the ground controller that they are not yet at their assigned position and they stopped because of a tow truck problem. About 2.5 minutes after the collision the ground controller instructed the 737 a/c pilot to stop, the pilot confirmed and stated that he is waiting for the controller's instructions. About 3 minutes after the accident the 767 a/c pilot reported that according to the ground crew they have hit another airplane. The ground controller did not respond, until the 737 a/c pilot also reported the accident. The controller asked the 737 a/c pilot whether he wishes to return to the gate.

The airport duty manager consulted with the airport manager on the phone and it was decided not to declare a state of emergency.

The passengers deplaned by mobile stairs and were transferred by buses to the terminal.

Accident site viewed from south-east (from secondary tower)

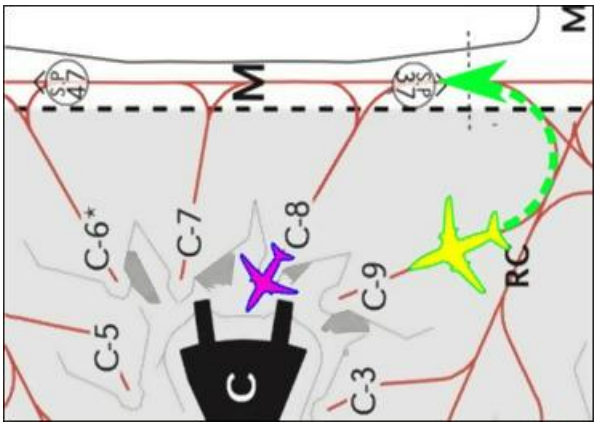
Seconds before the accident

The event was immediately reported by Elal's director of aircraft maintenance, to the Israeli Chief Investigator (herewith "**Chief Investigator**") and within a short time, investigators from the Chief Investigator's office were dispatched and arrived at the accident site for surveying and documenting. Due to the scope of personnel involved (2 flight crews, 2 towing crews and controllers), the investigating team was augmented by additional investigators.

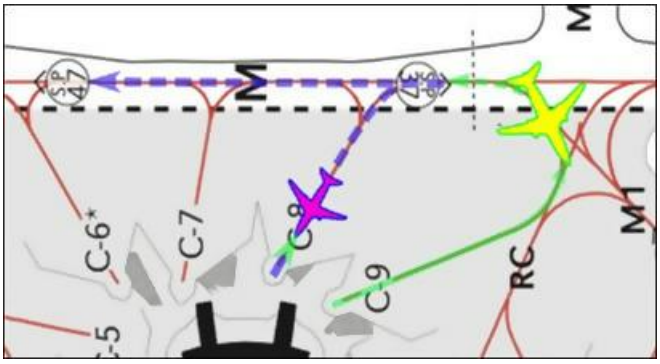
After completing the initial investigation, the Chief Investigator approved towing of the airplanes to other parking spots.

Stages of the event evolution

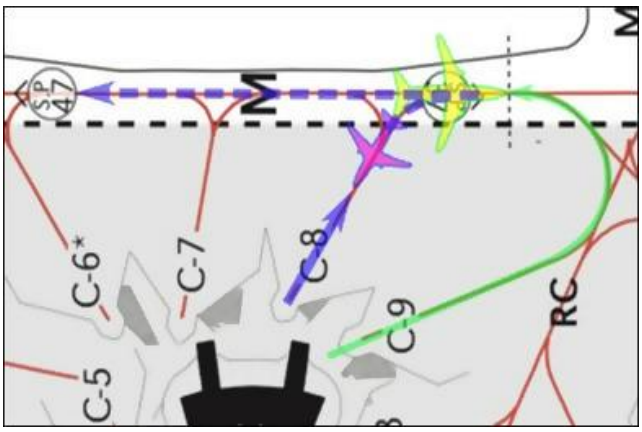
1. The 767 a/c pushback commencement from gate C9 to start-up position 37



2. The 737 a/c pushback commencement from gate C8 to start-up position 47, while the 767 a/c is near the end of its push back



3. Site of tails collision - 767 a/c towards end of pushback and 737 a/c towards starting the turn



1.2 Casualties

No casualties.

1.3 Damage to aircraft

1.3.1 The 737 a/c was severely damaged at the empennage assembly, rudder and vertical stabilizer. The company consulted with the aircraft manufacturer and the aircraft was eventually repaired at a high cost.

1.3.2 The 767 a/c was severely damaged at the empennage assembly, elevator and horizontal stabilizer. The company determined that a repair is not economically viable and it was permanently decommissioned.

1.4 Other damage

No other damage.

1.5 Personnel involved

Pilots

The 767 a/c Captain (PIC)

- ☒ Age – 53.
- ☒ Total experience – 15,000 hours.
- ☒ Proficiency check – valid, until 17.2.2019.
- ☒ Medical certificate – valid, until 5.9.2018.

The 767 a/c Copilot

Note: A captain in conversion course

- ☒ Age – 57.
- ☒ Total experience – 11,000 hours, 7 flight hours on type during conversion.
- ☒ Proficiency check – valid, until 20.3.2019.
- ☒ Medical certificate – valid, until 24.10.2018.

The 737 a/c Captain

- ☒ Age – 32.
- ☒ Total experience – 4,790 flight hours, including 4,400 on B737 model.
- ☒ License – valid, until 30.11.2018.
- ☒ Medical certificate – valid, until 14.11.2018.

Controller

Tower ground controller

- ☒ Age - 35.
- ☒ Airport Authority controller since 2010, 5.5 years at Eilat tower.
- ☒ Recent 2.5 years – controller at Ben Gurion tower.
- ☒ Formerly an air traffic officer at the Air Force.
- ☒ Qualifications – ground controller and tower controller.

Towing crews

Elal

The 767 a/c tow driver

- ☒ Age - 43.
- ☒ Employed at the company for 10 years, 8 of which in ground equipment department.
- ☒ Was trained on all the company's operational vehicles. Qualified for PB towing and not RT.

Tow escort

- ☒ Age - 24.
- ☒ A mechanic at the Air Force and at Elal.
- ☒ Began working at the company – October 2016.
- ☒ Was employed as a tow crew supervisor.

Laufer

The 737 a/c tow driver

- ☒ Age – 51.
- ☒ Employed at the company for 1.5 year.
- ☒ Tow driver for all aircraft models. Passed Ben Gurion tests and qualifications.

Note: Not directly related to the accident, the tow driver has resigned during the investigation.

Tow escort

- ☒ Age – 25.
- ☒ Began working at the company – August 2017.
- ☒ Was employed as a ramp supervisor/agent.
- ☒ Qualified for small and narrow body aircraft.

1.6 Aircraft and vehicles involved

The 767 a/c

- ☒ Model – Boeing 767-300ER.
- ☒ Registration – 4X-EAK.
- ☒ Airworthiness – valid.

The 737 a/c

- ☒ Model – Boeing 737-700W.
- ☒ Registration – D-ABLB.

Note: During the investigation, the company went bankrupt and seized operations..

The 767 a/c tow vehicle

- ☒ Model – TBL, Douglas, No. 3035 (a similar vehicle is shown).

The 737 a/c tow vehicle

☒ Model – TBL, Goldhofer.

1.7 Weather

☒ Visibility – limited, 5-7 KM.

☒ Clouds – 8/8, cloud base at 11,000', rain.

☒ Lighting – darkness. Aprons lighting was operating.

☒ Wind- South/Southeasterly 5-10 knots.

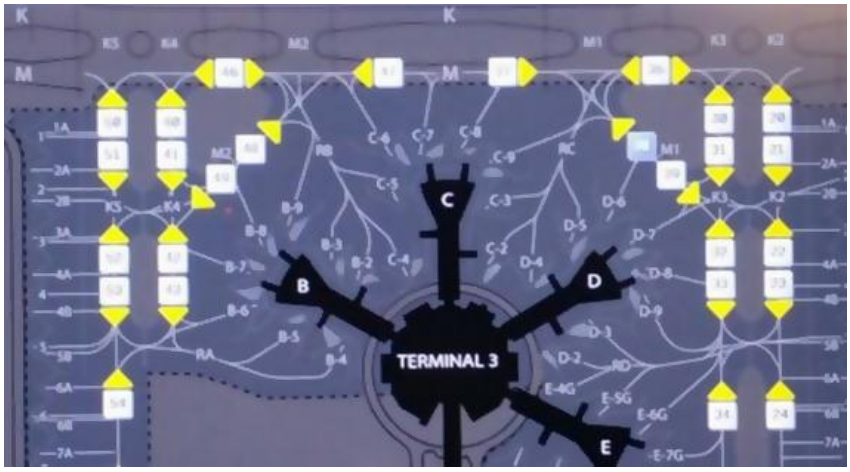
☒ Temperature – 18 Deg. C.

1.8 Systems, displays and navaids

☒ Both aircraft operated their transponders as required by airport procedures.

☒ Controller station displays:

✓ Parking aprons display – an illuminated monitor with marking of the gates, taxiways, parking spots, start-up positions and their directions.



✓ Electronic Flight Strips System (EFS) - displays all aircraft parameters, including the parking position, pushback and start clearance and the start-up position.

Note: The picture shows the strips of the colliding aircraft. At the time of the accident, the ground controller had additional strips.

☒ Ground control system, used by the tower (A-SMGCS)

A modular system which includes various functions for supporting safe, orderly and efficient aircraft and vehicle traffic in airports, according to traffic density and airport complexity, independent of line of sight to the aircraft or vehicle.

The system's general specification, detailed in ICAO document No. 9830 relates in paragraph 1.1.3 to the complete traffic area as a space designated for system operation, including aircraft movement since landing until arrival at the parking position and back from the parking position to the runway. The system also tracks vehicles with installed transponders, which are eligible to move within the operational zone.

The system gathers data from multiple sensors, including optical sensors, microwave, radars, aircraft transponders and others. It includes technological systems and complimentary procedures, which support in providing the required service at a very high reliability level.

The system consists of 4 functions:

- ✓ Surveillance
- ✓ Control
- ✓ Planning.
- ✓ Guidance.

Four levels were defined, 2 of which were already adopted by Eurocontrol. The 4 levels are:

- ✓ Level 1 – Enhanced surveillance

  By means of improved tracking and procedures, the ground vehicles **Maneuvering Area** and the aircraft **Movement Area** are covered. The procedures deal with identification and with complying with ATC instructions. Apron controllers are receiving data regarding the location and identity of traffic, an important step forward in comparison to traditional ground radar picture (SMR).

- ✓ Level 2 – <u>Surveillance and safety nets</u>

  This level adds safety nets protecting the runways and the areas included in the system's coverage, by means of relevant procedures. Appropriate warnings are generated for the apron controllers in cases of collision courses between vehicles and/or aircraft, or intrusion of aircraft into prohibited zones.
- ✓ Level 3 - <u>Conflicts detection – Apparently not yet implemented</u>

  Level 3 detects all conflicts in the movement area and provides the apron controllers with enhanced guidance and traffic planning.
- ✓ Level 4 - <u>Conflicts resolution, automated planning and guidance – Apparently not yet implemented</u>

  Level 4 will provide resolution for any potential conflict and will enable automated planning and guidance for the pilots as well as for the apron controllers.

The system's Level 1 & 2 are implemented at various locations, including Ben Gurion. System definitions state that vehicles and aircraft which are within a 50 meter radius from terminal 3 will not be displayed on the ground controller's monitor. Therefore, no system warnings are provided for this area.

<u>A-SMGCS monitor image</u> (1.5 minute before the accident)

A-SMGCS monitor image (at the time of the accident)

Notes:

At the center of the above illustration, the silhouettes of ELY385 and GER4915 are overlapping. Also visible are aircraft of Iberia, Turkish, Austrian and Elal, as well as the vehicle for preventing wildlife hazards (BRD3).

In the upper illustration, it can be seen that vehicles and aircraft which are near the terminal are not displayed.

1.9 Communication

- ☒ Communication between the pilots and the tow escorts conducted by means of headsets plugged to aircraft sockets. Between the tow truck drivers and escorts – direct verbal and by hand signals.
- ☒ Communication between the ground controller and the aircraft was conducted on VHF frequency 118.05.
- ☒ Following is the transcript of communications on channel 118.05 “ground west”. It only includes exchanges deemed important for understanding the accident scenario. Times are local. This transcript is included in the report per the Chief Investigator’s determination that it is essential for demonstrating the findings and/or the conclusions of the safety investigation.

L.T.	CALL SIGN	
06:08:48	ELAL 385	BEN GURION ELAL 385 GOOD MORNING
06:08:52	GND	ELAL 385 BEN GURION GROUND GOOD MORNING
06:08:55	ELAL 385	ELAL 385 INFORMATION FOX, C9, READY TO COPY ATC
06:09:00	GND	ELAL 385 CLEARANCE DELIVERY OPERATING ON 129.2 PLEASE
06:09:05	ELAL 385	129.2 TODA
06:13:32	ELAL 314	GROUND SHALOM ELAL 314
06:13:35	GND	ELAL 314 BEN GURION GROUND GOOD MORNING, PARKING POSITION C7 TAXI M HOLD SHORT M1
06:13:41	ELAL 314	C7 VIA M HOLD SHORT M1 ELAL 314
06:13:45	**GER 4915**	**GROUND GOOD MORNING GERMANIA 4915 STAND C8 REQUEST START AND PUSH**
06:13:50	GND	GERMANIA 4915 BEN GURION GROUND STANDBY CALL YOU BACK FOR THE PUSH, TRAFFIC TAXIING BEHIND.
06:13:58	GER 4915	STANDING BY, GERMANIA 4915.
06:14:19	ELAL 314	ELAL 314 JUST TO CONFIRM HOLD SHORT M1?
06:14:20	GND	ELAL 314 AFFIRM, TRAFFIC PUSHING ON M1, WHEN CLEARED OF THE TRAFFIC PUSHING CONTINUE TO THE GATE VIA C7.
06:14:30	ELAL 314	COPIED ELAL 314
06:15:38	ELAL 385	BEN GURION BOKER TOV ELAL 385 HEAVY C9 FULLY READY
06:15:40	GND	ELAL 385 BEN GURION GROUND GOOD MORNING STANDBY FOR THE PUSH DUE TRAFFIC TWO MINUTES TRAFFIC BEHIND, LESS THAN TWO MINUTES.
06:15:46	ELAL 385	STANDING BY
06:16:26	ELAL 314	ELAL 314 WHEN CLEARED FROM THE TRAFFIC MAY WE PROCEED?
06:16:31	**GND**	**ELAL 314 AFFIRM, CLEARED OF TRAFFIC CONTINUE TO C7**
06:16:33	ELAL 314	THANK YOU TO C7

L.T.	CALL SIGN	
06:17:00	**GND**	**ELAL 385 HEAVY C9 PUSHBACK AND STARTUP APPROVED, RELEASE POINT 37 FACING EAST.**
06:17:05	ELAL 385	37 EAST CLEARED FOR PUSH AND START ELAL 385 TODA
06:17:07	AUS 860V	GROUND GOOD MORNING AUSTRIAN 860V STAND C4 READY FOR STARTUP AND PUSH BACK
06:17:19	GND	ELAL 314 FROM C7 VIA M
06:17:22	ELAL 314	C7 VIA M ELAL 314
06:17:45	AUS 860V	GROUND GOOD MORNING AUSTRIAN 860V READY AT STAND C4
06:17:50	GND	AUSTRIAN 860V GOOD MORNING, STANDBY CALL YOU BACK FOR THE PUSH
06:18:53	**GND**	**ELAL… CORRECTION GERMANIA 4915 PUSHBACK AND STARTUP APPROVED, RELEASE POINT 48 FACING EAST.**
06:19:00	GER 4915	GERMANIA 4915 PUSHBACK AND STARTUP APPROVED, RELEASE POINT 48 FACING EAST.
06:19:07	GND	AUSTRIAN 860V ONE MINUTE FOR THE PUSH, TRAFFIC PUSHING BEHIND.
06:20:34	GND	GERMANIA 4915 BEN GURION GROUND
06:20:38	GER 4915	BEN GURION GERMANIA 4915 GO AHEAD
06:20:40	**GND**	**GERMANIA 4915 AMEND RELEASE POINT, RELEASE POINT 47 FACING WEST**
06:20:47	GER 4915	RELEASE POINT 47 FACING WEST GERMANIA 4915
06:20:50	GND	AUSTRIAN 860V PUSHBACK AND STARTUP IS APPROVED RELEASE POINT 48 FACING NORTH
06:20:55	AUS 860V	RELEASE POINT 48 FACING NORTH AUSTRIAN 860V PUSHBACK AND STARTUP APPROVED
06:22:00	GER 4915	GROUND GERMANIA 4915
06:22:05	GND	GERMANIA 4915
06:22:08	**GER 4915**	**AT THE END OF OUR PUSHBACK IS THERE AN AIRCRAFT BEHIND US?**
06:22:11	GND	SAY AGAIN GERMANIA 4915

L.T.	CALL SIGN	
06:22:15	GER 4915	GERMANIA 4915 IS THERE AN AIRCRAFT BEHIND US BECAUSE WE HAD TO ABORT THE PUSHBACK
06:22:22	GND	THERE IS TRAFFIC EAST OF YOUR POSITION, FOR FURTHER PUSHBACK CONFIRM YOU ARE UNABLE TO CONTINUE PUSH FURTHER OF YOUR POSITION?
06:22:35	GER 4915	THE PUSHBACK DRIVER JUST STOPPED THE PUSHBACK BECAUSE OF TRAFFIC CAN WE PUSHBACK NOW?
06:22:40	GND	GERMANIA 4915 ASK THE PUSHBACK DRIVER IF HE CAN PUSH DIRECT NOW FROM THIS POSITION TO RLEASE POINT 47 FACE WEST, IT SEEMS LIKE THE TRAFFIC IS NOT A FACTOR BUT IF IT IS NOT POSSIBLE I WILL GIVE YOU ANOTHER RELEASE POINT.
06:22:53	GND	OK WE ARE TALKING TO THE PUSHBACK DRIVER TO CONTINUE WITH THE PUSH, OK?
06:23:05	ELAL 385	BEN GURION ELAL 385
06:23:10	GND	ELAL 385
06:23:12	ELAL 385	WE ARE HOLDING POSITION NOT YET IN OUR FINAL STARTUP POSITION, DUE SOME PROBLEM DOWNSTAIRS WITH OUR TRACTOR, BE ADVISED
06:23:20	GND	GERMANIA 4915 HOLD POSITION CALL YOU BACK
06:23:27	GER 4915	HOLDING POSITION WAITING FOR YOUR CALL GERMANIA 4915
06:24:00	GND	GERMANIA 4915 ASK THE PUSHBACK VEHICLE IF HE CAN ENTER BACK TO THE STAND FROM THE CURRENT POSITION
06:24:10	GER 4915	BACK TO THE STAND GERMANIA 4915
06:24:54	ELAL 385	TOWER ELAL 385
06:24:55	GND	ELAL 385
06:24:58	ELAL 385	BE ADVISED OUR PUSHBACK… STANDBY

L.T.	CALL SIGN	
06:25:08	**ELAL 385**	**FROM ELAL 385 WE WERE INFORMED BY OUR GROUNDSTAFF THAT WE HIT ANOTHER AIRCRAFT ON THE GROUND, NOW HOLDING POSITION, STANDBY.**
06:25:17	GND	ROGER ELAL 385
06:25:40	GER 4915	GROUND GERMANIA 4915
06:25:42	GND	GERMANIA 4915
06:25:47	GER 4915	(UNCLEAR)
06:25:52	GND	ARE YOU ABLE TO PUSH BACK TO THE GATE BECAUSE YOU PROBABLY HIT TRAFFIC BEHIND YOU?
	GER 4915	THERE WAS TRAFFIC BEHIND US AND THAT WAS THE REASON WE STOPPED OUR PUSHBACK AND WE ARE PULLING NOW BACK TO OUR STAND AGAIN.
	GND	ROGER GERMANIA 4915

1.10 The airport

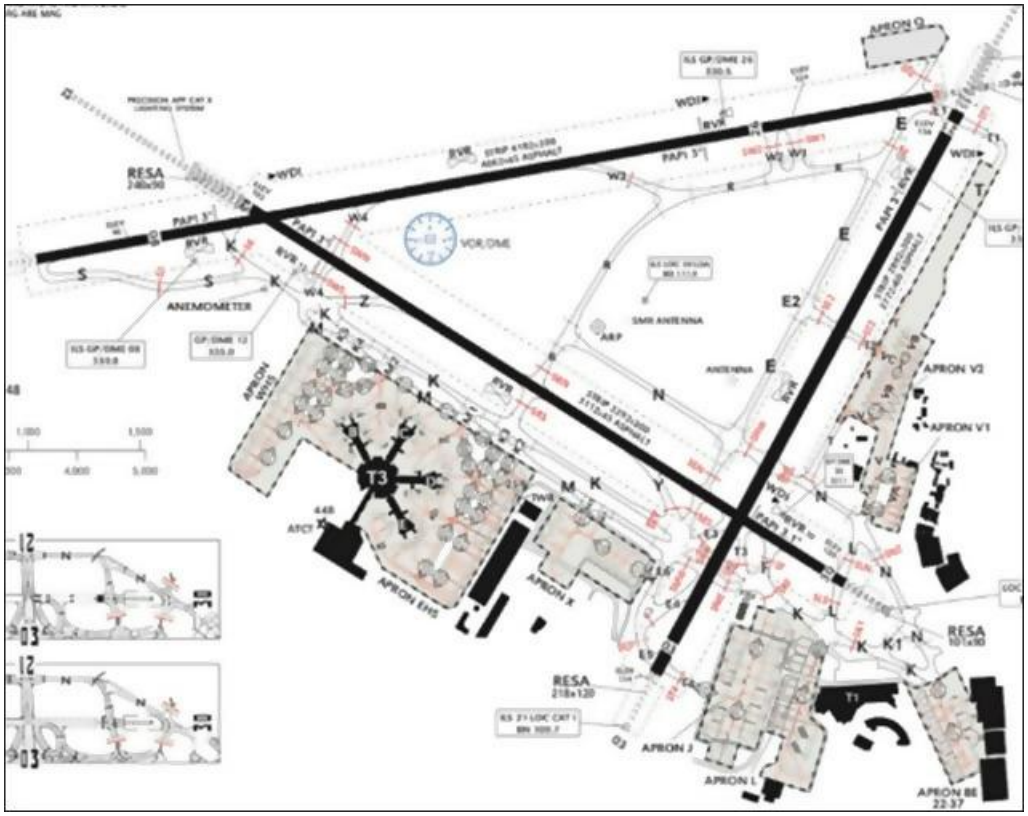
☒ **General**

- ✓ Ben Gurion International Airport, near Tel Aviv – TLV/LLBG.
- ✓ Central coordinates 32° 00.6' north, 034° 53.1' east.
- ✓ Magnetic inclination 4°E.
- ✓ Altitude – 134 feet above sea level.

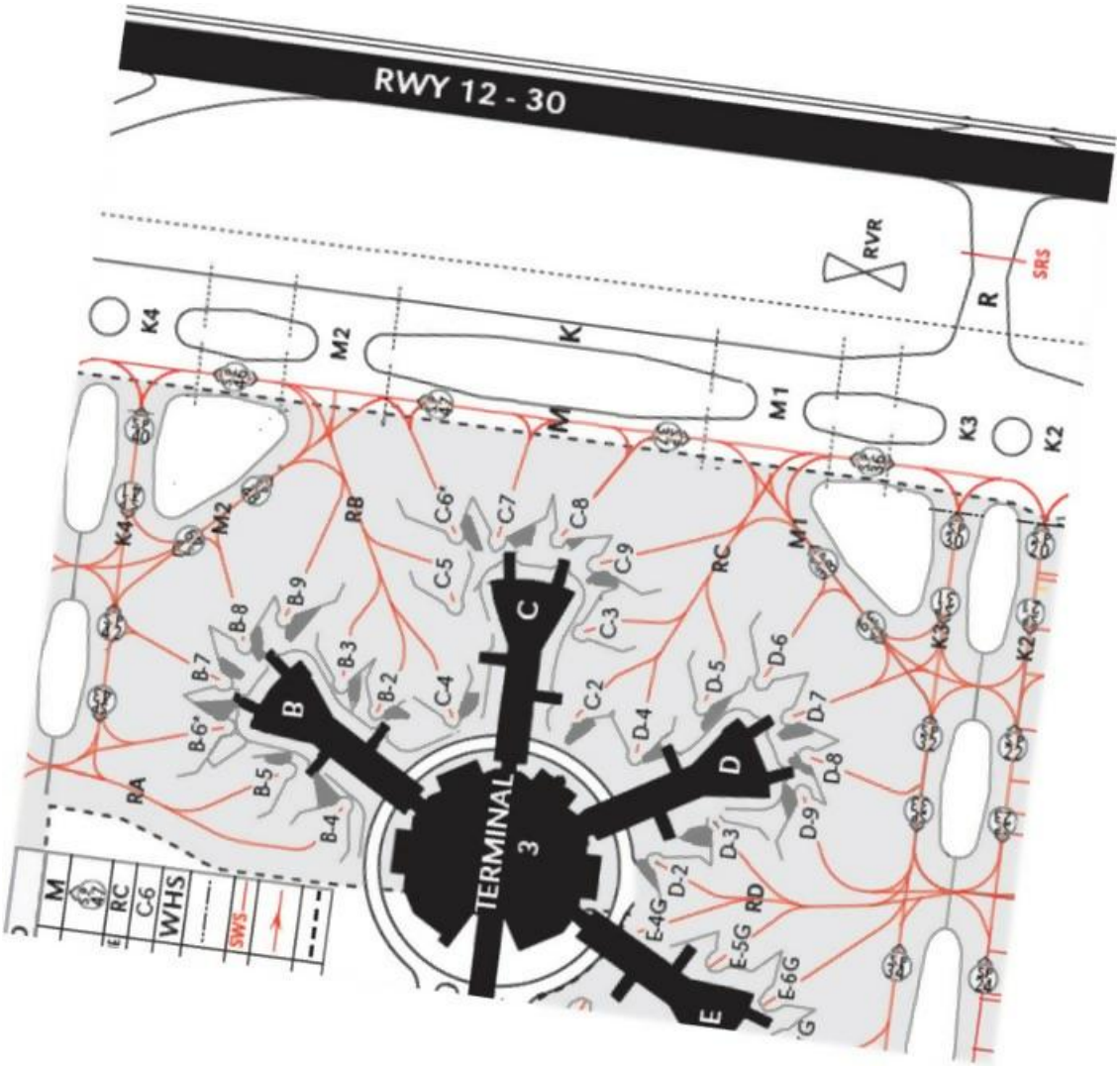
☒ **Runways – asphalt** (length and width in meters)

- ✓ Runway 03-21: 2,772 X 60 meters.
- ✓ Runway 12-30: 3,112 X 45 meters.
- ✓ Runway 08-26: 4,062 X 45 meters.

☒ The airport Diagram

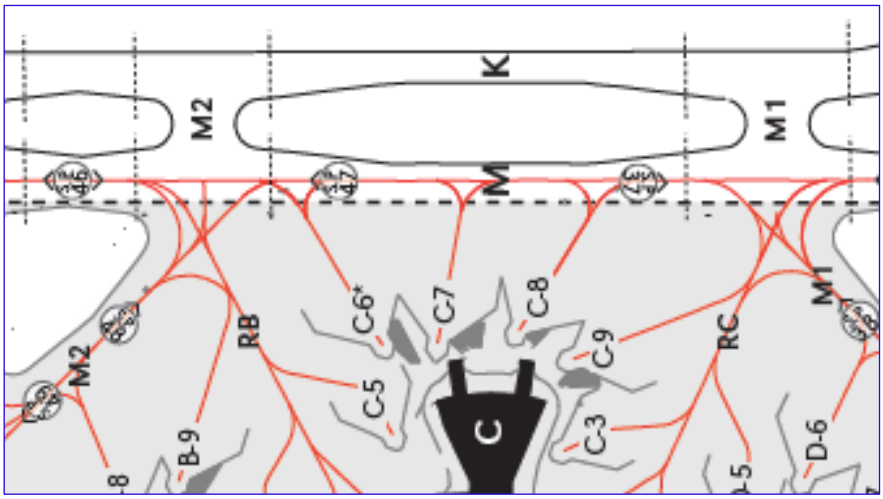


☒ **Diagram of the parking positions area and accident site**



☒ **Ben Gurion aprons**

At the time of the accident there were 117 parking positions divided among 12 aprons. Certain aprons are designated for certain aircraft categories and are sometimes being utilized under operational constraints defined in the procedures of the airport, tower and operations center. Gates are located only at the terminal 3 concourses.



Aprons at the accident area

Apron	Positions	Notes
Concourse B	8	At terminal 3, gate B6 designated for A340-600
Concourse C	8	At terminal 3, gate C6 designated for A340-600
Concourse D	8	At terminal 3
Concourse E	8	At terminal 3
WH (WHS)	9	Some of the parking positions have several parking alternatives depending on aircraft category (e.g. WH2, WH2A, WH2B)
EH (EHS)	9	Some of the parking positions have several parking alternatives depending on aircraft category (e.g. EH2, EH2A, EH2B)
H	13	-
J	13	Primarily serves terminal 1
L	6	Primarily serves terminal 1. Includes 3 Elal maintenance positions (K1, K3, K5)
BE	10	-
V1	7	Some of the positions have several parking alternatives depending on aircraft category
V2	18	Primarily for business jets
Q	-	Is not regularly used by air carriers
Total	117	-

☒ Ben Gurion aprons structure

Ben Gurion airport has several types of parking ramps, as detailed above table. These aprons have different features.

- ✓ L, J are parallel, straight and long ramps, their names stemming from the taxiway going through them.
- ✓ Ramps EHS/WHS on both sides of terminal 3, are also straight and long. Aircraft are parked parallel to each other, with aircraft nose on the western ramp facing west and the eastern ramp aircraft facing east.
- ✓ BE ramp at the airport's southeastern corner, near Maman cargo terminal includes parallel parking spots on both sides of the ramp.
- ✓ V1, V2 ramps are primarily assigned to business jets, which are parked in parallel, at V2 on both sides of taxiway VB and at V1 – on its eastern side only. Business jets are typically starting at the spot and taxi out on their own, without a pushback.
- ✓ H ramp has aircraft parked in parallel, on both sides.
- ✓ The parking gates around terminal 3 are oriented at various angles, as a function of the terminal's star shape.
- ✓ Some of the towing/pushback routes are very long and include turning arcs.

☒ Pushback management at Ben Gurion various ramps (see illustration):

- ✓ Pushback for engine's start is performed towards a start-up position marked on the ground. The SP's for ramps H/V1/V2/J/L/B, are located on the taxiways at their center. The typical maneuver for reaching a starting point includes a pushback out of the parking spot at 90 degrees and then a pushback or towing towards the designated point.
- ✓ In some cases, depending on traffic constraints, the pushbacks from these ramps might be more complicated, and include long routes with turns.
- ✓ Pushback from terminal 3 gates often requires a maneuver exceeding 90 degrees, including additional turns, direction changes and sometimes a long pushback.
- ✓ Some start-up positions are used frequently, while others are hardly used, due to their location.
- ✓ The SPs have serial numbers and directions of aircraft nose, which are mainly derived from the airport layout.

1.11 Recording devices

- ☒ DFDRs did not operate because aircraft engines were not operating.
- ☒ CVRs were not downloaded due to lack of contribution to accident deciphering.

1.12 Aircraft wreckage and ground impact

This was a ground accident during pushback.

The aircraft were found with their tails intertwined. The 767 a/c's horizontal stabilizer and elevator have penetrated the 737 a/c's vertical stabilizer and rudder. The investigating team did not examine the amount of damage and left it to the companies' engineers Vis a Vis the aircraft manufacturer.

Aircraft tail sections intertwined after the accident

1.13 Medical and pathological information

Irrelevant.

1.14 Fire

There was no fire as a result of the accident.

1.15 Survival

Aircraft passengers were evacuated to the terminal by mobile stairs and buses.

1.16 Examinations and research

☒ Pushback safety events have occurred in other airports and aprons and are not solely a LLBG problem. Several examples:

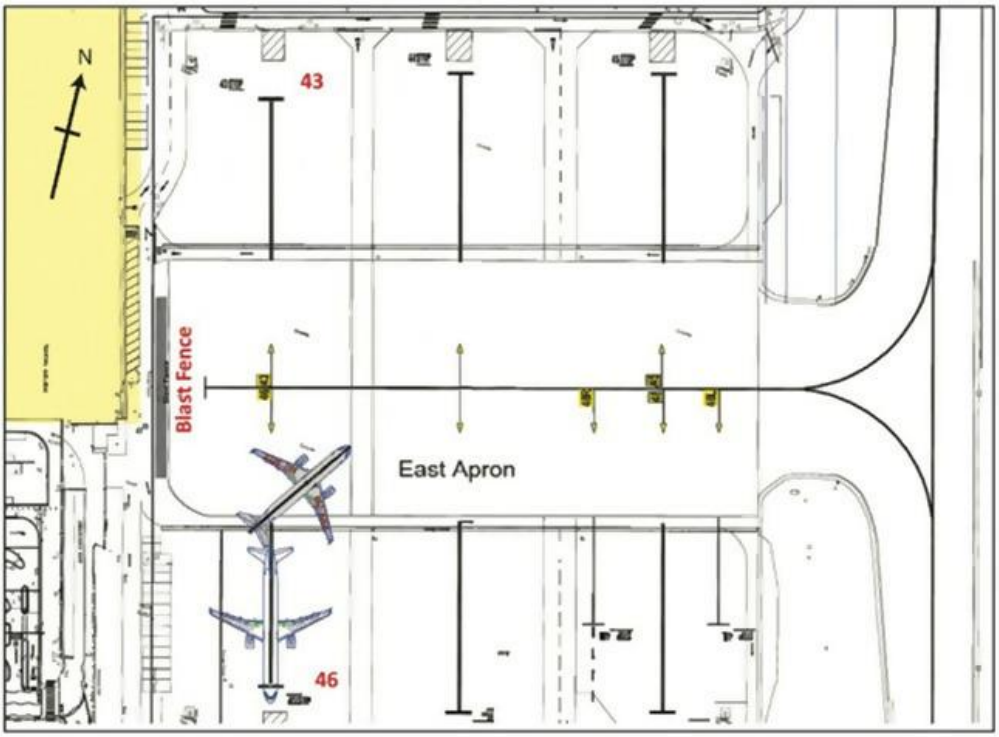
Example 1

- ✓ London-Luton international airport, UK, 30 May 2012.
- ✓ Aircraft: Two Airbus A320.
- ✓ Weather conditions: clear, low sun, shortly after first light.
- ✓ Damage: RH horizontal stabilizer of the impacting airplane and tail cone and APU of the parked airplane.

Description:

An aircraft was pushed back, began turning towards the apron axis, but the tow driver misjudged the axis position and pushed the aircraft beyond it. After turning about 40 degrees, the tow truck stopped and began pulling forward. The RH horizontal stabilizer promptly impacted the tail cone and APU of the other airplane of same model, which was parked at a parking position.

The tow driver's complete attention was directed to the proximity to a fence on the airplane's LH side. He misjudged the position of the apron center line and did not pay attention to the RH side where the other airplane was parked.

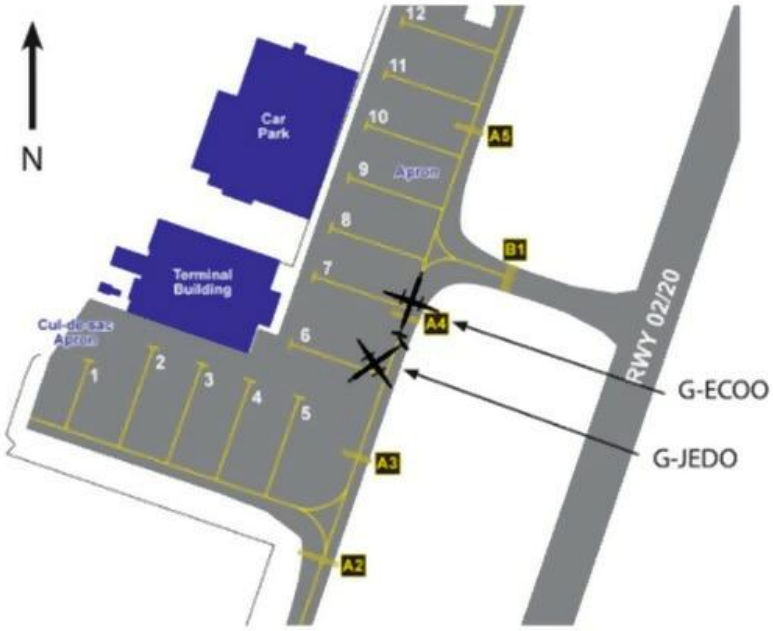


Example 2

- ✓ Southampton international airport, UK, 16 Jan 2012.
- ✓ Aircraft: 2 DHC-8.
- ✓ Weather conditions: shortly after first light, just prior to sunrise, CAVOK.
- ✓ Damage: RH elevator and tail cone (not specified which aircraft).

Description:

A serial terminal, supposedly contributes to reduction of problems. An aircraft was pushed from parking position 9 to start-up position A4, disengaged from the tow vehicle and began the engines start process. It was a non-standard pushing in order to enable a Jetstream aircraft parked at position 11 to taxi for holding position B1 and then to the runway. At this stage the Dash 8 in position 6 requested clearance for pushback and was told to standby. The Jetstream received a taxi clearance to holding position B1 and from there to the runway. The controller then cleared the Dash 8 for pushback from position 6. The "headset man" hand signaled the towing direction to the tow truck driver and positioned the wingtip walker to the south of the airplane. The controller asked the first Dash 8, which was during engines start up in start-up position A4 whether they are ready to taxi. He was told that they will be ready within 30 seconds and told them to please taxi to holding position B1 when ready. At this stage the Dash 8 of position 6 began the turn and the wingtip walker left for another task. During the turn, with the aircraft at a heading of about 220, the airplane slowed down and stopped. The "headset man" requested the captain to confirm that the parking brakes are not engaged, because at that time nobody has yet realized that a collision has occurred.

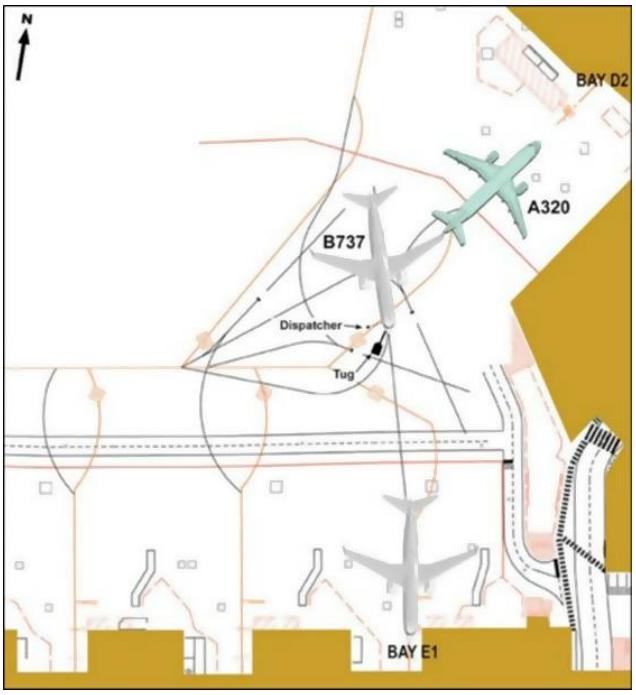


Example 3

- ✓ Melbourne international airport, Australia, 10 Aug 2013.
- ✓ Aircraft: Airbus A320 and Boeing B737.
- ✓ Weather conditions: clear and lucid.
- ✓ Damage: B737 winglet and A320 tail cone.

Description:

The A320 entered parking bay D2 by means of automatic guidance system (NIGS), which instructed it to hold short of the gate. The 737 requested pushback clearance and was told by the controller that they are cleared for pushback once the A320 taxiing behind them entering bay D2 will stop at the gate. The 737 captain conveyed the message to the tow truck driver and notified the controller that he saw the A320 passing behind them, by means of a reflection in the terminal windows in front. This message was not received due to concurrent radio transmissions. The tow truck driver managed to see the A320 and noticed that it stopped, assumed it is already at the gate and without actually having eye contact with the 737 LH wing tip, began pushback until the winglet impacted the A320's tail. None of the involved personnel has reported his position in the various communications.



The investigating team has requested and received from the UK AAIB additional data associated with examples 1 & 2, as well as other safety events during pushbacks. From the AAIB data it turned out that in Britain alone there were 7 pushback accidents between 2007 and 2017. The direct and indirect damage from those events was huge and the damage potential was even higher: In some of the cases the APU was impacted, so that there was a clear and tangible risk of combustion, injuries and casualties because of fire, smoke and passengers panic.

☒ Immediately after the investigated accident, the number of safety reports regarding pushback events at Ben Gurion has increased drastically, probably not because the number of events has increased objectively, but rather due to improved awareness of mandatory reporting as a preventive measure. It can be reasonably assumed that the actual number of events has decreased, not increased, due to a temporary order issued by the airport manager. In 3 months since the beginning of 2018 and until the accident, 3 events were reported, while in the subsequent 8 months more than 90 safety events related to pushback and taxi at the aprons were reported (an apparent 10 fold increase).

Ben Gurion pushback events from beginning of 2018 until 12 Nov 2018				
Pushback without any clearance	**Pushback and proximity to a parked airplane – change of SP in real time**	**Controller error in allocating SP**	**Tow error - pushback to a wrong SP**	**Pilot error in conveying SP to the tow crew**
4	**13**	**5**	**66**	**9**

☒ Summary

In the investigated accident, as well as in the above examples and in most other events found by the investigating team, the towing crew did not see the other aircraft and did not stop the pushback until the impact, in some cases even when a wing walker was present. In some cases, the tower ground controller did not see the emerging conflict, and in at list one case he did see the conflict – but failed to prevent it.

The apparent insight is that control of push backs is challenging and complex, even under excellent visibility conditions – it is performed with the captain not seeing what is happening, does not have complete situational awareness and is not involved, the tow crews are relying on other elements involved in the process. The factors affecting such cases beyond the specific circumstances of each accident are ground infrastructure, environmental conditions, operating and towing procedures, along with the competency of the tow crews.

1.17 Managerial and organizational information

Ben Gurion pushback/towing procedure

Different airports and companies define the tow/pushback supervisor (herewith: "**tow supervisor**") in different ways. Sometimes this is the tow truck driver and sometimes the person who is in contact with the captain. Regarding the investigated accident:

- ✓ Ben Gurion ground operations division procedure number 8-560-01/22 defines the towing process in aspects of presence of a tow supervisor, wing walkers (when required), and the conditions required for towing aircraft at Ben Gurion.
- ✓ Towing aircraft at Ben Gurion is performed by handling/ground services companies and/or Elal.

- ✓ Except for Elal, the other companies conducting towing and pushback do not have sufficient number of employees qualified for RT, such that they will be eligible to operate an aviation radio transceiver and conduct towing without a pilot in the cockpit. In such cases, Ben Gurion Operations are accompanying the towing on site, coordinating with the tower on F1 channel in "Tetra" network, which is separate from the communication network between the tower and pilots.
- ✓ Some of the ground services companies have 2 separate towing crews - One which is authorized to push aircraft back from the gates to start-up positions (does not require RT qualification), while the other is authorized to tow between terminals or between gates (does require RT). This segregation is because not all tow crews are fully familiar with the operational area in aspects of taxiways, runways and starting points and most crews are not RT qualified. Under such circumstances, Ben Gurion Operations are required to accompany the towing and communicate with the tower.
- ✓ Every company conducting tow operations defines the towing supervisor in a different manner. At some companies, the tow truck driver acts as the towing supervisor, while at others this is the company's ramp supervisor or a technician.
- ✓ The towing supervisor is not always familiar with the taxiways map and the start-up positions' location. Sometimes he is defined as the towing supervisor solely because he is the one communicating with the pilots.
- ✓ About 2 years ago, the engine of an aircraft impacted a baggage container while being towed into gate C8. It resulted in a directive that a Ben Gurion Operations' apron supervisor will approve and accompany every entry of a towed airplane into a gate in terminal 3 at the end of a towing, in addition to escorting every airplane taxiing into a gate. Elal received an exemption from entry clearance to a gate position at end of a towing.

<u>Ben Gurion pushback for departing flight</u>

- ✓ Ben Gurion ground operations division procedure number 8-560-01/22 defines and details the pushback process from a gate and the requirements for execution. The procedure dictates presence of a towing supervisor and wing walkers, when required. Regarding the investigated accident:

- ✓ The pilot requests pushback clearance, the ground controller clears for pushback and engine start, and specifies the start-up position and the nose direction (Facing). For instance:

  Austrian 860v pushback and startup is approved release point 48 facing north
- ✓ The pilots convey the instruction to the person on line communication with them by means of a headset plugged to the aircraft. Mostly this is not the tow truck driver, rather the ramp supervisor/technician, and he is conveying the message to the tow truck driver. It is possible that the individual talking with the pilots does not know the start-up positions, does not have the apron map and essentially is only transferring the message to the tow truck driver.
- ✓ Whomever performs the towing/pushback is responsible to position wing walkers, according to the procedures of the airline and the airport, if the conditions so require. Wing walkers are required for pushback in congested area, if an airplane is parked near another airplane or in an opposite position (Procedure 8-560-01/22, paragraphs 6.14.1, 2, 3).
- ✓ Elal is authorized to do the wing tip supervision by a person in a vehicle and not by a wing walker below the wing.
- ✓ A directive was published recently dictating that when departing a gate position in terminal 3 at darkness, an observer should be positioned so as to see the whole towing path until reaching the start-up position and exiting the safety hazard areas. He should be in continuous contact with the pushback/towing supervisor.

<u>Towing crews training process</u>

- ✓ The towing crews are trained by the companies for towing, pushback or apron management.
- ✓ In recent years Ben Gurion Operations have been training employees of the airlines and ground services companies in familiarization with the operational area and start-up positions. Such training is provided upon a company's request or at times set by Ben Gurion operations manager.
- ✓ The locations and numbering of the start-up positions are being modified occasionally. Several SPs were added during 2018. Some of the SPs are difficult to reach or return from and therefore seldom used, for instance SPs #30, 31, 36, 40, 41, 46. Using these SPs necessitates the towing crew to cross taxiways without radio communication with the tower.

Ben Gurion Operations

- ✓ Ben Gurion ground operations employees are working as "Marshallers" at the operational area for durations of 3 hours in a shift and also work in operations tower, controlling the operational area, in 3 hours shifts. They are all RT qualified. Those stationed at the minitower are in continuous Tetra communication with the marshallers patrolling the operational area and the aprons in the "Follow Me" vehicles. They regularly receive field reports about availability status of aprons, flights on the ground and timing of releasing occupied positions.
- ✓ The location of the operations tower, along with the continuous communication with the ground service companies provide Ben Gurion Operations personnel with broad and available angle of view and control span of part of the area and some of terminal 3's gates.
- ✓ In the past, a test was planned to evaluate operating an apron area by Ben Gurion Operations. The test was suspended a week before the scheduled date, was shelved and its processes were never tried.

1.18 Other information

Apron management systems

Definitions

Aircraft Parking Ramp (Apron) – A specified area in an airport used for parking aircraft, passengers boarding or deplaning, equipment and goods loading and unloading, refueling and maintenance.

Apron Management Services – A service for regulating activities and synchronization of aircraft and vehicles traffic at the aprons.

Maneuvering Area – The portion of an airport designated for aircraft taxiing, takeoff and landing, excluding aircraft parking areas.

Movement Area - The portion of an airport designated for aircraft taxiing, takeoff and landing, including the Maneuvering Area and aircraft parking areas.

Air Traffic Management Service (ATM) – A service provided for preventing aircraft collisions and collisions between airplanes and obstacles.

Note: The task of providing ATM service at the apron can be assigned to the control tower or to a separate unit (Annex 11, chapter 3, paragraph 3.2(c)).

Clarification: This report only presents the relevant parts of the definition in Annex 11. According to ICAO regulation, managing operations of aircraft at aprons, including areas for aircraft loading, unloading, refueling and maintenance, may be managed by a control tower or alternately by another entity at the airport. The runways and taxiway areas should of course be under the exclusive responsibility of the control tower.

Various ways for managing traffic on the aprons

- ✓ Apron traffic management by ground controller, as is common at Ben Gurion and numerous airports worldwide (Los Angeles, London).
- ✓ Apron traffic management by a dedicated apron unit, as is common at numerous US airports (New York, Newark, Miami) and in several major European airports (Paris, Munich).
- ✓ Mixed method – some ramps managed by a ground controller and some by a dedicated apron controller.

1.19 Investigation technique

- ✓ The accident investigation was led by the Chief Investigator and a team of investigators, with participation of observers from the involved Israeli entities (Israel Airport Authority [IAA]/Ben Gurion airport, Elal, Laufer ground services), and in coordination with the European entities: BFU, EASA, Germania.
- ✓ Aircraft DFDRs were not operating prior to engines' start. CVR recordings of both aircraft were not relevant.
- ✓ The investigating team used transcript of recordings from frequency 118.05 "ground west".
- ✓ The investigating team conducted several reconstructions, at the same time of day and similar weather conditions, including on the day following the accident, in order to understand the objective circumstances as thoroughly as possible. The reconstructions were based on video clips from 2 security cameras capturing the accident and the preceding events from 2 different directions.
- ✓ A week after the accident a reconstruction was made a with a random B737 departing gate C8 at the same time of day. The Chief Investigator personally observed, from the tow truck cabins, pushback operations of a B737 and a B767.

- ✓ Dynamic graphic illustrations were made from external points and primarily from the points of view of the involved towing crews, based on data gathered.
- ✓ The investigating team has visited the tower several times under similar environmental conditions, with an emphasis on the ground controller station, and evaluated the angles of view from the station and the instrumentation available to the controller for performing his task.
- ✓ The investigating team reviewed the relevant procedures for management of aprons, taxiing and towing processes – at various levels: international, national, Ben Gurion, companies and handling agents.
- ✓ The Chief Investigator studied the relevant policies, attitudes and norms in discussions with the airport manager and other senior managers at the airport.
- ✓ The investigating team dived deeply into the specific event, putting a primary emphasis on the whole background factors and norms of aircraft towing/pushback at Ben Gurion and on comparing them with leading airports in the world. The expanded investigating team has realized and internalized the necessity of dealing with the situation and improving it, through professional assessment of alternatives and options, some of which are utilized in other airports.
- ✓ The main addressees are the airlines. They are responsible for aircraft pushbacks, they should ascertain that the ground services companies are implementing the airlines' responsibilities. Ben Gurion airport management, although is not the primary and certainly not the sole address for dealing with the issue, has realized that it should act beyond its formal responsibilities, and initiated activities including impression of its team from several overseas airports.
- ✓ During the investigation there was a continuous communication of inquiries and consultation with the airport management and with relevant entities in Israel and abroad. Its outcome was understanding and concurrence regarding the causes of the accident and mainly regarding the required corrective actions in order to enhance safety, at immediate, short and long ranges, in Ben Gurion as well as in other airports. These actions are necessary due to the built-in hazard potential and the common norms, and should be focusing on correcting by the safety approach.

- ✓ On 18 April 2018 the Chief Investigator has published a preliminary report at an internal distribution. It included safety recommendations for execution by Ben Gurion management. The ongoing professional contact with Ben Gurion has contributed to focusing the insights and recommendations and enabled conducting safety measures already during the investigation.
- ✓ On 7 March 2019 the Chief Investigator sent a draft of the final report to the following foreign entities: German investigating authority (BFU), US investigating authority (NTSB), Germania airline (via the handling company), Boeing company and EASA.
- ✓ After receiving all the responses sent to the Chief Investigator, the final report was written and is submitted herein.

2. Analysis

Ben Gurion airport is operated by Israel's Airport Authority (IAA).

Airlines operating at the airport include Israeli companies, such as Elal, Arkia, Israir, C.A.L and over a hundred foreign airlines. Elal has a ground services array, while most other airlines are using ground service providers, such as Laufer, QAS & Aerohandling.

The overall responsibility for events at Ben Gurion is of the airport's management and it should be noted that the management is taking it very seriously and takes responsibility even beyond the written requirements.

There is uncertainty at almost all involved regarding the responsibility for operations at the aprons. It is absolutely clear that the pilot taxiing the aircraft on the ramp is under the full responsibility of the airline – it is training the pilots and is supervising their competency. This subject is entirely clear and no one wonders whether the management of Ben Gurion or of any other world airport should be involved in pilots' training, creating check lists for them or checking their professional competency.

The responsibility of towing drivers and ramp supervisors is apparently similar to that of pilots, as they are also moving aircraft on the aprons. However, during the investigation it was found that their responsibilities are not clear. When a controller provides instructions to a pilot does not create a feeling that responsibility was taken from the pilot and transferred to the controller, or to his employer, i.e. IAA. By the same token, an instruction by a controller or a pilot to a tow driver or a ramp supervisor does not transfer the responsibility from the driver or supervisor to the controller, pilot or their employer.

The airline is responsible for a pilot demonstrating low competency. The same applies to a tow driver or supervisor showing low competency. An airline using a ground services company as a subcontractor must verify that the responsibility will be implemented by the subcontractor.

Ben Gurion management will and does restrict or prevent operations of an airline whose pilots demonstrate low competency and create safety events, without corrective actions by the airline. The management can act in the same manner towards an airline whose ground crews, or ground crews on its behalf are creating safety events without corrective actions. As was already mentioned, Ben Gurion management is doing the maximum, through its senior managers' understanding of their inherent responsibility for the airport safety. At the same time, what is not defined as its responsibility should not be projected as such.

☒ The accident analysis is divided into several parts:

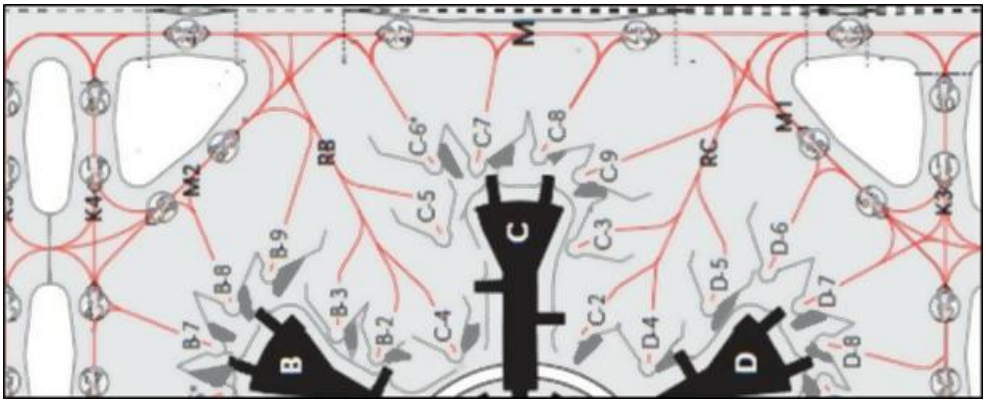
- ✓ Circumstances and conditions leading to the accident.
- ✓ The human factor.
- ✓ Apron infrastructure, regulation, work norms and methods, procedures.
- ✓ Procedural and technological solutions.

2.1 Circumstances and conditions leading to the accident

➢ **Accident arena**

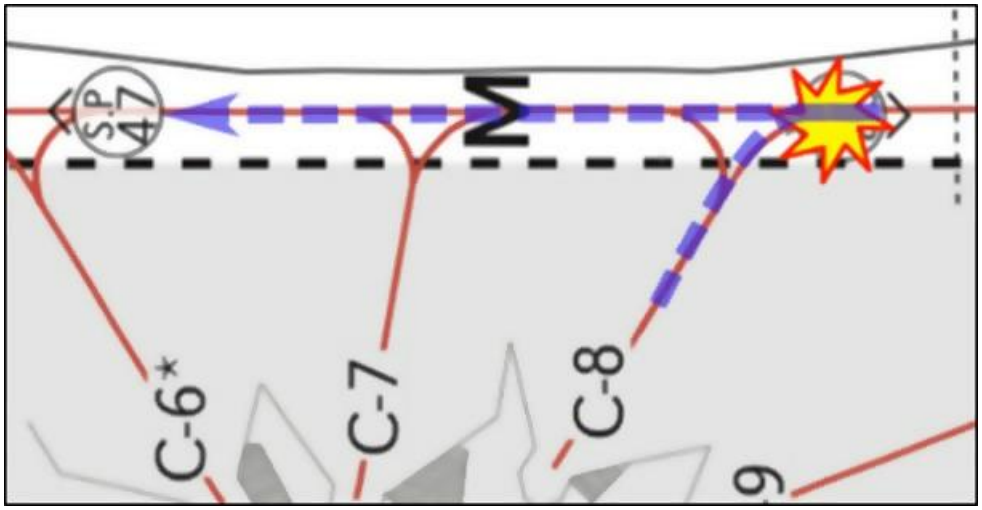
Ben Gurion terminal 3 aprons (ramps B, C, D, E) are located in an area between the concourses of the star-shaped terminal, thus causing complexity in the inner positions (those nearer to the base of the arms), where the spaces between gates are smaller compared to other ramps and the angles between adjacent positions sometimes limit the field of view of operators. Additionally, in some cases the pushback routes from these gates to the start-up positions are complex and relatively long, sometimes up to several hundred meters.

Terminal 3 concourse C northern tip includes several gates marked C6 through C9, from east to west. Aircraft pushed from these gates are typically served by starting points SP37 and SP47, which are on taxiway M and sometimes by adjacent starting points such as SP48. SP37 is defined as one where the starting aircraft is facing east, while at SP47 the aircraft starting is facing west.



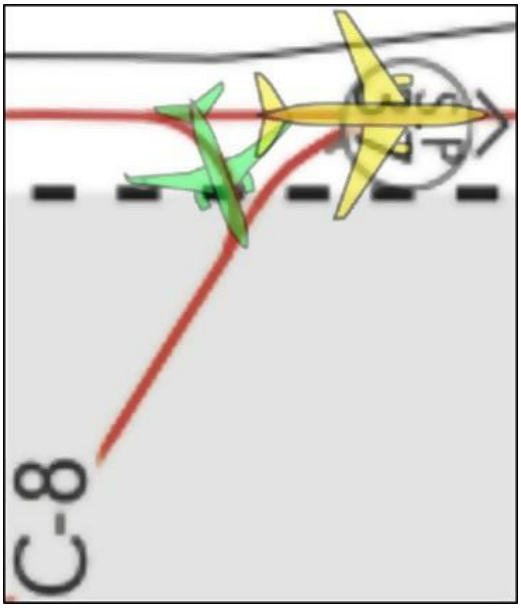
The start-up positions on the illustration represent the aircraft nose wheel location. Consequently, for instance, the fuselage of an aircraft starting at SP37 is practically blocking the turning point of aircraft pushed back from gate C8, regardless of his destination SP. Similarly, a pushback from C8 to SP47 requires getting onto taxiway M, pushing with the tail facing east until aligning with M centreline, and then pulling westbound to SP47. During the alignment on M, the pushed aircraft is within the area of SP37.

Potential conflict during pushback from C8 to SP47



The illustration demonstrates that when pushing from C8 to SP47 there is a conflict with SP37 if an aircraft is located there, since the tail is intruding SP37 and the aircarft starting at SP37 is blocking the turning point.

Potential conflict in pushback from C8 to SP48



Pushback to SP48 does not require a heading change, just a turn, but can bring the pushed aircraft to hazardous proximity to the aircraft starting at SP37.

The taxiways and the entry lanes to the starting points are marked by yellow lines. Taxiway M centreline, as well as the other taxiways, has green centreline lighting, controlled by the tower. There is no centreline lighting along the entry lanes to the gates. The yellow line is fairly visible under daylight and dry weather conditions. It is more difficult to see at night and in a rainy night the tow driver is straining his eyes and is entirely focused on tracking the hardly visible lines, and is almost unable to pay attention to searching for potential obstacles and/or other aircraft on the pushback path.

Obstacle avoidance is the main task of the tow supervisor, but the driver, being a member of the team and the one actually pushing the aircraft, is an additional pair of eyes looking for obstacles and verifying that the pushback route is clear. When he is strained to the limit in his driving task, he has no significant ability remaining for serving as such additional pair of eyes. The airport lights are generally intended for the flight crews, so that their locations, intensities, directions and colours were determined accordingly.

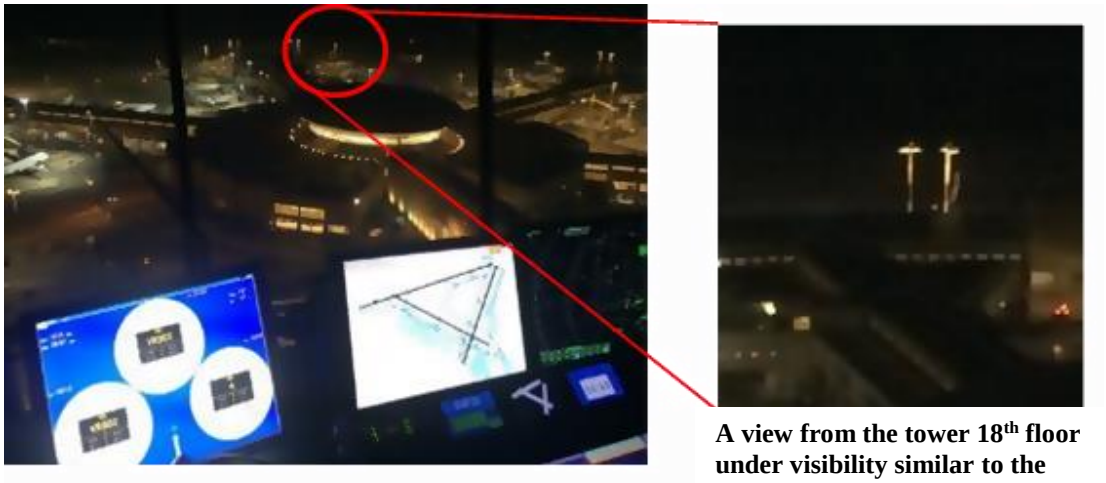
The aprons flood lighting enables good visibility in darkness or poor weather, but is also causing reflections, and the un-illuminated centerline markings are hardly visible to the tow vehicle driver.

Parking ramp lighting and guidance lighting are mentioned in ICAO's Appendix 14, Volume I, paragraph 5.3.27. It includes a recommendation to install such lights in places which will be utilized under limited visibility conditions. The lighting is specified as steady yellow lights, located on the manoeuvre axis marking. The distance between lights should not exceed 7.5 meters in turns and 15 meters in straight segments. Ben Gurion parking ramps do not meet this criterion and hence centreline lighting is not mandatory.

- **Environmental conditions**

On the morning of the accident, before first light it was dark and rainy. Visibility was reasonable for aircraft operations, but none of the aircraft pushed had wing walkers. Because of the rain, the escorts of both tow crews have huddled in the cabins together with the tow truck drivers. Visibility was reasonable, but from inside the cabins it was limited, considering the rain drops on the windows and maybe vapour condensation, to an extent. The drivers had difficulties in seeing the markings on the wet surfaces, which are sometimes hard to see on a sunny day. The escorts essentially saw nothing.

Seeing an aircraft fuselage parking at gate C8 or C7 was difficult even at noon on a summer day. The aft section of a large airplane could be seen, while for small aircraft, such as B737 only a small portion of the tail tip was visible. The aircraft could be seen clearly only after it was pushed back a substantial distance. In darkness it is much worse and it takes a substantial effort to see the tail navigation light of the airplane at the gate. In darkness and rain, and certainly in fog it is almost impossible for the controller to see an airplane at these gates.



A view from the tower 18th floor under visibility similar to the event's conditions, but without rain

Aircraft parked at the end of the concourse are facing the tower, thus practically preventing from seeing the passengers' windows.

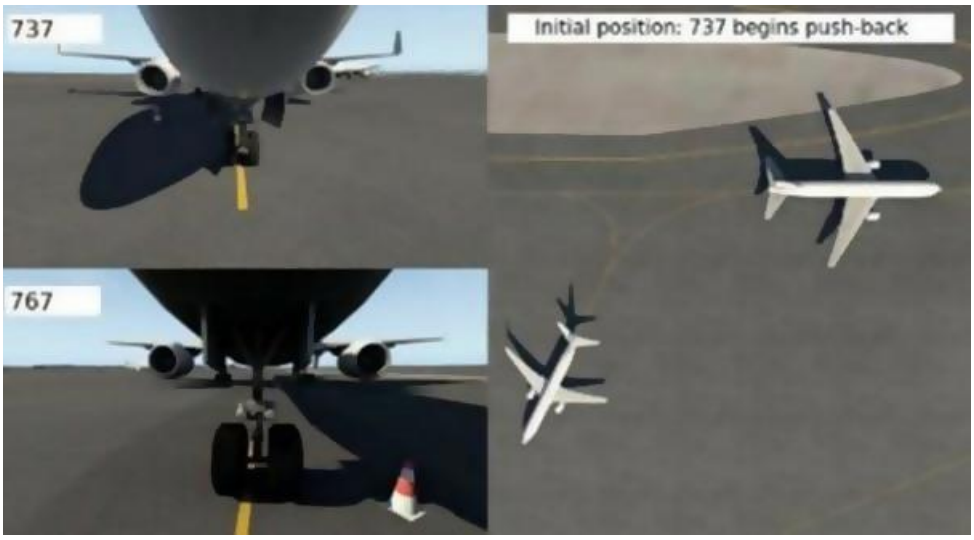
Controller eye contact with taxiing aircraft is not a prerequisite for airport operations. Aircraft may be moving in or exiting from ramps which are remote or not visible to the tower. In some cases, such as low clouds base or degraded visibility the airport can continue operation with auxiliary systems and radio communication.

Regarding A-SMGCS system, due to its defined restrictions it does not show movements near the terminal on the controller's monitor. Since that area is not clearly visible from his position, he has to construct a mental-procedural image in order to manage the ground traffic.

- **Tow crew field of view during pushback**

  The tow driver's field of view is limited: The tow truck connects with the nose landing gear by means of a tow bar or by wrapping and lifting (TBL). Either way the tow truck is very close to the nose gear, which blocks a certain sector of his field of view, a sector which is sometimes significant. In low aircraft such as B737 the aircraft belly and engines further reduce the operator's field of view. With higher aircraft such as B767 the view is broader. In order to overcome the restricted view and see directly forward, the operator is sometimes executing "S" motions. Concurrently the escorting person is supposed to move aside in order to obtain a larger field of view of the area forward and to have continuous eye contact with the wing walkers, if present, especially when there are obstacles on the sides.

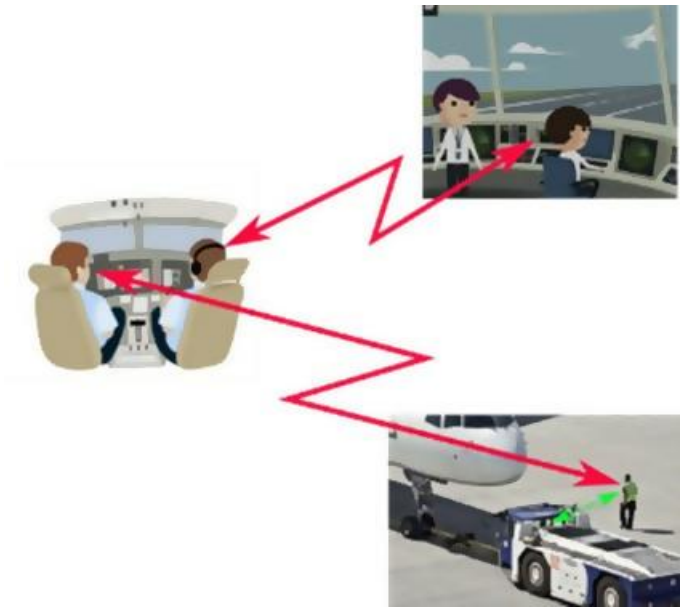
<u>Depiction of fields of views from both tow truck cabins</u> - before impact



- **Tow crews' management**

  <u>The rule</u>

  From the moment that the aircraft commander (captain), after being cleared by the ground controller, has confirmed that the brakes are released and has cleared the tow crew for pushback, the ground crew tow supervisor is responsible for the whole pushback. IATA Document Ground Operations Manual (IGOM) ,Supplement to Airport Handling Manual, paragraph 4.12.9.3.(a) specifies: at departure the ground crew leader will be responsible for the whole pushback procedure, from the moment the flight crew has authorized the pushback.



The B737 a/c pushback crew

The crew was led by the tow truck operator (according to "Laufer" company procedure). Due to the rain, both crew members huddled inside the driver's cabin, which enabled direct communication between them instead of hand signals. The ramp supervisor, the "earphones man" per Laufer's definitions was in direct contact with the captain by means of his earphones plugged into the aircraft socket. He was supposed to accompany the pushback at a position enabling him to control the process and a field of view which includes the pushback area, the wing tips and the tractor driver.

As previously mentioned, they were both in the driver's cabin. On one hand it enabled prompt exchange of information regarding the changing of the start-up position and allowed for time to confirm the change with the captain, since both of them wondered about the change. On the other hand, being huddled in the cabin made it difficult for both of them to see outside.

The B767 a/c pushback crew

The crew was led by the Elal technician, who had earphones in contact with the captain. He was transferring information to the tow truck driver. The tow supervisor was also sitting in the tow truck cabin.

Elal sometimes uses an additional escorting vehicle. It has a technician whose main role is solving minor technical issues during engine start, but he is also acting as an additional pair of eyes when moving out of congested areas, instead of wing walkers. In the subject accident this vehicle has left the pushback after the aircraft was out of the gate area.

Supervising towing crews with both crewmembers seated in the tractor cabin, is substantially limiting the crew's ability to detect threats or obstacles along the pushback route. The tow crew is focusing on the technical task of pushing the aircraft to the start-up position, and not enough attention is being paid to maintain safety during the pushback process. The tow crew is assuming that the controller's instructions, conveyed to them via the pilot were indeed transferred to them accurately and are based on a reliable ground situational picture. They are also assuming that the controller is seeing everything and has a continuously accurate and reliable situational picture.

Summary

A cornerstone of aviation safety is cross/double checking.

Primary paragraphs in company procedure 8-560-01/22 were not performed in the subject event, and apparently are not being complied with at all. The procedure mandates a briefing before pushback. Even if the B737 tow crew did conduct a briefing, the fact that the controller changed the start-up position during the process has practically negated the majority of such a briefing.

The current procedures require to conduct a briefing before any pushback, including mentioning of potential risks. Changing a start-up position during a pushback is not prohibited, and if it has been used, it was probably necessary. It is almost impractical that in case of change of start-up position during a pushback, the whole process will be stopped and a briefing will be performed again. Therefore, the initial pre-pushback briefing should review the various alternatives, which are not many, and the towing crew should not only be prepared to execute them, but should also know the associated hazards. Under any condition, the towing crew is primarily responsible for the towing safety, with an emphasis on avoiding obstacles.

Laufer's procedure "Moving an Airplane from a Parking Position" has a contradiction in paragraph 5.4 definition of the towing supervisor and his roles, including maintaining proper two-way communication with the air crew. In reality the communication is performed by the ramp supervisor – the "earphones man" in Laufer terminology, who is not the towing supervisor. The procedure requires the "earphones man" to be at a safe distance from the tow vehicle and from the aircraft. In certain cases, he may stand at the designated place beside the driver on the tow vehicle and hold the guard rail (paragraph 26). In the subject event the "earphones man" was sitting with the driver inside the tow vehicle cabin, in violation of the procedure.

Example of correct actions by a tow crew

Prior to push back, the ramp supervisor goes out and stands outside of the tow vehicle cabin, to obtain maximum field of sight

2 tow crew members huddling inside the tow vehicle cabin, waiting for the pushback to begin

- **Ground traffic management by the tower**

  Ben Gurion airport ground traffic, including at the aprons, is managed and supervised by a ground controller at the tower. Communication is conducted on 2 frequencies – Ground East 129.2 and Ground West 118.05. All the communication of terminal 3 ground traffic is on Ground West frequency. Ground East frequency is also used for providing departure clearance to aircraft which are unable to receive information via data link.

  The controller's role is to regulate the traffic of incoming and outgoing aircraft while strictly maintaining safety, so as to prevent conflicts or hazardous situations between taxiing aircraft and pushed/towed aircraft.

  The ground controller should provide a pushback clearance only when the aircraft is pushed to a clear area and the process can be completed safely.

Controllers sometimes give a "conditional clearance" to push back subsequent to crossing traffic. In such a scenario, the responsibility transfers to the towing supervisor, who should verify that the condition for pushback is fulfilled.

The controllers typically inform aircraft about other adjacent aircraft which might pose a risk. Although the controller should make sure that his clearance meets the safety requirements, the flight crew or the towing crew, as applicable, should have their own image and should not solely rely on the controller's instructions. The flight crew's ability to detect obstacles during pushback is very limited and should not be anticipated. However, there are situations and circumstances in which an alert flight crew might detect a clearance to an in-correct point or being towed to a wrong point, etc.

In the subject event the ground traffic at terminal 3 area was managed by a controller on Ground West channel, 118.05. He was receiving calls from aircraft requesting pushback after cleared for departure via data link or on Ground East channel, 129.2.

The ground controller's station has an electronic flight strips' system (EFS): Each aircraft on the frequency has a strip, which includes data about the flight, including the gate.

The 767 a/c crew has initially called Ground West for clearance and was transferred to Ground East. After issuing the departure clearance, the Ground East controller transferred the pilot back to communicating with Ground West for pushback and start clearance. After a brief waiting, Ground West controller gave the 767 a/c a pushback clearance to SP37, facing east. It should be noted that the pilot mentioned his gate while requesting the pushback clearance. The controller repeated the gate in the pushback clearance and the pilot read back the clearance including the gate, as required.

The 737 a/c pilot mentioned his gate when requesting pushback and the controller instructed him to standby for clearance, since he knew that an Elal airplane was about to pass behind him for entering gate C7. More than 5 minutes later and following numerous communications with other airplanes, the controller called the 737 a/c and gave him the pushback and start

clearance, without specifying the parking gate. The 737 a/c pilot repeated the clearance and also did not specify the gate from which he was to be pushed. The controller claimed that throughout the process he was fixated on the 737 a/c 's gate as C7 and not C8 – despite the fact the several minutes earlier an Elal B737 on flight 314 was cleared to enter gate C7. It should be emphasized that debriefing the EFS shows that the 737 a/c was properly marked in gate C8 throughout the process.

The controller has initially instructed the 737 a/c to be pushed to SP48, which is further and is intended for starting with the aircraft facing east on taxiway M2.

During the pushback, about 30 seconds before the collision the controller changed the instruction and the SP to SP47, in which the aircraft is facing west, in order to enable pushing another aircraft which in the meantime called and requested pushback.

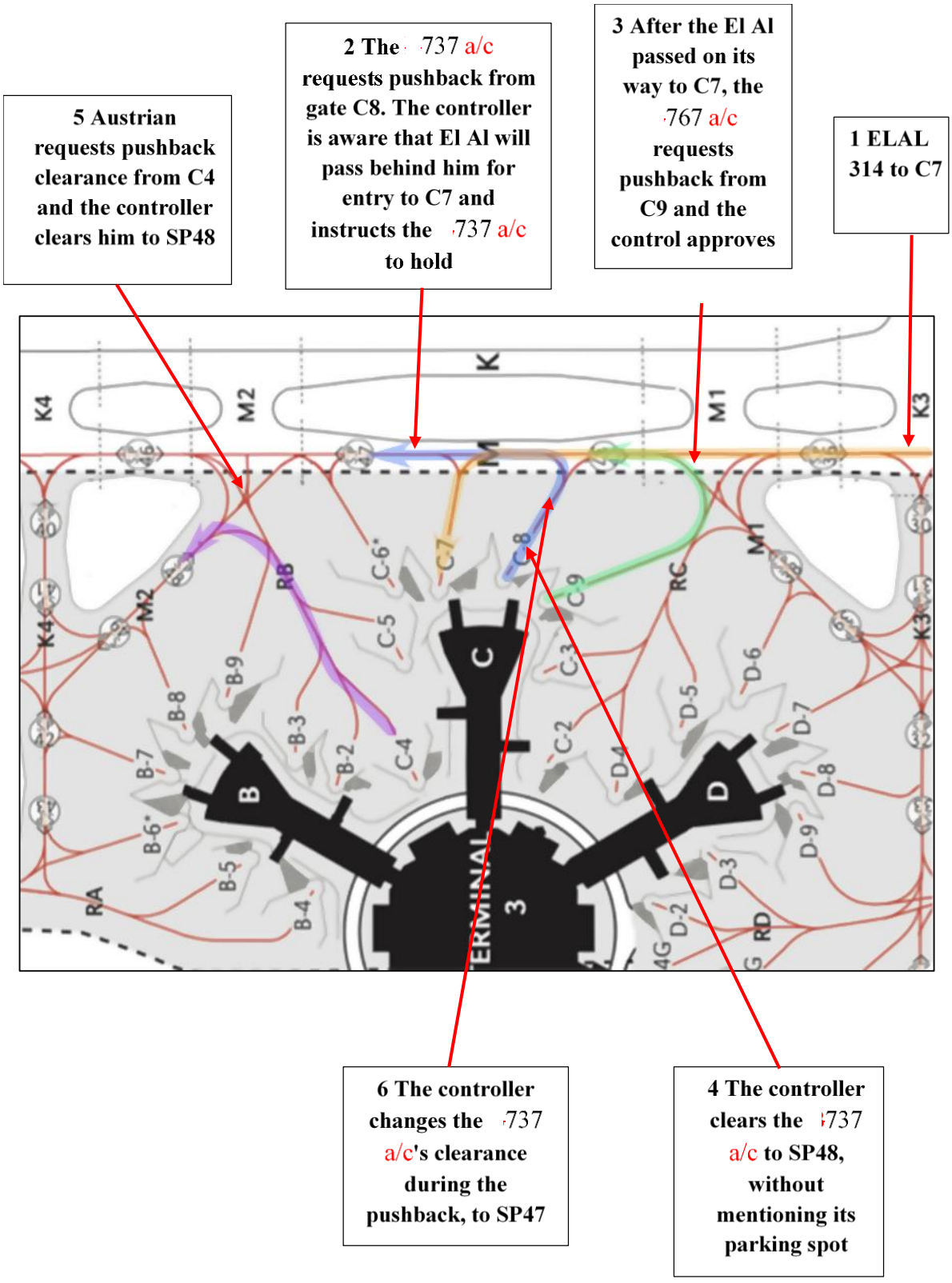
As mentioned above, any pushback from gate C8, either to SP47 or to SP48 actually creates a conflict with an aircraft starting at SP37 and therefore should not be executed concurrently. It can be concluded that this conflict was enabled by the controller's fixation that the aircraft was parked at gate C7.

It should be further noted that the starting point change at a relatively late stage of the pushback has precluded the possibility to brief the towing crew about the route change and there was hardly enough time for transferring the information from the pilot to the tow supervisor.

In order to have a complete picture of aircraft movements the controller's work is combining looking outside at the aprons and taxiways, watching the A-SMGCS ground radar system and observing the electronic strips system. As noted above A-SMGCS utilization at terminal 3 area is limited due to the system's definitions. The controller has to remember the clearances he has already provided to aircraft and give an additional clearance accordingly. With a high load of movements, it is sometimes difficult to monitor all movements on the apron. Controllers are using various means to alleviate the operation, such as: real time checking of all active strips and verification of aircraft position, recording the most recent clearance on the strip clearance, recording the holding point given to an aircraft before a taxiway, using a conditional clearance "when clear of…", etc.

2.2 Accident scenario

Description of sequence of events:



On Wednesday, 28 March 2018, early in the morning, it was raining and still dark.

A 737 a/c parked at gate C8 requested pushback and starting and mentioned his current parking gate. The controller has previously cleared an Elal B737 to enter gate C7 while it was taxiing behind the 737 a/c, which was instructed by the controller to standby. Sometime later, an 767 a/c at gate C9, which previously requested pushback while mentioning its parking gate and was instructed to hold, was cleared for pushback to SP37, facing east. The 767 a/c pilot mentioned his gate and the controller repeated it in his clearance, although about 2 minutes have passed between the communications. About 5 minutes after the 737 a/c was instructed to hold, during which there were numerous other communications, the controller called the 737 a/c and cleared it for pushback without mentioning its parking gate. The 737 a/c pilot read back the clearance. The aircraft was first cleared to SP48, facing east, a pushback which does not require a change of direction on taxiway M.

At that time an Austrian aircraft requested pushback from gate C4 while the 737 a/c was being pushed back, and the controller changed the clearance and instructed the 737 a/c to be pushed to SP47, facing west – a change which necessitates an initial pushing of the aircraft eastbound on taxiway M centerline towards SP37, and then pulling it westbound to SP47.

For an unclear reason, the controller was mentally fixated since the beginning of the process on the 737 a/c being parked at gate C7. This explains the rationale of his instructions to be pushed to SP48 and then change to SP47, both instructions are not executable with another aircraft at SP37.

The 767 a/c towing crew consisted of a driver and a towing supervisor technician, both of whom were huddling inside the tow truck cabin, and a mechanic sitting in another vehicle. There were no wing walkers. Visibility from the tow truck cabin was limited.

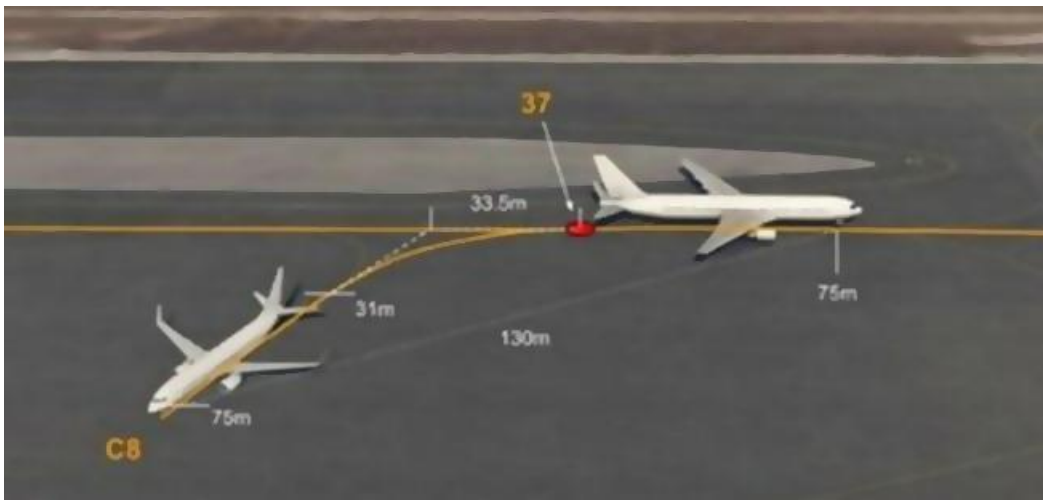
During the towing, when the aircraft was out of the congested area and the towing seemed to be completed soon, the car with the mechanic has left. The tow driver was making an effort to follow the taxiway's lines marked on the ground, which are barely visible in darkness and rain.

While the 767 a/c was already being pushed westbound along taxiway M with its nose facing east, the 737 a/c began being pushed back towards M. The 737 a/c 's tow truck driver and the ramp supervisor were also huddling in the truck's cabin because of the rain, and both had a limited field of view. The tow driver's

visibility is very limited not only because of the rain and darkness but also due to the low airplane fuselage and nose landing gear in front of him.

During the 737 a/c 's pushback, the controller changed the destination starting point from SP48 to SP47. The immediate consequence was the need to reverse the towing direction upon arriving M taxiway, i.e. instead of pushing with the nose facing west, the aircraft should now be pushed facing east towards SP37, and then start towing on M towards SP47. The pilot hardly had the time to convey the information to the towing crew, and the towing supervisor had practically no time to brief the driver or to carefully examine the towing route. The initial briefing should have included the various alternatives as part of risk management, because during a pushback it is very difficult to stop, regroup and conduct a revised briefing, even when it is not raining.

The pushback was very slow: In reconstructions and observations made by the investigating team, similar routes required 26 seconds on average, while at the subject event the pushback took 58 seconds, i.e. a speed slower by more than a half of normal towing speed. The slow speed was most probably an outcome of the tow drivers' difficulties in following the lines on the ground and push accordingly.

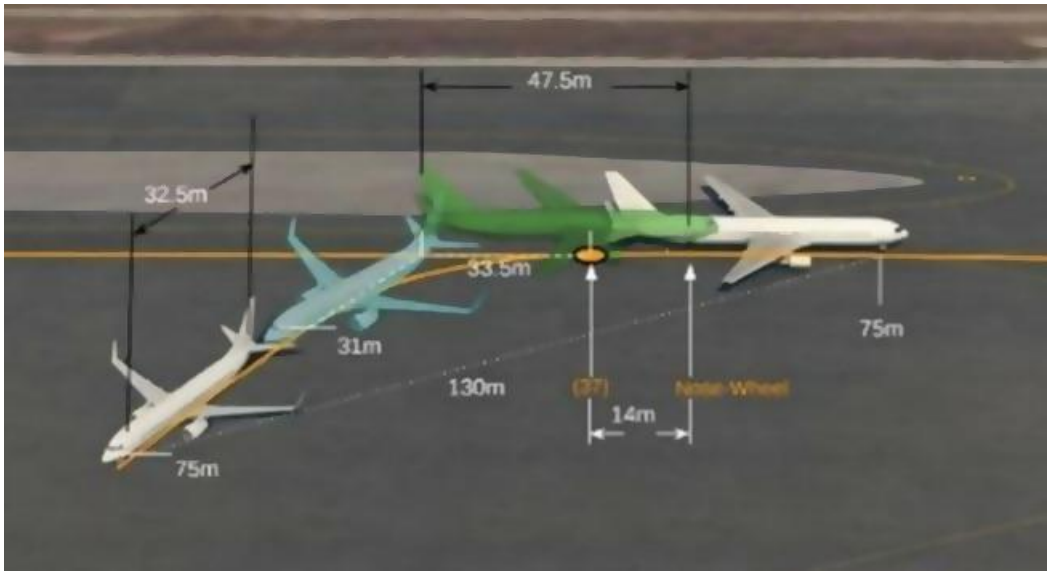


With 14 meters remaining for the ~~B~~767 a/c to reach the start-up position and stop, and with the 737 a/c about to turn for lining up and its tail penetrating taxiway M, the 737 a/c 's tow driver briefly noticed a white silhouette.

The ramp supervisor noticed the other airplane about 2 seconds before the collision but did not fully comprehend it and all he managed to say at the final second was "airplane".

The 767 a/c towing crew did not notice anything until the collision. The airplanes' tails have actually collided with none of the towing crews realizing that a collision has happened.

Graphic illustration of the event's final stage



The 767 a/c pilot has felt a kind of slight motion and asked the tow supervisor what happened. The technician, who also felt it, was thinking that it was a slight skid because of the rain and answered the pilot accordingly. In reality, he has not seen anything from the cabin, so he went out of the truck cabin and only then discovered the airplane with which they have collided.

An Operations Control Centre vehicle ("Follow me") arrived at the scene 45 seconds after the accident but did not report it, either because he did not realize what has happened or due to another reason.

From analysis of the communication transcripts and personnel testimonies it turns out that the people involved have not realized that there was a collision for a relatively long time, about 2 minutes after impact:

- The 737 a/c pilot reported that they stopped towing due to an airplane behind them.
- The controller at this stage could have seen that the two airplanes are standing very close to each other and could begin realizing that an accident has happened. He answered the 737 a/c crew that there is an airplane east of them but "it is not a factor". He even suggested another start-up position, after the accident has already occurred.
- The 767 a/c pilot also reported that the towing has stopped due to a problem with the tractor.

A bout 2 minutes after the accident the controller instructed the 737 a/c crew to stop. Even after the 767 a/c pilot reported that according to the ground crew an accident has occurred, the controller did not comprehend it and for some time he did not respond on the radio. Later on, the controller asked the 737 a/c pilot whether he wants to be towed back to the gate.
Emphasis: The above demonstrates the length of time required by the controller to realize what happened.

Summary

The accident scenario presents an image of mental fixation by the ground controller, beginning with his pushback clearance, throughout the process and even for several minutes after the collision has occurred. This fixation caused him to clear a pushback route which is in inherent conflict with a previous clearance he gave to another airplane. The 737 a/c pushback clearance was given 5 minutes after requested and without mentioning the parking gate. During this timeframe he provided several informative communications to aircraft, which did a will to provide good service. He failed to generate accurate situational awareness and continued to provide inaccurate and inefficient instructions and information.
The aircraft flight crews have acted reasonably. They had no practical way to prevent the accident, neither by eye contact nor by generating a complex ground situation image, because they were being pushed back to areas outside their field of view.

Both towing crews operated in a way which does not comply with and even violates the airport procedures, their companies' procedures and the required pushback safety, in that the 2 members of each crew were huddling inside their tow vehicle cabin. This has significantly reduced their field of view, which was restricted to begin with by the environmental conditions.

The towing crews have actually focused on the technical aspects of the pushback but did not pay attention to verify that the pushback routes are clear of obstacles. They assumed that the clearances they got from the tower via the pilots are an evidence that the routes are clear, and this was not the case! It should be noted that the 737 a/c 's SP change made it more difficult for the towing crew because practically they could not conduct a full briefing. However, once there was a change the crew should have paid better attention to the pushback route.

At the seconds preceding the collision, both aircraft were being pushed towards each other's tail for about 48 seconds, on a straight line for about 75 meters each, at a relatively constant angle of 125 degrees, and none of the 2 towing crew members noticed the imminent danger.

The crews could and should have detect the impending conflict, because the 125 degrees angle places each aircraft within the clear sector of field of view of the other towing crew. Towing speed was very slow and there was relatively long time to detect the conflict, stop and prevent the accident.

About 2 seconds prior to impact, the ramp supervisor of the B737 saw the danger and managed to say something, but it was too late and the accident occurred.

2.3 Human factor

☒ **Analysis by "Swiss cheese" model**

- ✓ A model accepted by ICAO for investigating the human factor in aviation accidents and incidents, first presented in 1990 by James Reasons from Manchester University. The model describes causes for an accident, consisting of several layers of failures – some are latent, some active and some are active and latent. Each is depicted by a plate with holes.
- ✓ For an accident to happen, all the failures or holes should line up with each other. This model was called the "Swiss cheese model".
- ✓ An active failure is a direct action by a crew member which has led to a severe outcome. For instance: A crew member retracting the flaps instead of the landing gear after takeoff, causing the aircraft to stall.
- ✓ A latent failure is a background factor, such as tight schedule and time pressure, inadequate work processes, inappropriate staffing, etc. Such factors are always in the background, but only at a certain opportunity they align with an active failure, say by a crewmember, and materialize to an accident or incident.
- ✓ An accident is never an outcome of a single factor.
- ✓ The Swiss cheese model is commonly used in human factor investigations and is included in the investigation guidance of ICAO's Human Factors Digest.

☒ List of failures in this accident

Active failure 1

The ground controller failed by giving both aircraft pushback clearance for a collision course or proximity to a collision.

The controller mistakenly thought that the 737 a/c is parked at gate C7, while it was actually at C8. The controller cleared the 737 a/c for pushback to SP48, facing east and after the pushback began, he changed the clearance to SP47, facing west. The controller was not aware of the conflict between the pushed airplanes. He was also not aware that the towing crew has to conduct risk management and a briefing and changing the instructions during the pushback was overloading the crew and essentially prevented them from re-briefing.

The question is what caused the controller's fixation, leading him to believe the 737 a/c is at gate other than the correct gate, although all the means and indications were available to him.

Possible answers: fatigue, routine, inadequate division of attention, environmental factors.

The chain of failures and events leading to the accident was initiated by the controller's mistaken instruction, which stemmed from his fixation mentioned above.

Active failure 2

The ground controller gave the 737 a/c pushback clearance without mentioning the gate. He did not mention the gate in several previous pushback clearances. Providing a clearance without specifying the gate can prevent the recipient of the clearance or other, adjacent aircraft from obtaining a correct situational image and detect a developing conflict. Not mentioning the gate also caused the pilot to repeat the clearance without the gate and thus precluded an opportunity to detect the mistake, nor could the 767 a/c pilot wonder about it and inquire.

Why did the controller not mention the gate in his clearance?

Possible reasons: workload, inadequate professional competency, not understanding the importance of mentioning the gate, or lack of a requirement in the procedures to mention the gate.

Active failure 3

The towing crews' leaders did not pay sufficient attention to clearing the towing route from obstacles. They did not perform a required, adequate risk management, a process which should have included "what if" actions if, for instance, the SP will be changed. The towing crews did not look at the direction of the towing and did not detect the impending collision, despite moving at a constant angle towards the other aircraft.

It is reasonable to assume that no risk management was conducted because the pushback is considered a routine task. The probability to hit an obstacle on the route after leaving the congested apron is low, which probably contributed to the crews' complacency. Additionally, the visibility conditions and the wet taxiways which adversely affected the tracking of the route, the limited field of view from the cabin and the changing of the start-up positions during the pushback have all made it more difficult for the 737 a/c towing crew, which was focusing on seeing and tracking the line on the tarmac.

The two tow crewmembers were huddling inside their tractors' cabins, which violates the pushback procedure, reduced their field of view and may have prevented them from seeing the other aircraft in time. These actions were probably due to crew complacency and routine.

Additionally, the tow crews feeling was that the controller sees everything, supervises from above, has an accurate situational image and it is impossible that he will issue instructions which include a conflict with another airplane. The tow crews focused on the towing route being free of other obstacles.

Latent failure 1

Limited field of view from the ground controller's position in the tower. It makes controlling the aprons more difficult. There are no auxiliary means for providing a picture of the aprons and the pushback routes. No technological means for advance warning about a conflict.

Latent failure 2

Controllers' competency at the various stations. Each control tower station has different characteristics. A controller's change of station during a work shift or work day might require adjustment time or reduce his command of the new station, momentarily or permanently. It is possible that the ground controller's station is considered less complex than the tower controller's station, which might lead to some recklessness.

Latent failure 3

Ben Gurion pushback procedure paragraph 6.17 contains contradictions and discrepancies which could cause it to be not applicable and not implemented, as was the case in this accident. On one hand, the procedure requires wing walkers in congested areas and in some cases requires enhancement. On the other hand, it allows leaving certain parking positions without wing walkers if there are no aircraft in adjacent positions. The procedure defines the towing crew members, but in a subsequent paragraph it uses the term "directors", which is not mentioned at all in the towing crewmembers list. The procedure then states that wing walkers should accompany the aircraft until its alignment on the taxiway for the required SP. This poses a difficulty, since Ben Gurion's taxiways are sometimes active or even primary, such as taxiway M, and it is not desirable to have pedestrians on it in the first place, let alone when they have no means of communication. Moreover, the main hazard requiring usage of wing walkers is when entering or leaving the apron, due to obstacles, as evident from the exemption when adjacent gates have no aircraft. Wing walkers are not intended for the pushback segment outside the parking areas. The procedure's contradictions and terminology discrepancies lead to its being partially not applicable and not implemented, as was the case in this accident. It can also lead to disrespect towards procedures in general.

It is possible that Ben Gurion's rapid growth in the last decade, along with revising procedures, yielded a procedure with contradictions and paragraphs which actually cannot be executed. An airport procedure should be implementable and should be enforced. If it includes paragraphs which are not feasible, they should be revised to become implementable, while maintaining adequate safety level.

Latent failure 4

The airlines are solely responsible for towing and pushing the aircraft at the aprons and for training and maintaining competency of the towing crew and equipment. They are responsible for training and operation of their employees to the same extent that they are responsible for training and operating their pilots, even when utilizing subcontractors, such as the ground services companies. The airlines must implement their responsibility by requirements to and control of the ground services companies. Ben Gurion management is obliged to set the framework and general rules by which the airlines will operate. The current procedure was written and published in this way. Although the airport management is not responsible for the towing crews and equipment, it is still vulnerable to failures by having the overall responsibility to Ben Gurion airport.

Ben Gurion management, is taking responsibility beyond what has been defined for it, and dictates requirements and rules to the airlines and ground services companies. The airport management has decided to develop strategy for aprons management, in order to convert the current procedure, which has evolved over the years without a coherent concept and strategy, and make it effective and adequate.

According to the procedure that "earphones man" should be at a safe distance from the tow vehicle and the aircraft. In certain circumstances it is permitted for him to stand on the tow tractor at the designated place and hold the guard rail beside the driver (paragraph 26). In this case the "earphones man" was sitting with the driver inside the tow vehicle cabin, in violation of the procedure.

Why did the crew violate the procedure?

It was understood from the interviews that this was not an isolated case, and it is an evidence of a culture of not complying with procedures or of not understanding the safety importance of these paragraphs.

Latent failure 5

Communication between the tow truck driver and the person who is in contact with the aircraft flight crew is done by shouting or hand signals. This method forces them to have eye contact and be close to each other. Sometimes it might encourage them both to sit inside the truck cabin, which could adversely affect the field of view and their ability to scan the area and the pushback route.

Latent failure 6

Ben Gurion's aprons layout is complicated, and almost every pushback requires maneuvering. It creates a complex scenario for the controller who clears pushbacks and, as well as for the operators. The tow truck driver is supposed to have a map of the aprons. It is also desirable that the towing supervisor should have a map. The driver is required to perform a navigation which is sometimes complex, with well-maintained ground markings which are difficult to see from the driver's height, under rainy and degraded visibility conditions. Currently there is no navigation system, which can provide the driver with guidance for arriving at the designated position, thus alleviating his difficulties and giving him a true visibility in the direction of the towing and ensure its safety.

Latent failure 7

The location and specification of the starting points sometimes cause an aircraft tail to penetrate the area of one starting point while the aircraft is towed into another point. Changing the directions of the starting points, whether permanent or for one time, could prevent or reduce the maneuvering and the conflict.

Latent failure 8

Routine and complacency. Numerous push backs are conducted during airport operations, on every shift and every day, mostly without any safety event. This could lead the operators to complacency. The feeling that the clearing controller has apparently taken care to avoid a conflict, that he sees everything and is supervising from above, is inducing complacency and is entirely erroneous.

Latent failure 9

A captain's total responsibility for the aircraft and its occupants begins when the doors are closed for departure. During pushback the captain is formally responsible but has no way of knowing the hazards behind, while the aircraft safety is essentially at the hands of the towing crew. The flight crew has no means, such as a camera, for observing the pushback route.

Latent failure-10

Insufficient or lacking regulation and supervision of the Civil Aviation on ground operations at the airports, including towing and pushback tasks, becomes a fertile ground for errors and for development of inadequate and/or non-uniform operational norms.

☒ **Analysis by failure barriers theory**

- ✓ In order to prevent an accident and based on experience and investigation reports, barrier systems are being constructed, which should operate at the system level or at any single barrier level. Typically, the action of one barrier is sufficient to prevent the accident or reduce its severity. In the terms of the "Swiss cheese model": blocking a hole in one of the plates will prevent the creation of a straight line through aligned holes, which could lead to an accident.

The regulatory barrier

Insufficient regulation of ground operations by ICAO and CAAI has contributed to the licensing by Ben Gurion for the ground servicing companies being not according to a detailed and binding regulation. This has led the ground services company to develop, at best, incomplete procedures, which do not provide for all safety and operation issues, and in a worse case, to have no procedures at all. The ground services companies were having no obligation to comply with specific regulations and mandatory safety standards.

At Ben Gurion, there was no "coherent concept and mandatory model for aprons management". The airport accelerated and extraordinary development has resulted in voids, which were not well thought of.

The technology barrier

There was no technology whatsoever for preventing collisions on the aprons. The A-SMGCS ground radar system is operated but is blocked in the area of terminal 3. Therefore, the ground controller does not have a real time picture of the situation until the aircraft are further from the gates. Traffic warning systems between aircraft are not intended for ground operations.

Processes and procedures

The existing procedures were insufficient and not fully complied with - A briefing was not conducted for the towing crew and the towing route was not checked before executing it.

The current procedures did not mandate using wing walkers and thus the possibility of a walker detecting the impending collision has been negated (This does not imply that wing walkers are mandatory under all circumstances, in any pushback and for the pushback's complete duration).

There was no good procedure for operation under reduced visibility conditions. The current procedure does not even require using wing walkers under such conditions.

Some of the paragraphs of the applicable procedures are not feasible and thus can contribute to a culture of disrespect and disobeying procedures.

Summary

Analysis of the investigation material shows that the direct causes for the developing of the accident, under its environmental conditions and the specific circumstances, are primarily in the discipline of the human factor, of both the ground controller and the two towing crews and of the airport's organization-administration and the involved operating companies, with indirect responsibility of lacking regulation.

Examining the conduct and functioning of the above direct human causes points at errors in planning and execution, which for a relatively long time were not prevented by the inherent protection barriers – the mere fact that a ground collision has occurred during a fairly straight movement of both towing crews is demonstrating that no barrier has functioned and that active and latent failures have materialized.

It should be emphasized that although in certain aspects the barriers were ineffective and in some they did not function properly, the final safety barrier of visual detection should have worked and should have prevented the accident, similar to typical traffic accidents.

2.4 Infrastructure, procedures and examples of apron management

Beyond the direct causes of the accident, this event justifies focusing on indirect causes.

- ☒ Aprons management is a frequent topic at the Chief Investigator's table, due to numerous events with similar characteristics and issues of aprons management and control, towing drivers etc., which are intertwined in many events.

  A number of recent investigation reports related to safety events on the aprons. For instance, report 17-17 which dealt with management and control of the business jets parking ramps at Ben Gurion. Other reports dealt with the airliners parking ramps at Ben Gurion. Herein, for instance several reports from recent years: 154-13, 155-13, 22-14, 57-15, 85-15, 34-16, 11-17.

- ☒ Apron management at Ben Gurion is historically the responsibility of the control tower. ICAO Annex 11 definitions, which are also included in "Airport Authority Rules (Movement at Ben Gurion airport operational area, 1984)", do not require such assignment, since the control tower is supervising aircraft movement "except for the airport parking ramps".

  Annex 11 states that the role of providing services at the aircraft parking ramps may be assigned to either the control tower or to a separate unit.

☒ As was mentioned in the factual information chapter, there are 3 main alternatives for apron management:

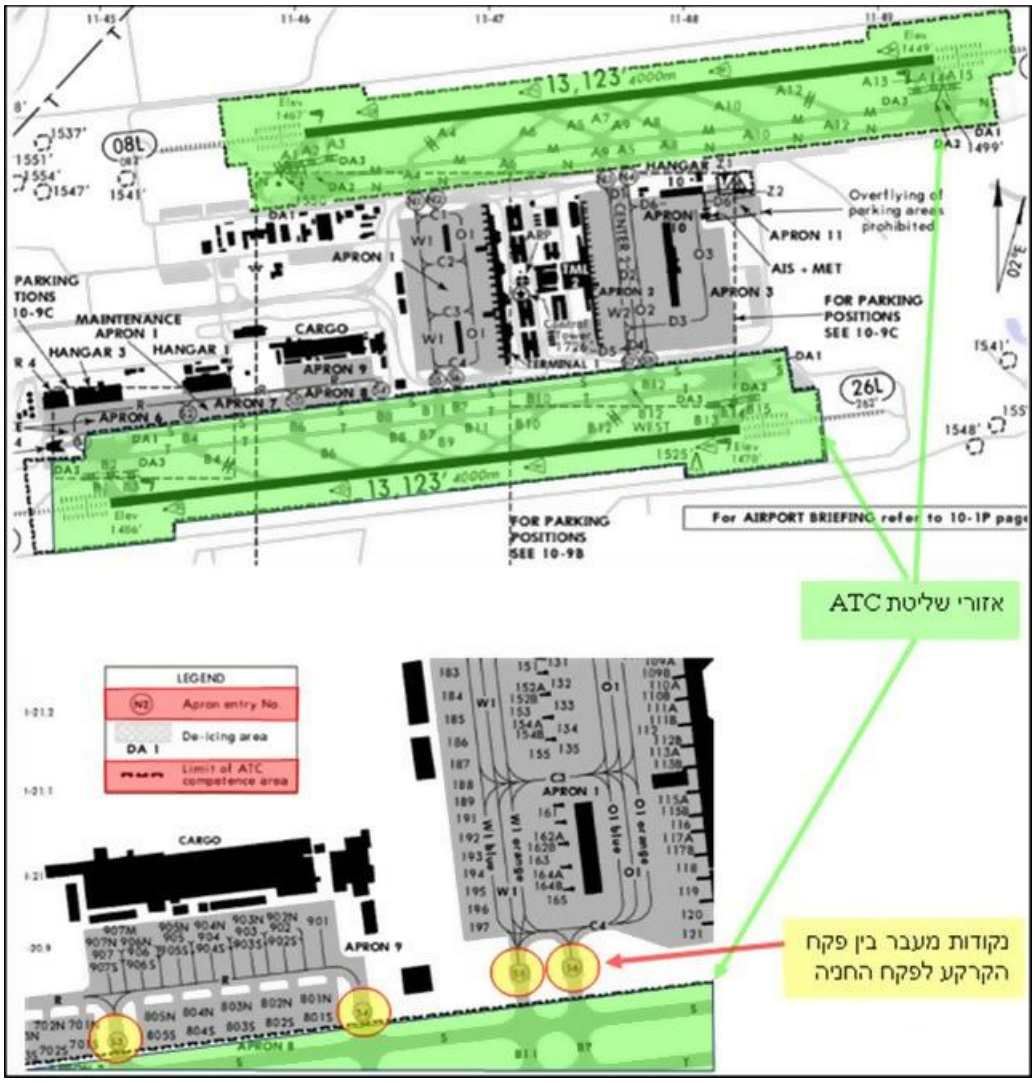
- ✓ Management of all ground traffic, including the ramps by the ground controllers.
- ✓ Managing all ramps by dedicated supervision units (Ramp/Apron).
- ✓ Mixed management, some ramps by the ground controllers and some by dedicated units.

☒ Several examples for apron management by dedicated units:

- ✓ New York Kennedy airport has a large number of various parking ramps. Each ramp has a dedicated supervision unit. The controller in charge of taxiing to and from the runways does not even know the designated parking gate for an aircraft, nor from which intersection it would access the apron. A landing flight crew contacts the ramp controller (on VHF2), receives a gate assignment and an entry route and conveys the information to the ground controller, who then plans the taxi route accordingly. The crew is operating concurrently on 2 radio frequencies. Upon arrival at the entry to the ramp, the responsibility is transferred solely to the ramp controller. A similar method is utilized at Miami, Newark and other airports.
- ✓ In Johannesburg airport the flight crew of a landing aircraft has to find out his parking position prior to landing, convey the information to the ground controller after landing and get taxi instructions accordingly. The airport does have an apron frequency but sometimes the traffic is performed on a single frequency, including clearance delivery, taxi, takeoff and landing.
- ✓ Munich airport has 3 ramp control units - Apron 1, 2, 3 (see illustration below). The airport has an inherent physical separation between the main taxiways and the ramps (see illustrations). After landing the ground controller knows the designated parking position, the target ramp and the entry route to that ramp. Upon arriving at the transition point, the aircraft switches to the ramp frequency and receives additional instructions. The crew is using one radio channel at a time. A similar method is utilized at Paris, Zurich and other airports.

*ATIS	ACARS:	MUNICH Delivery (Start-up clearance)	MUNICH Ground		Apron 1	Apron 2	Apron 3
123.12	DCL	121.72	Rwy 08L/26R 121.97	Rwy 08R/26L 121.82	121.77	121.7	121.92

Tower		MUNICH Radar (DEP)		MUNICH Arrival (DEP)	
Rwy 08L/26R	Rwy 08R/26L	North	South	North	South
118.7	120.5	123.9	127.95	128.02	120.77



☒ Ground traffic managements by the various methods

- ✓ In general, it can be said that the complexity of an airport and its traffic volume, along with conditions and constraints are determining the desired structure of ramps and ground maneuvering management.
- ✓ Control by a single controller or a zone controller (e.g. Ground West, Ground East) has the advantage of the pilot communicating with a single traffic control unit at a time. On the other hand, it can overload the controller at busy airports or with complex aprons.
- ✓ In huge airports with large traffic volume and complex, busy ramps there is an advantage to using a dedicated controller to manage a ramp, which is his specialty.
- ✓ Specialty in managing a ramp does not necessarily imply that there should be a separate control unit.
- ✓ Ramps can be managed by the tower, by a handling agent or by an airline, according to the concept and conditions.

- ✓ The method in use at airport such as Paris and Munich, is simple and transparent to the pilot users. There are clear relay points, one frequency at a time, at previously known points and frequencies. From the pilot's perspective it makes no difference whether it is a separate unit or not and what are the unit's means of control – in any case he is communicating with the controller who is controlling his area of responsibility.
- ✓ The method at major US airports such as New York makes a clear distinction between the apron and the main taxiways. This method does burden the taxiing flight crew at a crucial point, right after vacating the runway, by forcing them to communicate on 2 busy frequencies within a short time frame. This might cause misunderstandings and taxi errors with potential for delays and safety conflicts. However, the departure process is simpler and the relaying is conducted on a single radio.
- ✓ To the pushback operators it does not matter who is guiding them and generating their instructions, because the instructions are anyway given to the pilot and he is conveying them to the towing supervisor.
- ✓ When towing an empty airplane from one ramp to another there has to be an RT-qualified technician at the cockpit or in the tow truck and he is operating similar to a taxiing pilot.

Managing the aprons requires professionalism and ability to control the ramp. Whether a separate control unit, a separate tower frequency or direct control of the ground controller, it should be a part of a coherent strategy, based on comprehensive risk management derived from the airport size, complexity, traffic volume and numerous other parameters and unique conditions. It should be emphasized that in the course of the investigation a professional team headed by Ben Gurion airport manager has visited several airports overseas, in order to study their ways of tackling the task.

☒ Ramp management in the world projecting on Ben Gurion

- ✓ The method at Ben Gurion has the ground controller supervise all the ground traffic, from the parking spots to the runways area.
- ✓ Traffic is divided between 2 radio frequencies, Ground East (129.2) and Ground West (118.05), as applicable. Most of the traffic is on Ground West, resulting in controller workload, which sometimes becomes high.

- ✓ The advantage of a separate apron management method is in complex airports and where there is a clear physical separation between the ramp areas and the main taxiways. Since at Ben Gurion several starting positions are located right on main taxiway M, such a separation is most probably not practical.
- ✓ Allocating a separate frequency or a separate control unit to the ramps of terminal 3 could on one hand reduce the workload on the ground controller, but on the other hand could result in relaying of messages and transfer of responsibility between various elements at short intervals.
- ✓ Enhancing the competency of a controller at his station, along with development and installation of systems and improved control technologies will improve aprons safety and ground traffic management. Achieving this goal does not necessitate establishing a separate unit.
- ✓ The distant, serial parking ramps are less complicated and are inherently separated from the main taxiways - Managing them by a separate control station would be easy, convenient and feasible. It requires means for monitoring and control to be placed at the ramps.
- ✓ In large airports which serve as hubs for major airlines, some ramps are entirely dedicated to such airlines and are managed by them. A vast number of airlines are operating at Ben Gurion. Elal maintains the largest traffic volume at the airport and is authorized to actually operate the gates at concourse D, but this area, its adjacent taxiways and the starting points are used by other airlines as well.

☒ Management of Ben Gurion aircraft ramps

- ✓ The airport has experienced a huge growth in the last 2 decades. A new, complex terminal was built, taxiways, parking ramps and starting points were added, and traffic has grown substantially. The airport's ground operations concept was not adapted to this growth.
- ✓ World regulatory authorities are not ignoring this issue and it is handled either directly versus the airlines and then to the ground services companies, and/or by regulation and via airports' management.

- ✓ Israeli ground service companies comply with ISAGO standards but are not directly obligated to conduct SMS processes, unlike the practice in some other countries, where such companies train and qualify their professional personnel. In some cases, the airports' managements are involved in the process and in other cases they only examine the qualified personnel upon completing the training and during periodical refreshers.
- ✓ The amount and complexity of Ben Gurion's start-up positions versus their scatter relative to the gates and runways indicate that either there are too many start-up positions or their positioning is not optimal. Maybe a change in their locations or operating flexibility will improve traffic and reduce ground conflicts.
- ✓ Aircraft parking ramp management has in the past received reduced attention, both naturally and due to the scope of activities: Most attention was paid to aircraft movement in the air, on the runways and subsequently on the taxiways. No sufficient technological tools were developed by the airport to monitor movements on the aprons. It should be noted that existing tools such as A-SMGCS are disabled near the terminal, allegedly to reduce false alarms.
- ✓ Parking ramps operating procedures have evolved over the years without allocating deep thoughts and/or devising a strategy based on increasing efficiency along with professional risk management. At the current congestion in the airport, any pushback error could end up in an accident, as has happened in the investigated case. It should be noted that the airport management did realize that a thorough action is required, although it is not under its sole responsibility.
- ✓ Discussions with the airport management in the course of the investigation have resulted in the following insights:
  - ❖ There is a need to define a concept and a model for apron management.
  - ❖ There is a need for a total concept of management, control and monitoring.
  - ❖ The regulator should be involved in the process.
  - ❖ A situation should be reached where ground services companies will be obligated to maintain a safety management system (SMS).

- Involvement of Ben Gurion management in the training and qualification of the professional personnel of the airlines and the ground service companies is justified theoretically and practically – by examining their training programs and process and by checking whether they conduct periodical monitoring of the crews.
- It is suggested to consider limiting the number of ground services companies operating at the airport, based on parameters including their ability to conduct ground movements at the required level of safety.
- It is appropriate and important to assess the number of start-up positions at the airport, their locations and aircraft positioning, vis a vis the resulting constraints and limitations.
- The policy of using "Follow Me" for entering the parking positions should be reviewed considering diverting these resources to maintain ramps safety.
- It was decided to train employees of Unit 170 (LLBG safety unit) and others at IATA safety management courses such as "IATA Inspector Course", in order to enable their operation for enhancing ramps safety. This is already being done.
- Using ramp management models which are common worldwide and adapting them to Ben Gurion's conditions.

Summary

The complex structure of Ben Gurion airport, in particular terminal 3 area, necessitates developing a strategy, which will correspond with its current situation and future development, and will be translated to a comprehensive program by the ground services companies. The strategy and the program should provide a procedural and technological solution, along with studying the pros and cons of various management methods as applied in other airports worldwide.

2.5 Technological means for preventing accidents during taxiing, towing and pushback

Unlike humans, technology is not affected by fatigue or moods, and if it was properly defined and built, is almost without errors and surprises. In view of this, the surveillance and management of aprons have poor means, if any.

- ☒ Safety devices for ground traffic have substantially improved for cars moving on roads. Such devices include rear and peripheral cameras, reverse driving sensors, lane deviation warnings, active protection and control systems and up to autonomous vehicles.
- ☒ Existing automotive navigation systems have low cost and high accuracy and they support drivers in optimizing the trip, minimize the time enroute and even save fuel. Moreover, they contribute to reducing the driver's workload, who in the past had to navigate by himself, sometimes with maps. There also are applications which enable cross communication and thus reduce the probability of an accident.
- ☒ Aircraft nowadays have systems which make it difficult to imagine how aircraft could be operated without them. TCAS is based on communication between aircraft transponders for preventing midair collisions. EGPWS generates warnings based on radio altimeter and ground proximity warnings based on actual aircraft position relative to a data base. RAAS and other systems based on position and data base provide warnings against active runway incursions.
- ☒ There are aviation and other systems which can be adapted for surveillance and control of aircraft and vehicles traffic on the aprons, such as:
  - ✓ A-SMGCS system, operated at Ben Gurion for the taxiways and runways. This system has additional excellent features, at the definition level, which apparently are not yet implemented. As mentioned above, the system at terminal 3's gates area is not operating near the terminal structure, apparently due to masking. It does not display movements on the controller's screen, due to its inability to detect movements in this zone.
  - ✓ A system similar to FLARM system can be installed in tow vehicles, to warn when the vehicles are on a collision course. These are fairly simple, GPS-based instruments, which communicate with other instruments and check proximity and potential collision courses.

- ✓ Installation of towing vehicles guidance systems – A system which finds the tow vehicle's precise position, the driver will enter the start-up position and will receive aural and visual instructions. Such system will reduce drivers' workload, reduce risk of errors, and free the drivers' attention for peripheral scanning.
- ✓ Installation of peripheral cameras on aircraft - Although a captain is responsible for flight safety since the doors are closed, he cannot realize this responsibility during the whole pushback stage because he does not see the pushback route. Installing peripheral cameras including a rearview camera and with cockpit displays might enable the flight crew to intervene in case of conflict. Such installation has to be certificated and can only be accomplished after risk management assessment, since pilots often start engines during a pushback and the camera should not divert their attention away from the primary task of starting.

Boeing 777 cameras display.
<u>Aft looking cameras can be added at the tail and wingtips</u>

3. Conclusions

The main causes for the accident

3.1 The severe safety event began with a wrong instruction in the pushback clearance, issued by the ground controller for the 737 a/c aircraft, a pushback which evolved to an accident, under the prevailing local visibility and environmental conditions, as a result of the pushback supervisors of the two pushed back aircraft failing to perform a safe pushback and detect hazards and obstacles on the pushback routes.

The contributing factors to the accident

3.2 The initial and primary factor contributing to the accident was the ground controller's error, in giving the 737 a/c aircraft a pushback clearance, which was in inherent conflict with both the clearance he has previously given to the ~~B~~767 a/c aircraft and with the actual location of the 767 a/c. It is highly probable that the controller did not notice his error throughout the process, due to fixation and partial situational awareness, as if the 737 a/c was parked in gate C7, while it actullay was parked at and pushed from C8.

3.3 The ground controller did not construct a situational picture of the airplanes under his responsibility, neither by technical means available to him nor by visual means, even when such were possible. Even after the aircraft collided, at an area which was clearly visible from the tower, the controller did not see or did not understand the picture and continued in providing mistaken instructions.

3.4 The ground controller did not specify the parking gate upon giving the pushback clearance to the 737 a/c, especially when considering that his previous communication with that flight crew has occurred 5 minutes prior, when the clearance was requested. When the clearance was given without mentioning the gate, the pilots reading it back have also refrained from mentioning the gate and thus the possibility for preventing a hazardous situation, which eventually developed into an accident, has been missed.

3.5 The 737 a/c towing crew did not peform risk management, nor an adequate briefing before beginning the pushback. It should be anticipated that the towing crew will take into consideration, at the beginning of and throughout the pushback, the location and direction of movement of the 767 a/c, which has left the adjacent gate just a short time before the 737 a/c.

3.6 The change of the 737 a/c start-up position by the ground controller during the pushback did not anticipate the evolving conflict and thus made it harder for the towing crew to adjust to the new towing route. The towing crew did not stop for a moment to assess the associated risks and to brief accordingly.

3.7 The accident occurred in darkness, it was raining, the ramps were wet and illuminated by lamps. This situation substntially reduced the visibility from the tow truck cabins. Because of the rain, both tow escorts of the two aircraft joined the drivers inside the cabins, in violation of procedures and safety rules. The visibility conditions on the wet ramps led the drivers to focus on searching for the yellow lines on their routes and adversely affected their ability to look around and in the direction of pushback.

3.8 Beyond the ground controller's responsibility for setting up the stage for an accident, most of the responsibility for the accident falls on the two towing crews, who have become used to rely on the controllers' instructions, felt that the controller is seeing everything and always has an accuare situational picture, and did not anticipate the possibility of encountering airplanes in their area. The routine on one hand and the difficulties that morning on the other hand, have led to the towing crews failed in implementing their full responsibility to conduct a safe pushback and detect each other in a timelt manner.

3.9 At the ground controller's station in the tower and elsewhere in the airport there are no sufficient technological means for presenting an up to date situational picture of airplanes' positions and for warning of ground conflicts at the aprons.
Note: A-SMGCS system does not provide a situational picture of terminal 3 and the gates area and does not generate alarms regarding impending collisions.

3.10 The complexity and variations of managing the tower's various types of stations necessitate that the controllers will be highly professional, competent and better familiar with any type of control station. At the current situation, let alone in the future when airport traffic will increase, the tower controllers' working on most types of the stations could lead to reduced control and to making more mistakes.

3.11 the complexity of terminal 3 layout and of the infrastructure on the parking ramps and the routes to the taxiways, and in particular the concourses, contributes to the pushbacks being typically associated with a long, complicated manuever among obstacles, which makes it difficult to generate situational picture and makes it difficult for the tow truck drivers and escorts to follow the pushback route. The potential for errors is increasing significantly in darkness and when the ramps are wet. It should be emphasized that the crews were not equipped with any technological means for ground navigation and collision warning.

3.12 There is no effective means of communication between the tow drivers and the escorts who are communicating with the pilots. Communication is mainly by shouting and hand signals. This situation actually requires the drivers and escorts to be nearer to each other, thus reducing the tow crew ability to monitor its route.

3.13 Ben Gurion airport has not utilized a total concept and adequate model for aprons management. The airport's accelerated development and the significant growth of traffic volume, while adding parking ramps and start-up positions, were not accompanied by a revised concept of ground operations, which would be compatible with the size and the activity level.

3.14 Ben Gurion's management did not execute sufficient control over the airlines and ground services companies regarding their implementation of their sole responsibility for the professional competency of their employees and for the employees' ability to perform safe aircraft pushback. Among other things, it was found out that Ben Gurion's aircraft towing procedure is not coherent and includes a number of contradictions, conflicts and non-applicable paragraphs which are not being enforced - a situation leading to disrespect and to a culture of non-compliance with procedures.

Note: The ground services companies are not obligated to conducting SMS programs.

3.15 National and international regulation of ground services and ground traffic management is still insufficient, although in recent years there is increased awareness of the need to correct it.

3.16 Flight crews do not have the capability to monitor the pushback process from their cockpits, due to lack of adequate means (e.g. cameras).

4. Recommendations

The Chief Investigator has issued a preliminary report on 18 April 2019. Six urgent safety recommendations were submitted to Ben Gurion airport manager, to be implemented concurrent with the continuation of the investigation. Some of the preliminary report's recommendations were revised and updated in accordnace with information and insights which surfaced as the investigation proceeded.

Preliminary report's recommendations

4.1 Temporary order

Initial examination of the event indicates that it is difficult for the towing crew to see forward, towards the direction of the pushback, in particular at night and/or under restricted visibility conditions. In the accident it has eliminated a critical and apparently ultimate safety protection barrier, which could have prevented the accident and similar future events.

Recommendation: Until completion of the investigation and issuance of final conclusions and recommendations, continue ground operations as dictated in the airport's temporary order for night and low visibility conditions.

Responsibility : Israel Airport Authority/Ben Gurion

Recommended time for implementation : Done.

4.2 Towing crew responsibilities definition, training and qualification

There are broad variations and differences in the interpretation of the qualifications for the roles of towing supervisor and crew. In particular, it is not clear who is in charge of the safety of the towing process, and where defined – the definition is not necessarily the optimal one. It seems that unlike the tow driver, who is focused on driving and following the track, the ramp supervisor is more available for a broader look over the towing, he can detect conflicts and warn in time and he should be defined as the towing supervisor. Review and discussion should include defining the tasks of the towing crew members, their locations and the means for the crew's internal communication, in addition to what is already defined regarding the pilot and controller.

Recommendation: In the formation of the concept and model for aprons management at Ben Gurion, the procedures of the airport and the companies should define the roles and responsibilities of towing crew members, means and ways of communication between the various participants, briefings, pushback route familiarity, wing walkers and an emphasis on the individual responsible for the safety of the process.

Responsibility : Israel Airport Authority/Ben Gurion

Recommended time for implementation : End of 2019.

4.3 Mentioning the gate in pushback/towing request and clearance

ICAO's and other documents (e.g. document 4444, chapter 12, paragraph 12.3.4.4) direct that thepilot should mention the aircraft location in the initial radio communication with the controller, and the controller is not obliged to read back the parking position. In cases where the controller instructs the pilot to hold, and calls the pilot some time later on, it is probable and reasonable that the controller will mention the parking position, even if not required to by the current regulations. In communications performed near or at the time of the accident, the pilots always mentioned the parking position, while the controller did not do it in 2 of the 3 relevant communications.

Recommendation: To direct and obligate the controllers to mention the parking position when responding to pilots' clearance requests. If a pilot refrains from doing so, the controller should require that the location will be mentioned.

Responsibility : Israel Airport Authority/Ben Gurion

Recommended time for implementation : Immediate.

Additional Recommendation: To recommend to ICAO and IATA to change their definitions, and require rhe controllers to mention the parking position in communication with pilots, primarily if some time has elapsed since the pilot's request and the parking position was mentioned.

Note: The additional recommendation is not included in the preliminary report but is related to the same topic.

Responsibility : CAAI

Recommended time for implementation : End of 2019.

4.4 Start-up positions assessment, renumbering & cancellation of unused points and moving entry/exit routes away from parking ramps

Recommendation: To assess the existing start-up positions: utilization, necessity and location, to cancel unutilized points, locate start-up positions where safe access is feasible. Modify the parking ramps' entry and exit routes so as to reduce prerequisites and conflicts during accessing the ramps.

Responsibility : Israel Airport Authority/Ben Gurion

Recommended time for implementation : End of 2019.

4.5 Establishing a station for apron planning, management and control

As part of a team for generating apron management concept and model, it is recommended to consider transferring the apron management to a dedicated, professional unit which will specialize in this area, or alternately consider enhancing the various stations' controllers focus on a single type of station (gates, ground, tower, approach).

Recommendation: Consider transferring the responsibility for ramps management from the tower's ground controller to a dedicated entity in a form of "Apron Control" or another form, for creating a focused and more professional control of aircraft movements on the ramps, from the movement planning stage until the stage of handover to the tower controller.

Define the interfaces, both pyshical and procedural with Ben Gurion Ground Operations and the ground controller, through procedures, concurrence statements and regulatory approval.

Responsibility : Israel Airport Authority/Ben Gurion

Recommended time for implementation : End of 2019

Additional recommendations

4.6 Computerized systems for ramp collisions prevention

The investigation indicated that there are no protective barriers for preventing similar accidents, beyond the controllers and the towing crews. In particular there is no computerized system capable of warning about ground conflicts.

Recommendation: Identify warning systems for preventing ground accidents, desirably systems which are operational worldwide, study them and procure a suitable system.

Responsibility: Israel Airport Authority/Ben Gurion

Recommended time for implementation : End of 2020

4.7 Establishing a team for developing apron management concept and model

Recommendation: Establish a team which will examine the various topics involving apron management, will gather data about the various methods and will develop alternatives for review and determination of a concept for managing the aprons by an advanced and efficient model, applicable to Ben Gurion.

Responsibility : Israel Airport Authority/Ben Gurion

Recommended time for implementation : End of 2019

4.8 Establishing Apron Safety Team

Preliminary data indicated that there is no regular, structured platform for distributing safety information among the various units operating mainly on the aprons. Safety updates, debriefings and ramifications are mostly distributed in the wake of safety events and not via regular, proactive processes.

Recommendation: Establish an Apron Safety Team, led by Ben Gurion airport and with participation of representatives from the Israeli airlines, the ground service providers and the office of the Chief Investigator. The team will convene regularly (at least twice a year), for professional discussions and exchange of information regarding ongoing safety issues.

Responsibility : Israel Airport Authority/Ben Gurion

Recommended time for implementation : End of 2019

4.9 Risk management method and SMS principles

The parking ramps operating procedures evolved over the years, without deep thought and/or developing a strategy, which will obligate the ground service companies to develop, embed and a safety management program, including mandating that they will conduct professional risk management and meet mandatory standards.

Recommendation: Conduct a full and comprehensive program for managing safety, based on SMS principles including professional training, examinations and checking tasks and their accomplishment according to SMS methodology.

Responsibility: ground servicescomapnies operating at Ben Gurion

Recommended time for implementation : End of 2019

4.10 Audits of ground service companies

In the world leading airports it is common to supervise the handling companies and get assistance from organizations such as ISAGO (IATA Safety Audit for Ground Operations), which conduct comprehensive audits of ground service companies.

Recommendation: Engage an appropriate organization and conduct a comprehensive audit of the ground service companies at Ben Gurion.

Responsibility : Israel Airport Authority/Ben Gurion

Recommended time for implementation : End of 2019

4.11 Involving the captain in the pushback phase

Both ICAO and Ben Gurion procedures put no responsibility on the pilots for preventing aircraft collisions at the ramps. The only phase in the aircraft operation where the captain is neither knowing nor controlling the events is the pushback phase. At this phase the responsibility is on the towing crews, whose qualification is lower than those of the controller and the captain. Nowadays there are simple devices, such as cars' aft looking cameras. These devices are installed in cars, which are much cheaper than airplanes and have a much lower damage potential. Such devices can easily show the captain the areas behind and around his aircraft, enable him to be involved and, in extreme cases, even take control for preventing a pushback accident.

Recommendation: Suggest to manufacturers of large airliners to install aft looking cameras at the wingtips and empennage, and maybe at additional locations and display the images on the captain's screens, to enable his seeing and knowing what is going on and in extreme cases even enable taking control to prevent a pushback collision.

Responsibility : Chief Investigator

Recommended time for implementation : End of 2019

Sincerely

Adv. Raz Yitzhak (Razchik)
Chief Investigator

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