The State of Israel

Ministry of Transport and Road Safety
Aircraft safety Investigation Authority of Israel (AIAI)

Safety Investigation Report

Accident File No. 19-23

Ground accident during pushback while engine starting

Date	**July 17, 2023**
Aircraft	**B747-400F & B757-200F**
Registration	**OE-LRG & N918FD**
Location of event	**Ben Gurion International Airport, Apron N**

For Safety Purposes Only

The law regarding the safety investigation and its results

(Aviation Law, 2011 and ICAO Annex 13)

Safety investigation - An investigation of a safety incident to this chapter is a procedure that includes gathering information and analyzing it, drawing conclusions, including determining the causes of the safety incident or the factors that contributed to its occurrence, and providing recommendations related to the matter for the purpose of improving aviation safety, as far as the Aircraft safety Investigation Authority of Israel (the AIAI) deems it necessary (article 104 of the law).

Purpose of a safety investigation - The sole purpose of a safety investigation is the prevention of safety incidents, and its purpose is not to attribute civil, criminal or disciplinary liability to such incidents (article 105 of the law).

Duties of the AIAI - The IIC will be in charge of conducting safety investigations according to the provisions of this chapter. In fulfilling his duties, the IIC will act in accordance with the provisions of ICAO Annex 13, insofar as they are applicable in Israel, with the exception of such provisions for which the CAAI informed ICAO, according to the provisions of article 4(b) of the Civil Aviation Authority Law, that Israel operates in a different manner (article 108 of the law).

Independence - in carrying out a safety investigation according to this chapter, there is no prejudice against the AIAI manager and his deputy, other than the justice; The provisions of this section shall also apply to an investigator authorized under article 115, subject to the provisions of subsection (c) of said section (article 109 of the law).

Publication of the Final Report - The AIAI will publish the final report on its Website and will also make the report available for public inspection, free of charge, at the Ministry of Transportation and Road Safety, provided that it will not publish the report or part of it and will not make it available for public inspection as stated, if there is any contradiction with the country's security or its foreign relations (article 119 of the law).

The recommendations of the AIAI - the CAAI and anyone for whom the AIAI included recommendations in the final report will examine the aforementioned recommendations concerning him, will decide as to their implementation and will notify the AIAI of his reasoned decision in writing; The CAAI will forward his reasoned decision to the minister as well (article 122 of the law).

Inadmissibility of the final report - The final report will not be accepted as evidence in a trial, except in an appeal according to article 39, in an administrative petition or in an administrative appeal against decisions according to this law, according to the Law of Courts for Administrative Matters, 2000, and will not be used in a procedure taken by an employer against his employee , and regarding a procedure against a pilot employee according to article 38 - will not be used unless the circumstances stated in article 138(b) are met (article 124 of the law).

Confidentiality and inadmissibility of safety investigation material - Safety investigation material will not be given and will not be accepted as evidence in a trial and will not be used in a disciplinary procedure, in an administrative procedure or in a procedure taken by an employer against his employee (article 123 of the law).

Summary of the event

On Monday, July 17, 2023, at 01:15 local time, a ground accident occurred at Ben Gurion International Airport involving a Boeing 747-400F cargo aircraft (hereinafter: "**the aircraft**" or "**the cargo aircraft**"), operated by Challenge Airlines (BE) (hereinafter: "**the airline**"), a pushback/towing tug (hereinafter: "**the tug**") which was pushing back the aircraft from its parking stand for departure, and a parked Boeing 757-200F cargo aircraft operated by FedEx (hereinafter: "**the parked aircraft**").

The cargo aircraft was pushed-back from parking stand N21 on N Apron toward the centerline, as part of a combined pushback and towing procedure to engine start point 71 (located on the apron centerline). The aircraft was moved from the parking stand by a ground crew from the Line Maintenance Department of IAI (hereinafter: "**IAI**"), which also provides maintenance services for the aircraft.

The pushback/towing operation was performed using a T-500 tug equipped with two driving positions ("**the tug**"), using a towbar. During the pushback procedure, and with authorization from the Headset Operator, the flight crew initiated sequential engine start of the aircraft's four engines, from right to left (from engine number 4 on the right wing to engine number 1 on the left wing).

Upon completion of the push, before transitioning to the supplementary tow toward the engine start point, the aircraft was positioned in a manner that required a corrective tow. After towing approximately 2 meters, the driver was required to move to the second enclosed driving position (hereinafter: "**the cabin**") to continue the tow. For this purpose, the tug driver set the parking brake.

As the driver was switching between the two driving positions, the cargo aircraft began moving forward under its own engines power, pushing the tug. Simultaneously, communication was lost between the flight crew and the Headset Operator. Attempts by the Headset Operator to establish voice contact with the flight crew to affect an immediate stop of the cargo aircraft were unsuccessful. The Headset Operator flashed a white-light pocket flashlight toward the flight crew.

The cargo aircraft continued its movement, pushing the tug forward and sideways, and during an uncontrolled turn, its left wingtip struck the rudder of the parked aircraft, which was parked at stand N15. During the cargo aircraft's movement, the towbar shear pins broke, causing the towbar to disconnect from the tug. The tug came to a stop and became lodged against the body gear of the aircraft, which also came to a stop as a result.

The tug driver evacuated the tug several seconds before the cargo aircraft struck it.

The accident caused damage to the cargo aircraft, the parked aircraft, and the tug.

The accident resulted in no physical or psychological injuries.

The occurrence was reported to the Director of the Aircraft Accident Investigation Authority (hereinafter: "**AIAI**") and an AIAI investigation team arrived at the scene to initiate an investigation of the accident.

Figure 1 - **The cargo aircraft**

Figure 2 - **Rudder of the 757-200F, wingtip of the 747, and impact marks**

Figure 3 - **T-500 tug, landing gear, and belly of the cargo aircraft**

Figure 4 - **Cargo aircraft tire and portion of the tug**

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Abbreviations and Definitions

Headset Operator	Headset Operator	**Note: In IAA (Israel Airports Authority) procedures, the Headset Operator may fulfill the role of Headset Operator and vice versa.**
AMT	Aircraft Maintenance Technician	
SMS	Safety Management System	
IAA	Israel Airports Authority	
CAAI	Civil Aviation Authority of Israel	
IAI	Israel Aerospace Industries	
AMM	Aircraft Maintenance Manual	
ATPL	Airline Transport Pilot License	
CVR	Cockpit Voice Recorder	
EASA	European Aviation Safety Agency	
ERA	Equipment Restraint Area	
DFDR	Digital Flight Data Recorder	
GHSP	Ground Handling Services Provider	
IATA	International Air Transport Association	
ICAO	International Civil Aviation Organization	
IGOM	IATA Ground Operations Manual	
MOT		
NOTAM	ICAO: Notice to Airman FAA: Notice to Air Missions	
OM A	Operation Manual - Part A	
TBL	Tow bar less Tractor	
TBT	Tow bar Tractor	

Useful Terms and Additional Definitions

a. **"Ground Handling Service Providers"**: IAA (Israel Airports Authority) concessionaires that provide (under regulated agreements) ground handling services to aircraft. This report addresses their activities in moving aircraft from parking stands to engine start positions at the airport. Typically, the process combines pushback and towing in a continuous operation. Such operations sometimes include aircraft engine starts before the aircraft is positioned at the engine start point. The process is performed using a tug that connects directly to the nose landing gear (Tow bar less - TBL), or by using a Tow-bar Tug (TBT).

b. The term **"administrative towing"** refers to towing of an aircraft **without flight crew**, for the purpose of positioning it for or returning it from maintenance operations, or moving it from one parking stand to another. In these cases, typically no pilot or flight crew member is present in the cockpit; a technical crew member present in the cockpit during this type of towing for brakes operations.

c. The terms **"Aviation Convention"** and **"Chicago Convention"** are used interchangeably in this report.

d. **Operational Vehicle**:

A vehicle, as defined in the Ordinance, excluding private and public vehicles, whether permanently fitted with equipment or not, and whether transporting cargo or carrying passengers, which has been granted an operating permit under this section in an operational vehicle area.

According to Regulation 95B, an operational vehicle is exempt from the registration and licensing requirements under the Ordinance. Example: a club car (lightweight) and/or an aircraft tractor weighing 50 tons (which tows aircraft weighing over 400 tons). Detailed in Appendix No. 7."

1. Factual information

1.1 History of the flight

1.1.1 The aircraft landed at Ben Gurion Airport (LLBG) at 21:49 (all times in this section are local time), approximately one hour and forty minutes behind schedule. The planned departure time of 23:45 was postponed to 01:00.

1.1.2 Airport closure times - last pushback time is 01:20, last takeoff time is 01:40.

1.1.3 The flight destination from Ben Gurion Airport was Liège International Airport in Belgium (EBLG).

1.1.4 After loading and fueling, the planned takeoff weight was 251,939 kg, approximately 63% of the maximum takeoff weight of 396,893 kg.

1.1.5 The flight crew consisted of two flight crew: a captain and a first officer. In addition, three off-duty crew members were onboard (having arrived on the inbound flight from Hong Kong): two flight crew and a maintenance person (FE - Flight Engineer per the operator's designation) who was present in the cockpit at the time of the accident.

1.1.6 The flight crew moved up their pickup time for the flight in order to reduce potential time pressure during departure.

1.1.7 The loading point and departure location was stand N21 on Apron N. See the positions of the aircraft involved in the accident in Diagram 2. The loading process was completed without delays.

1.1.8 The IAI ground crew assigned to move the aircraft consisted of a Headset Operator (who also served as headset operator), a right wingtip guide, a left wingtip guide, and a Tug driver.

1.1.9 Before departing for the assignment, the wingtip guides received illuminated marshaling wands (hereinafter: "**wand**"), one per guide. The wand consists of an elongated upper section illuminated with orange light and a wireless transmitter unit operated by push button, which enable the activation of a horn and a flashing yellow light magnetically attached to the vehicle, instructing the driver to stop immediately if necessary.

Note: The marshaling wands and flashing horn constitute a dedicated "marshaling/ signaling kit." A description of the kit is provided in Appendix 2.

1.1.10 **The Headset Operator did not equip himself with marshaling wands.**

1.1.11 To maintain continuous voice communication with the flight crew, the Headset Operator used a headset system (including wireless headphones and microphone) provided to Headset Operator by IAI. A description of the headset system is provided in Appendix 1.

1.1.12 The ground crew met at the parking apron of the cargo aircraft. The Headset Operator assigned tasks to his crew members but did not conduct a formal, detailed briefing for the assignment, as he stated (during post-accident questioning) that it was defined as "A simple and routine task."

Note: Per IAA procedures, the airline is responsible for the process conducted on the parking apron. The airline may delegate authority to the ground handling service provider. IAA procedures require ground crews to conduct a briefing that includes, among other items, communication, agreed-upon signals, and "events and responses."

1.1.13 The towing/pushback was planned to be performed using a TBL tug, which connects to the nose landing gear, lifts it, and effectively becomes part of the aircraft during the transfer from point to point.

1.1.14 Due to a technical malfunction, the TBL tug failed to connect to the cargo aircraft, and the ground crew was required to replace it with a tow-bar tug (TBT).

1.1.15 The driver returned the TBL tug to the IAI parking area (outside Ben Gurion Airport) and returned with a T-500 vehicle equipped with a towbar (see Diagram in Figure 5). This vehicle has two driving positions: an open position on one side and an enclosed position (cabin) on the other side. The driver connected the towbar using a pin to the yoke on one side of the tug and using a dedicated connector with shear pins on the other side to the nose landing gear of the cargo aircraft.

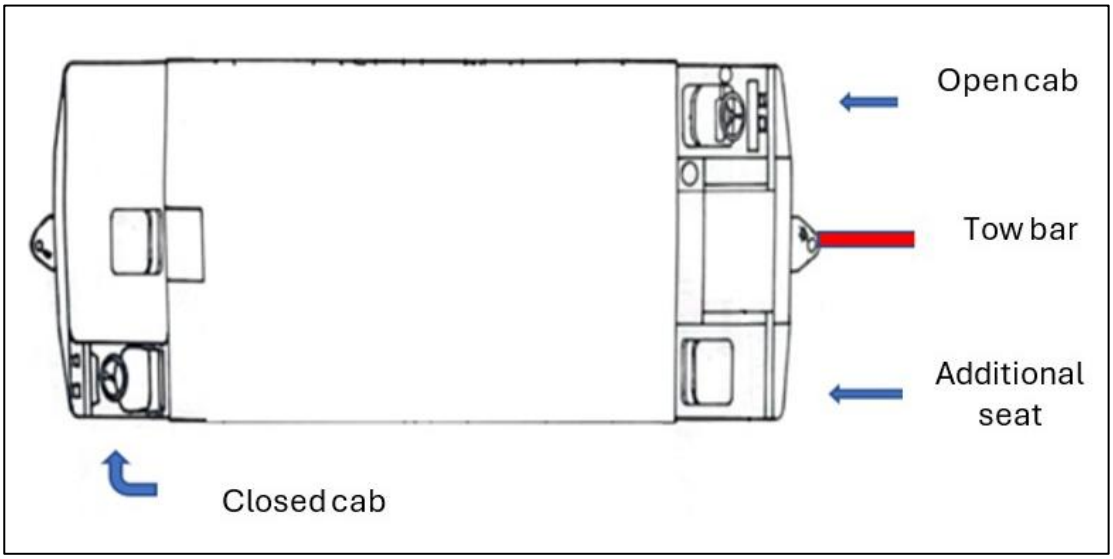


Figure 5 - **T-500 Tug Diagram**

Note: Technical explanation of the tug structure and operation is provided in Section 1.6.3.

1.1.16 The process of replacing the TBL tug with the TBT took approximately 15 minutes.

1.1.17 No briefing was conducted for the ground crew before or after replacing the TBL tug with the TBT.

1.1.18 The actual pushback process began at 01:10, **approximately 10 minutes before the last departure time**. The pushback was performed from the open driving position - the one closest to the towbar connection to the aircraft.

1.1.19 The flight crew received pushback and start clearance from the tower: "Cleared for push and start."

1.1.20 At the start of the pushback, the Headset Operator sat in the auxiliary seat next to the driver.

Note: The procedure specifies that he should accompany the tug by walking alongside the aircraft nose.

1.1.21 The captain received authorization from the Headset Operator to start all four engines during the pushback.

Notes:

a) Per airline and IAI procedures, the flight crew was not required to obtain authorization from the Headset Operator before starting each engine individually, while starting all engines sequentially from right (engine number 4) to left (engine number 1) during the pushback/tow toward the engine start position.

b) Positive authorization for starting each engine individually is standard practice at some airlines; however, it is not defined as mandatory in the procedures of the airline involved in the accident or in the airport procedures.

1.1.22 The pushback was performed very slowly. The aircraft was pushed to a position several meters east of and at a converging angle to the taxiway centerline (Under Turn). See Diagram in figure 6.

1.1.23 The tug driver, who was pushing the aircraft back slowly, was surprised by the engine starts. The driver was not consulted, did not authorize, and was not informed by the Headset Operator regarding the authorization given to the flight crew to start the aircraft engines during the pushback.

Notes:

a) The tug driver cannot hear the communication between the Headset Operator and the flight crew.

b) The Headset Operator maintains voice communication with the flight crew and is the authority who grants them permission to start the engines. Although no written procedure exists on this matter, the practice among IAI Headset Operators is to obtain authorization from the driver before granting such authorization for engine start.

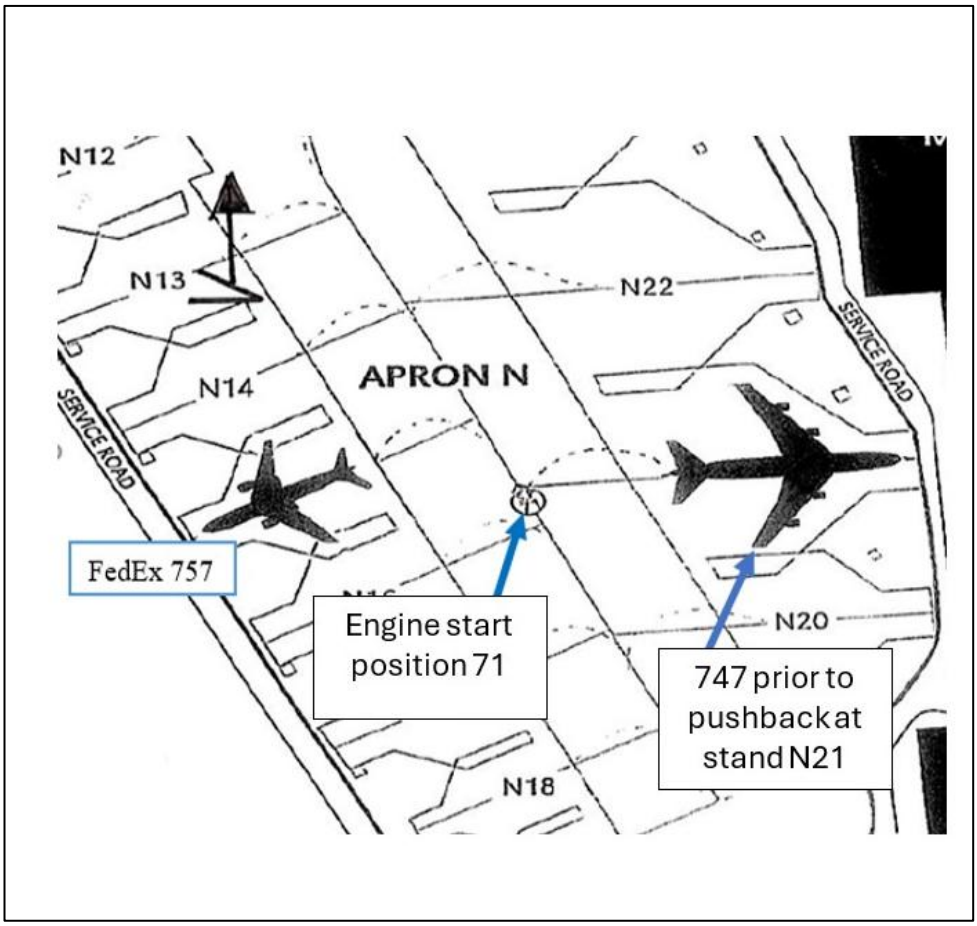


Figure 6 - **Diagram of Aircraft Position on the apron**

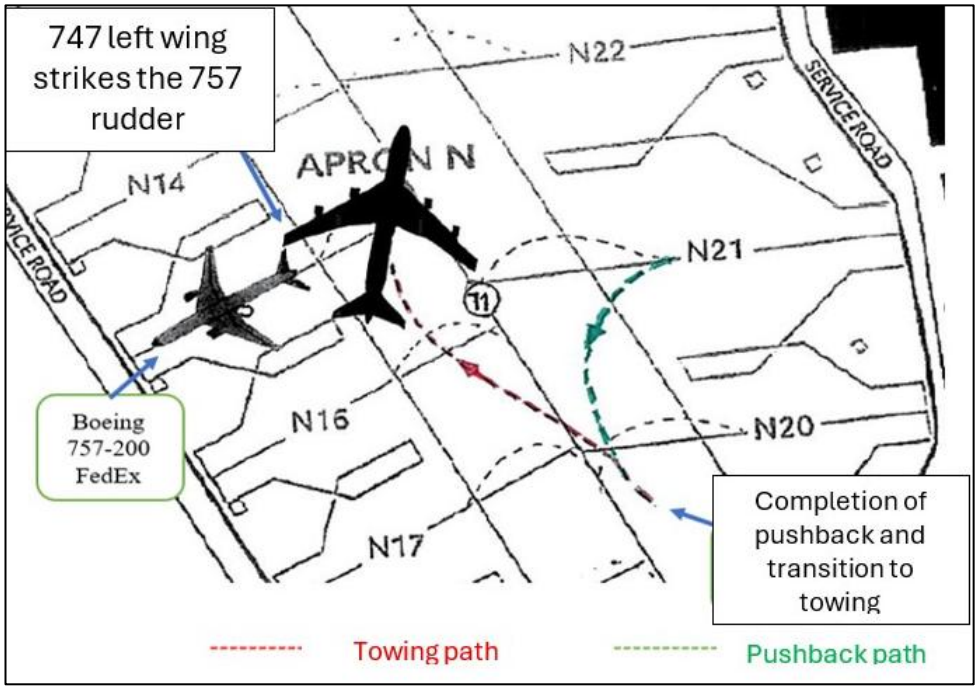


Figure 7 - **Diagram of the Cargo aircraft position after the accident**

1.1.24 According to the Headset Operator, during the pushback three "brief" communication disconnections occurred between him and the flight crew. Per the technical specifications of the headset (see Appendix 1), **only the Headset Operator received "Disconnect" alerts during the disconnections**. According to the additional crew member (off-duty FE) who was present in the cockpit during the event, "**Connected**" messages were heard in the background; however, these messages were not acknowledged by the flight crew due to background noise and their full attention on the engine start process.

Despite the communication disconnections, the pushback was not halted and no transition to marshalling using hand signals was made.

Note: Erasure of the CVR data after the accident prevented the possibility of listening to the events that occurred in the cockpit during the accident.

At a certain point which could not be accurately timed, voice communication between the Headset Operator and the flight crew was lost and not restored.

1.1.25 To reach engine start point 71, a position correction was required at the end of the pushback phase. Towing of the aircraft to the left (westward) toward the center of the taxiway was required, followed by a directional correction to the right and forward until reaching the engine start point. The Headset Operator got off the tug and stood beside it without visual contact with the flight crew.

1.1.26 The tug driver began towing the aircraft (reverse travel) for position correction. After several meters, he realized that a significant position correction was required, necessitating a move to the cabin. The driver stopped the tug, shifted the gear lever to Neutral, and engaged the Parking Brake.

1.1.27 At this stage, the start of engines number 4 and 3 was complete, and engine number 2 start had begun.

1.1.28 The driver got off the tug and began walking to the cabin (on the other side of the vehicle), which is the enclosed forward driving position, in order to complete the aircraft towing phase (forward) to engine start point 71.

1.1.29 **While the driver was moving between driving positions, no driver was present in the tug. The tug and aircraft were held only by the tug's parking brake.** The aircraft had two engines running on the right side and a third engine in the start process. **The aircraft parking brake was not set.**

The flight crew at that time had no available voice communication with the Headset Operator, without being aware of this, had no visual contact with him, and were unaware of what was happening on the ground beneath the aircraft.

1.1.30 While walking and before sitting in his seat in the enclosed cabin, the driver noticed that the aircraft was moving slowly forward (on its own power), pushing the tug.

1.1.31 The driver quickly entered the cabin and pressed the brake pedal. There was no response. In video footage of the event, it can be seen that the brake lights did not illuminate (i.e., the brakes were not controlled from the cabin at this stage); the aircraft and tug continued to move slowly while the tug was shaking and bouncing slightly. From the driver's debrief, it cannot be determined whether he attempted to transfer the control selector to the cabin, an action that in any case could not have been performed due to the tug's movement.
Note: Control transfer can only be performed when the tug is at a complete stop.

1.1.32 The Headset Operator saw the movement, understood from the driver that he had no stopping capability from the cabin, ran to the open driving position, sat in the seat, and pressed the brake pedal multiple times. The brake lights illuminated (i.e., brake control remained with and was active at this driving position). The aircraft and tug slowed to a near-stop and after several seconds accelerated again.

1.1.33 According to the flight crew's statements, they understood the forward movement of the aircraft to be a position correction by the tug (a standard process)

1.1.34 The Headset Operator ran toward the nose landing gear and pressed the flight crew call button several times (located on this landing gear, next to the headset jack). Immediately afterward, he ran to the left forward side of the aircraft to establish visual contact with the flight crew, **while flashing a white-light pocket flashlight** (which he took out from his pocket) toward them several times.

1.1.35 The flight crew saw the white flashlight flashing but did not associate it with any signal known to them and did not understand the Headset Operator's intentions.

1.1.36 The captain saw they were approaching a parked aircraft and, according to his statement, he called the ground crew about 3-4 times to stop but received no response. **The captain refrained from braking without external instruction, out of concern that braking might damage the tug located beneath the aircraft in a "blind spot," as there was no direct line of sight to it.**
Note: Given the situational awareness in the cockpit, the vast majority of flight crew would not have braked the aircraft without the agreed-upon signal to do so.

1.1.37 The aircraft continued moving forward, pushing the tug in a rightward rotational motion around its axis, until the towbar shear pins broke. The left wingtip of the cargo aircraft struck the rudder of the parked aircraft on the west side of the apron. In the final position, the tug came to a stop against the body gear, bringing the cargo aircraft to a stop.

1.1.38 The flight crew was not aware of the ground event as it developed; however, at its conclusion, due to the aircraft's position and the commotion they saw on the ground, they shut down the engines and reported to the control tower that there was some problem and that they "would provide further update".

1.1.39 The accident resulted in no physical injuries. The driver's evacuation from the tug prevented him from being physically injured. Damage was sustained to the body gear, belly, and wingtip of the cargo aircraft. The parked FedEx Boeing 757-200F aircraft sustained damage to the rudder and tail cone. The tug was damaged and permanently decommissioned.

Note: Damage details appear in Section 1.3.

1.1.40 A representative from the Ben Gurion Airport Operations Center arrived at the scene upon conclusion of the event, gathered the ground crew for an initial debrief with the purpose of providing a report to the airport Operations Center. **The debrief by airport personnel was conducted with all crew members together, while repeating certain details for clarification, and before the arrival of AIAI investigators at the scene**.

Notes:

- *A joint debrief creates a narrative and contradicts professional investigation principles. Due to differing situational awareness among those involved, there is high importance for initial individual debriefs by professional investigators.*
- *The need for an initial debrief to immediately prevent a similar is clear and valid. This issue is discussed further in the report.*

1.1.41 The aircraft captain reported to the AIAI team that arrived at the scene that he had pulled the CVR circuit breaker. In practice:

a) No entry was recorded in the aircraft technical log requiring download of the recordings for analysis.

b) The CVR circuit breaker was found in the Pushed-in position by the investigation team that returned to the aircraft the following morning. The circuit breaker was pulled at 11:00 in the morning by a maintenance technician from IAI (who recorded this action in the aircraft technical log).

1.2 Injury to Occupants

Injuries	Pilot + Crew	Passengers	Other
Fatal	0	0	0
Severe	0	0	0
Minor	0	0	0
None	2	3	4

1.3 Damage to aircraft

1.3.1 The aircraft sustained damage to the doors and tires of the main landing gear (Body Gear), the underside of the fuselage, the left wingtip, and the housing and bulb of the left navigation light.

1.3.2 The parked aircraft sustained damage to the rudder and the aft cone of the fuselage.

1.4 Other damage

1.4.1 Damage to the T-500 tug - The driver's cabin was crushed as a result of impact with the aircraft's landing gear door.

Additional findings included: drag marks on the left tires, impact marks on the right side and front of the tug, wear marks on the parking brake discs, a broken wheel axle, and a jammed control selector. The tug was permanently decommissioned by IAI.

Figure 8 - **Tug position and tire marks**

1.4.2 Damage to towbar - Both shear pins were sheared and the towbar head disconnected from the towbar body (the towbar-tug connector was not yet inspected for damage to the spring and discs).

Note: Shear pins were found that did not match manufacturer's specifications.

1.5 Aircrew and other personnel involved

1.5.1 Pilot in Command (PIC)

- ATPL license with B747-400 type rating valid until 31.12.2023.
- Medical certificate valid until 25.8.2023.
- Last proficiency check on B747-400 - 5.12.2022.
- Total flight hours (as of 14.10.2022) - 17,910.
- Total flight hours as Captain (as of 14.10.2022) - 14,867.
- Of which 279 hours on B747-400.

1.5.2 First officer

- ATPL license with B747-400 type rating valid until 31.10.2023.
- Medical certificate valid until 28.03.2024.
- Last proficiency check on B747-400 - 15.10.2022.
- Total flight hours (as of 30.08.2022) - 4,129 hours.
- Flight hours as co-pilot on B747-400 (as of 30.08.2022) - 2,686 hours.

1.5.3 Towing Crew

The crew consists of a supervisor (headset operator), a driver, and two to three wingtip/tail walkers.

Crew assignments are made ad hoc from a fixed, named list, with only the listed drivers having received dedicated training. The other crew members are aircraft technicians who perform these duties in addition to their regular technical roles, according to work schedules determined from time to time.

Tug Driver:

- Qualified for towing commercial aircraft at Ben Gurion Airport.
- Certification date: 6.062021.
- Valid until: 27.09.2023.

Towing Crew Chief (Headset Operator):

- Aircraft maintenance technician – B1 rating.
- Designated by Israel Aerospace Industries (IAI) as "qualified to manage aircraft towing."
- No technical familiarity with the T-500 tug.

1.6 Information about the aircraft

1.6.1 Cargo Aircraft – B747-400F.

- Registration: OL-LRG
- State of Registration: Austria.
- Operator: CHALLENGE AIRLINES (BE).
- Engines: Four Pratt & Whitney 4056 engines.
- Weight at the time of the accident: 251,939 kg.
- Maximum takeoff weight: 396,893 kg.
- Cargo: The aircraft was carrying hazardous materials.

1.6.2 Parked Aircraft – B757-200F

- Registration: N918FD.
- State of Registration: United States.
- Operator: FedEx.
- Cargo: None.

1.6.3 Tug - T-500

General Information

- Manufacturer: USA HOUGH-PAYMOVER
- Year of manufacture: 1978 (the tug was 45 years old at the time of the event)
- License number: 200629, license valid until 21 February 2024, diesel engine
- Towing capacity: 380,000 kg
- Empty weight: 50,000 kg
- The manufacturer ceased operations in 1983. Currently, several companies still sell or lease refurbished tugs of this model. There are difficulties in obtaining spare parts due to the discontinuation of production approximately 20 years ago.

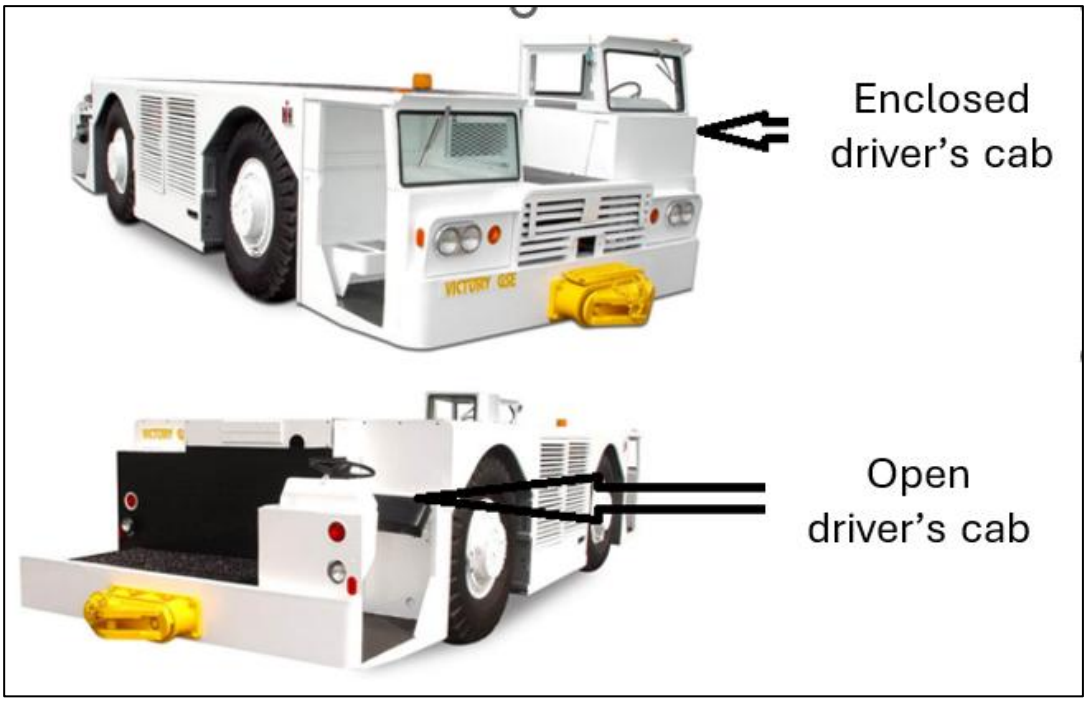


Figure 9 - **T-500 Tug**

Operation and Control

- The tug is equipped with two driving positions: one enclosed (cab) and one open, located on the opposite side (see Figure 6). The open position also includes an additional seat.
- It is not possible to operate the tug from both positions simultaneously.
- A pneumatic control unit, which includes a compressor and air tank, provides command control over the main systems of the tug.
- In the cabin, there is a gear lever with four forward gears, neutral, and reverse. In the open driving position, the lever provides only forward, reverse, and neutral. **The transmission system does not include a "Parking" position.**

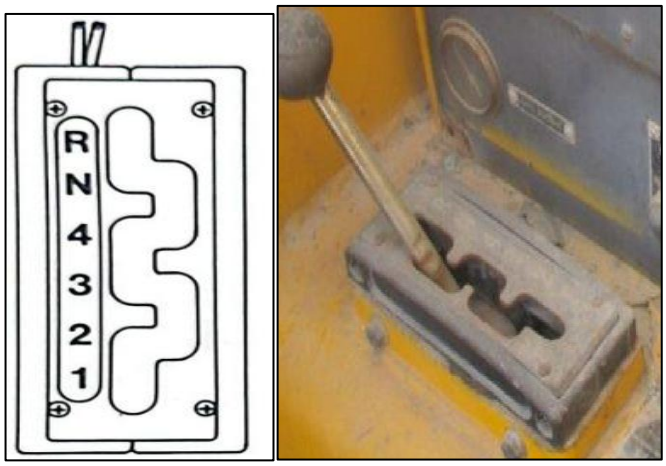


Figure 10 - **Gear shift lever in the cabin**

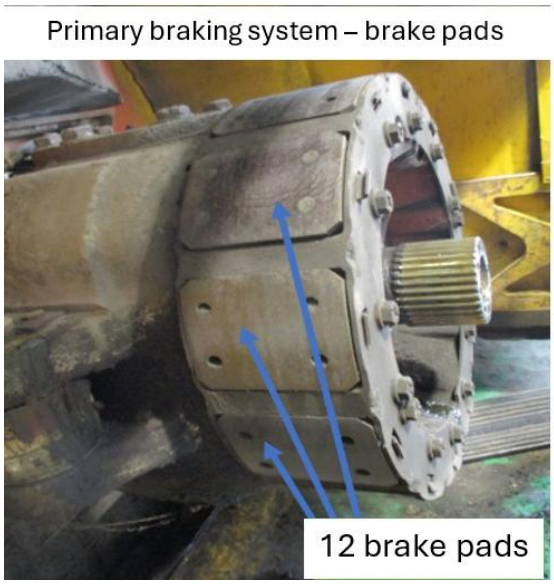
- Most control indicators are located in the cabin, including the air pressure gauge and a mechanical-visual control unit displaying air pressure, which provides control over the hydraulic braking system.
- The tug can only be started from the enclosed cabin. Movement can begin only after the pneumatic control system reaches an air pressure of 90 PSI. Afterward, one of four steering modes is selected (the tug is typically set to "bi-directional axle steering" for optimal turning radius), and either forward or reverse gear is engaged.
- **The only braking method available when the driver transitions between the two driving positions is the parking brake.**
- **When parking the tug, the gear lever must be set to "neutral" and the parking brake engaged.**
- The dual-position control selector between the driving stations is located only in the enclosed cab and determines which driving position has control over the vehicle. Control includes the brakes, brake lights, and gear selection.
- Control transfer between driving positions can only be performed when the tug's gear lever is in "neutral" and the vehicle is **completely stationary**.
- **Attempting to brake from one driving position while the selector is set to the other will not succeed; in such cases, the brake lights will also not illuminate**.
- Aircraft pushback is usually performed from the open driving position. When only a short towing distance is required to adjust the aircraft's position on the taxiway, this is typically done without changing the driving position.

Braking System

- The vehicle is equipped with two separate braking systems.
- The brakes operate via a single central hydraulic system, which is controlled by a pneumatic system.

Primary Braking System

- Each wheel is fitted with 12 brake pads (48 in total), which receive pressure from the hydraulic system. The pads are in direct contact with the wheels.
- Control of the hydraulic system is performed via the brake pedal and depends on the presence of air pressure in the pneumatic unit.
- Low air pressure in the pneumatic control system can result in an inability to operate the primary brakes. Pressing the brake pedal releases compressed air from the tank into the environment. Simultaneously, when the engine is running, the tank is refilled. When rapidly pumping the brake pedal, a situation may occur where the air depletion rate exceeds the replenishment rate. **This can lead to loss of braking capability** (see operational paragraph for the driver Figure11).



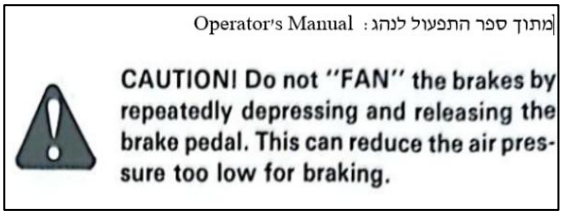


Figure 11 - **Main brake pad system**

Parking brake

- Consists of 4 brake pads actuated by hydraulic pressure. Each pad is approximately 5 cm in diameter. The pads are installed on the drive shaft connecting the engine to the wheels. Control of the parking brake depends on air pressure in the pneumatic system.
- The parking brake is intended only to hold the tug stationary when in neutral, on a level surface, and after coming to a complete stop. The parking brake is engaged using the "parking brake" mushroom button at the driving position, selected via the control selector, or automatically when air pressure in the pneumatic system drops below 45 psi.

Two out of the four parking brake pads

- Figure 12 - **Main brake pad system**

- **The contact area of the parking brake pads is less than 2% of the main brake pad area**. This substantial difference in braking capability is reflected both in the placement of the pads and in the fact that the main system pads grip the wheels. The parking brake discs were found worn and scored after the accident.

Findings from post-accident brake system inspection

- No malfunction was found in the pneumatic system that controls brake actuation via the hydraulic system.
- No technical malfunction was found in the hydraulic system or the tug's main brakes.
- After removing the wheels, inspection of the main brake discs indicated a large amount of friction material remaining on the pads.
- No technical malfunction was found in the parking brake. The parking brake discs were found scored and worn after the accident.
- No skid marks indicating a "locked" wheel during the pushback were found on the tires (lateral skid marks were found—resulting from the tug being pushed sideways, not in the direction of wheel rotation, due to the angles formed between the cargo aircraft, the tug, and the towbar between them).

Brake inspection methods - regulation and practice

- Regulation 95(a) of the Transportation Regulations does not define a uniform national procedure for brake inspection of operational vehicles (unlike vehicles undergoing annual testing at a licensing facility).
- There is no brake testing facility in Israel capable of testing an operational vehicle with a wheel axle load exceeding 12,500 kg. The axle load of the T-500 is 25,000 kg.

- The brake inspection method is not defined in any regulations or procedures. This matter is left solely to the discretion of the "Operational Vehicle Inspector" at IAI.
- The investigation team found that the Operational Vehicle Inspector's involvement regarding the tug involved in the accident was minimal, and garage personnel were the ones who determined the brake inspection procedure and process.
- There are approximately 360 operational areas in Israel, most containing more than one operational vehicle inspector.
- The maintenance garage determined that stopping using the main brakes must occur within 2 meters of pressing the brake pedal. The test is performed on a tug not connected to an aircraft during operation.

  Note: The speed at which the test is performed was not specified.
- Since the inspection reports reference the condition of brake pads, the investigation team examined the practical meaning of this requirement and whether it was actually implemented.
- Each wheel is mounted on a planetary gear system within a special housing—the "wheel housing." Only disassembly of the wheel housing and planetary system allows visual access to the brake pads. Therefore, inspection of the main brake pads (noted in the periodic serviceability report, Appendix 3) requires removal of all 4 wheels and their housings. The ground services garage lacks a dedicated lifting tool for this task, creating significant difficulty in execution and requiring improvisation, such as hanging the wheel housing (after removing the wheel) using a heavy-duty fabric strap from a forklift tine in order to lower it from the tug and set it aside.
- According to professional personnel, the last main brake pad inspection was **performed approximately 15 years ago**.
- In Appendix 3 of the periodic inspection reports, the inspection task "brake pad condition" was recorded as having been ostensibly performed during each inspection.

Figure 13 - ***Wheel housing***

Disassembly of the wheel housing after removal of the wheel and planetary gear system

Parking brake inspection method

- Inspection of the parking brake pads requires disassembly of the brake unit located on the drive shaft, between the engine and the wheels.
- There is no specific procedure for inspecting this brake.
- The tug manual states that brake functionality should be checked while fully parked on a level surface (there is no reference of applying external force such as an aircraft with running engines).

Tug inspections and serviceability documentation

- See Appendix 3 - Operational vehicle serviceability inspection.
- Serviceability inspections are performed at the IAI garage by garage personnel.
- The periodic inspection form for operational vehicles has no dedicated field for recording engine hours. The vehicle's mileage remains blank and is not filled in as required, despite a dedicated field for this on the form.
- Operational vehicle serviceability is defined in Regulation 95c(a) of the Traffic Regulations, 1961, and is valid for one year. Despite the above, the letter of appointment for the Operational Vehicle Inspector at IAI, issued by the Ministry of Transportation, imposes stricter requirements mandating inspection every 120 days. The roadworthiness inspection and additional audits do not include a braking efficiency test on a mechanized apparatus (unlike the annual licensing test for non-operational vehicles).

  Note: The roadworthiness inspection is the equivalent of the annual vehicle inspection that every vehicle must pass as a condition for driving on the country's roads.

- Inspection tracking records were found to partially not comply with the requirements in the letter of appointment.
- Approximately five years before the accident, vehicle technical documentation was transferred to a computerized SAP system.

  The investigation team found no documentation prior to this transfer. In examining brake condition documentation over those 5 years, the team reviewed, among other things, compliance with legal requirements regarding periodic inspections and monitoring of their execution.
- No record was found of the inspection that should have been performed between February and July 2023.
- Main brake inspection documentation: The periodic serviceability reports note brake pad inspection (Appendix 3). There is no supporting evidence of wheel removal and disassembly of the planetary systems.
- Based on the findings, no visual brake pad inspection was performed during the last 15 years.
- Parking brake documentation: No record of periodic parking brake pad inspection was found.
- Approximately two months before the accident, drivers complained about a stopping problem with the tug. On 17.5.2023, a brake booster (a component in the pneumatic system that controls the hydraulic brake system) was replaced. After the replacement, drivers confirmed that the brakes were functioning properly. There is no record/ information regarding engine hours/km between this repair and the accident.

  Note: Since this is a backup vehicle operated infrequently, and in the absence of engine hour/mileage records, it cannot be ruled out that this was the tug's first towing operation after the repair, which may not have been fully completed. However, the tug drove before the accident from the IAI parking area to the cargo aircraft, and after the accident returned to the garage (under its own power with no signs indicating brake malfunction). The brake inspection at the garage after the accident found no malfunction.

Tow-bar

- Towbar for 747 aircraft manufactured by Eaton (whose operations were sold to AGSE), model 220530. License validity - 02.01.2024.
- The towbar includes a head adapted for the nose landing gear of 747 aircraft and connects to the towbar body via 2 shear pins.
- The towbar has a head with a lug. The other end of the towbar connects to the tow vehicle via a spring and washers.
- The towbar is also equipped with a pair of wheels, which can be folded using a manual hydraulic pump, used when transporting it by tow vehicle when not connected to an aircraft.
- When connecting the towbar to an aircraft for pushback/towing, it must be disconnected from the tow vehicle, manually pushed and connected to the cargo aircraft's nose landing gear; then the tow vehicle reverses and connects to the towbar, and finally the towbar wheels are raised off the ground.

Figure 14 - **Towbar**

- Tug connection - spring and washers found intact.
- Shear pins - remnants of a 7/8" bolt were found, whereas according to manufacturer specifications there should be a 3/4" shear pin with bushings (inner dimension 3/4" and outer dimension 7/8").

  Note: Bushing - a "sleeve" in which a pin (shear or other) sits. An explanation of the implications of the shear pin mismatch is provided in Chapter 2, Analysis of Findings.

1.7 Weather

1.7.1 CAVOK.

1.7.2 Lighting conditions at the time of the accident: night, floodlighting on Apron N.

1.8 Radio Navigation aids - Not applicable

1.9 Communication

1.9.1 Ground crew - Pilots Communication

- Communication between the Headset Operator and flight crew is conducted using a headset system that includes earphones and a microphone, connected via cable or a component enabling wireless communication. If necessary, a person on the ground can press a spring-loaded button located on the aircraft's nose landing gear that activates an alert in the cockpit.
- There is variation in communication methods (Bluetooth, other), operating ranges, resistance to electromagnetic interference, and other parameters across the various types of systems.
- The use of wireless headset systems has become increasingly common at airports and is replacing the older wired headsets.
- **Despite the growing use, there is currently no international standard for wireless headset systems.**
- At Ben Gurion Airport, there have been past incidents where headset transmissions overlapped between two adjacent aircraft on the apron. There is no definition in Israel for technical parameters of a headset system suitable for use at airports, with emphasis on Ben Gurion Airport, while meeting defined safety requirements.

1.9.2 Use of a headset

- Voice communication between the ground crew and flight crew was conducted using a wireless headset system used by the Headset Operator and the cargo aircraft's intercom system in the cockpit.
- The Headset Operator was equipped with and used a wireless headset system operating on Bluetooth 2.1 technology (see Appendix 1).
- Technical publications referring to Bluetooth Class 2 communication specify a typical operating range of up to **10 meters**. The manufacturer's official document (Appendix 1) defines the range as **up to 30 feet (less than 10 meters)**.
- The wireless communication system consists of a headset/microphone with the Headset Operator and a wireless transceiver that connects via plug to the communication jack located on the nose landing gear.

- Alerts: The headset system in use has two types of alerts:
  - ✓ Disconnect/reconnect.
  - ✓ Low battery.
- The disconnect alert - "**Disconnect**" - is heard only in the Headset Operator's headset; the flight crew are not aware of it.
- The connection message - "**Connected**" - is heard in both the Headset Operator's headset and the cockpit.
- Audio volume in the cockpit depends on the volume selector knob position and varying background noise (conversation between flight crew, external radio transmissions from other aircraft to the control tower, constant background noise in the cockpit such as air conditioning, etc.).
- To understand which signals are heard in the headset and cockpit during connection and disconnection of wireless voice communication, a test was conducted on a B747-400F aircraft identical to the accident aircraft at IAI Bedek (test description is in Appendix 1 - Ground Crew-Pilots Voice Communication System).
- During inspection, it was found that exceeding the 10-meter range specified in the "Headset technical specifications" resulted in a communication loss within the cockpit (downlink audio failure) prior to any headset alert. Upon further distancing from the cargo aircraft, the 'Ground Crew Lead' audio "Disconnect" notification was clearly heard in the headset.
- The "Connected" message was heard in the cockpit according to the volume selected via the audio selector knob.
- During the test, no disconnections occurred within the range defined in the technical specifications.

  Note: The FE accompanying the flight crew in the cockpit on the day of the accident stated that he heard the "Connected" messages. The flight crew did not report hearing these messages.
- The accident occurred while there was no wireless voice communication between the Headset Operator and the flight crew, **and the disconnection was without the flight crew's knowledge.**

1.9.3 Loss of ground crew-pilot voice communication during aircraft pushback/towing for departure:

- IAA Procedure No. 8-560-01/27 - "Aircraft Pushback for Departure" - under which the IAI crew operated: The procedure does not specify a situation of loss of voice communication between the ground crew and flight crew during pushback/towing. It only states that in the absence of a headset with the Headset Operator, he must maintain visual contact with the flight crew. Section 6.5.5.9: "**If the Headset Operator is not equipped with a headset, he shall maintain visual contact with the flight crew during pushback**".
- The instruction to stop the process due to any changes occurring during it, does not explicitly refer to loss of ground crew-pilot voice communication. Section 6.5.5.7: "**During aircraft pushback for departure, if for any reason there is a change in pushback parameters (movement axis, change of startup position, etc.), the process must be stopped and new planning for the pushback process must be conducted safely, and all parties involved in the process must be informed**".
- No procedure was written by IAI based on the following IAA procedure, including consideration of the associated risks and all aspects of the required ground crew operations for this activity.

1.9.4 **Hand signals**

- **Hand signals** are a universally recognized and exclusive means of guidance, used for communication between the Headset Operator and the flight crew **in the absence of verbal communication**.
- Hand signals are defined as "marshaling signals" in Annex 2 to the Chicago Convention. "Marshaling signals" defined also in Regulation 74 and the First Schedule to the Aviation Regulations (Aircraft Operation and Flight Rules), 1981, paragraphs 4 and 5.
- The IGOM definitions, Edition 12, April 2023, are also derived from the Annex 2 to the Chicago Convention. The IAA adopted these as the basis for operating procedures at Ben Gurion Airport, while ensuring compliance with the Aviation Regulations (Aircraft Operation and Flight Rules).

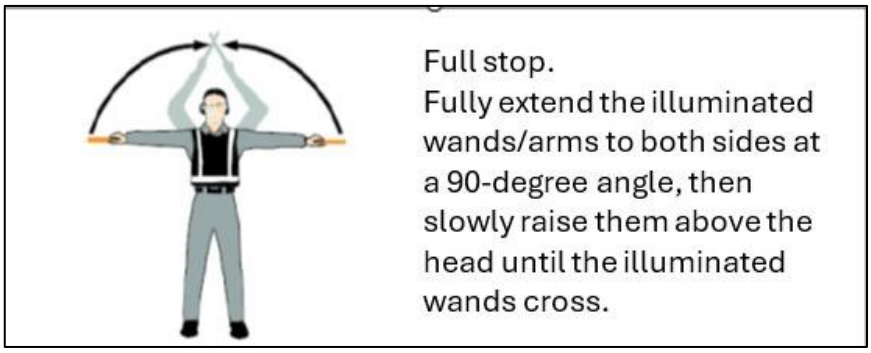


Figure 15 - **Example of hand signals (marshaling signals)**

- The airline's literature on hand signals conforms to IGOM.
- IAI was not familiar with IGOM requirements and also did not act in accordance with the Aviation Regulations (Aircraft Operation and Flight Rules), 1981 on this matter.
- IAI personnel established an internal procedure (Towing and Pushback of Aircraft with Towbar 237-11-07, effective date 01/2023) that IAA procedures are the sole binding procedures for all their activities at Ben Gurion Airport. IAA procedures contain no detail addressing hand signals and the marshaling equipment required for their implementation.
- The IAA refers to IGOM Edition 12 as one of 6 documents forming the basis for establishing Procedure 8-560-01/27 (Aircraft Pushback for Departure). Hand signals are not mentioned in this procedure.
- The investigation team found no documentation of coordination between IAI and the airline regarding agreed-upon hand signals and the marshaling equipment required for their implementation during loss of voice communication while pushing back/towing an aircraft for departure.
- Presentations were found at IAI offices for use in training and refreshing the knowledge of ground crew members. In the chapter "Communication and Signals in Aircraft Towing," two pages were found regarding instructions from the Headset Operator to flight crew when there is a need to stop the aircraft, presented below:
- In Figure 16, the "**stop" signal does not display hand signals that meet international and national requirements**.
- In Figure 17, correct signaling is presented on an image of a person without representative clothing/reflective vest.

  Note: The refresher training materials do not address the differences between administrative towing operations (moving an aircraft from one location to another) and pushback/towing operations for aircraft departure, which involve flight crew who may start the engines during pushback.

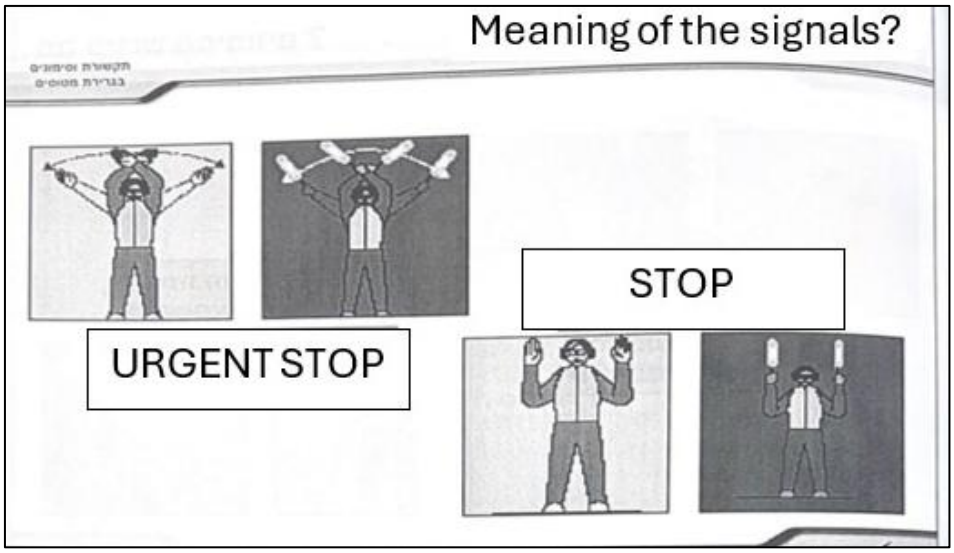


Figure 16 - **The stop signal does not conform to international and national requirements**

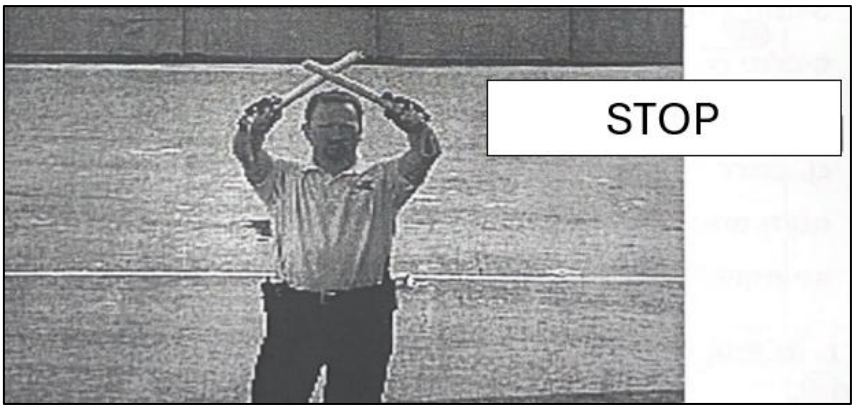


Figure 17 - **Correct signaling with non-standard appearance of the marshaller**

1.9.5 Marshalling wands/lights used by IAI

- IAI ground crew members use marshaling wands/lights. For this purpose, they have a dedicated kit consisting of four wands/lights with wireless transmitters coded to a horn and portable flashing light. The portable flashing light is positioned on the tow vehicle and attached magnetically near the driving position.
- The horn and light are activated when the relevant operator (e.g., wingtip walker) identifies a hazard and when there is a need to stop the aircraft towing process. Activation is performed wirelessly via the transmitters as described (see Appendix 2).
- The kit is coded to a specific frequency. If there is a malfunction in a wand, it cannot be replaced with a wand from another kit. In such a case, the entire kit must be replaced. The practical implication in such a case: driving back to the towing service provider's office (exiting Ben Gurion Airport), testing marshaling wand communication in another kit (per procedure), returning to the work apron (entering Ben Gurion Airport), replacing the horn and flashing light on the tug, and providing ground crew members with new wands/lights.

Note: If three walkers are required - two at the wingtips and one at the tail - the Headset Operator has only one wand remaining, and even theoretically cannot comply with the Aviation Regulations (for signaling stop).

- According to the Aviation Regulations (Regulation 74 and the First addendum to the Aviation Regulations (Aircraft Operation and Flight Rules), 1981, paragraphs 4 and 5) and IGOM, the Headset Operator's **hand signals in the absence of voice communication with flight crew during hours of darkness are performed using two illuminated marshaling wands. At the time of the accident, the Headset Operator had no marshaling/signaling equipment in his hands.**
- A sample check conducted by the investigation team at Ben Gurion Airport during hours of darkness revealed no use of marshaling equipment by pushback crew supervisors for aircraft departures, including among other ground service providers. Only one ground service company out of three observed equipped its pushback Headset Operators with two illuminated marshaling wands/lights (and they were used).
- The investigation team found that IAI personnel in various roles—managers, instructors, and technicians (participating in actual operations) -lacked familiarity with Regulation 74 (which addresses marshaling signals and prohibits the use of other signals that may mislead or confuse) and the First Schedule to the Aviation Regulations (Aircraft Operation and Flight Rules), 1981, paragraphs 4 and 5.
- It was found that even the regulator does not include examination of this matter, in the inspections it conducts.
- This matter is detailed in the sections dealing with procedures, inspections, and oversight in this report.

1.10 Aerodrome Information

1.10.1 Ben Gurion Airport, Apron N.

1.10.2 Apron and taxiway lighting were operational.

1.10.3 Engine startup point 71 is located on the centerline of Apron N.

1.11 Flight Recording data

1.11.1 FDR

The FDR data were downloaded and decoded. The FDR data were only partially sufficient for detailed analysis, as they are not fully suited for this type of operation (very low movement speeds). The transition from pushback to towing (zero speed) is clearly represented.

1.11.2 CVR

The CVR allows for continuous recording of up to two hours. No data were available from the time of the event, and therefore no analysis could be performed.

1.12 Aircraft wreckage and information regarding the ground impact - Not applicable.

1.13 Medical and Pathological information - Not applicable.

1.14 Fire - Not applicable.

1.15 Elements of Survivability

The driver of the tug managed to exit the cabin before the vehicle became lodged under the aircraft's wheels. Broken window glass and burst tires from the cargo aircraft did not cause any injuries.

1.16 Tests and Research

Several lines of inquiry were examined:

1.16.1 Procedures – Israel Airports Authority (IAA)/Ben Gurion Airport, ground handling service provider, airline.

1.16.2 Regulation – national and international.

1.16.3 Cooperation agreements between the involved parties.

1.16.4 Technical condition of the tow vehicle, with emphasis on brake integrity.

1.16.5 Operation of the tow vehicle during aircraft dispatch.

1.16.6 Engine startup during pushback/towing.

1.16.7 Use of a towbar.

1.16.8 Procedures for operating ground equipment and ground handling.

1.16.9 Wireless headset – technical specifications, including actual communication range testing, operational standards, international standards, and common practices.

1.16.10 Conduct of the ground crew during the event.

1.17 Information about the organization and management relevant to the event of the company and the regulator

1.17.1 International Civil Aviation Organization (ICAO)

The ICAO was established in 1944 under the Convention on International Civil Aviation and, as of 2024, has 193 member states. Its primary objective is to provide cross-border regulation (international standards) and to enable the safe conduct of international civil aviation activities.

The "ICAO regulations" comprise 19 annexes. With respect to international regulation, each annex details binding standards for all states that are signatories to the Convention. Any state that chooses not to comply with a particular standard must notify ICAO accordingly.

Among other responsibilities, ICAO sets the international standards required for the design, management, and operation of airports. The State of Israel has been a party to the Convention since 1949.

1.17.2 International Air Transport Association (IATA)

IATA was established in 1945 and brings together a large number of airlines, both passenger and cargo, from over 120 countries. Airlines in the association account for more than 80% of all scheduled flights worldwide and are required to comply, in addition to mandatory national regulations, with guidelines, standards, and audits proactively conducted by the association.

IATA has defined the IGOM (IATA Ground Operations Manual) as a "guidance document" for all matters related to ground operations on airport aprons. This is currently the only detailed international document available to airlines and ground handling service providers, and as such, it is significant in establishing international rules (which are not part of ICAO standards) for ground operations on aprons.

Note: ICAO intends to add an annex addressing ground operations at airports.

1.17.3 Ministry of Transportation and Road Safety

The Ministry of Transportation and Road Safety is responsible for the planning, development, and regulation of air, maritime, and ground transportation infrastructure and systems in Israel.

The ministry is also responsible for traffic safety, including the regulation and oversight of operational vehicles operating at airports in Israel. At the time of writing this investigation report, the ministry employs two inspectors responsible for supervising "operational vehicle inspectors" across Israel, overseeing approximately 360 operational areas nationwide, including all airports and specifically Ben Gurion Airport. *Note: As of the publication date of the report, only one inspector is operating within the Ministry of Transport, overseeing all operational areas in Israel*.

According to Regulation 95(a) of the Traffic Regulations, the Ministry of Transport appoints at least one inspector for each operational area.

According to ministry officials, enforcement powers over these inspectors are limited. These safety inspectors are employed by the entity they supervise. The IAI tow vehicle involved in the accident was under the supervision of an operational vehicle inspector, an IAI employee, personally appointed and exclusively authorized by the Ministry of Transport.

1.17.4 Civil Aviation Authority of Israel (CAAI)

- The Civil Aviation Authority is the regulator, standard-setter, and responsible body for various aspects of civil aviation in Israel. The authority operates under the Civil Aviation Authority Law, 2005, and in accordance with the powers detailed in the Aviation Law, 2011.

  According to the authority's website: "The mission of the Civil Aviation Authority is to be the regulatory authority for civil aviation in Israel, to ensure its safety, and to enable its efficiency, development, and prosperity for the benefit of all users, in accordance with the standards and international conventions to which Israel is committed to."

  Among its many roles, the authority is responsible for implementing international standards and guidelines in national regulation and for licensing and supervising airports and Israeli maintenance organizations.
- The investigation team found no evidence of CAAI oversight regarding the IAA in general, and IAI in particular, concerning the risk analysis and management processes associated with aircraft dispatch operations
- The Aviation Law, 2011, does not address the provision of ground handling services at airports. The regulation of ground handling services was recently defined by the CAAI director as a national risk, and action has begun on this issue. **The CAAI has not set a timeline for regulating this matter.**

1.17.5 Israel Airports Authority (IAA)

- The Israel Airports Authority is a statutory corporation operating under the Israel Airports Authority Law, 1977. The IAA holds the license to operate airports in Israel. Among its duties are to manage, operate, and maintain Ben Gurion Airport safely and continuously.
- While the authority holds the license to operate the airport, it is also a ground handling service provider at Ben Gurion Airport. In parallel, the authority authorizes the activities of external operators (such as airlines, logistics companies, and ground handling service providers), has the authority to set required standards, and conducts periodic audits of them (and itself). According to authority officials, there is no overlap between the services provided directly by the IAA and those provided by contracted service providers.
- At the time of the accident, the IAA conducted annual audits, which served as the sole tool for evaluating IAI's activities at Ben Gurion Airport. A review of IAI oversight reports reveals a failure to address risk analysis and management regarding the aircraft dispatch process.

- After a serious incident involving the rolling of a Silkway aircraft on Apron N (Investigation File 22-24, July 2024), the Head of Ground Operations at Ben Gurion Airport emphasized the binding nature of IGOM procedures and implemented dedicated oversight procedures (separate from the annual audits of ground handling service providers) for activities on aircraft aprons.
- At the time of the accident, ground handling service agreements- concessions (such as aircraft dispatch)- were in place between the IAA and three companies operating at Ben Gurion Airport. These agreements were based on IGOM requirements and included independent ISAGO audits.

  No such agreement was signed with IAI, which also performed aircraft dispatch activities at Ben Gurion Airport.

1.17.6 Challenge Airlines (BE)

Challenge Airlines (BE) was established in Belgium in 2016 under the name ACE Belgium Freighters and was registered by the local aviation authority under European aviation regulation (EASA). In 2019, the company received an Air Operator Certificate (AOC) from the Belgian authority.

In 2020, the company's name was changed to Challenge Airlines (BE) as part of the Challenge Group. The company transports cargo by air from its logistics hub at Liège International Airport to various destinations in Asia, Europe, the Middle East, and North America.

The airline is a member of IATA and is part of the Challenge Group, which is Israeli-owned. The company operates a regular flight schedule to and from Ben Gurion Airport.

1.17.7 Provision of Ground Handling Services by Israel Aerospace Industries (IAI) – Aviation Division

- The Aviation Division of IAI, through its maintenance center "Bedek", provides line maintenance and heavy maintenance services for aircraft and airlines at Ben Gurion Airport.

  Bedek Aviation Group operates under a license granted by the Civil Aviation Authority.
- Until 2018, the Aviation Division provided ground handling services, including pushback/towing for aircraft dispatch, via AeroHandling, which was then a subsidiary of IAI.

  After Aero Handling became an independent company, no longer affiliated with IAI (and not involved in the investigated event), IAI continued to provide ground handling services under a contract defined as a "maintenance contract," which in practice included "towing/pushback services for Challenge Group aircraft" (these definitions appear in the 2021 annual IAA audit). IAI considered all towing/pushback activities related to aircraft dispatch as "maintenance" relying on the aircraft's AMM.

  Note: As of the current stage of the investigation (January 2026), IAI is no longer performing aircraft dispatch activities at Ben Gurion Airport, and, if required, refers such activities to one of the ground handling service providers at the airport.

1.18 Additional Information – Regulations and Procedures

The IAI area is defined by the Ministry of Transportation as an "operational area." The division's operational vehicles (including aircraft tugs) are supervised by an "operational vehicle inspector" (as defined by the Ministry of Transport in Regulation 95(a)), who is personally appointed by the Ministry of Transport and is prohibited from holding any other position in addition to this appointment. The operational vehicle inspector is an IAI employee. In the Aviation Division, his role is limited to "light/medium" operational vehicles only. It was found that he was not familiar (technically) with the tug and had not received training on it. At IAI, the responsibility for testing the tug's braking capability was assigned to the maintenance garage staff, without involving the inspector in the process. Additional Relevant Information – Regulations, Procedures, and Background Material (further detail is provided in Appendix 7).

1.18.1 General

This chapter consolidates the key information pertaining to regulatory, organizational, and inter-organizational aspects, procedures, and specific background materials. Full elaboration and detail are provided in Appendix 7.

1.18.2 Ground Services – Regulation and Procedures

- State regulation in the field of ground operations on parking aprons is lacking.
  At the top of the regulatory "pyramid" is the **Aviation Law, 5771 – 2011**. At the current stage of the investigation, **the Aviation Law does not address ground operations on parking aprons and aircraft operations at airports**.
  As the official holding national oversight responsibility, the CAA Director has classified ground services as a **strategic State risk**. He has further mandated a **Risk Management Task Force** to review potential regulatory frameworks for implementation, however, **no** definitive timelines have been set at this stage. The IAA, operating under the **Israel Airports Authority Law, 5737 – 1977**, received an operating license from the CAAI for the five airports in Israel (Ben Gurion, Haifa, Rosh-Pina, Herzliya, and Eilat-Ramon). **The IAA Law does not serve as a substitute for, nor does it fill, the gap in the Aviation Law with respect to ground operations on aircraft parking aprons**.
- At the international level, ICAO does not yet have detailed and binding regulation pertaining to ground operations on parking aprons (provision of ground handling services). ICAO guidance document 10121 serves as "guidelines" in this domain pending the establishment of binding regulation. IATA (which includes only a portion of airlines) has produced the IGOM document (corresponding to ICAO Document 10121), which consolidates procedures, instructions, and guidelines for minimum requirements on the aforementioned subject. In the overall perspective, **the international framework is general in nature and, at the current stage, is not binding in the State of Israel**.
- The IAA defines the section of the IGOM document addressing ground operations on parking aprons as binding for ground handling service providers and airlines.
- A detailed list of documents reviewed in this investigation: ICAO documents, IATA documents, Israeli regulation (the Aviation Law, 5771 – 2011, the Israel Airports Authority Law, 5737 – 1977, IAA procedures, IAI procedures, and the organizational procedures reviewed as part of the investigation) is provided in Appendix 7.

1.18.3 Relevant Organizational Procedures and Role Holders

- Numerous international airlines operate at Ben Gurion Airport and receive ground handling services from three main service providers (excluding the self-handling ground services of certain local airlines).
- In order to enable operation according to as uniform a standard as possible, the IAA requires entities operating on parking aprons to comply with the IGOM – IATA Ground Operations Manual, which corresponds to ICAO Document 10121 (detail in Appendix 7).

- The IGOM document **defines the pushback/towing operation of aircraft as an activity with a high potential risk of injury to persons and damage to equipment**. In addition to defining the roles of the Headset Operator/headset operator, tug driver, and wingtip guides, the document defines the required hand signals in the absence of direct voice communication between the flight crew and the ground crew. **The document mandates an immediate halt of the pushback/towing process in the absence of communication capability between the ground crew and the flight crew**.

- **IAA and IAI procedures at Ben Gurion Airport** (see details in Appendix 7).
  a. The IAA defines a dedicated procedure "Aircraft Pushback for Departure" – 8-560-01/27 (detail in Appendix 7). The IAA defines this procedure as a "**minimum**" upon which operators using it are required to make adaptations and additions as necessary. **The procedure does not detail situations involving loss of voice communication between the ground crew and the flight crew**. The procedure contains no definitions regarding the quantity, type, and manner of use of manual guidance devices when required. The procedure does not detail situations relating to engine start during pushback/towing. The procedure does not differentiate between the use of a TBL tug and a TBT. The procedure does not address administrative towing.
  b. The procedure places responsibility on the airline. The airline may delegate this responsibility to the ground handling service provider (IAI in the present case).
  c. The procedure requires the airline/ground handling service providers to conduct risk management once a year. **The investigation team found no documentation of risk management regarding aircraft dispatch conducted by the airline or IAI**.
  d. **IAI, whose activities at Ben Gurion Airport focused on administrative towing (transferring aircraft from one location to another) and pushback/towing for aircraft dispatch, treated these two activities as identical despite the substantial differences between them**.
  e. IAI defined IAA Procedure 8-560-01/27 as the **sole and exclusive procedure** for its activities at Ben Gurion Airport. No supplementary measures were implemented to address safety deficiencies (such as loss of intercom communication during pushback, with emphasis on the combination of engines start during the process and/or use of a towbar).
  f. The procedure defines the responsibility of airlines/ground handling service providers to verify equipment suitability, serviceability, and proper functioning. IAI did not provide the Headset Operator with a pair of illuminated guidance wands for use during loss of voice communication between him and the flight crew. Questioning of safety and training personnel at IAI revealed a lack of familiarity with the requirements of the relevant regulations and a lack of understanding of the need to equip the Headset Operator with a pair of guidance devices.

Note: The kit of 4 illuminated guidance wands with wireless communication to a portable horn magnetically mounted ad hoc on the tug is not suitable for the task due to a missing wand and due to coding, that does not allow operational flexibility in the event of a transmission malfunction between the guidance device held by the ground crew member and the horn/light mounted on the tug (see Appendix 1).

g. No documentation was found of coordination and training conducted between IAI and the airline regarding the method of performing pushback/towing for aircraft dispatch.

- **Post-accident operational restrictions**

Following the accident, the IAA issued a NOTAM prohibiting engine start during pushback using a towbar for cargo aircraft types: Boeing 747, Boeing 777, and Airbus 330 at Ben Gurion Airport; however, without similar reference to passenger aircraft. The procedure was replaced on 15/5/25 by an AIP update with identical restrictions (see Appendix 7).

- **IAI - Tug drivers and Headset Operators**

a. **Tug drivers**: Approximately 10 drivers. Minimum requirement: category "B" driving license. Drivers receive classroom-based training (including a knowledge test), driving instruction, and mentoring for approximately six months by a senior driver. At the end of the process, a final certification test is administered. No records, detail, or tracking were found of the activities performed by the driver during his training, with emphasis on the operation of TBT or TBL tug types. No documentation was found regarding continuity of activity and tug type operation following the training during routine operations.

Note: Theoretically, a possibility exists that a driver may perform a pushback / towing operation using a towbar at night, independently, for the first time, years after completing his certification, without managerial awareness of this fact.

b. **Headset Operator/headset operator**: Approximately 10 B1 aircraft maintenance technicians. They perform this role in addition to being aircraft technicians specifically trained for their particular specialty.

They do not receive dedicated training for pushback/towing of aircraft for dispatch.

Note: Israeli regulation contains no reference to pushback/towing of aircraft for dispatch (including minimum requirements, training, and testing of those engaged in this activity).

The Headset Operator does not receive driving training on an aircraft tug and is not authorized to operate one.

- **The airline**

The airline is a member of IATA and operates in accordance with the IGOM document regarding operations on parking aprons (detail is provided in Appendix 7).

a. The Operations Manual (OM-A) contains no reference to loss of voice communication (transition to hand signal communication) during pushback/towing for aircraft dispatch.

b. The GOM (the company's internal guidelines for ground operations based on IGOM), in Section 7.16.5.2, recommends not authorizing engine start before completion of pushback/towing when the process is to include both pushback and towing. **This section does not appear in the Operations Manual (OM-A) – available to the company's flight crew**.

Note: All aircraft dispatches on Apron November are performed using a combined pushback and towing process.

c. The company's guidelines contain no requirement for flight crew to obtain engine start authorization for each engine individually from the ground crew.

d. Following a serious safety occurrence, the captain is required to pull the CVR circuit breaker. There is no definition of a "fault entry" indicating that the circuit breaker was pulled. In the present accident, the captain verbally confirmed to the investigation team that he had pulled the circuit breaker. No record of this action was found in the maintenance logbook. The circuit breaker was found in the pulled position by maintenance personnel approximately 12 hours later.

1.18.4 **Oversight and Audits** (detail in Appendix 7)

- The **regulator**: The CAAI does not conduct oversight of the ground operations of airlines/ground handling service providers at Ben Gurion Airport.
  Nevertheless, IAI is among the entities subject to CAAI oversight. No documentation was found regarding oversight of the aircraft dispatch process or the lack of relevant risk management and analysis.

- **IAA:** The IAA conducts annual audits (distinct/ oversight of ground handling service providers;
  "Since 2020, the Ground Operations Division has been conducting surveillance and inspection activities within the airside operational area.
  Since 2021, a concentrated week of proactive monitoring is conducted twice a year, targeting the activities of various stakeholders in the airside area. This includes auditing operations on the parking aprons and during aircraft turnarounds. Reports from these inspections/surveillance activities are distributed to relevant stakeholders, including the Head of the Ground Operations Department. Additionally, Unit 170 personnel have undergone IATA Inspectors training and perform these inspections as part of their duties. Over the past two years (following the accident), Ben Gurion Airport (TLV) Operations has been conducting routine inspections as part of regular shift duties within the airside area, including the parking aprons. These inspections encompass a full turnaround audit of the sampled aircraft. Quarterly reports are subsequently distributed to ground handling agents and relevant management at Ben Gurion Airport."

- Separately from the aforementioned inspections, the IAA conducts annual audits (as opposed to routine inspections) of the ground handling agents.
  however, at the time of the accident, these did not address individual performance on parking aprons, neither not to a deficiency in Risk Management and Analysis during flight dispatch. (Risk management/analysis constitutes an integral part of the Safety Management System (SMS), and the requirement to conduct an 'Annual Risk Assessment' is mandated by IAA Procedure 8-560-01/17 Chapter 6 (Methodology)) by the relevant IAA managers for ground operations at Ben Gurion Airport (LLBG) and the oversight of the regulator – CAAI.
  a. At the end of 2021 and 2022, the IAA conducted operational audits of IAI (detail in Appendix 7). The IGOM document was established, among other things, as a basis for these audits (which, as stated, was not recognized at this time by IAI personnel).
  b. The audits contained no reference to IAI's definition of IAA Procedure 8-560-01/27 **as the sole governing procedure** for aircraft dispatch.
  c. The audits did not address non-compliance with the Aviation Law/Operating Regulations regarding guidance devices in the hands of the Headset Operator (detailed in Appendix 7).
  d. No evidence was found in the audits of a ramp inspection being conducted during aircraft dispatch.
  e. The gaps identified in the audits revealed non-conformity of procedures against standard requirements regarding the human resource in relation to recruitment/training and deployment.
  f. In the audit format, under the "standard" definition that forms the basis for requirements, a need is defined for "alignment of activities" between the airline and IAI. The investigation team found no documentation of such alignment being conducted. The audit does not address the non-fulfillment of the required alignments as stated.
  g. The audit identified an "absence of authorization" regarding the service that the company was permitted to provide at Ben Gurion Airport. IAI's response to this item, characterizing it as the provision of "maintenance services," received no response from IAA officials.

     Note: In the 2021 annual audit, it is noted that the headset operator (Headset Operator) "receives internal training within the framework that includes Ben Gurion Airport procedures" (quotation). No documentation supporting this training was presented to the investigation team, with emphasis on the specific nature of the aircraft dispatch process.

- **ISAGO audits** – IATA Safety Audit for Ground Operations:
  a. These audits are conducted by international organizations and serve as oversight to assess compliance with IGOM requirements.
  b. **At the time of the accident, the relevant IAI personnel were not familiar with the IGOM document. Concurrently, IAI (which did not hold a concession for providing ground handling services at Ben Gurion Airport) was not required to undergo ISAGO audits** (unlike the three concession-holding ground handling service providers, which had signed a "ground handling services" agreement with the IAA).

- **Transportation Safety Department audits – Ben Gurion Airport**
  (see detail in Appendix 7)
  In the Transportation Safety Department audit at Ben Gurion Airport, safety inspection deficiencies and inappropriate inspections (at IAI) were identified in 2021 with respect to the tug involved in the accident.

- **Operational vehicles – Aircraft tug in the State of Israel** (detail in Appendix 7)
  Regulation 95(a) of the Traffic Regulations, 5721 – 1961, addresses operational vehicles (aircraft tugs) and areas defined as "operational" (within which only operational vehicles are permitted to operate).
  a. An aircraft tug weighing 50 tons, intended to tow an aircraft weighing over 400 tons, is defined by regulation identically to an electric "club car" transporting an elderly person in a kibbutz/hospital or similar compound. Vehicles of this type are not required to have a vehicle license or registration number (but are required to carry insurance).
  b. There is no requirement for a driving license for these vehicles (including a 50-ton tug).
  c. These vehicles are not subject to annual inspection. Due to the weight of the tug, (an axle load of over 25 metric tons) such as the one involved in the accident, **there is no facility in Israel capable of testing its braking capability** (as exists for standard vehicles at every vehicle testing institute of the Licensing Authority).
  d. Gaps in periodic inspections and tracking are detailed in Section 1.6.3 of this report.
  e. These vehicles are not subject to any age limit or age-based special inspection requirements. The tug involved in the accident was 45 years old. The manufacturer has been out of business for more than 20 years.
  f. The entity responsible to the Ministry of Transportation for the serviceability and operation of the operational vehicle is the "operational vehicle inspector," a personal appointment (by ID); however, this inspector is employed (salaried) by the entity he supervises (IAI).

g. Only two oversight staffing positions exist at the Ministry of Transportation for hundreds of personally appointed "operational vehicle inspectors" on behalf of the Ministry of Transportation.

h. On January 11, 2026, the Ministry of Transport issued a circular updating the frequency of periodic inspections to at least once every 90 days (instead of once every 120 days, as previously practiced)."

1.19 The technique and methods of investigation

1.19.1 Collection of evidence at the accident scene.

1.19.2 Analysis of camera footage documenting the event.

1.19.3 Interviews with involved parties.

1.19.4 Detailed review and analysis of procedures of the organizations involved.

1.19.5 Technical testing of communication equipment.

1.19.6 Inspection of the tug's brakes.

2. Analysis

2.1 General

The operational analysis focuses on the actions of the tow crew and flight crew.

The regulatory analysis primarily addresses the impact of non-compliance with law and regulations regarding ground operations on aircraft parking aprons. The procedural analysis addresses the impact of the procedures of the parties involved in the accident.

The impact of the absence of regulation specifically addressing ground services on parking aprons is evident in almost every stage of the accident.

2.2 Human Factors

2.2.1 Without specifically referring to a human factor's analysis model (HFACS or other), the actions of those involved can be viewed as part of an orderly process that led to the accident, examining whether errors were made that may have contributed to its occurrence, what was the role of direct and indirect participants, what caused their conduct, and how such a situation can be prevented in the future. Human factors are present in almost every stage of the accident's development. Therefore, no separate detailed analysis is performed on this issue, which is interwoven throughout the overall analysis.

2.2.2 The overall picture indicates that all stakeholders were operating within a deficient regulatory and standardization framework, which is non-existent in the field of Ground Handling Services.

2.2.3 Within the work procedures, norms, and practices existing among ground crew members and flight crew (it should be emphasized that it is permitted and a position shared by the operator and airport authorities, to start engines during pushback/towing, without any limitations when using TBT with a towbar), a situation arose whereby all those involved in the process acted within their knowledge and understanding with the goal of dispatching the aircraft for flight under the time constraint created by the tug replacement. Errors were made, some due to lack of knowledge (the risks of engine startup during pushback with a towbar were unknown to any of the crew members, that were normally used to perform this task with TBL tug), some with the intention of shortening processes assuming that communication problems would resolve themselves. Personal and mental pressures resulting from a complex task given the hour (approaching airport closure for departures), unplanned use of a tug with towbar, lack of marshaling wands, and especially inadequate or missing procedures.

2.2.4 Continuation of pushback/towing despite 3 ground-pilot communication disconnections can be simply explained by the task-oriented mindset with which the crew operated under the constraining time schedule, hoping that "communication would work out" later (it returned on its own twice).

2.2.5 The analysis addresses the quality of ground crew training, absence of appropriate marshaling equipment, lack of procedures addressing how to act upon loss of ground crew-pilot voice communication (identifying communication loss, how an unplanned transition to hand signal communication is executed), in addition to the lack of a procedure for parking a tug harnessed to an aircraft with running engines while the driver transitions between driving positions—all factors that can cause ground crew members to improvise in real time, without understanding priorities and without having the appropriate tools to do so (for example: no immediate attempt was made to signal the flight crew to stop before the Headset Operator's attempts to apply the brakes).

Note: Since there is no procedure requiring flight crew to maintain visual contact with the ground crew supervisor during pushback/towing (when communication is conducted via voice communication system), they may not have seen the signal (if there had been a proper one) while engaged in starting the engines.

2.3 Technical Aspects

2.3.1 No brake malfunction was found in the tug. Regarding its technical condition before and after the accident, the possibility of a technical malfunction that could have caused the described accident was ruled out with high probability. The tug's travel under its own power, without malfunctions, with full operation of its systems, from the IAI parking area to the cargo aircraft at Ben Gurion Airport, and the return to parking the next day (after the accident), reduces the likelihood of a technical malfunction in the brake system.

2.3.2 Loss of braking capability in the main system is explained later in the report as improper operation of the main brakes. Contributing to this was the fact that the ground crew supervisor who tried to stop the tug from the open driving position has no training or driving certification on the tug and therefore is also unfamiliar with the method of operating and using the brakes. A sequence of pumping caused the air tank controlling the braking system to empty, neutralizing it.

2.3.3 Parking of the tug, can only be done using its Parking Brake (as stated, there is no Parking position in the gearbox). When the tug is connected by towbar to an aircraft (without using the aircraft brakes or chocks), the drivers must use the main Brakes. **The Parking Brake is not designed to stop an aircraft at all**, particularly when its engines are running. Since the aircraft's brakes were not used, all 4 parking brake discs were worn down (while the aircraft pushed it simultaneously), which indicates from a technical standpoint that this tug brake was functioning properly during the accident.

2.3.4 The condition of the tires and their marks on the ground support the determination that there was no brake malfunction.

2.3.5 The tires were found without skid marks on the circumferential contact area (which is in constant contact with the ground). This fact indicates that the wheels were rotating when the tug was pushed by the cargo aircraft.

2.3.6 "Lateral" tire marks on the ground are explained by the tug being pushed sideways. As stated, no longitudinal stopping marks resulting from wheel stoppage due to brake lock-up were found.

2.3.7 Wear marks on the sides of the tires indicate the lateral movement the tug experienced during the pushback with the towbar until the shear pins broke, and subsequently due to the tug's rotation around itself.

2.3.8 Recording and documentation of tug condition, periodic inspections - according to the records, inspection gaps were found as well as missing records of engine hours/mileage during inspections (when conducted). All of these indicate, in the investigation team's opinion, the manner and level of vehicle maintenance; however, their direct contribution to the accident cannot be determined.

2.3.9 **Towbar shear pins**:

The shear pins were found to have a diameter approximately 16% larger than defined in the technical manual. It cannot be determined with certainty how the ground movement of the tug and cargo aircraft would have occurred if the shear pins had been of the standard thickness. However, the investigation team does not view this as a factor that affected the accident's outcome.

2.3.10 Technical condition of the wireless headset/microphone system:

- No technical malfunction was found in the headset system (wireless headphones and microphone).
- With regard to technical parameters, the system functioned as expected.
- The headset system that was used (Bluetooth 2.1 with defined distance of 10 meters) was not adequate for this mission.

2.4 Operational Factors

2.4.1 Direct operational factors that contributed to the accident:

- Starting four engines in sequence, without startup approval for each engine separately, while pushing with a towbar.
- Leaving the tug parked using its parking brake, without a driver in control (while switching between driving positions), harnessed to an aircraft with running engines, without applying the aircraft's brakes or placing chocks at the aircraft's wheels.
- Communication disconnections between the ground crew and flight crew without the pushback being stopped immediately.
- Non-use of hand signals and standard marshaling equipment by the Headset Operator.
- Unplanned transition to marshaling via hand signals.
- Improper use of the tug's main brakes (by an unqualified person).

2.4.2 Contextual factors that influenced the event:

- Regulation, organizational culture, lack of procedural coordination between the parties involved, as reflected throughout this report.
- Action by all involved under a "tight" and binding schedule.
- "Light" aircraft (approximately 62% of maximum takeoff weight). This has a greater effect during engine startup (pushing of the tug by the aircraft).

2.5 Pushback, Towing, and Engine Startup

2.5.1 Startup during pushback/towing shortens ground time and constitutes a shared interest of the airline, IAI, and the airport.

2.5.2 At the time of the accident, IAA procedures did not prohibit engine startup during pushback with a towbar.

Note: An immediate NOTAM, later followed by an AIP update, prohibited startup of wide-body cargo aircraft on Apron N (see Chapter 1, Section 1.18.2.3).

2.5.3 Airline and towing service provider procedures do not require ground crew approval to the pilot before starting each engine separately.

2.5.4 Tugs used for towing/pushback at most major airports worldwide typically connect directly to the aircraft's nose landing gear (TBL - Tow Bar Less). Use of a towbar (TBT) has become less common, being more complex, and typically serves as a fallback when a TBL tug is unavailable.

2.5.5 Use of a towbar in a process involving engine startup contains significant risks. Some operators avoid engine startup during pushback/towing with a towbar. However, there is no international procedure or established local Israeli procedure prohibiting or restricting startup in such a process.

2.5.6 Examples of pushback-to-startup accidents - twin-engine aircraft - using towbar - Poland (2019/436 BOEING 777-258 - Israeli Prime Minister's flight): The aircraft "jumped" over the towbar during pushback while starting both engines.

2.5.7 Singapore (6.12.2015 AIB/AAI/CAS.118 2017 737-800): The towbar broke during pushback of an aircraft with running engines.

2.6 Analysis of Ground Crew Actions

2.6.1 A standard pushback and towing process for departure from parking position N21 to startup position 71 should be performed as follows: pushback, turning the aircraft 90 degrees left (south) while positioning it on the apron centerline in the direction of travel south to the startup position, momentary stop and transition to a short tow (a few meters) to startup position 71. In practice (no defined procedure was found), the ground crew supervisor receives confirmation from the driver before giving approval to flight crew for engine startup during pushback.

2.6.2 The default in this process is use of a TBL (Tow Bar Less) tug. This tug, which connects directly to the nose landing gear, effectively becomes part of the cargo aircraft while transporting it to the required location. This tug has only one driving position with a rotating control system (steering wheel, brakes, gears). The transition from pushback to towing is performed after rotating the driving position 180 degrees so the driver always faces the direction of travel and does not leave the seat.

2.6.3 Use of a tug with towbar, the subject of this accident, is more complex. The towbar distances the nose landing gear from the tug while creating a situation requiring the driver to visualize and understand the movement of the entire assembly (tug, towbar, aircraft).

2.6.4 The presence of a towbar creates lateral pushing torque in all situations where pushback is performed with a direction change, and/or when the pushing force does not act in a straight line on all four tug wheels, the towbar, and the cargo aircraft's nose landing gear wheels. In the present case, where engines 4 and 3 (right side) were started while correcting position leftward toward the centerline, it can be assumed that the torque created contributed to the rotational movement that occurred during the accident.

2.6.5 The T-500 tug has **two driving positions** (as described in Chapter 1, section 1.6). The pushback is performed from the open driving position, closest to the cargo aircraft's nose landing gear. When a significant position correction is needed to complete the process through towing, the driver must move to the second driving position, the cabin (which now becomes the front), on the other side of the tug. **During the transition, the tug is remains harnessed to a powered aircraft without a driver in the seat**. Since there is no "Parking" position in the gearbox, the only parking option (for the tug itself) is via the parking brake alone.

2.6.6 This tug type is of low priority for operation, leading to a low maintaining proficiency on it

Note: Due to the absence of tug usage records and absence of driver activity documentation, it cannot be known whether, when, and how many times the driver performed towing/pushback in general and with this specific tug in particular. The entire process took place with the driver operating very cautiously, reflected in slower-than-usual pushback according to his statement.

2.6.7 The cargo aircraft's position at the end of the pushback phase, approximately 5-10 meters right (east) of the centerline and heading toward it, required a correction whose execution method depended on the driver's skill and experience.

2.6.8 The combination of slower-than-usual pushback and the Headset Operator granting startup approval without requesting (and receiving) confirmation from the driver (as stated, there is no mandatory procedure) led to a situation where at the end of pushback, before transitioning to towing, both right engines were already running. The third engine startup began during towing, before the driver moved to the cabin, unlike a "normal" situation where, according to veteran drivers, only one engine is running.

2.6.9 To move to the cabin, the driver engaged the tug's parking brake and dismounted. At this stage, only the parking brake was holding the cargo aircraft and tug. It should be noted that the driver acted in accordance with the practice customary among tow crews. IAI did not establish a procedure requiring application of the cargo aircraft's brakes as a condition for switching between driving positions when the cargo aircraft's engines are running. It should be emphasized that **the parking brake is not supposed to, and cannot, stop a powered aircraft.**

Note: When questioned, a significant portion of the drivers all claimed that the parking brake stops a powered aircraft. This knowledge gap indicates a fundamental problem in driver training.

2.6.10 **DFDR data analysis**: The flight data recorder activated upon startup of the first engine. This system records thousands of parameters during flight, from engine data, through cockpit lever and switch positions, to additional data related to systems such as electrical, etc. However, according to security footage, the system does not detect very slow movement (between complete stop and approximately half a knot). As can be deduced from the diagram (Appendix 5), the driver stops the tug using the main brakes - the brake lights illuminate and speed drops to zero. When the driver releases the pedal and engages the parking brake, the brake lights turn off. During the transition to the cabin, "slow creep" of the aircraft and tug begins.

Note: The creep is visible in the footage but displayed as "zero speed" due to the precision level of the accelerometers recorded by the DFDR. Subsequently, the stopping attempt by the Headset Operator can be seen (momentary complete stop before resuming movement, due to emptying of the air tank in the brake control system). Slow tug movement resumes until it stops due to collision with the other tug.

2.6.11 Reliance on the parking brake without instructing flight crew to apply the aircraft's brakes while engines are running was found during the investigation to be an "accepted" practice among ground crews. Several drivers were questioned; all stated that the parking brake stops a powered aircraft without problem. Only maintenance personnel familiar with the tug's details noted that the parking brake has no such stopping capability.

Note: Testimony from veteran drivers that at the end of the pushback phase, before transitioning to towing (performed at normal speed), usually only one engine is running, may indicate their understanding that the cargo aircraft can be stopped using the parking brake alone, because they had not (according to them) previously encountered the need to use the parking brake against multiple engines. It should be emphasized that this lack of understanding is troubling and raises questions about the quality of tug driver training.

2.6.12 With regard to the parking brake in the maintenance manual, stopping is specified on a flat, dry surface, without reference to the possibility of external force application (powered aircraft). Since the driver's entry into the second driving position - the cabin - occurred while the tug was already in motion, he was prevented from transferring the control selector to this driving position.

The brake lights not illuminating during stopping attempts from the cabin confirms that pressing the brake pedal in the cabin had no effect on the brake system.

2.6.13 The Headset Operator was unfamiliar with the tug (he has no training or driving certification on it) and did not know that a sequence of pressing the brake pedal causes brake neutralization. The sequence of pressing (on the brake pedal in the open driving position, which he entered in an attempt to back up the driver in the cabin) caused the air tank in the pneumatic control system to empty. The initial presses caused a momentary stop of the cargo aircraft until the air in the pneumatic tank emptied, neutralizing the main braking system, and only the parking brake (which resumed operation when air pressure dropped below 45 PSI) was active. The investigation team believes that had the Headset Operator applied one continuous press on the brake pedal, the tug would have stopped and prevented the aircraft's advance. In this situation, the driver might have been able to transfer the control lever to the cabin to continue towing from there.

Note: The brake lights illuminating with the momentary stop indicates that control of the tug remained in the open driving position from which the driver exited and where the Headset Operator sat as stated.

2.6.14 The angle formed between the tug, towbar, and cargo aircraft led to rotational movement while the powered cargo aircraft "pushed" the tug, breaking the towbar's shear pins, until the cargo aircraft was stopped by the tug becoming wedged in its landing gear.

2.6.15 Insights regarding the event's occurrence: In some of the testimony (based on a debriefing conducted on-site by a Ben Gurion Airport operations person with the entire tow crew together, before the investigation team arrived at the accident scene, and individual questioning which constitutes a central tool in any investigation), it was noted that the driver's transition to the cabin was performed due to an apparent braking malfunction from the open driving position. The facts on one hand (footage and DFDR analysis) and the technical analysis on the other contradict this possibility.

- During a braking malfunction, the driver should have immediately instructed the Headset Operator to signal the flight crew to stop the cargo aircraft using the aircraft brakes (the crew preferred first to try stopping independently anyway).
- The driver is familiar with the tug and knows that changing driving positions does not solve a brake malfunction if one exists.
- The Headset Operator's involvement in stopping attempts indicates an apparent attempt to correct an error without involving the flight crew in the event.

The attempt to apply brakes from the open driving position by the Headset Operator (after speaking with the driver who moved to the cabin) rules out a claim of brake malfunction from this driving position. There is low probability that the Headset Operator would have been sent there if the driver's reason for moving to the cabin was, in his understanding, a brake malfunction in the position he had just exited. As far as events could be reconstructed, he was sent there after attempts to transfer control to the cabin failed.

2.6.16 The slow pushback performed and granting startup approval to flight crew without consulting the driver led to a situation where at the end of pushback, multiple engines were running rather than just one as in a "normal" process. The parking brake was not designed for and could not meet the stopping requirement demanded of it in the situation that developed.

The Headset Operator's failure to request startup approval from the driver indicates, in the investigation team's opinion, a lack of understanding of the risks present in such a pushback, with the time pressure approaching to airport closure for departures. Everyone was rushing and trying to shorten processes.

2.6.17 **The (late) instruction to flight crew to apply brakes, not using standard international signals, was not understood and was not complied with by them**.

2.7 Analysis of Pilot Actions

2.7.1 From the flight crew perspective, pushback/towing for aircraft departure constitutes an "almost transparent" process without intervention on their part. In Chapter 1, paragraph 1.9.5 of this report, the company's AOM defines pilot and ground crew responsibility upon loss of communication between them and the ground crew during pushback and towing. The investigation team found no deviation by flight crew from the AOM definitions with regard to the information available to them at the time of communication loss (which they were not even aware of).

2.7.2 The information available to flight crew during pushback and towing is limited. They have no ground picture and no ability to intervene except when they identify pushback to a position not according to the clearance received. Visibility to the sides, below, and behind from the cockpit is limited. The cargo aircraft's wings cannot be seen from the cockpit. The tug is beneath the nose and cannot be seen from the cockpit. Pilots depend on instructions received from the ground crew. When voice communication exists between them and the Headset Operator, they are not required to maintain visual contact with him. During engine startup, most of their attention is directed at the instrument panel. Hence the difficulty in an unplanned transition to actions based on hand signals, especially when there is no information about the voice communication disconnection itself.

2.7.3 The transition from pushback to towing without using the cargo aircraft's parking brake and continuing engine startup are part of a standard daily process. Since startup approval for each engine separately is not required, flight crew continued with startup without knowing they no longer had voice communication with the ground crew (no Disconnect message is received in the cockpit). The unplanned transition to hand signals in the absence of voice communication must be executed immediately. Since the agreed signals defined in Aviation Regulations and IGOM are identical, both flight crew and ground crew members should know them and act precisely according to them.

2.7.4 Pilots act in accordance with company procedures. These procedures contain no prohibition on starting engines during pushback/towing, let alone any reference to use of a towbar in such a process. There is no procedure requiring notification to flight crew regarding use of a towbar during pushback/towing, and even if there were, it would not be backed by a definition of the risk derived from it.

2.7.5 The investigation team views the flight crew' decision not to apply the cargo aircraft's brakes to avoid hitting the tug, whose condition they could not see, as a logical decision given that the Headset Operator standing in front of them at an international airport (meeting stringent international regulatory requirements) did not signal them with a standard stop signal they would recognize.

2.8 Timeline Analysis

2.8.1 A flight departing close to the airport's nighttime closure is almost always under "time pressure." Original time planning allowed for departure without time pressure, but the delay in the cargo aircraft's arrival led to postponement of the departure time while reducing the remaining time margin until airport closure.

2.8.2 The flight crew's early pickup from the hotel, at the captain's initiative, indicates his awareness of the narrow time window remaining for the flight, and according to testimony from the field, this had an influence on his communication with the ground crew, creating an element of pressure on them to meet the schedule.

2.8.3 Following the tug replacement, approximately 10 minutes remained until the time allowing to commence pushback. Within this constraint, a new factor was introduced - a T-500 tug with towbar - a challenge in itself given a driver with relatively limited experience working with such a tug opposite a B747-400F with 4 engines, under time pressure, and without advance preparation. Very slow pushback (affecting the number of engines running during it) and the cargo aircraft's position requiring transition between the open position and the cabin also contributed to the sense of time shortage among ground crew members.

2.8.4 Ground crew testimony referenced the time pressure existing during the cargo aircraft's departure.

2.8.5 The failure to immediately transition to hand signals upon the first communication drop (a process that would have taken time) can be attributed to time pressure. The lack of appropriate signaling equipment with the Headset Operator may have also contributed to continuing the pushback despite communication problems.

2.9 Effect of Aircraft Weight

2.9.1 Aircraft weight has a direct effect on the force required to move it. The natural resistance to movement of a light aircraft is much lower than that of a heavy aircraft. During startup, each additional running engine has a significant effect on the aircraft's tendency to move from its position. The cargo aircraft's weight at the time of the event was 251,939 kg; maximum takeoff weight is approximately 397,000 kg.

2.9.2 The cargo aircraft's low weight contributed to the effect of engine thrust against the tug's parking brake, which is not designed to stop a powered aircraft, unlike the main brake system. Use of a towbar in this situation exacerbated the problem as the aircraft pushed the tug in rotational movement with relative ease.

2.10 Analysis of Sequential Engine Startup During Pushback/Towing

2.10.1 Startup during pushback/towing is an accepted process in commercial aviation.

2.10.2 Such a process involves risks. Operators should be aware of them, conduct detailed risk analysis, and define appropriate procedures addressing the varying situations that can occur at different airports and with changing ground crews.

2.10.3 Sequential engine startup: Is ground approval received before starting each engine separately?

2.10.4 Airline and IAI procedures allow starting 4 engines in sequence once startup approval is received. In this situation, after general startup approval, communication between the ground crew and flight crew typically does not occur until tug disconnection at the startup position at the end of pushback/towing.

2.10.5 One of the risks during engine startup is a tailpipe fire. Pilots have no indication/warning on the cargo aircraft instruments during such an event. Only the ground person in visual contact with the engine can see and notify the flight crew. For this purpose, he must position himself facing the engine undergoing startup.

2.10.6 In wind (even light), difficulty may arise in identifying externally, on the ground apron, from the noise of already-running engines, when an engine startup begins (fan rotation), as the fans of all engines rotate in such conditions.

2.10.7 Pilots requesting startup approval for each engine focuses the ground crew supervisor on the correct engine.

2.10.8 Such approval, although its original purpose is monitoring each engine's startup separately, requires four mandatory communications (one before each engine), with the additional benefit of identifying unexpected communication disconnection by the ground crew supervisor should this occur during startup.

2.11 Startup Approval from Tug Driver Analysis

2.11.1 The ground crew supervisor/headset operator is responsible for the pushback/towing crew and manages the process. Therefore, he is the ground party who approves engine startup to flight crew. No procedure was found regarding whether he is required to obtain startup approval from the tug driver, but this is the accepted practice at IAI.

2.11.2 It is important to note - ground crew members perform the pushback/towing task on an ad hoc basis without dedicated training, in parallel to their main occupation as aircraft technicians (they are indeed B1 licensed technicians selected from a large group of technicians; however, this does not address the lack of training and definition of appropriate procedures that would provide them with a suitable framework for performing the task). In contrast, tug drivers undergo training and certification, and **this activity is the core of their work**. Hence also their understanding of the variables affecting the process (aircraft weight, tug type, etc.).

2.11.3 Despite the above, no procedure was found requiring the Headset Operator to obtain driver approval before giving startup approval to flight crew during pushback.

2.11.4 Would the driver have approved startup before completing pushback? Should any driver be expected to order cessation of engine startup after the startup process has begun? Does he have such authority in accepted practice?

2.11.5 It is the investigation team's opinion that obtaining startup approval from the driver is undoubtedly required.

2.12 Communication Between Ground Crew Supervisor and Pilots

2.12.1 Headset/microphone:

a) Until recently, primary use was via a communication cable connecting the headset to the nose landing gear. In recent years, wireless headset systems have become more common and the trend is increasing.

b) Since no international standard has been established for these systems to date, no binding technical parameters have been set as a basis for use (and procurement).

c) In the investigation team's opinion, use of a communication system with an "official" range of up to 10 meters, when working with flight crew on a B747-400, is unsuitable for the task.

d) The electromagnetic environment within Ben Gurion Airport (and any large airport) contains radar transmissions, radio, communication devices, cellular systems, and more, at high intensities and in a variety of transmission methods, constituting a challenging electromagnetic environment for wireless communication systems. There are reports of transmission/reception overlaps at certain parking positions. These reports did not reference Apron N until now; however, their very existence constitutes a "warning sign" and requires, in the investigation team's opinion, special attention to the possibility of wireless communication failures on parking aprons.

e) The protocol for messages heard in the headset used in the accident (disconnect/connect) was found by the investigation team to be unsuitable for use when working with an aircraft starting its engines.

f) "In real time," flight crew have no information about voice communication disconnection from the ground crew supervisor.

g) The Connected message, if heard in the cockpit, has no contribution to identifying communication loss that follows it.

2.12.2 Illuminated marshaling equipment:

a) The lack of a procedure defining how to transition to hand signals in an unplanned manner is evident in this accident. The investigation reveals lack of awareness of the need for availability of illuminated marshaling equipment and how to use it. This issue is reflected starting with the ground crews performing the aircraft departure operation, "ascending" to the procedures as defined by the operator, and continuing to the periodic audits (IAA) which ignored the issue.

b) Use of standard marshaling equipment, given the absence of direct voice communication, is required by Aviation Regulations.

c) The possibility that the voice communication device will stop working during aircraft pushback/towing for departure always exists. Responsibility for performing an appropriate and immediate transition to manual marshaling equipment lies at the foundation of the responsibility of those engaged in this work. Hence there is absolutely no doubt about the obligation for their immediate availability in such a case.

d) Ground crews from various operators questioned by the investigation team at Ben Gurion Airport report inability to use this equipment due to lack of appropriate pockets in their standard clothing.

e) Non-use of this marshaling equipment among some ground service providers at Ben Gurion Airport indicates at best a lack of understanding of the need and at worst a lack of knowledge (and observance) of procedures.

f) Appropriate oversight by authorities over aircraft departure processes could contribute to preventing accidents of this type.

2.12.3 Aircraft pushback/towing for departure compared to towing/pushback for administrative/ maintenance purposes (transfer from place to place):

a) **Administrative/maintenance towing/pushback**: The main risk in such a process is collision with a foreign object (pole, obstacle along the way, hangar wall, etc.) during towing due to failed execution. This is the focus of communication among ground crew members. A technician does sit in the cockpit, and there is communication with him as well; however, the fact that the activity is performed without engine startup leaves this technician primarily as the party supposed to release the brake at the beginning of the process and apply it at the end of towing. Alerts and warnings are directed to **the driver** when needed. The marshaling equipment held by wingtip walkers (and the Headset Operator if and when he is equipped with them) is technically characterized for warning the driver via wireless transmitters that activate the flashing siren he positions near himself (Appendix 2).

b) **Pushback/towing for departure**: Performed similarly, but the main difference is the presence of flight crew in the cockpit, and especially when engines are started during pushback/towing. Engine startup requires continuous voice communication **or** use of standard hand signals between ground crew and **flight crew** (whose recognized hand signals are defined according to IGOM).

2.12.4 IAI's treatment of aircraft **pushback/towing (sometimes while starting its engines)** as a maintenance operation indicates, in the investigation team's opinion, a lack of understanding of the risks arising from engine startup during pushback/towing with flight crew in the cockpit. The risk analysis performed at IAI contains no reference to a process combining flight crew, engine startup, and simultaneous pushback/towing.

2.12.5 In the IAA procedure under which the tow crew operates, 8-560-01/27 "Aircraft Pushback/Towing for Departure," there is no reference to incorporating **flight crew** in the process. Communication in the process refers to the ground crew among themselves. The quotes from the procedure "speak for themselves" (emphasis not in original):

> **4.30** "Agreed and known communication - regulated, agreed, and known communication means **between aircraft pushback/towing crew members** adapted to lighting conditions (day/night) and weather conditions."
>
> **6.5.5.8** "The ground crew supervisor will maintain continuous contact with the tug operator" (the driver).

2.12.6 Coordination and understandings between the airline and IAI:

a) According to IAA Procedure 8-560-01/27, Section 5 - Authority and Responsibility, 5.1 - quote: "Responsibility for the cargo aircraft's safety in the aircraft pushback for departure process from start to finish at the required level rests with the airline." Continued quote: "The airline delegates responsibility for the task to the ground service company or operator (authorized to perform the task)."

Note: According to Section 76(a) of the Aviation Law, 5771-2011, the pilot in command is the decisive and final professional authority for the safety of crew members, passengers, and cargo on the aircraft and is also responsible for flight safety. This authority is placed upon him from the moment the aircraft is ready to move. During pushback/towing for departure, the captain has no ability to monitor what is happening on the apron and therefore has no tools to realize his safety responsibility (which as stated in the IAA procedure mentioned below is placed on the airline, which delegates it to IAI).

b) The airline's ground operations procedures are based on IGOM.

c) IAI, in this case, to which responsibility is delegated, was completely unfamiliar with IGOM. In the contract between it and the airline, "maintenance" activity is defined, meaning work according to the AMM (performed on an aircraft **in maintenance** and does not include aircraft departure operations). There is no reference to the clear difference between towing requirements within maintenance operations and those performed during aircraft departure (IGOM) - see quote in Appendix 4.

d) Responsibility for appropriate coordination regarding ground activity performed between a ground service provider and the airline is defined in the IGOM introduction (Appendix 4) as follows (quote): *"b. In the event an airliner or GHSP deviate from a published IGOM procedure, the variation needs to be communicated between the airline and GHSP or vice versa by means of a* ***standard communication channel established by both parties****."*

e) Even if aircraft towing/pushback activity within its departure, is activity performed as stated in the maintenance manual - AMM, it differs from the processes defined in IGOM on this subject. This is a "classic case" requiring coordination and alignment between IAI and the airline, as mentioned below.

f) The investigation team found no document indicating such coordination was performed. Also, in oral questioning of relevant parties, no coordination as defined below was found.

g) In the investigation team's opinion, the lack of appropriate marshaling equipment, use of incorrect hand signals, and lack of readiness for sudden voice communication loss during cargo aircraft pushback/towing for departure could all have been avoided had appropriate coordination and risk management/ analysis been performed between the airline, operating according to IGOM, and IAI, which was completely unaware of it.
Note: With high probability, had such coordination occurred, the airline might have understood the professional gap between providing maintenance services and providing ground services (from one of the 3 companies operating at Ben Gurion Airport) and assigned the task to one of the dedicated companies.

2.12.7 Activity at **Ben Gurion Airport without an appropriate contract**:

Since IAI's aircraft departure activity did not occur within a representative contract like the contracts/franchises between the IAA and the three regular ground service providers at Ben Gurion Airport, the part of this contract requiring work according to IGOM rules was not observed. It is reasonable to assume that ISAGO audits, had they been conducted, would have surfaced the gap that existed while highlighting the need for analysis and reaching understandings regarding the activity definition - maintenance or otherwise.

2.13 Ben Gurion Airport Operations Conduct

2.13.1 Debriefing the accident participants (all together) by Ben Gurion Airport operations personnel before AIAI investigators arrived contradicts what is defined in Section 112 of the Aviation Law, 5771-2011. This action, which may harm the safety investigation process and could even constitute investigation obstruction, was indeed found during analysis to have led to a kind of testimony coordination (not intentionally but by virtue of conducting a joint debriefing). Complex analysis work was required later in the investigation to obtain a reliable and accurate picture of the complete process and each participant's role.

2.13.2 Ben Gurion Airport operations' role is to freeze the situation, ensure all participants are detained on-site, ensure the aircraft and/or involved equipment are not moved, all until an AIAI accident investigator arrives. The need for immediate clarification of the event is understandable; however, its implementation must not lead to investigation obstruction.

2.14 Regulation and Procedures (Safety on Parking Aprons)

2.14.1 Within the analysis of activities, procedures, and regulation directly related to the investigated accident, the investigation team focused on regulation related to ground operations. Due to the large volume of material, the investigation team chose to focus specifically on pushback/towing and aircraft departure on parking aprons at Ben Gurion Airport (as practically reflected in IAA Procedure 8-560-01/27 "Aircraft Pushback for Departure").

2.14.2 The "responsibility pyramid" and authority on the overall issue of what occurs on aircraft parking aprons consists of "four levels." **The base is the law and regulations under CAAI responsibility**. Based on this law and regulations, the **IAA** (of which Ben Gurion Airport is part) **should operate**. Within Ben Gurion Airport, on parking aprons, operational responsibility is placed on **airlines**, and these can delegate it to **companies providing ground services** on their behalf.

2.14.3 Concerning **ground handling services** on the **apron** constitutes a **material gap** in the regulator's (CAA) **oversight capability** at airports. Consequently, the regulator ostensibly lacks the legislative framework to directly supervise or hold responsibility for activities within this domain. Notwithstanding the above, the Regulator is responsible for conducting oversight, at minimum, of defined requirements such as the implementation and execution of a Safety Management System (SMS). IAI's SMS must comply with IAA/LLBG requirements regarding all airport operations. risk analysis and management (which were not performed by IAI in this domain) are integral components of the SMS. As previously noted, no documentation of oversight regarding this matter was found.

2.14.4 Although the regulator has declared the commencement of a regulatory process regarding ground services, however, the failure to simultaneously define milestones/timelines seriously undermines, in the investigation team's opinion, this effort.

Notes:

a. *In July 2025, the regulator published a tender for an airport ground services inspector.*
b. *The State of Israel is required to adopt standards and requirements defined in binding ICAO documents. As stated, ICAO Doc 9981 - PANS is a binding international document (including for the State of Israel). Update 3 of this document was published in 2020 but has not yet been adopted by the regulator in Israel.*

2.14.5 PANS documents define responsibility for what occurs on airport parking aprons (including activities of third parties within airport premises) is defined as resting with the airport license holder (IAA). However, Doc 10121, Section 3.2 (see Chapter 1.18, Section 2.1) explicitly refers to activity performed for the operator through a third party - the airline uses a ground service provider (GHSP) as occurred in the investigated accident. Responsibility for coordinating activities and overall safety is placed on the operator (the airline in the present case).

2.14.6 In practice, the manner of activity within parking aprons is indeed under an overall procedural framework (IAA); however, operational details vary between operators and between ground service providers. Therefore, coordination between operating parties is of utmost importance. An example of differences in aircraft departure activity details: how many chocks are placed before/behind landing gear, where they are placed, in which situation chocks are used versus aircraft or tug brakes, and so on.
The IAA, understanding the problem, requires ground service providers at Ben Gurion Airport to operate according to IGOM. Not all airlines operating at Ben Gurion Airport are IATA (IGOM) members, however, the ground handling agents' accountability shifts directly to each of the airlines receiving services from them.

2.14.7 It is important to note that even IGOM rules do not address specific issues such as engine startup during pushback with a towbar tug.

2.14.8 Safety Management System (SMS):
Aviation Regulations (Safety Management System), 5778-2017 do not require a separate Safety Management System for each airport. The investigation team positively notes what is defined in IAA Procedure "Safety Management System" (SMS) 18-00-01/03 dated 06/04/2021 - maintaining a separate SMS for each airport. The absence of an SMS implementation requirement **among ground service providers** at Ben Gurion Airport constitutes, in the investigation team's opinion, a safety problem. Maintaining an SMS among ground service providers is important for applying standardization and defined safety and reporting rules that "communicate" with Ben Gurion Airport's safety and reporting system in particular and the IAA in general.

2.14.9 IAI's reliance on a general procedure without analysis and understanding of associated problems: IAA Procedure 8-560-01/27 directly referring to the aircraft departure process (Chapter 1.18.2 of the report), the procedure under which IAI operated verbatim, is a basic procedure. Significant issues can be identified that IAI did not complete on its own initiative following activity analysis:

(1) Lack of reference to whether towing is performed with or without a towbar and the differences between them.

(2) Lack of reference to the possibility of engine startup during pushback/towing.

(3) The procedure's ignoring of required actions within the tow crew and between the tow crew and **flight crew** during the transition from pushback to towing of the aircraft to the startup position.

Note: Pilots are not always required to apply brakes during pushback/towing direction change.

(4) No reference to how to transition from direct speech to providing instructions via hand signals. This need existed in the accident without the flight crew knowing about it and without appropriate marshaling equipment in the headset operator's hands.

(5) The procedure does not mention the obligation to use two (illuminated) signaling wands by the ground crew supervisor during hours of darkness, in the absence of direct ground-pilot voice communication, despite what is defined in Aviation Regulations (Aircraft Operation and Flight Rules), 1981.

(6) There is no mention in the procedure of **transition between two driving positions in the tug** when such need arises.

(7) The procedure places risk management on the Headset Operator (in the investigated accident - an aircraft technician performing a role that is not at the core of his daily work and who never received dedicated training in this field).

From the IAA's perspective, this procedure established an obligation on the airline/IAI to perform risk management once a year regarding the "aircraft pushback for departure" process; however, this subject was not included in the annual oversight (by the IAA). Appropriate oversight would have, with high probability, led to early identification of risk factors, emphasizing that the airline and IAI did not analyze or understand the risks in this specific process at all.

2.15 Oversight

2.15.1 Examining the connection between IAA procedures and the procedures of parties operating at Ben Gurion Airport (ground service providers, for example) reveals that annual audits (by the IAA) constituted the sole factor in the relationship between IAI and the IAA in this connection at the time of the accident. Hence the importance of these audits' quality and ensuring their full execution every year. The 2022 audit of IAI was limited, in the office only, and dealt only with examining several points raised in the preceding audit.

2.15.2 The investigation team did not find in audits conducted regarding IAI any issue whose handling would have prevented the accident.

2.15.3 Generally, a survey of ground activity during hours of darkness on parking aprons at Ben Gurion Airport conducted after the accident by the investigation team found that of three ground service providers (and El Al), only one provider complied with the regulation requiring use of two illuminated marshaling devices at night (the obligation refers to hand signals when there is no ground crew-pilot voice communication). This ground service provider went further, and its personnel were found to act this way even when continuous voice communication with flight crew existed.

Note: Regulations do not mandate carrying two such marshaling devices; however, ***there is an obligation to use them when needed.*** *Their unavailability for immediate use does not allow their use upon voice communication loss during pushback/towing for aircraft departure, particularly when starting its engines at that time.*

The investigation team found no reference to this issue in inspections conducted by IAA personnel.

2.15.4 Examination of annual audits conducted regarding IAI in 2021 and 2022 **reveals a lack of reference to risk management**, emphasizing the fact that IAI involved in the accident is not one of the three franchise companies (with all its implications) from the IAA for providing these services at Ben Gurion Airport:

- The audits contain no reference to the fact that operations were performed according to IAA procedure without detail and highlighting of risks arising from use of a towbar and starting 4 engines during the pushback/towing process.
- The audits contain no reference to the mismatch between risk management performed by IAI and the specific activity of aircraft pushback/towing during departure while starting its 4 engines and using a towbar.
- There is a contradiction between what is noted in the 2021 audit regarding headset operator training and what actually occurred.

  The shortened 2022 audit, which did not include reference to field processes, did not contribute (to put it mildly) to preventing the accident.

2.15.5 Approximately one year after the accident (July 2024), a serious incident occurred - a Silkway company aircraft rollaway on Apron N. Noteworthy is the initiative by Ben Gurion Airport ground operations following both events to implement new procedures based on IGOM and begin conducting periodic inspections of activities on aircraft parking and operating aprons.

2.15.6 Operational vehicles, supervisors of utility vehicles, aircraft tug drivers - Regulation 95(a) of the Traffic Regulations:

- **Ministry of Transportation**: The following analysis examines the Ministry of Transportation's oversight manner regarding operational vehicles in Israel, through two inspectors overseeing 360 operational areas containing thousands (possibly even tens of thousands) of operational vehicles (including Ben Gurion Airport and the operational vehicles operating there). The picture that emerges is one of "deficient oversight" resulting from lack of professional staffing positions. The practical implication of this situation is the Ministry's actual disconnection from what occurs in the field regarding operational vehicles in Israel, while in the background no appropriate regulations are defined regarding how to maintain and inspect these vehicles.

  Note: Currently, at the time of the investigation report's publication, there is only one inspector in the office

- Operational Vehicle Inspector: A personal appointment (with obligation to the Ministry of Transportation) whose salary is paid by the party he oversees places the Operational Vehicle Inspector in a conflict of interest.
- Part of this is expressed in IAI's decision to separate his oversight from involvement with heavy operational vehicles.
- The absence in Israel of technological means for testing the stopping capability of heavy operational vehicles such as aircraft tugs weighing 50 tons, concurrent with the lack of definition of professional, uniform, and binding criteria regarding brake inspection methods, is not only unacceptable but also places on those filling this role a professional task (and responsibility) they may not be capable of fulfilling.
- **Aircraft tug drivers**: Traffic Regulation 95 does not distinguish between types of operational vehicles (a mobility scooter has the same status as a 50-ton aircraft tug), and particularly does not address the type of driving license required for these operational vehicles. Since the regulation leaves the Operational Vehicle Inspector to decide regarding threshold requirements and which license is required for the driver, the conflict of interest issue is even more pronounced.

2.15.7 Summary of procedures and regulation:

- In the absence of regulation, the investigation team believes there must be a comprehensive and recognized procedure that all entities operate according to, i.e., standardization for providing ground services, as exists for other aviation fields.
- Into the regulatory vacuum existing regarding ground operations at Ben Gurion Airport, the Operations Division has defined clear rules requiring operation according to IGOM; concurrently, inspections are conducted on aprons and periodic discussions are held with ground service provider participation.
- Recently, the regulator in Israel began working to regulate ground activity, including on parking aprons, but has not defined timelines and milestones for its execution and completion.
- In the investigation team's opinion, IGOM procedures, which currently serve as a procedural tool for many airlines, are suitable for providing an immediate (not perfect) response to the described situation, until completion of a legislative process by the regulator.

3. Finding and Conclusions

3.1 Findings

3.1.1 The accident occurred during pushback/towing of the aircraft using a tug with towbar, while starting all four engines in sequence, and during loss of ground crew-pilot voice communication.

3.1.2 The flight crew were not aware of the voice communication disconnection between them and the ground crew.

3.1.3 The pushback process was not stopped immediately upon the first (of three) ground-pilot voice communication disconnections.

3.1.4 The ground crew did not signal the flight crew to stop immediately upon realizing that the cargo aircraft was pushing the tug.

3.1.5 No technical malfunction that allegedly caused loss of braking capability was found in the tug.

3.1.6 The cargo aircraft pushed the tug while it stood without driver control with only the **parking brake engaged**.

3.1.7 The stopping attempt (after the tug began being pushed by the cargo aircraft) from the tug's open driving position failed due to improper operation of the main brake system by a ground crew supervisor who was not certified to do so. A series of rapid pumping emptied the pneumatic control tank that controls the hydraulic brake system.

3.1.8 The ground crew supervisor was not equipped with two marshaling wands. The instruction he gave the flight crew to stop, not using standard hand signals but by flashing with a pocket flashlight, was not understood by the flight crew and consequently the cargo aircraft's brakes were not applied.

3.1.9 The international stop signal (existing in the operating regulations) for giving appropriate instruction from the ground crew to flight crew is not correctly presented in IAI crew training and instruction materials.

3.1.10 Wireless headset system: There is no international or national standard for "ground crew-pilot" headset systems.

3.1.11 The headset system used in the event had an "official" range of up to 10 meters and was unsuitable for the required task.

3.1.12 The towbar caused lateral torque and uncontrolled circular movement of the tug and cargo aircraft, reducing stopping capability (the tires slid sideways) and striking a parked aircraft before the final stop.

3.1.13 The flight crew reported pulling the CVR and FDR circuit breakers immediately after the accident. No such action was recorded in the maintenance log, and the circuit breakers were found pushed in at 11:00, approximately 9:30 hours after the accident. The CVR data (two-hour recording) was erased.

Procedures, Regulation, Standards:

3.1.14 There is no state regulation in Israel addressing ground activity on aircraft parking and operating aprons at airports. The regulator's announcement of initiating regulation is not accompanied by timelines, and therefore the implementation horizon is unclear.

3.1.15 Ground Operations – IAA: IGOM sections (Relevant) have been defined as the basis for standardization binding ground service providers at Ben Gurion Airport (they in turn are obligated to ensure that service recipients operate accordingly). Detailed procedures have been written, periodic discussions are held with ground service provider participation, and implementation and oversight have commenced accordingly.

3.1.16 No regulatory oversight was found regarding compliance with operating regulations concerning use of marshaling equipment and signals at airports in Israel.
Note: Prior to distribution of this accident report, the CAAI published a tender (application deadline 16/7/25) for an airport ground services inspector.

3.1.17 No regulatory oversight was found regarding the maintenance of an adequate Safety Management System (SMS) at IAI, specifically concerning risk management and analysis during ground handling operations, with an emphasis on aircraft dispatch at LLBG

3.1.18 Ground service providers at Ben Gurion Airport are not required to maintain a Safety Management System (See Appendix No. 6 - SMS).
Note: IAI, which provided ground services at the time of the accident, is required to have an SMS;
however, as stated, it contained no reference to the specific activity of aircraft departure. IAI's risk management addressed only administrative towing activities. Relevant fundamental issues: aircraft engine startup during pushback with a towbar, loss of voice communication between ground crew and flight crew, tug driver transition between driving positions—none of these were part of the risk management performed.

3.1.19 At the time of the accident, airline, IAI, and IAA procedures contained no reference to aircraft engine startup during pushback/towing, particularly regarding use of a tug with towbar.
Note: Although the AIP update, Ben Gurion Airport, May 2025, established a permanent procedure prohibiting wide-body aircraft engine startup on Apron N (Ben Gurion Airport) during pushback/towing with a towbar, this procedure does not apply to all parking aprons.

3.1.20 IAI procedures make no distinction between administrative/maintenance towing and aircraft pushback/towing for departure. According to its definitions, these are identical activities.

3.1.21 No coordination was performed between airline procedures (based on the IGOM document) and IAI procedures (based on the AMM).

3.1.22 The airline was not aware that IAI treats aircraft departure as a maintenance operation and of the procedural gap created as a result.

3.1.23 No checklist was found at IAI that could assist the ground crew in performing pushback/towing for aircraft departure.

3.1.24 No procedure was found at IAI requiring the ground crew supervisor to obtain approval from the tug driver before authorizing flight crew to start the aircraft engines during pushback/towing.

3.1.25 **No procedure was found at IAI for switching between the tug's two driving positions during aircraft pushback/towing for departure**.

3.1.26 IAI procedures do not address the signaling and marshaling requirements for ground crews as stated in the First Schedule to the Aviation Regulations (Aircraft Operation and Flight Rules), 1981, nor the requirements appearing in the IGOM document on this subject.

3.1.27 The hand signals (marshaling signals) appearing in the booklet "Commercial Aircraft Towing Refresher" (November 2013, Edition A), which serves as briefing/refresher material for IAI ground crews, were found to partially not conform to Aviation Regulations.

3.1.28 Interviews with the ground crew revealed ambiguity regarding whether a pre-pushback briefing was actually conducted prior to the accident (testimony indicated it was viewed as a simple process not requiring a briefing). The operational implications of switching to a conventional towbar tractor were not raised following the equipment change. According to IAA Procedure 8-560-01/27, which serves as the framework for IAI (Israel Aerospace Industries) procedures, the ground crew is strictly mandated to conduct a pre-task briefing

3.1.29 The airline's instructions to flight crew contain no requirement to obtain startup approval for each engine separately. This situation may cause late discovery of voice communication loss between the ground crew and flight crew (as occurred in the investigated accident) and deficient monitoring by the ground crew of the startup process.

3.1.30 IAA procedures (upon which all operators' procedures at Ben Gurion Airport are based) contain no mention of the requirement for the ground crew supervisor to use two signaling/marshaling devices when needed.

3.1.31 IAA Procedure addressing aircraft pushback for departure, 8-560-01/27, does not detail significant aspects of the aircraft pushback/towing process from the parking position to the startup point, particularly cases requiring process cessation. IAI did not supplement this procedure.

3.1.32 The contract governing the provision of maintenance services between IAI and the airline does not address the specific activity of aircraft pushback/towing for departure as defined in IGOM documents.

3.1.33 Following the tender for providing ground services at Ben Gurion Airport, the IAA signed agreements with 3 companies. "IAI," involved in the accident, is not one of these three companies. No contractual document was found permitting it to dispatch aircraft for departure.

Tug Technical Condition and Licensing/Maintenance Inspections:

3.1.34 The IAA limits the age of its operational vehicles at Ben Gurion Airport to approximately 15 years but does not set a similar age limit for third-party operational vehicles operating at Ben Gurion Airport.

3.1.35 The tug involved in the accident is 45 years old and has maintenance documentation for only the last five years.

Note: The tug manufacturer has not been active since 1983.

3.1.36 IAI separates operational vehicles into "light/medium" and "heavy." The "Operational Vehicle Inspector" (as defined in Regulation 95 of the Traffic Regulations, 1961—a personal appointment by the Ministry of Transportation) is an IAI employee who was found in the investigation to handle light and medium vehicles. The investigation team found that the heavy utility vehicles are being serviced in the garage under insufficient supervision.

3.1.37 Review of periodic inspection records for the tractor revealed **missing inspections**; for example, only two inspections were documented in 2022 instead of four. This indicates gaps in monitoring and control regarding maintenance of this specific tug. Not all "heavy" operational tugs were inspected.

3.1.38 In all tug inspection records, engine hours/mileage data was not filled in. The investigation team found no activity data for the tug (if any existed) between the date of pneumatic system repair, approximately two months before the accident, and the accident date (this may have been the first activity after the repair was performed).

3.1.39 In serviceability inspection records (every 120 days), a requirement for brake pad inspection is noted **with confirmation of execution**. Information available to the investigation team indicates that main brake system pad inspection was not performed in the last fifteen years.

Note: The pads were inspected after the accident and found to have substantial friction material remaining.

3.1.40 Aircraft tug/operational vehicle brake inspection: There is no brake testing facility in the State of Israel for an operational vehicle—aircraft tug—weighing approximately 50 tons. Despite the above, the Ministry of Transportation has not defined a uniform and binding procedure for how to inspect this operational vehicle's brakes.

3.1.41 There are approximately 360 operational areas in Israel containing thousands (possibly tens of thousands) of operational vehicles. At least one safety officer, personally appointed by the Ministry of Transportation, is defined for each area. Only one staffing positions is defined at the Ministry of Transportation for oversight of safety officers and what occurs regarding operational vehicles.

3.1.42 Training, recording, documentation, and use of aids:

- No recording or tracking were found of the frequency and types of towing activities performed by tug drivers after their certification.
- There is no dedicated training for headset operators/ground crew supervisors and no mandatory periodic refreshers on this subject. B1 aircraft technician certification constitutes the minimum (and maximum) requirement.

3.1.43 Ground crew supervisor familiarity with procedures and hand signals:

- The Headset Operator was not aware of the obligation to use two marshaling devices. The obligation to be equipped with (and use) these two marshaling wands was found to be neither known nor understood by all parties responsible for this task among professional personnel at IAI.
- A spot check conducted by the investigation team at Ben Gurion Airport regarding the three ground service providers at Ben Gurion Airport, found that only one provider equipped the Headset Operator/ground crew supervisor with a pair of marshaling wands at night.

3.1.44 At the time of the accident, there was no agreement between the IAA and IAI permitting performance of the "aircraft pushback for departure" task. Consequently, the binding rules, such as working according to IGOM, were also not defined.

3.2 Conclusions

Background

3.2.1 Numerous factors combined to cause a towing accident that only by luck ended without physical or psychological casualties. In principle, there was no party in the process who performed their role without some failure.

Lack of regulation, an insufficiently hierarchical procedural framework (which procedure takes precedence over which regarding the airline and IAI, for example), lack of understanding of the operational process of aircraft departure, lack of appropriate risk analysis and identification of vulnerabilities in the process, inadequately detailed work procedures at the ground crew and airline level, erroneous actions by the ground crew during the process with emphasis on loss of voice communication during it, failure to equip the ground crew with appropriate equipment, inadequate familiarity of the ground crew and driver with the tug - all constitute the background to the accident.

3.2.2 **The primary and direct cause of the accident was starting the aircraft engines during pushback/towing while using a tug with towbar**.

3.2.3 The ground crew's attempt to regain control of the tug before giving a stop instruction to the flight crew exacerbated the problem that developed during pushback/towing rather than solving it.

3.2.4 The need for a "sudden" transition from direct voice communication (via headset) to marshaling via hand signals due to voice communication failure constitutes a vulnerability in the aircraft pushback/towing process during departure. Such a transition constitutes a vulnerability in any process of this type. This fact was not analyzed and was not known to those engaged in this work.

3.2.5 Prior risk assessment and mitigation by the relevant safety personnel at IAI, with understanding of the difference between administrative towing/pushback operations (AMM maintenance procedures per the aircraft manufacturer) and pushback/towing for aircraft departure (as appearing in IGOM), would have reduced the likelihood of the accident and contributed to safety regarding ground handling of aircraft departing for or returning from flight, particularly regarding the following issues:

- The transition from use of voice communication to signaling via marshaling equipment and hand signals during sudden communication failure.
- Reliance on the tug's parking brake while the driver transitions between driving positions.
- Sequence of actions given an unplanned and uncontrolled situation during cargo aircraft pushback/towing for departure.
- Starting four engines in sequence without approval before each engine separately.

3.2.6 Engine startup approval by the ground crew supervisor during pushback/towing should properly be given only after the tug driver's approval. Among the ground crew, the driver is the only professional who performs his exclusive role for which he was trained and tested. Only he knows and understands the nuances related to changing situations in the process.

3.2.7 The use of Procedure 8-560-01/27 "Aircraft Pushback for Departure" **as the sole and exclusive procedure adopted verbatim** by IAI constituted, in the investigation team's opinion, a stumbling block for the ground crew. The procedure reasonably addresses loss of communication among ground crew members themselves; however, it contains no mention of a situation of **communication loss with the flight crew**.

3.2.8 The flight crew' inability to know that voice communication between them and the ground crew supervisor was lost constitutes a fundamental safety problem. The headset used did not allow this information to exist.

3.2.9 The absence of an international standard regarding use of headset systems-headphones/microphone-constitutes a safety vulnerability. Significant differences exist between various headset systems. These differences exist in transmission methods, operating ranges, and resistance to electromagnetic interference. Due to the complexity of the subject, a detailed risk management process is required on this specific issue with emphasis on real-time ground-pilot communication loss.

3.2.10 Non-use of two illuminated marshaling devices by the ground crew supervisor among some ground service providers operating at Ben Gurion Airport, against a background of no oversight whatsoever on this issue (IAA oversight), constitutes, in the investigation team's opinion, a "breeding ground" for the next towing/pushback accident.

Technical Condition:

A 45-year-old tug, partial inspection documentation, and no visual inspection of main brake pads in the last 15 years- all of these were not found to be direct causal factors in the accident; however, the overall picture that emerges indicates gaps between requirements and findings regarding this matter, as manifested during the investigation.

Agreements, Work Permits, Compliance with International Standards and Binding Procedures:

3.2.11 Contracts, commercial agreements, and/or operational agreements should form the basis for establishing defined and binding work procedures. Activity performed without such a framework is exposed to various problems, of which safety is among the most serious. It can be concluded that a contract/agreement between the IAA and IAI regarding aircraft pushback/towing for departure would have addressed the required operational details and the responsibility placed on the parties in the process.

The airline, which contracted IAI's services for aircraft departure, was obligated to ensure that IAI operates in accordance with appropriate international rules, with emphasis on IGOM procedures.

Annual Audits:

3.2.12 The IAA audits conducted (not aforementioned oversight activities) in the years preceding the accident, 2021 and 2022, regarding IAI, did not contribute to preventing the accident. By their very nature, these are sample-based audits designed to detect systemic deficiencies, but not necessarily those specific to the case in question. Given their broad scope, they did not identify the lack of an appropriate risk analysis for the process executed, nor the reliance on a procedure that failed to fully address the task for which it was written.

4. Recommendations

4.1 **Establishing** milestones and schedules to enable oversight of the ongoing regulatory advancement of Ground Handling Service Providers (GHSP) by the CAAI.
Note: Recurring recommendation following Report 22-24, cargo aircraft rollaway at parking position.
Responsibility: CAAI Director
Recommended completion date: October 15, 2026

4.2 Conduct appropriate oversight of IAI, with an emphasis on risk management and analysis processes regarding operations at LLBG.
Responsibility: CAAI Director
Recommended completion date: October 15, 2026

4.3 **Prohibit** engine start of wide-body aircraft during pushback/towing performed using a towbar (TBT) at airports in Israel.
Responsibility: IAA CEO
Recommended completion date: Next AIP update

4.4 Require ground handling service providers at Israel's international airports to implement training, certification, and recurrent training for ground crew dispatching aircraft, emphasizing crew roles, communication with flight crew, agreed hand signals, use of guidance equipment, and conduct during malfunctions in the process, and conduct oversight accordingly.
Responsibility: GHSP managers
Recommended completion date: October 15, 2026

4.5 **Conduct** risk management for the aircraft pushback/towing process during dispatch, emphasizing loss of ground-to-pilot voice communication during the process.
Responsibility: GHSP managers & EL AL airlines
Recommended completion date: October 15, 2026

4.6 Require ground handling service providers at Ben Gurion Airport to operate an SMS, as a condition for their operations at Ben Gurion, and subsequently at other airports in Israel, while sharing accumulated information among themselves and with IAA.
Responsibility: IAA Director
Recommended completion date: January 17, 2027

4.7 Establish standards in IGOM for wireless headset systems suitable for aviation and their use by ground crews.
Responsibility: IATA
Recommended completion date: October 15, 2027

4.8 Maintain tracking and organized management of tug driver staffing, emphasizing experience accumulation in aircraft pushback and towing using a towbar.
Responsibility: GHSP
Recommended completion date: October 15, 2026

4.9 Update Traffic Regulation 95(a) by establishing appropriate requirements for inspecting operational vehicles using suitable equipment to test braking capability, emphasizing heavy vehicles exceeding 12 tons per axle.
Responsibility: Ministry of Transportation, General manager
Recommended completion date: July 15, 2027

4.10 Update Traffic Regulation 95(a) to include parameters whose non-compliance will restrict or prevent operation of operational vehicles (for example: age, unavailability of spare parts, inability to perform required inspections on the vehicle, etc.).
Responsibility: Ministry of Transportation, General manager
Recommended completion date: January 17, 2027

4.11 Define IAI's ground operations at Ben Gurion Airport.
Responsibility: IAA CEO
Recommended completion date: January 17, 2027

4.12 Separate administrative towing procedures for maintenance purposes from towing/pushback procedures for aircraft dispatch, emphasizing communication with flight crew, guidance equipment, and marking.
Responsibility: IAI CEO
Recommended completion date: Immediate

4.13 Define the criteria for approving a company to provide ground handling services (GHSP) at airports in Israel.
Responsibility: IAA CEO
Recommended completion date: January 17, 2027

Sincerely,

Ofer **Vaknin**
AIAI Director

July 20, 2026 4000-0098-2026-0000205

Appendix 1 - Headset Operator Headset System (Headphones and Microphone)

The wireless headset system operates using Bluetooth 2.1 transmission technology.

Technical publications referring to Bluetooth Class 2 communication indicate a typical operating range of 10 meters. The manufacturer's official document defines the range as up to 30 feet (less than 10 meters).

The headset system consists of two main components:

a. A wireless transmitter that connects to the headphone jack located on the nose gear strut.

b. A headset - headphones and microphone.

The headphones have two types of alerts: battery status and wireless connection status.

An audio alert is played in the headphones (only) when the wireless connection with the transmitter unit on the nose gear strut is lost. There is no alert in the cockpit when this communication is lost.

Figure 18 - **Headset controllers' layout**

[redacted] GROUND MECHANIC WS™ HEADSET AND ADAPTER

The [redacted]round Mechanic WS Solutions Headset and adapter are the perfect solution to any airport ground support function.

This new adapter is designed to work with Peltor WS Headset XP, featuring Bluetooth technology so users never have to worry about cords and wires.

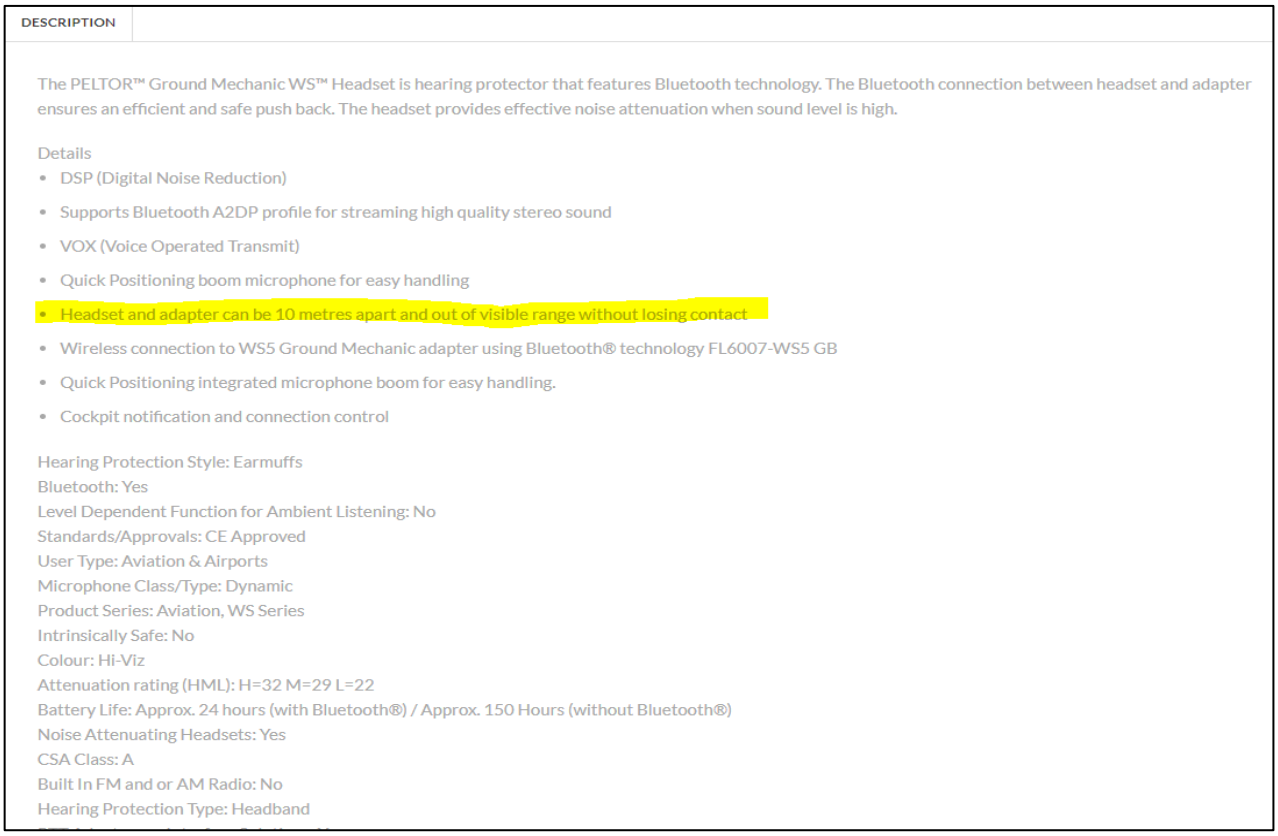
NRR	Class	CSA Freq	125	250	500	1000	2000	3150	4000	6300	8000
25 dB	A	Mean	17.4	25.4	36.3	38.3	35.2	39.3	37.8	36.8	37.6
		SD	3.6	2.3	2.0	2.3	2.9	2.5	2.7	2.2	1.8

Stock Number	Product Number	Description
XH001679634	MT7H7AWS5-01 GB	3M Peltor Ground Mechanic WS Solutions Headset, Headband, Hi-Viz, 1/CS
XH001679717	FL6007-WS5-01 GB	3M Peltor Ground Mechanic WS Solutions Aircraft Adaptor, Hi-Viz, 1 EA/CS

Model	Cable	Connector	Picture
FL6007-WS5-01 GB	Kevlar reinforced 5-cores neon green 0.6 m	3-pole, 6.34 mm diam.	

*Research suggests that many users will receive less noise reduction than indicated by the NRR due to variation in earplug fit and wearing time. It is recommended that the NRR be reduced by 50% for estimating the average amount of noise reduction provided.

Figure 19 - **Head set Specification**



DESCRIPTION

The PELTOR™ Ground Mechanic WS™ Headset is hearing protector that features Bluetooth technology. The Bluetooth connection between headset and adapter ensures an efficient and safe push back. The headset provides effective noise attenuation when sound level is high.

Details

- DSP (Digital Noise Reduction)
- Supports Bluetooth A2DP profile for streaming high quality stereo sound
- VOX (Voice Operated Transmit)
- Quick Positioning boom microphone for easy handling
- Headset and adapter can be 10 metres apart and out of visible range without losing contact
- Wireless connection to WS5 Ground Mechanic adapter using Bluetooth® technology FL6007-WS5 GB
- Quick Positioning integrated microphone boom for easy handling.
- Cockpit notification and connection control

Hearing Protection Style: Earmuffs
Bluetooth: Yes
Level Dependent Function for Ambient Listening: No
Standards/Approvals: CE Approved
User Type: Aviation & Airports
Microphone Class/Type: Dynamic
Product Series: Aviation, WS Series
Intrinsically Safe: No
Colour: Hi-Viz
Attenuation rating (HML): H=32 M=29 L=22
Battery Life: Approx. 24 hours (with Bluetooth®) / Approx. 150 Hours (without Bluetooth®)
Noise Attenuating Headsets: Yes
CSA Class: A
Built In FM and or AM Radio: No
Hearing Protection Type: Headband

Figure 20 - **Headset Data sheet**

Headset System Function Test Description:

The investigation team conducted a test of the headset system on an aircraft identical to the accident aircraft. For this purpose, the headphones and the transmitter connecting to the aircraft were loaded with new batteries. The system was tested on the cargo aircraft in the aircraft hangar.

1. The "headset person" connected the system to the nose gear strut and activated it.
2. The word "CONNECTED" was clearly heard in the headphones.
3. The word "CONNECTED" was heard in the cockpit, but the speaker volume needed to be adjusted for it to be heard above the background noise.
4. The ground crew supervisor moved away from the cargo aircraft while speaking continuously.
5. At a certain point (well beyond the 10 meters defined in the technical specifications), reception in the cockpit stopped, without any notification in the headphones. As the distance continued to increase, a "DISCONNECTED" message was heard in the Headset Operator's headphones.
6. No message was heard in the cockpit.
7. The ground crew supervisor moved back toward the aircraft.
8. At a certain distance (over 10 meters), "CONNECTED" messages were heard in the headphones and in the cockpit.

9. The test was conducted several times. The disconnection and reconnection distances were not identical between tests, but all were at distances exceeding the 10 meters defined in the technical literature.

Conclusions: From the flight crew' perspective, it is not possible to know that communication has been lost unless an attempted transmission fails. The "CONNECTED" messages provide no meaningful value.
From the Headset Operator's perspective, the disconnection message, when heard, is clear and definitive. The same applies to the reconnection message.

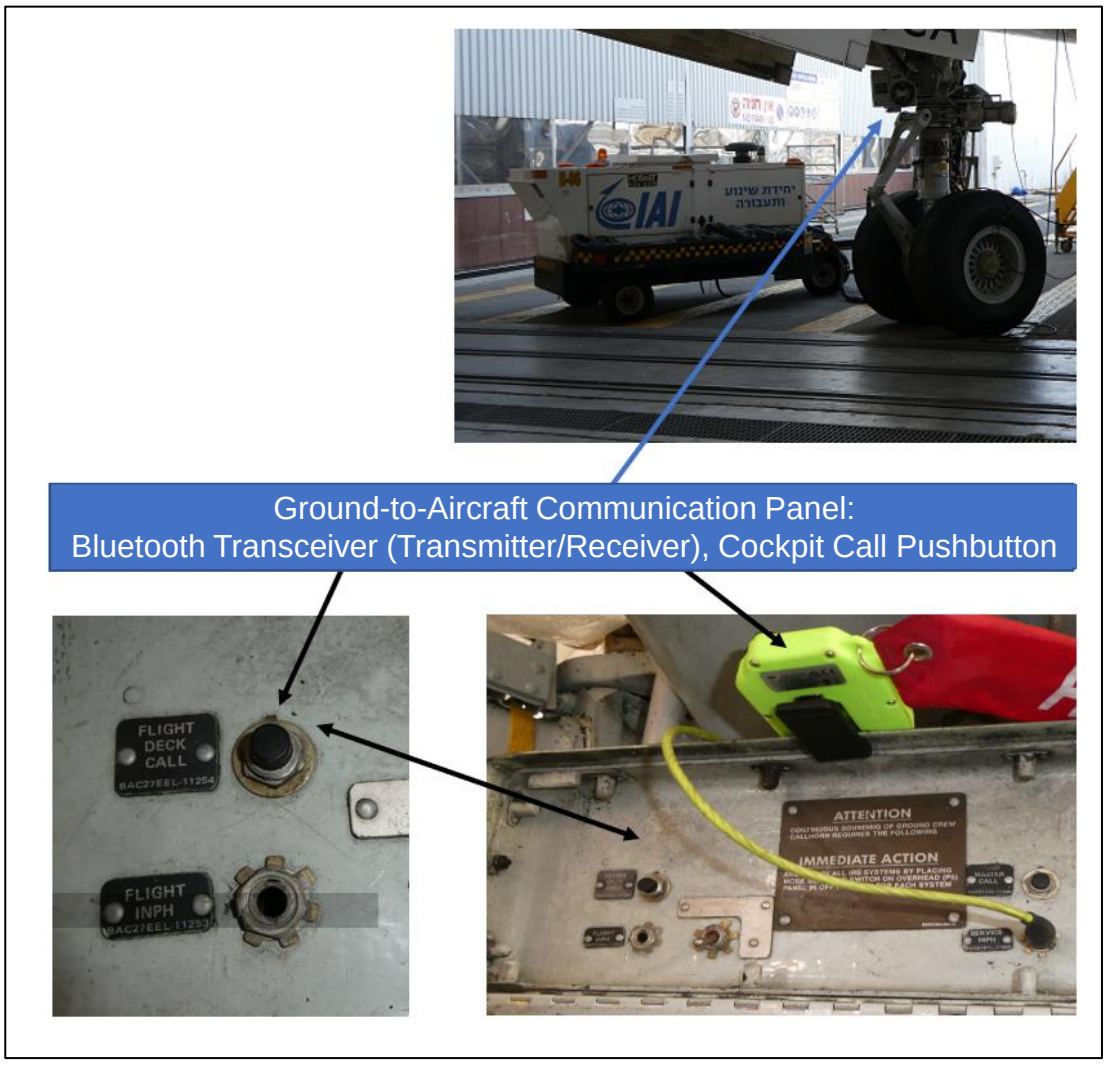


Figure 21 - **Ground to Aircraft communication panel**

The pilot call button is a small spring-loaded button located on the nose gear strut. Attempting to press this button while the cargo aircraft is moving poses a risk of a ground crew member being run over.

Appendix 2 - Illuminated Wireless Marshalling/Guidance Wands

The system includes:

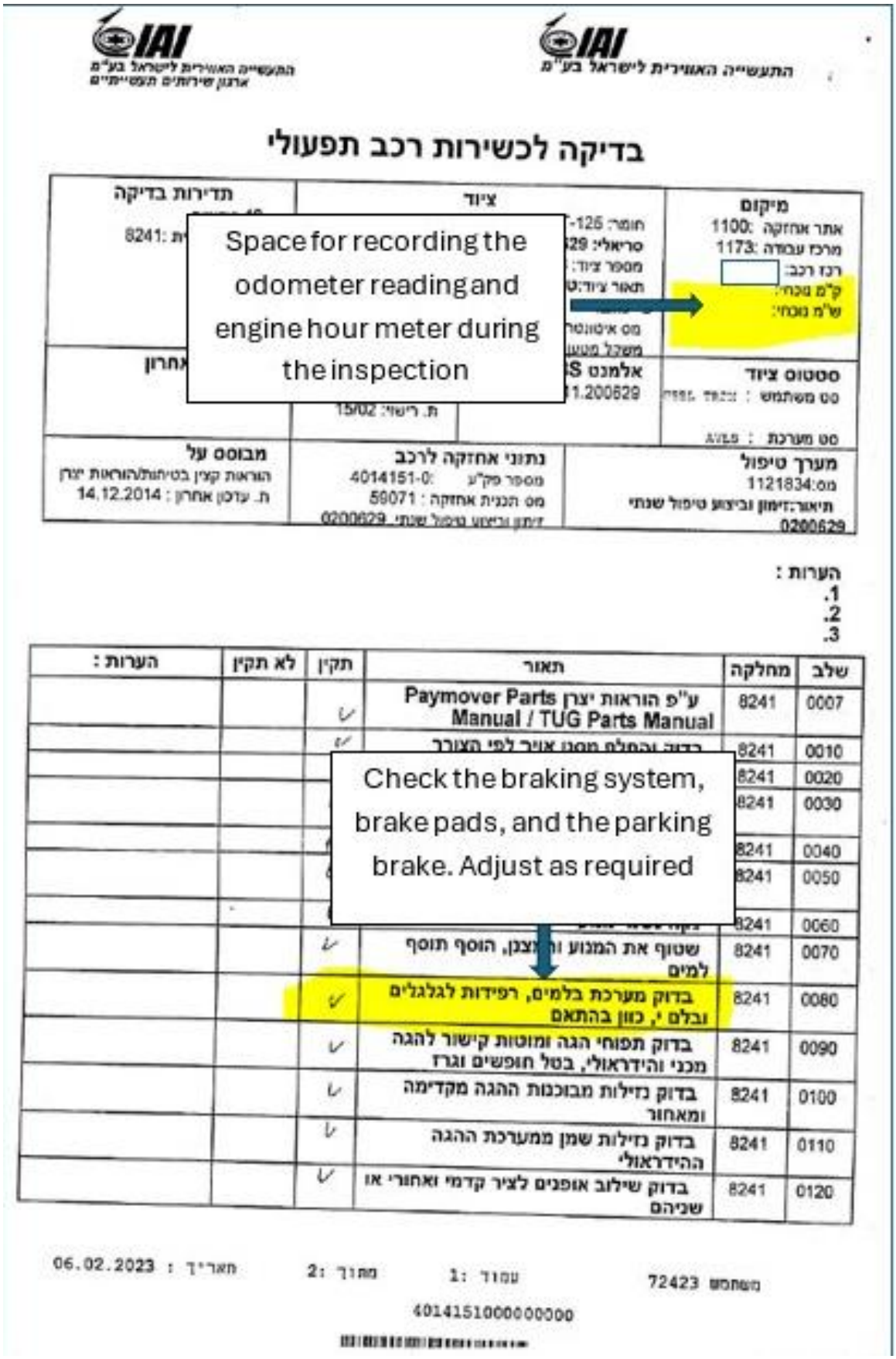
a) A portable wireless horn equipped with a magnetic base, placed on the tug near the driver before pushback.

b) 4 "dual-purpose" handheld flashlights - an orange sleeve for use as a regular marshaling wand and a wireless transmitter for activating the horn. Two activation buttons on the flashlight serve one to operate the flashlight and the other to activate the horn.

Each one of these alert units has individual coding between the "flashlights" and the horn. Pressing the alert button on a flashlight belonging to a different kit will not activate the horn on the unit in question.

Figure 22 - **Marshalling/Guidance Wands**

Appendix 3 - Operational Vehicle Fitness Report (Example)



התעשייה האווירית לישראל בע"מ
ארגון שירותים תעשייתיים

התעשייה האווירית לישראל בע"מ

בדיקה לכשירות רכב תפעולי

מיקום	ציוד	תדירות בדיקה
אתר אחזקה :1100 מרכז עבודה :1173 רכז רכב: ק"מ נוכחי: ש"מ נוכחי:	חומר: 125- סריאלי: 29 מספר ציוד: תאור ציוד:ט מס איטומ משקל מטע אלמנט S 1.200629 ת. רישוי: 15/02	8241:
סטטוס ציוד סט משתמש : סט מערכת : AVES		אחרון
מערך טיפול מס:1121834 תיאור:זימון וביצוע טיפול שנתי 0200629	נתוני אחזקה לרכב מספר פק"ע :4014151-0 מס הכנית אחזקה : 59071 זימון וביצוע טיפול שנתי 0200629	מבוסס על הוראות קצין בטיחות/הוראות יצרן ת. עדכון אחרון : 14.12.2014

Space for recording the odometer reading and engine hour meter during the inspection

הערות :
.1
.2
.3

שלב	מחלקה	תאור	תקין	לא תקין	הערות :
0007	8241	ע"פ הוראות יצרן Paymover Parts Manual / TUG Parts Manual	✓		
0010	8241	בדוק והחלף מסנן אויר לפי הצורך	✓		
0020	8241				
0030	8241				
0040	8241				
0050	8241				
0060	8241				
0070	8241	שטוף את המנוע והצנן, הוסף תוסף למים	✓		
0080	8241	בדוק מערכת בלמים, רפידות לגלגלים ובלם י, כוון בהתאם	✓		
0090	8241	בדוק תפוחי הגה ומוטות קישור להגה מכני והידראולי, בטל חופשים וגרז	✓		
0100	8241	בדוק נזילות מבוכנות ההגה מקדימה ומאחור	✓		
0110	8241	בדוק נזילות שמן ממערכת ההגה ההידראולי	✓		
0120	8241	בדוק שילוב אופנים לציר קדמי ואחורי או שניהם	✓		

Check the braking system, brake pads, and the parking brake. Adjust as required

משתמש 72423 עמוד 1: מתוך 2: תאריך : 06.02.2023

4014151000000000

Appendix 4 - IGOM Definitions Regarding Aircraft Ground Handling Services

The quote is from the INTRODUCTION chapter of the IGOM document.

1 Purpose and Scope

The *IATA Ground Operations Manual* (IGOM) defines ground handling procedures for airlines and ground handling services providers (GHSP) to ensure ground operations activities are safely, efficiently and consistently accomplished. The manufacturers' aircraft maintenance manuals (AMM) contain the maintenance instructions necessary to ensure the continued airworthiness of aircraft. They also provide servicing sections that give specific information required to service aircraft on ramps or in maintenance hangars. Procedures in the AMMs are drafted considering aircraft in a maintenance configuration whereas IGOM deals with operational conditions on the ramp. As such, the procedures may differ from one to the other.

The procedures detailed in IGOM reflect the minimum standards identified and agreed to by the aviation industry.

b. In the event an airline or GHSP deviates from a published IGOM procedure, the variation needs to be communicated between the airline and GHSP or vice versa by means of a standard communication channel established by both parties.

Appendix 5 - Activity Description Against DFDR Data

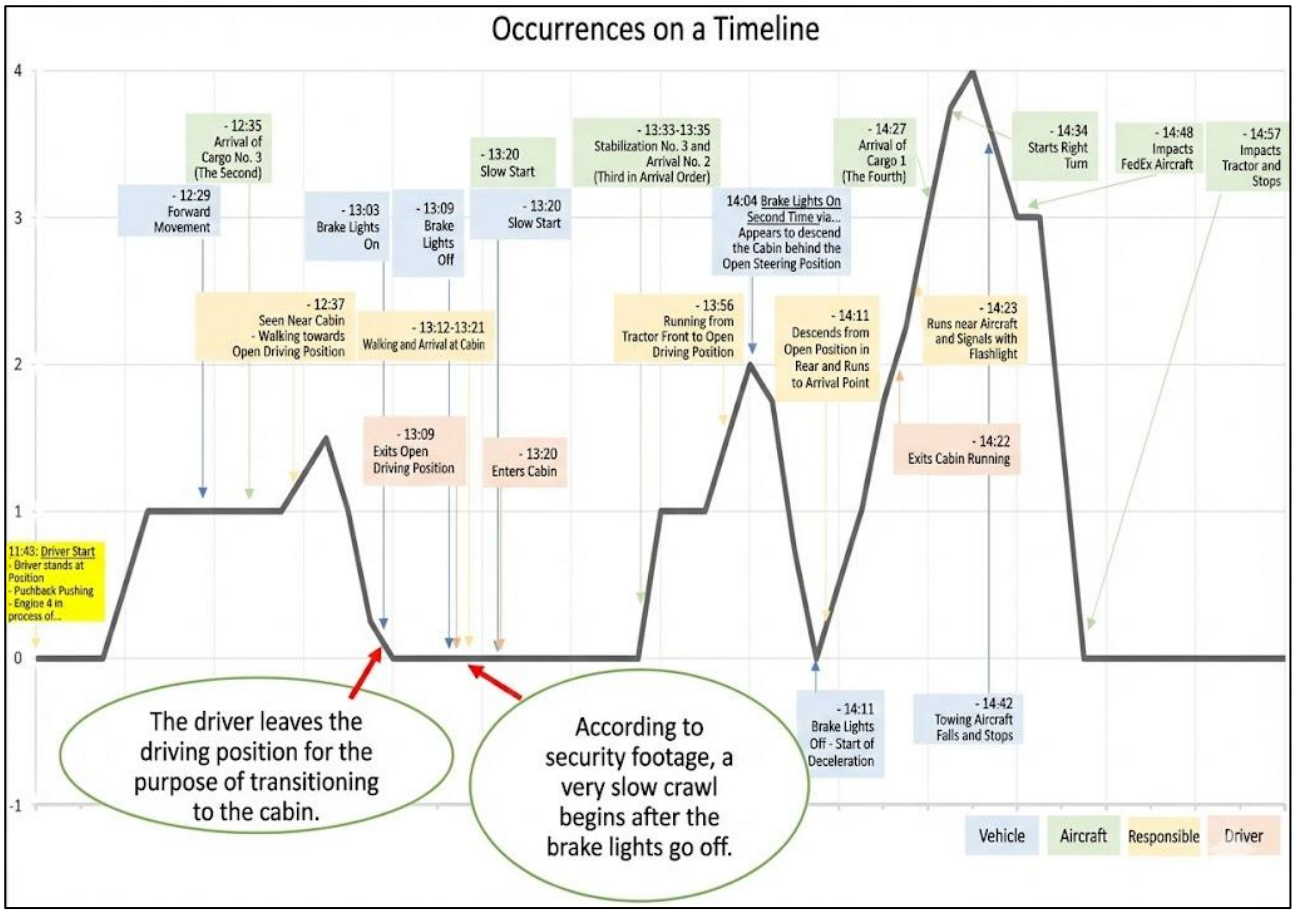


Figure 25- **Timeline events**

Important note: The aircraft's data recording system is not designed to capture very low taxi-speed resolution. The very slow creep during the driver's transition between the two driving cabins appears as "stationary," but according to security cameras, after the brake lights went off (the driver releases the brake pedal and applies the parking brake), slow creep begins. When the driver attempts to stop from the cab, the aircraft is already "creeping." In this situation, the driver (who entered the cab) cannot transfer the control selector to the cab, meaning braking from there is not possible. Control remains in the open driving position, and the braking (momentary, until the pneumatic air tank is depleted) performed from there by the crew chief confirms this fact.

Appendix 6 - Safety Management System (SMS)

"Service provider" – any of the following:

(1) Holder of an air operator certificate under Part Thirteen of the Operating Regulations;

(2) Holder of a license to operate a maintenance organization under the Aviation Regulations (Maintenance Organizations), 5773-2013, that the Director has approved under Regulation 414 of the Operating Regulations to perform maintenance on aircraft operated by a certificate holder as stated in paragraph (1);

(3) Holder of a license to operate an ATS unit; (4) Holder of a license to operate an airport under Section 31 of the Law;

(5) Holder of a license to operate a flight crew training school, which conducts training under its license for obtaining a flight crew license to serve in the role of: pilot, flight navigator, or aviation technician;

Every "service provider" is required to develop and maintain an SMS manual acceptable to the regulator. The manual must address the four pillars of an aviation organization's safety management system:

a) Safety policy (in accordance with Chapter B of the SMS Regulations).
b) Safety hazard identification and risk management (in accordance with Chapter C of the SMS Regulations).
c) Safety assurance (in accordance with Chapter D of the SMS Regulations).
d) Safety promotion (in accordance with Chapter E of the SMS Regulations).

Currently, international and Israeli standards:

a) Do not require ground handling service providers at airports to establish, operate, and manage an organizational safety management system. This obligation applies, as stated, only to airport operating license holders and airlines.
b) **IAA SMS The Israel Airports Authority**

   IAA, as the holder of the license to operate airports in Israel, is defined as a "service provider" under the SMS Regulations and maintains a single, unified SMS for all its airports **together**.

   In the SMS manual, written by IAA and accepted by the regulator, it is established that:

   - ☒ The person with overall responsibility for safety at all airports in Israel is the IAA CEO.
   - ☒ He is responsible for allocating all resources (financial and human) for all airports.
   - ☒ Safety policy is dictated to all airports by IAA (Section 6.5 of the IAA SMS manual).
   - ☒ Hazard identification and management is performed through a "risk file" and centralized by IAA.

☒ Safety indicators are set by IAA for all airports. Section 6.7.11.4 of the IAA SMS manual states: "In each unit required to maintain an SMS, indicators and targets will be defined." Nevertheless:

(a) IAA airports are not units required by law to maintain an SMS. However, IAA procedure 18-00-01/03, "Safety Management System," defines a requirement for a unit-level SMS at airports, meaning an SMS for Ben Gurion Airport.

(b) Safety reports and hazard reports for all airports are centralized and maintained by IAA.

(c) **Ben Gurion Airport SMS**

The Ben Gurion Airport SMS, updated as of 4/22/2021, is defined in Ben Gurion Airport Procedure 8-400-03/10 "Safety Management System."

(1) Section 6.6.1.3 defines the responsibility of the Ben Gurion Airport manager or his designee to validate the risk database at least once a year.

(2) Section 6.9 **HAZARD LOG** – deals with the list of hazards and risks that are handled on an ongoing basis. 6.9.2 - The method for managing the **HAZARD LOG** is detailed in **IAA's unified SMS**.

(3) Section 6.12.11 defines the responsibility for QA/SA (Quality Assurance and Safety Assurance) tasks to a designated person on behalf of the Ben Gurion Airport manager.

(4) Section 6.4.4.1 defines the Ben Gurion Airport manager as "responsible for aviation safety in his area and in units under his responsibility."

(5) Section 6.6.1.1 notes the existence of a database of permanent safety risks existing in the airport's operational area.

The main tasks assigned to the Headset Operator relate to **executing safety risk management processes**, controlling risk management processes, updating the risk database, monitoring risk treatment, and monitoring handling of reports/audits/oversight/inspections.

(d) **Airline SMS**

The airline involved in the incident maintains a safety management system under European regulation and requirements of the European Union Aviation Safety Agency (EASA). Currently, safety reports from airline safety management systems do not interact with the safety management systems of the airports where the airline operates or with IAI's safety management systems (to the extent such a safety management system exists), and no sharing, synchronization, or feedback occurs between them.

(e) **IAI SMS**

IAI in the investigated event is a "maintenance organization" performing maintenance on aircraft operating under Part Thirteen of the Operating Regulations. Therefore, the maintenance organization, defined as a "service provider," is required to maintain an SMS in accordance with Regulation 2 of the SMS Regulations. The investigation team found no interface between the maintenance organization's SMS and the reporting systems of the airline and the airport. Furthermore, safety reports on ground events, even if reported in IAI's safety management system (to the extent it maintains an SMS), do not reach, in a methodical and organized manner, the knowledge of the airport operating license holder (IAA) and the airline.

Appendix 7 - Additional Information - Regulations and Procedures

General

This section reviews additional information related to regulatory, organizational, and inter-organizational aspects as reflected in the investigated event.

This chapter will focus on:

a. A review of the regulation and procedures dealing with ground services.
b. The agreements between the IAA (which holds the license to operate Ben Gurion Airport) and ground service providers.
c. Examination of the audit findings, conducted by the IAA on IAI in relations to this event.
d. IAI training materials according to which ground crews operating at Ben Gurion Airport are trained.
e. Examination of the commercial agreement between the airline and IAI
f. Ground services and the safety management system.

1. Ground Services - Regulation and Procedures

- **Background**

The regulatory framework includes three levels, headed by state laws and regulations. Laws and regulations related to aviation should not contradict binding international standards (mandatory ICAO standards and procedures). Company and organizational procedures complete the regulatory framework as stated.

This section reviews the various regulations and procedures dealing with the process of dispatching an aircraft for flight and maps the international regulation,

state regulation, and relevant organizational procedures applicable to ground service providers at Ben Gurion Airport. As stated, Israel joined the Convention, and like all signatory states is obligated to "ICAO Standards" which effectively constitute an international regulatory framework in civil aviation areas. In addition to standards, states that are party to the Convention are expected to include, embed, and implement in state regulation the procedures detailed in PANS documents. These documents provide additional technical detail and operational procedures that expand upon the standards appearing in the Annexes.

These are "highly recommended" for implementation, with the aim of ensuring uniformity and safety in international aviation procedures. Although these strong recommendations do not constitute an "obligation" in the legally binding sense of the Annexes, PANS documents are an integral part of the global aviation system and form the basis for implementation of ICAO standards; most countries and airlines adopt and implement these procedures in full.

ICAO guidance documents (Documents) are not binding documents but assist in charting the path for implementing primary international standards.

The main ICAO documents reviewed in this investigation report include the following documents:

- Annex 14, Volume I, Aerodromes (8th Ed, 2022).
- PANS-Aerodromes, Doc 9981 (3rd Ed, 2020).
- Manual on Ground Handling, Doc 10121 (1st Ed, 2019).

The Israeli state regulation reviewed in this investigation report mainly includes:

- Aviation Law, 2011.
- Israel Airports Authority Law, 1977.
- Aviation Regulations (Safety at Airports Authority Airports), 1992.
- Aviation Regulations (Aircraft Operation and Flight Rules), 1982.
- Regulation 95 of the Transportation Regulations, 1961.

The organizational procedures reviewed in this investigation report include the following documents:

- Israel Airports Authority Procedure - Aircraft Pushback for Departure 8-560-01/27, update date 19/02/2023.
- IAI Procedure - Towing and Pushback of Aircraft with Towbar 237-11-07, effective date 01/2023.
- Challenge Airline (BE) Ground Operation Procedure Manual (GOPM) - Rev 9, 06/2023.
- Challenge Airline (BE) Operation Manual - Part A (OM A) - Rev 8.2, 09/2023.

In addition to the above, an IATA document dealing with ground operations was reviewed:

- IATA Ground Operations Manual (IGOM) - (12th Ed, 2023).

International Regulation

- **As of the writing date of this investigation report, the International Civil Aviation Organization (ICAO) has not yet published binding standards dealing with ground operations and ground service companies.**
- Professional manuals and practical recommendations exist, both from ICAO and from other international aviation organizations, some of which will be reviewed below. Their implementation is not mandatory, but they have potential for regulating ground operations and reducing the number of safety events in this field.
- In 2025, EASA published groundbreaking regulation in the field of ground service companies and ground operations. This regulation, which will be embedded and implemented in EASA member states in the coming years, does not include Israel
- which is not an EASA member).

- ICAO PANS Document 9981 (Edition 3): The first chapter of the second part of guidance document 9981 (a PANS document establishing procedures for implementation) deals with training for airport operational employees. This chapter establishes that the airport license holder is responsible for:
- Ensuring **development and implementation of training programs** for all such employees, including employees of third parties operating at the airport (for example, airline outsourcing companies).
- Ensuring that airport employees will be trained and will be proficient and qualified to perform their duties.
- Ensuring that training programs will include the manner and frequency of periodic training in which employee proficiency will be tested, and will include at least theoretical material, practical training (OJT), proficiency testing, and demonstration of performance capabilities.
- Ensuring that findings from accidents, serious incidents, and incidents applicable to the employee's role will be included in refresher training.

The seventh chapter of the second part of Document 9981 deals with safety on aircraft parking aprons and establishes the following principles:

- Overall responsibility for ensuring safety on aircraft parking aprons rests first and foremost with the airport license holder (Section 7.1.2), i.e., the IAA Director; however, this does not reduce responsibility from operators operating on parking aprons: "7.1.2 Ensuring safety on the apron is primarily the responsibility of the aerodrome operator, however, all third parties operating on apron have a responsibility to ensure the safety of their specific operations."

  Note: In Israel, airport managers are responsible to the IAA Director for overall safety in all activities at the airports managed by them.
- Concurrently, every entity operating on these aprons bears responsibility for ensuring safety in the specific activity area it performs.
- Hazards on parking aprons will be identified by ground crews and handled within the airport's safety management system. These hazards will be mapped through joint work of ground crews and the airport and will be shared among all users within the training provided to ground crews operating on these aprons.
- The airport license holder must write and ensure the existence of safety procedures that will enable, among other things, safe aircraft pushback operations.

Some of the provisions of Document 9981, as written in previous editions of the document, are embedded in the Aviation Regulations. However, the third and updated edition, which came into effect over four years ago (**November 2020**), containing procedures in areas that in ICAO's view require regulatory attention and implementation by member states, **has not yet been written and has not yet been embedded in Israeli regulation**.

- The updated edition includes requirements for the airport operating license holder to establish:

  a) Training programs regarding qualification of operational employees in general and airport ground crews in particular.

  Conditions and programs for driver qualification and maintenance of operational vehicles operating in the airport's operational area.
- Requirements for a safety management system, cooperation, and coordination with all parties for the purpose of improving safety on aircraft parking aprons and specifically for safe pushback of an aircraft from its parking position upon departure.

As stated, all of these are "guidelines" not yet implemented into Israeli regulation.

- **Guidance Document 10121 (Edition 1) - Manual on Ground Handling**

  Ground operations and routine ground operations occurring at airports are directly related to flight safety and airport safety.

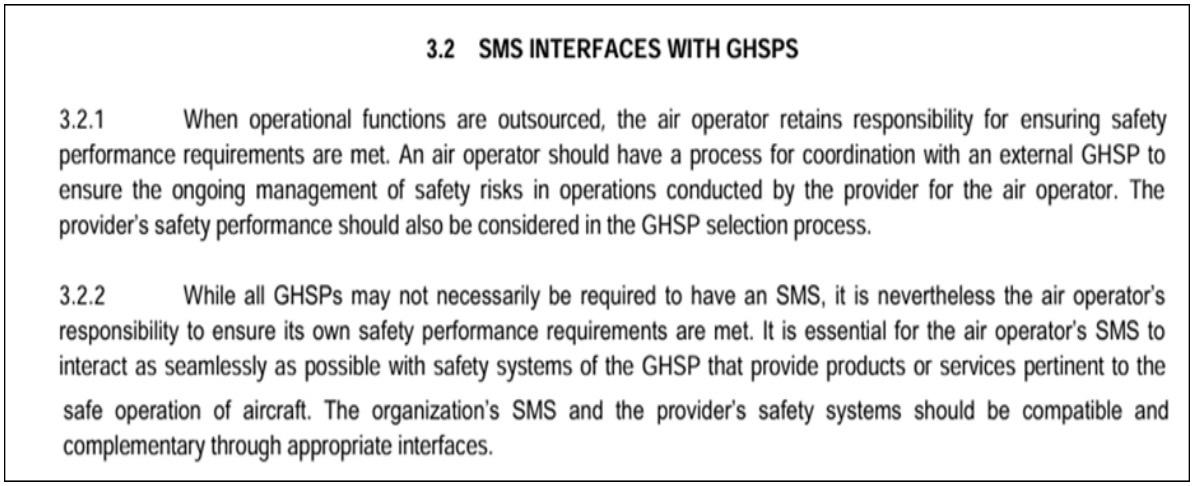
  Guidance document 10121 serves only as a guidance document (Guidance Material) and is not a binding document, but it contains instructions and guidelines for the various stakeholders involved in ground operations at airports.

  The document details in dedicated chapters the role of the main stakeholders (from the state aviation authority (regulation) through the airport license holder, ground service companies, and airlines) in various aspects relating to the provision of ground services:

  a) National Aviation Authority – recommended to consider implementing direct or indirect regulatory oversight of ground-handling providers.
  b) Airlines - reminded of their responsibility for safety and of their obligation to extend their Safety Management System (SMS) requirements to contracted ground - handling providers.
  c) Ground-handling companies – recommended to adopt an SMS voluntarily, even if there is currently no regulatory obligation.

d) Airports - the document recommends anchoring and obligating ground service providers to an SMS within the contract with them.

e) Document 10121 defines the airline's responsibility for coordination and overall safety when operating a ground service provider.



3.2 SMS INTERFACES WITH GHSPS

3.2.1 When operational functions are outsourced, the air operator retains responsibility for ensuring safety performance requirements are met. An air operator should have a process for coordination with an external GHSP to ensure the ongoing management of safety risks in operations conducted by the provider for the air operator. The provider's safety performance should also be considered in the GHSP selection process.

3.2.2 While all GHSPs may not necessarily be required to have an SMS, it is nevertheless the air operator's responsibility to ensure its own safety performance requirements are met. It is essential for the air operator's SMS to interact as seamlessly as possible with safety systems of the GHSP that provide products or services pertinent to the safe operation of aircraft. The organization's SMS and the provider's safety systems should be compatible and complementary through appropriate interfaces.

Figure 23 - **SMS interfaces with GHSPS**

Chapter 6 details the relationship between the airport operating license holder, the ground service company, and the airline for selected ground activity areas.

Section 6.3, for example, addresses handling of aircraft arrival at a position after a flight and its preparation for departure to its next destination. The document emphasizes the close cooperation and understandings required between the airline and the ground service company in such activity.

The document defines the airline's responsibility to ensure that proper and correct phraseology, communication, and signaling standards are maintained between the ground crew and the flight crew.

The investigation team's review indicates that ICAO intends to establish some of the document's provisions as binding standards in the future.

State Regulation

- **The Air Navigation Law, 2011**

  As stated, there is currently no state regulation detailing ground operation issues on aircraft parking and operating aprons at airports. **No timelines have been set** for regulating ground services, which was defined by the CAAI Director as a "state-level risk." The CAAI leaves an "open field" to the IAA, the airport operator, with all that entails.

  a. Article 32(a)(5) of the Aviation Law stipulates that an applicant to operate an airport intended for aircraft on international flights (and certainly an entity already holding such a license) is **required to comply with the requirements of Annex 14 to the Chicago Convention**.

  b. According to this requirement, the licensed airport operator (IAA Director) is responsible for establishing professional knowledge and competency requirements for operational vehicle drivers derived from their roles and the various areas in the airport's operational zone where they are intended to operate.

  c. Based on the materials collected in this investigation, with respect to ground handling providers operating at Ben-Gurion Airport, IAA places the responsibility for defining these requirements and competencies on the ground handling providers themselves.

  d. The IAA includes ground service providers in periodic discussions it conducts and performs inspections on these providers, separate from ISAGO audits.

- **Israel Airports Authority Law, 1977**

  Article 5(a)(1) of the law details the functions of the Airports Authority. Among its functions is to operate, develop, and manage airports in Israel. Under this law, the Airports Authority received an operating license from the CAAI for the five airports in Israel, Ben Gurion, Haifa, Rosh Pina, Herzliya, and Eilat-Ramon. That is, in accordance with the law applicable today, there is one license holder (IAA) operating all airports in Israel, while the airports themselves differ from one another.

- **Aviation Regulations (Safety at Airports Authority Airports), 1992**

  Regulation 10 of the Aviation Regulations (Safety at Airports Authority Airports), 5752-1992, details the subjects required to be included in an airport's Aerodrome Operations Manual (AOM). Article 33 of the Civil Aviation Law, 2011 (in regulations regarding airport and airfield operation) defines the obligations regarding airport operation, including activity on parking aprons. Article 33(1)(b) defines the obligation to maintain an AOM that includes subjects relevant to airport operation. The regulation mentions ground services superficially without detail addressing the specific safety issues on parking aprons and aircraft operations. During the investigation, the investigation team did not find an explicit and orderly requirement from the regulator to include this subject in airport procedures as stated.

- **Aviation Regulations (Aircraft Operation and Flight Rules), 1981**

  a. Regulation 74 and paragraphs 4 and 5 of the First Schedule to the Aviation Regulations (Aircraft Operation and Flight Rules), 5742-1981, establish the marshaling signals and manual visual communication signs accepted in routine **and emergency situations between the flight crew and ground crew. These** marshaling signals are derived from the requirements of Annex 2 to the Convention. When intercom communication with the flight crew is lost, the ground crew member is required to communicate with the flight crew using the accepted manual-visual marshaling signals. **In this situation, the ground crew member must hold two illuminated marshaling wands** (in daylight) and these wands are required to be **lighted wands (at night)**.

  b. Oversight: Given the lack of regulation and standardization, at the time of the accident no adequate oversight was performed on activities on aircraft parking and operating aprons. Even on subjects defined in regulations, such as the use of hand signals and appropriate marshaling equipment when needed, no such oversight was performed. Today, two and a half years after the accident, the IAA conducts inspections on the aprons, on its own initiative, based on IGOM definitions which it defines as the basis for standardization until the matter is regulated by the CAAI.
  Note: In July 2025, the regulator (CAAI) published a tender for an airport ground services inspector position.

- **Regulation 95(a) of the Transportation Regulations**

  Regulation 95(a) of the Transportation Regulations, 1961, addresses operational areas and operational vehicles and defines the conditions for their use.

  a. Operational vehicles are motor vehicles of various dimensions and weights for defined purposes. These vehicles can be tugs, trailers, passenger transport vehicles within a defined area - hospital, kibbutz, factory, etc.; they can be powered by electricity or gasoline/diesel. Operational vehicles are not registered with the Ministry of Transportation, do not require a vehicle license or license plate number, but do require compulsory insurance. An aircraft tug (weighing approximately 50 tons) that tows an aircraft that can weigh over 400 tons is an operational vehicle. There are no age limitations for operational vehicles, particularly the heavy ones, nor are there special maintenance or requirements for retirement from service beyond a certain age (the tug involved in the accident was approximately 45 years old, with no original manufacturer support for 20 years).

  b. An operational area is a defined area only within which an operational vehicle is permitted to operate. In accordance with the regulation as stated, there are 360 operational areas in Israel, and two oversight positions for hundreds of appointed safety officers.

c. An operational vehicle receives an operating permit from the Operational Vehicle Inspector for a limited period of up to one year and may only move within the operational area in which its operation was approved.

d. The vehicle must undergo periodic safety inspections every 120 days to ensure safe operation of the vehicle.

e. 95d. (2), there is no requirement to hold a driving license from the Ministry of Transportation to drive and operate an operational vehicle, even when dealing with a 50-ton aircraft tug towing a 400-ton aircraft. A person may drive various types of operational vehicles if he holds a permit issued by the "Operational Vehicle Inspector."

Note: Ben Gurion Airport procedures require a valid driving license.

The following findings emerge from a review of the regulation:

a. The regulation does not distinguish between types of operational vehicles and there is no distinction between the weight of the operational vehicle and/or its use (private/commercial). For example, there is no distinction between a club car (lightweight) and an aircraft tug (which can weigh up to 50 tons).

b. The regulation contains no detail regarding applicable safety inspections (such as brake inspection and how to perform them) and does not specify minimum required standards for determining the serviceability of an operational vehicle in general and a heavy operational vehicle in particular. It is important to note that there is no facility in Israel for brake testing (as exists at licensing test institutes) for vehicles where the maximum load on each of its axles exceeds 12 tons.

c. The regulation contains no clear definitions (such as sanctions) regarding enforcement against the Operational Vehicle Inspector if he does not exercise his authority as required.

d. The permit to drive an operational vehicle is a general permit. The regulation does not require the Operational Vehicle Inspector to specify in the permit issued the vehicle models the driver is permitted to drive.

e. The regulation exempts operational vehicles from vehicle registration and licensing requirements.

f. The regulation contains no requirements addressing the age of the operational vehicle, maintenance instructions, and dedicated oversight relating to the vehicle's age.

Relevant Organizational Procedures

Introduction

☒ Ground crews operating at airports are required to comply with various organizational procedures, including airport procedures, airline procedures, and of course the procedures of the ground service company by which they are employed.

Multiple procedures, lack of hierarchy between them, information gaps, contradictions, and incompatibility form a basis for safety gaps.

The following sections will describe the procedural environment for ground crew operations in the investigated event.

☒ **IATA GOM (IGOM)**

The IATA Ground Operations Manual (IGOM) document was written by the International Air Transport Association and consolidates procedures, guidelines, and instructions aimed at creating minimum and uniform requirements for how various ground services will be provided to aircraft operating at the airport.

The document outlines guidelines and corresponds with the requirements of ICAO guidance document 10121 and details them. It addresses a variety of ground aspects from the aircraft's entry to its parking position at the airport until its departure for flight, including, among others, passenger handling, baggage, fueling, loading, and safe operation on aircraft parking aprons.

The IGOM document does not provide adequate response, in the investigation team's opinion, in the following aspects:

a. Document hierarchy - IGOM does not detail the interrelationships and expected hierarchy between airport procedures, ground service provider procedures, and airline procedures. How to overcome procedural gaps, if such exist.

b. Safety Management System - insufficient coverage regarding the place of ground activity in the Safety Management System (SMS), emphasizing the importance of safety reports. Additionally, the document does not detail the expected interrelationships between internal organizational safety reports and the SMS of the airline and the airport in which they operate.

c. Minimum standards for operational vehicles - the document does not detail, for the airline (whether it operates ground services independently or through an external ground service provider), minimum standards for inspection and maintenance of vehicles operating at airports. Additionally, the document does not address requirements for recording, documentation, and tracking of malfunctions and maintenance actions, or criteria for determining loss of serviceability or unsuitability of an operational vehicle for performing a selected ground operation.

d. Minimum training content for ground crews - lack of detail regarding minimum training content required to be included in initial onboarding training and periodic refreshers for ground crews.

e. Professional requirements for operational vehicle drivers - no detail was found regarding recommended minimum professional requirements for employing operational vehicle drivers within airlines or ground service providers.

f. Intercom communication with flight crew in the aircraft - while the document details operational differences between pushing and towing aircraft with and without a towbar, no reference was found in the document to differences between wired intercom connection (connection of Headset Operator's headset to intercom and use of wired headsets) and wireless (via remote transmission technology such as Bluetooth). It is important to note that despite the great variance between wireless intercom system models (transmission ranges, transmission methods, etc.), there is no international standard for them, which leaves operators with the decision regarding professional and economic parameters when purchasing and using a system.

g. Reference to engine startup during aircraft towing or pushback: the document does not define clear criteria and conditions, compliance with which would allow the airline or ground service provider's Headset Operator to authorize flight crew to start the aircraft's engines during towing or pushback.

h. ISAGO audits: Within IGOM, a periodic audit performed on ground service providers by independent inspectors is defined.

This audit is called ISAGO - IATA Safety Audit for Ground Operations.

Within the operating contract, the IAA requires ground service providers at Ben Gurion Airport to undergo these audits (separate from inspections performed by it). At the time of the accident, no such contract existed between IAI and the IAA, and no ISAGO audits were performed on IAI.

Many airlines and ground service companies worldwide, and some operating in Israel, have adopted IGOM principles and embedded its contents in their procedures. Airlines have the ability to track ISAGO audits performed on ground service providers from which they receive service (including setting the existence of these audits as a condition of employment).

i. In the introduction to the IGOM document, ground service areas are classified according to potential risk levels in accordance with the ICAO Safety Risk Matrix. **Aircraft pushback and towing, as well as marshaling using hand signals, is defined as an activity with high potential risk for harm to people and equipment.**

Chapters 3 (Aircraft General Safety and Servicing Operations) and 4 (Aircraft Turnaround), include references to subjects directly related to the investigated event. Chapter 4.6.2 details the areas of responsibility of ground crew members, including the Headset Operator, wingtip walkers, and tug driver (given TBT/TBL).

j. **Headset Operator/headset operator:**

During an aircraft departure task, the Headset Operator is the person with overall responsibility for the aircraft pushback process from the parking position. He must conduct an appropriate briefing for the ground crew, verify that the vehicle is suitable for performing the task, and also verify continuous communication with the flight crew, and alert them during aircraft pushback from the parking position, if necessary, when abnormal situations occur requiring operational changes in the pushback process.

k. **Tow tractor driver:**

The driver of the tractor intended to push an aircraft from a parking position must ensure that the vehicle is suitable for performing the task and must act according to the instructions of the Headset Operator.

- ☒ **Wing walkers:**

  Requirements for wingtip walkers during aircraft pushback from the parking position vary between authorities in different countries (this depends on the regulator/entity operating the airport) and between airlines.

- ☒ **Hand signals:**

  Chapter 3.4 in IGOM demonstrates the hand signals accepted in aviation in the absence of voice communication between the ground crew and flight crew and emphasizes that every ground crew member must hold two marshaling wands - during daytime / lighted wands at night or in poor visibility, to enable effective and clear communication between ground crews themselves and between them and the flight crew.

  This is especially important when an abnormal event occurs that could lead to a ground safety event.

Sections 4.6.6 and 4.9.5 address communication between the ground crew and flight crew and establish, among other things, that **if intercom contact with the flight crew is lost and communication cannot be established, towing must be stopped immediately**.

The aircraft departure operation may continue only after effective contact has been established with the cockpit via intercom or using accepted hand signals (marshaling signals as termed in the operating regulations).

☒ **IAA and IAI Procedures at Ben Gurion Airport**

Ben Gurion Airport procedures are written and published by the Israel Airports Authority and their purpose is to regulate various aspects relating to airport operation in routine and emergency situations.

Airlines and ground service companies wishing to operate at Ben Gurion Airport are required to sign a commercial contract with the Israel Airports Authority. Contract clauses require that all ground activity conducted by the company within airport premises be performed in accordance with Authority procedures and **in accordance with nine procedural documents that also include IGOM** (IAA Procedure 8-560-01/27, Section 3 - "Applicable Documents").

IAA Procedure - "Aircraft Pushback for Departure" 8-560-01/27, addresses the aircraft departure process while noting that it is a binding minimum procedure to which specific detail must be added as needed by the operating parties.

This procedure, under which IAI operated at the time of the accident, was defined by it as the exclusive procedure with regard to all its activities at Ben Gurion Airport. No detail was provided and no reference was written to the substantive safety issues present in aircraft pushback/towing activity during departure.

The procedure states (quote from Section 1.4): " The process of pushback for departure requires authorized parties to establish detailed procedures, train personnel, certify them, and maintain their competency, with oversight and control, in order to conduct the process at a high level of safety."

Chapter 5 - Authority and Responsibility, specifies the responsibility for aircraft pushback for departure is defined as belonging to the airline. The airline delegates this responsibility to the ground service company authorized to perform the task as stated.

Chapter 6 - Method, defines the obligation on airlines/ground service companies to perform risk management once a year on the aircraft pushback for departure process. No risk management assessments performed for activity derived from this procedure were presented to the investigation team during the investigation.

The procedure establishes that airlines or ground service providers must verify equipment suitability, serviceability, and proper functioning:

- ☒ As stated, the headset operator/Headset Operator was not provided with two illuminated marshaling devices. Performance of the task using a tug with towbar while starting engines is analyzed in Chapter 2 later in the document.
- ☒ Three stages of aircraft pushback for departure are detailed: preparation for pushback, the pushback process, tug disconnection.

  In the preparation for pushback stage, it is established that the pushback supervisor must conduct a comprehensive briefing and check the proper functioning of equipment required for the pushback process (including the tug and towbar, headset, marshaling wands, etc.). It should be noted that in questioning after the accident, a ground crew member stated that no briefing was conducted because the task was simple. No briefing was conducted even after changing to a tug with towbar. As stated, the Headset Operator was not provided with appropriate marshaling equipment.

In the pushback process stage, it is described that:

a) Information transfer between the tow crew supervisor (Headset Operator) and flight crew will be performed verbally only, except for exceptional cases which, although written that they would be detailed, were not found in the procedure.

b) In case of loss of visual contact between the **tow driver/pushback supervisor and one of the wingtip walkers**, aircraft pushback will be stopped until it is restored.

c) Section 6.5.5.7 establishes that **if for any reason there is a change in pushback parameters, the process must be stopped** and new planning for the pushback process must be conducted safely, and all parties involved in the process must be informed.

d) Section 6.5.5.8 establishes that the "Headset Operator" (tow crew supervisor) will maintain continuous contact with the **tug operator**. The procedure does not establish that continuous contact will be maintained with the **flight crew** and what actions are required if this contact is lost. Regarding the driver's actions during the pushback process stage, it is written that pushback will always be performed with the tug facing the direction of movement, except in cases where the tug's structure does not allow this. Chapter 6 of the procedure establishes that airlines or ground service providers are responsible for conducting annual refresher training for employees mentioned in the procedure, and that an audit will be conducted by the head of the Authority's ground operations division on companies regarding training and certification of employees.

Operational restrictions following the accident:

Following the accident, the IAA issued a NOTAM prohibiting engine startup during pushback using a towbar on Airport. No similar restriction was issued for **passenger aircraft** in general, nor for other apron areas. cargo aircraft types: Boeing 747, Airbus 330, Boeing 777 at Ben Gurion.

A0476/24	LLBG	E) ENGINE START-UP OF CARGO FLT OPR BY ACFT TYPE/B747 B777 A330,
		WHOSE PUSHING BACK BY TOW-BAR AVBL ON RELEASE POINT ONLY. ISRAEL AIP, PART AD, PAGE AD-2-LLBG-15, PARA 2.5.6 REF)

In the AIP update AD-2-LLBG-16 dated 15 May 2025, the NOTAM was replaced by a permanent procedure:

"**2.5.6 Startup procedure:**

d. From Apron N: Start-up engine of wide-body aircraft, whose pushing-back by towbar available on release point only (SP)."

☒ **IAI Procedures - Towing and Pushback of Aircraft with Towbar**

At the outset, it should be clarified that at the time of the accident, IAI was a maintenance service provider that operated (and continues to operate) in accordance with the manufacturer's AMM literature. Within this framework, it performed towing operations for maintenance purposes, but also pushback/towing for aircraft departure (with flight crew, including engine startup). The AMM contains no specific reference to ground activity of "pushback for startup and departure," particularly regarding use of a towbar and engine startup. IAI was never defined by the IAA as a "ground service provider" like the ground service providers operating at Ben Gurion Airport under franchise. Despite the above, IAA procedures, which are based in part on IGOM, applied to IAI by virtue of its operations at Ben Gurion Airport.

The IGOM document is the only one on the list that refers to the difference between a maintenance operation and an aircraft departure operation (ground services). The IGOM introduction contains a reference to use of the AMM in the case of providing ground services, noting the need to coordinate procedures accordingly (see Appendix 4). In IAI view, maintenance services and ground services are one and the same. Neither IAI nor the airline presented to the investigation team a procedure or documentation related to the required procedural coordination (maintenance services vs. ground services) for departure.

Note: IAI is not an IAA/Ben Gurion Airport approved company to provide "ground handling services" to airlines. The signed agreement between IAI and the IAA/Ben Gurion Airport specifies provision of "maintenance services."

☒ **The IAA procedure, the aforementioned IAA procedure shall be followed**.

Section 9 details additional conditions for aircraft towing at night or in poor visibility conditions.

Following Sections 5.2.6 and 9.7.3 of the procedure, the tow Headset Operator must ensure that the walkers and Headset Operator **each have one warning wand**.

The procedure (IAI 237-11-07):

a) **Does not refer** to airline procedures (as reflected in the GOM), the airline being the aircraft owner and the party that contracted IAI services to perform the pushback from the parking position.

b) **Does not refer** to IGOM and IATA procedures dealing with aircraft pushback.

c) Treats aircraft pushback from the parking position as a maintenance activity of the maintenance facility and **ignores the presence of flight crew and the continuous communication required with them during aircraft pushback for departure.**

d) **Does not include reference to engine startup during the towing process.**

e) **Does not address cases and immediate actions required of the Headset Operator and driver when an abnormal event occurs requiring the aircraft to stop moving.**

f) **Does not address the transition from pushback to towing to bring the aircraft to the startup position and the actions required of the Headset Operator and tug driver to perform this transition safely.**

g) The procedure lacks practical aspects related to emergency situations that may occur during pushback of an aircraft departing for flight:

(1) The procedure does not detail the use of signaling and marshaling equipment and the hand signals required of ground crews as specified in the Aviation Regulations (Aircraft Operation and Flight Rules), 1981.

(2) The procedure does not mention the immediate actions the tow crew must take upon unexpected loss of voice communication with the flight crew.

h) The investigation team did not receive answers to the following questions:

(1) Why an aircraft maintenance technician is considered qualified to perform this role.

(2) What initial and periodic training is required of an aircraft maintenance technician to assume responsibility for aircraft departure.

(3) What is the frequency and content of the initial training and required refreshers.

☒ **Airline Ground Operations Procedures**

The airline is an IATA member and, with regard to ground operations of its aircraft, operates according to the company's GOM (based on the IGOM document).

From a review of the company's OM A in relation to issues arising in the investigated event, it was found that:

- ✓ Communication between flight crew and the tow supervisor and ground crew is required to be conducted during regular operations via headset (without reference to communication failure (disconnection)), in accordance with agreed hand signals established in company literature and Annex 2 to the ICAO Aviation Convention.
- ✓ In accordance with Section 8.2.2.7:
  a) Pilots are permitted to start the aircraft engines during pushback without any condition regarding the type of vehicle (TBL/TBT) pushing/towing the aircraft during departure.
  b) Individual approval from the Headset Operator is not required before starting each engine.

☒ Chapter 11.8 dealing with CVR establishes that after a serious safety event, the captain, in consultation with the company's operations manager and safety manager, is required to pull the CVR circuit breaker. No requirement was found that pulling the circuit breaker must be recorded as a defect in the aircraft's maintenance log.

☒ In practice, the audio recording from the time of the event was not available to the investigation team, although upon the investigation team's arrival, the captain confirmed that the required circuit breaker had been pulled. Apart from the captain's confirmation, it cannot be determined whether the CVR circuit breaker was actually pulled by the flight crew after the incident and not reinserted later by an unknown party, or whether the CVR circuit breaker was not pulled at all after the event.

☒ From a review of the GOM (the company's internal procedure on ground operations), it was found that:

☒ Pushback of the airline's aircraft is required to be performed in accordance with airport procedures, and responsibility for execution rests with the IAI Headset Operator (Section 7.16.5).

☒ Section 7.16.5.2 establishes that if it is known in advance that aircraft departure will involve both pushback and towing to the startup point, it is recommended not to authorize starting the aircraft engines until towing to the position is completed.

<u>Note</u>: The parking configuration on Apron N requires all company aircraft to undergo a combined pushback and towing process for departure.

No similar section was found in the instructions for flight crew/flight operations in the OMA.

- ✓ Regarding aircraft marshaling, Section 7.13.2a establishes that aircraft marshaling will be performed in accordance with ICAO requirements and that illuminated marshaling wands will be used during hours of darkness.

Agreements for Providing Ground Services at Ben Gurion Airport

In addition to the Israel Airports Authority and El Al, three other companies operate at Ben Gurion Airport providing airlines with ground services and aircraft pushback for departure.

These companies (QAS, AeroHandling, and Laufer) received a franchise to provide these services under a commercial contract issued by the Israel Airports Authority several years ago.

The agreement between the ground service providers and the airport states that they must operate in accordance with airport procedures and IATA recommendations as reflected in the IGOM document.

During the investigation, the investigation team found no confirmation that IAI, which is not one of the companies that won the tender, held an identical contract at the time of the incident.

Despite the above, evidence collected indicates that:

a) IAI provided these services to additional parties at the airport beyond the airline involved in the event.

b) Aircraft departure service, although not defined in the agreement between IAI and the airline (the agreement defines "maintenance services"), was performed with the wledge of the airport and the responsible parties at the Israel Airports Authority.

Maintenance and Serviceability of Operational Vehicles at the Airport

Strict and close documentation and monitoring of operational vehicle maintenance is maintained by the Israel Airports Authority in general and Ben Gurion Airport in particular. Furthermore, in accordance with the Authority's and airport's procurement policy, operational vehicles are scrapped, sold, and removed from service according to orderly criteria and/or upon reaching a set age. The Authority does not require identical conditions from ground service providers operating under contract.

Inspections and Audits

☒ **Inspections**

The Civil Aviation Authority of Israel conducts periodic inspections on entities holding licenses from it, including the Israel Airports Authority—the entity holding the license to operate airports in Israel (including Ben Gurion Airport).

The CAAI conducts inspections on IAA procedures and infrastructure related to operations, training, maintenance, and safety at Ben Gurion Airport.

The CAAI does not conduct inspections and does not examine the activities of third parties (such as ground service providers) and other companies operating within Ben Gurion Airport's operational area.

These entities, whose activities are not overseen by the CAAI (and in many cases are also not inspected by the IAA), may constitute a safety vulnerability in ground operations within the airport's operational area.

The IAA conducts annual audits on ground service providers at Ben Gurion Airport. At the time of the accident, no routine inspections (separate from the audits below) were conducted by it on activities on parking aprons. It should be noted that today inspections are conducted (in addition to annual audits) and quarterly reports are distributed accordingly.

Note: The IAA currently requires ground service providers to operate according to IATA/IGOM rules, and therefore ISAGO audits are also conducted on them every two years (by international parties).

☒ **Israel Airports Authority Audits on IAI**

General:

The annual audits by the Israel Airports Authority, Operations Division, conducted on ground service providers (the IAA also conducted audits on IAI) in Ben Gurion Airport's operational area, were at the time of the accident the only "tool" that actually enabled monitoring of ground activity with all that implies. During the investigation, the investigation team learned that audit results were not distributed to the head of the ground operations division.

On 30.12.2021 and 18.12.2022, an inspector on behalf of the Israel Airports Authority conducted an operational audit on IAI involved in the event, despite the investigation team not finding that the latter held an appropriate contract for providing ground services at Ben Gurion Airport at the time of the event.

It should be noted that Section 1 of both operational audit summaries conducted in 2021 and 2022 established, among other things, that the documents forming the basis for the audit include the IGOM document and IAI procedures.

2021 Operational Audit:

Note: The audit conducted the following year, 2022, addressed only limited topics while defining an examination of gaps found in the previous audit.

Quoted sections from the audit: (emphases are defined by the investigation team and do not exist in the original).

Objectives:

Overall control of the operations system and activities of **ground service providers to aircraft within the ERA in commercial and general aviation (GA) in Ben Gurion Airport's airspace.**

Implementation of operational directives of the Israel Airports Authority – Ground Operations Division (in routine and emergency) and to ensure that service is provided safely, efficiently, and consistently; **finding operational gaps between ground service companies.**

Scope:

The audit will focus on recruitment, training, competency validation, and operational deployment of human resources, ground service equipment and its operational deployment, operational work procedures, pushback/towing, work rules in the aircraft environment in Ben Gurion Airport's operational area - Ground Operations Division, and abnormal procedures (stormy weather, poor visibility, abnormal positioning, fueling with passengers, etc.).

In the "mentoring" section for the headset operator/pushback supervisor, it is noted that **there is no requirement for mentoring on this subject (N/A)**.

The following sections are quoted from the 2021 audit summary:

Audit definitions:

Standard - a specification defining a **method, policy**, plan, process, procedure, means, facility, component, GSE, or any other aspect of operations under the audit scope considered an operational necessity **requiring adaptation by the airline/service provider**.

Gap - lack of uniformity between standard requirements and procedures/ means/human resources.

Finding - absence of a procedure/human resource/instruction/means for a standard requirement.

Recommendation - at the discretion of the Ground Handling Service Provider (GHSP).

Variance (clarification) - a unique item for reference.

Gaps/findings/recommendations in this audit:

Gaps - 2

Findings - 1

Note: The gaps do not relate to the sections emphasized below.

Recommendations - 0

The investigation team found no documentation referring to adaptation by the airline/service provider and no audit reference to this issue (as stated, there are no recommendations).

In the courses and training chapter - Section 2 establishes that the Headset Operator receives theoretical and practical training for this role within the maintenance facility's training program.

No dedicated initial or periodic theoretical and practical training program was presented to the investigation team for training technicians to function as supervisors for aircraft towing and pushback processes.

In Section 4, a gap was found requiring IAI to define a minimum number of pushbacks and towing as part of mentoring for the pushback supervisor and tug operators.

The audit summary states that IAI performs "pushback missions for departure for CAL company aircraft (as part of the maintenance contract)." The following gaps, findings, and comments were also recorded:

a. Gap - "A minimum number of missions including day and night and vulnerable areas on routes must be defined and documented in the personal file."

b. Finding - "Minimum required missions for maintaining operational competency must be defined and ensured."

   Note: In the audit summary conducted on the Israel Aerospace Industries, it was written: "Since Israel Aerospace Industries provides services within the ERA to CAL company and to three GA aircraft on a regular basis, ***you are requested to present/explain what authorization exists for this****." (This note was written in the audit summary).*

In IAI response to the 2021 audit, no authorization was presented regarding the service the company is permitted to provide, but it was recorded that IAI performs pushback and towing of aircraft from commercial and general aviation "within the framework of a maintenance contract." **Despite the response received from IAI, the findings in the report were accepted and closed on 20.01.2022 without further response from the IAA**.

Not included in the audit:

a. No reference was found in the audit to the procedure (the actual process) under which IAI operates when dispatching an aircraft for departure. IAI defined IAA Procedure 8-560-01/27 as the sole exclusive and binding procedure for performing aircraft pushback/towing during departure. This is a basic procedure that does not detail cases and responses in critical situations and does not include risk analysis relevant to the activity that formed the background to the accident.

b. There is no evidence in the audit (or in the subsequent audit the following year) of an inspection being conducted on the parking apron during aircraft departure.

2022 Operational Audit:

The audit emphasized examining the performance and existence of IAA operational directives and examined implementation of corrective actions arising from the 2021 audit.

a. In the "professional refresher" section, it was recorded that Headset Operators do not undergo IGOM refresher training.

b. In the "quality control on task by role" section, regarding the headset operator (Headset Operator), it is noted that 3 to 4 inspections on personnel in this role relate to "ground service companies only." **There is no mention of IAI place on this list** and no reference to its status by the IAA as a provider (or non-provider) of ground services as stated.

2021 Operational Vehicles Audit:

Ben Gurion Airport's Traffic Safety Department conducts periodic audits on IAI operational vehicles operating at Ben Gurion Airport, including aircraft tugs.

In the audit conducted by the Authority in 2021, the tug involved in the investigated event was sampled. The report summary found that **safety inspections for the aircraft tug involved in the event were missing and that safety inspections were not being conducted as required.** The finding is supported by material collected by the investigation team.

The corrective actions taken following the audit were not presented to the investigation team.

Agreement Between the Airline and IAI

At the end of 2018, while the airline was still operating under its previous name, it signed a contract with IAI titled:

IATA STANDARD GROUND HANDLING AGREEMENT
STANDARD GROUND HANDLING AGREEMENT – *SIMPLIFIED PROCEDURE*

The content of paragraph 1 and Appendix 2 to the agreement clarify that the engagement between the parties mainly concerns routine line maintenance tasks and operations, storage, administration, and aircraft parking at the airport between flights.

The investigation team found no reference in the contract to an engagement between the parties **regarding aircraft pushback for departure**.

A company official told the investigation team that aircraft pushback service for departure was provided to the airline by IAI as part of the **maintenance** engagement held by the parties (operations are performed according to the relevant aircraft's **AMM**).

Additionally, upon examining the commercial agreement between the airline and IAI, it was found that:

- The agreement requires the airline to provide the ground service provider with literature related to maintenance and loading of the aircraft. Despite the agreement's title "Ground Handling Agreement," the agreement does not contain a requirement for operations according to the airline's GOM or OM A with IAI.
- IAI lack of familiarity with airline procedures is further supported by testimony collected in the investigation file and by the airline's lack of oversight of training provided to the service provider's ground crews for performing their role and of the ground equipment used by IAI.

Ground Services and Safety Management System (SMS)

The requirement to maintain an SMS applies to a "service provider" as appearing in Regulation 2 of the Aviation Regulations (Safety Management System), 5778-2017.

With regard to the investigated accident, the parties required to have a Safety Management System are: the maintenance facility (IAI), the IAA, and the airline. Ground service providers (operating under franchise contract at Ben Gurion Airport) are not required to maintain an SMS.

Details of the requirements and relevant parties are in Appendix 6.

Tug Drivers

- IAI tug drivers team includes approximately 10 drivers in total.
- Minimum conditions for training and certification: Class B license.
- Drivers undergo dedicated training as part of their certification as tug drivers.
- Driver training includes frontal instruction, during which a knowledge test is administered, driving instruction, mentoring for approximately six months by a senior driver, and final certification.
- Driving instruction and mentoring are conducted on all types of tugs.
- No recording, tracking, or detail of activities performed by the driver during training was found, particularly regarding tug type TBL/TBT.
- No recording or tracking was found regarding tug type and pushback/towing activities performed by the driver during work after completing training.
- Theoretically, there is a possibility that a driver could perform towing/pushback with a T-500 tug (two driving positions and towbar), at night, for the first time without instructor accompaniment—years after certification. No supporting evidence was found for this since no such tracking/recording is performed.

Headset Operator

- 10 technicians (in the LINE MAINTENANCE team) selected from a group of hundreds.
- Minimum conditions - B1 aircraft technician (technician for a specific aircraft type).
- **No dedicated training is conducted regarding aircraft pushback/towing during departure.**

Note: In the IAA's 2021 annual audit (on the maintenance facility), it is noted that the headset operator (Headset Operator) "receives internal training within a framework that includes Ben Gurion Airport procedures" (quote). No documentation supporting this training was presented to the investigation team, particularly regarding the uniqueness of the aircraft departure process.

- Regulatory licensing requirements contain no reference to aircraft pushback/towing activity for departure (such as training and periodic testing).
- Some technicians conduct personal refresher training (on their own initiative) based on material found in the office.

  Note: See Section 1.18.11 - the material found in the office does not address the aircraft departure process and is partly incorrect (incorrect hand signals).
- The ground crew supervisor does not receive driving training on aircraft tugs and is not authorized to operate them.

Training, Instruction, and Refresher Materials

- A 64-page printed booklet "Commercial Aircraft Towing Refresher" for tow crews is located in the office of the head of flight line management (at the aircraft facility), the office responsible for performing aircraft towing operations.
- The material is updated to 2013.
- Sources and references are from 2005, 2009, 2012.
- No pushback/towing process for departure with engine startup is mentioned.
- The "stop" instruction within hand signals, Chapter 5, is incorrect (see paragraph 1.9.4, Figure 12).
- No checklist was found for a crew departing on a pushback/towing mission for aircraft departure.
- Risk management at IAI does not address aircraft pushback/towing during departure and therefore also does not address engine startup during the process.

Towing/Pushback - Airline AOM Instructions

Note 1: During the pushback process, the brake operator is the pilot in the cockpit.

- Section 5: Brake application by flight crew - only upon explicit instruction from the ground crew member, or when the cargo aircraft is disconnected from the tug (flight crew have no way of knowing about tug disconnection as long as they cannot visually see it before it exits from under the cargo aircraft's nose).
- Pilots must be notified immediately of loss of voice communication so they can stop the cargo aircraft.

7.16.5.6 Brake Operator

NOTE: 1. When Pushback procedure is in place, the Break operator will be the crew in cockpit
2. When performing Towing procedure, the break Operator will be qualified mechanic

The Break Operator shall:

1. Ensure all aircraft doors are closed by authorized personnel.
2. Apply the 'brakes on' and 'Brakes off' procedures in coordination with the headset operator.
3. Position the seat in such a way that the brakes can be easily applied where required.
4. Inform the headset operator immediately if potential contact with any objective is detected.
5. Only apply the brakes during the tow where instructed by the headset operator or where it is clear that the aircraft had become separated from tractor.

NOTE: For procedure related to incidents during towing, refer to **7.17.3 - Incidents during Towing**

Caution: The flight crew or brake operator must be notified immediately, in the event any connection between the tractor and the aircraft is lost during aircraft movement;
stop the aircraft movement using gentle brake application if the aircraft is about to overtake the tractor.