BUREAU OF AIR ACCIDENT INVESTIGATION

This investigation has been conducted in accordance with *Annex 13 to the ICAO Convention on International Civil Aviation*, *EU Regulation No 996/2010* and *The Civil Aviation (Investigation of Air Accidents and Incidents) Regulation; Legal Notice 16 of 2013*.

Under these Regulations, the sole objective of the investigation of an accident or incident is the prevention of accidents and incidents in the future. It is not the purpose of this investigation to assign fault or blame and the reporting process should not be used to determine liability.

Accident Report

COLLISION BETWEEN

BOEING 737-800 9H-QCJ

UNDER TOW

AND

PARKED FUEL TANKERS

AT

MALTA INTERNATIONAL AIRPORT

2ND APRIL 2021

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1. General Information

Location: Taxiway K / Cargo & GSE Area at Malta International Airport.	**Report Number:** BAAI/020421
Date & Time: 2nd April 2021, 1130hrs (Local)	
Defining Event: Collision with parked vehicles.	
Aircraft: **Type:** Boeing 737-800 **Registration:** 9H-QCJ **Aircraft Damage:** Substantial **Injuries:** NIL **Flight Conducted Under:** N/A (under tow)	

2. Synopsis

Boeing 737-800 registration 9H-QCJ was being repositioned from Apron 8 to Apron 2 at Malta International Airport under tow. The aircraft was pushed back from Stand 2 onto Taxiway I (India). The tow then proceeded along Taxiway I (India) and Taxiway J (Juliet), crossing Runway 23. As the tow truck (tug) turned left on Taxiway K (Kilo) on vacating Runway 23, the tow bar became detached from the aircraft and the aircraft continued straight until it collided with and came to rest against a bank of four parked fuel tankers inside the Cargo and GSE area.

3. Factual Information

History of the Event

The tow crew, comprising the driver, wing walker and brake operator, had just completed the repositioning of another Boeing 737-800 to Stand 1 next to 9H-QCJ on Apron 8 at Malta International Airport. They then proceeded directly to reposition 9H-QCJ using the same tug and tow bar.

The tow bar was connected to 9H-QCJ and the aircraft was pushed back onto TWY I (India) under the supervision of the wing walker. The wing walker then alighted the tug and the tow proceeded along TWY I (India) and TWY J (Juliet) prior to crossing RWY 23. On vacating RWY 23 and as the tug turned left on TWY K (Kilo), the tow bar became detached from the aircraft. 9H-QCJ then continued straight until it collided with and came to rest against a bank of four parked fuel tankers inside the Cargo and GSE area (Figures 1 and 2).

The airport Rescue and Fire Fighting Service (RFFS) arrived on site and provided a ladder for the brake operator to evacuate 9H-QCJ from Exit Door no. 1 (front left).

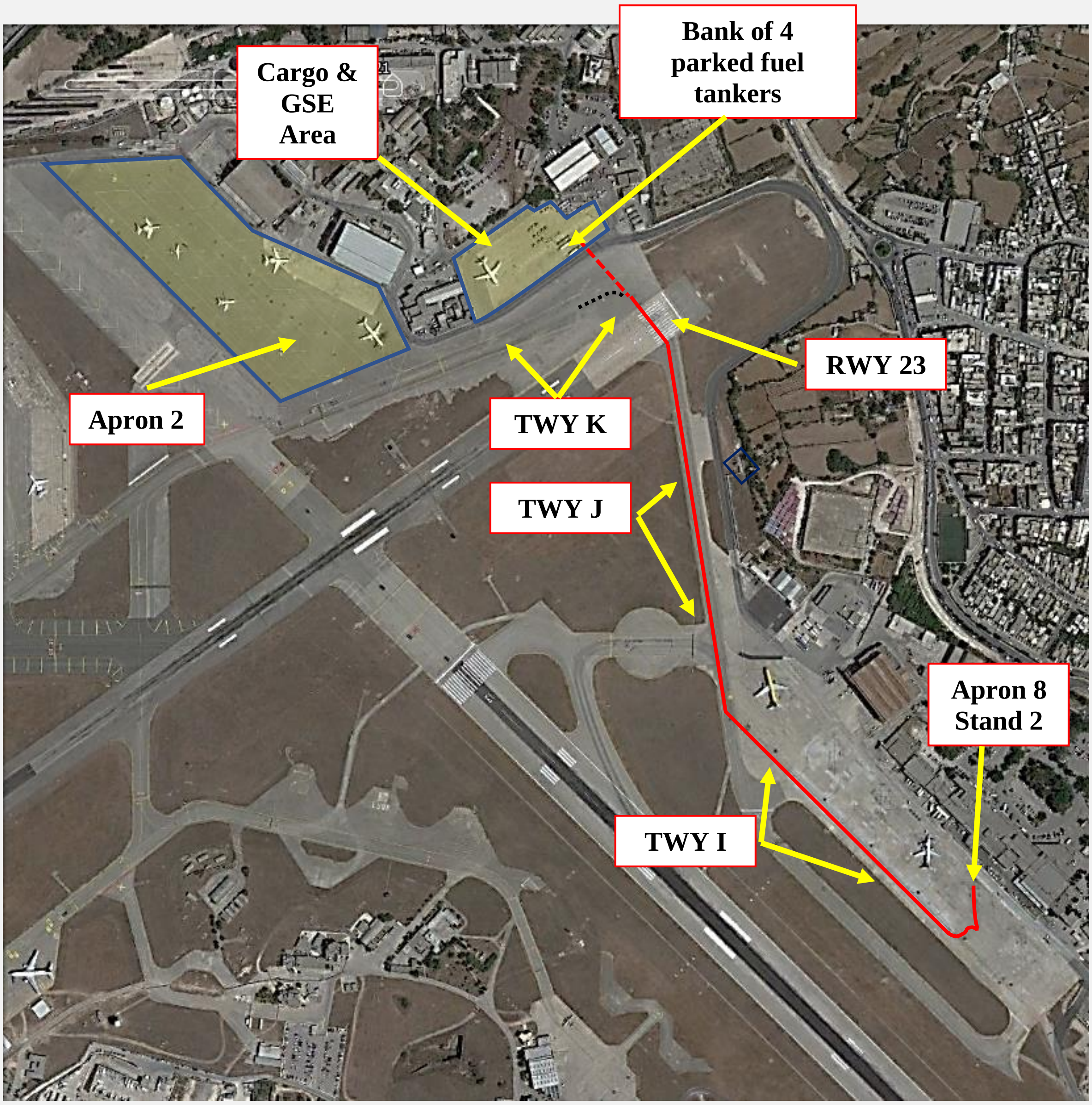

Figure 1: Aerial view of LMML (Google Earth), with overlay showing the tow path followed and place of aircraft impact with parked fuel tankers.

Legend: (solid red line) Path of aircraft under tow (tug and aircraft)
(dashed red line) Path of aircraft following separation from tug
(dotted black line) Path of tug following separation from aircraft

Figure 2: The aircraft at rest against the bank of four fuel tankers.

Injuries to Persons

Flight Crew: N/A
Passengers: N/A
Tow Crew: None
Other: None

Damage to Aircraft

9H-QCJ: Substantial, in the nose and No. 1 Engine areas.

Other Damage

Damage to 3 parked fuel tankers.

Pilot Information

N/A

Aircraft and Owner/Operator Information

Aircraft Make: Boeing
Model/Series: B737-800
MSN: 62690
Registration: 9H-QCJ
Aircraft Category: Part 25 certified
Year of Manufacture: 2016
Landing Gear Type: Tricycle
Engine Manufacturer: CFM International
Engine Model/Series: CFM56-7
Certificate of Registration: Issued by Transport Malta – Civil Aviation Directorate (MT) no. 1262
Operator: Malta Air Ltd.

Meteorological Information

Conditions at Accident Site: Visual Meteorological Conditions
Condition of Light: Day, bright, sun high over the horizon
Precipitation and Obscuration: Nil

4. Findings

Video surveillance data of Apron 8 at Malta International Airport (LMML) recorded the push back of 9H-QCJ onto TWY I (India) with the wing walker stationed on the starboard side of the aircraft/tug. When the push back was complete and the tug was stationary, the wing walker proceeded to cross close in front of the tug to alight from the left. The tug started moving forward as the wing walker was crossing it and the driver braked suddenly to stop from a slow speed. The wing walker then alighted, and the tow proceeded on TWY I (India). The shear pins were not checked after the sudden braking.

During the field investigation, the bottom part of two shear pins, one head and the bottom part of a retaining pin were found on Apron 8 close to the intersection between Stand 2 and TWY I (India) (Figure 3).

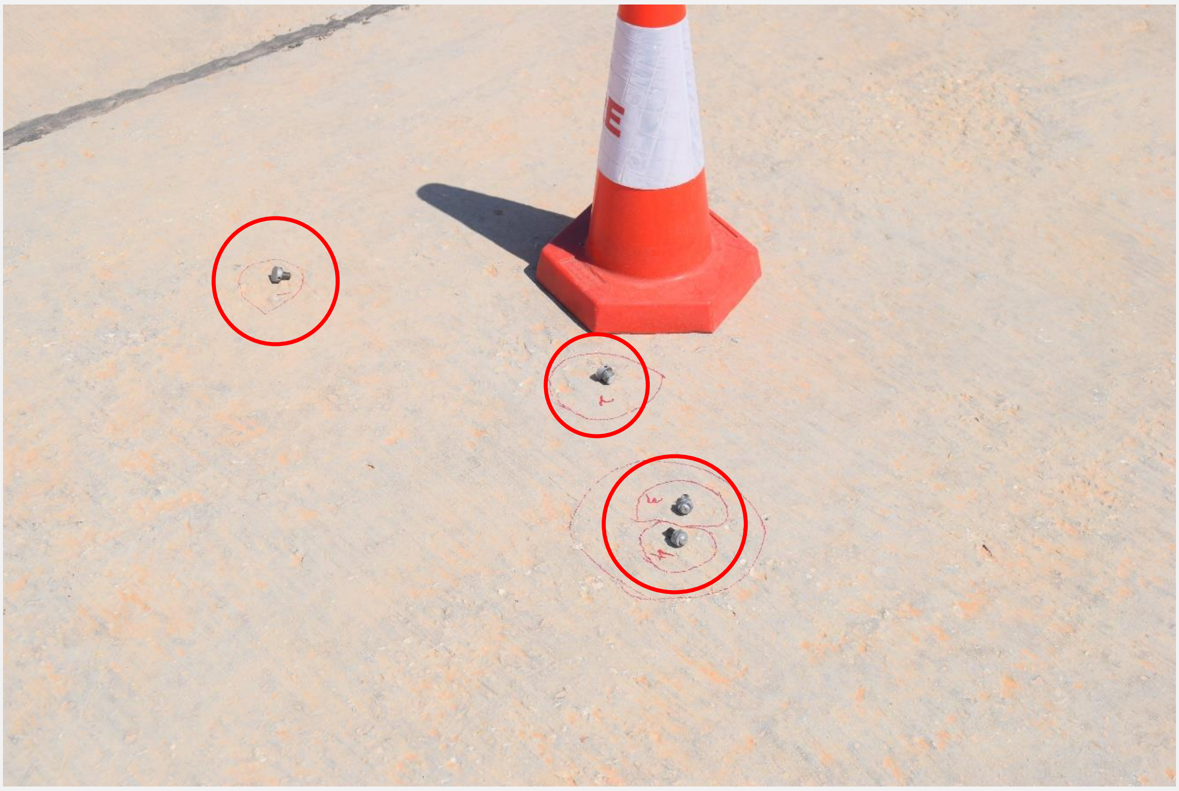

Figure 3: Broken shear and retaining pin parts found on Apron 8.

Two shear pin bottom parts (marked 3 and 4); one shear pin head (marked 1); one retaining pin head (marked 2).

The close proximity of the four items and the shearing of the retaining pin correspond to a sharp and sudden shear stress that would be experienced in a braking event as the one that occurred.

The tug used in the accident movement was a Douglas DC10-4H (Figure 4), which is ballasted at 32 metric tons and has a rated drawbar pull of 20 metric tons. The Boeing 737-800 has an empty operating mass of just over 40 metric tons, requiring a drawbar pull of under 2 metric tons in dry conditions. The use of such a tug is permissible for push back and towing of narrow body aircraft of the category of the Boeing 737, but the weight of the tug in comparison with that of the aircraft and its drawbar pull increase the risk of excessive stresses being transmitted through the tow bar and may result in the shearing of the installed shear pins, which are matched to the specific aircraft being towed. This is particularly so in the event of sudden braking as that occurring in the accident event.

Figure 4: The Douglas DC10-4H tug and tow bar used in the accident event.

The tow bar used was of the approved type for the Boeing 737-800. The tow bar head has 2 10mm shear pins and a larger retaining bolt to reduce the risk of separation in the event the shear pins fail (Figure 5). The eyelet of the tow bar was directly attached to the bar and did not have a shock absorber, which is optional on approved tow bars. The absence of a shock absorber allows larger shock loads to be transmitted through the tow bar and this increases the risk of shear pin failure.

Figure 5: The tow bar head attachment lug.

Two sets of shear pin holes for different aircraft models as marked. The centre hole is for the retaining pin.

The shear pins and retaining bolt have two grooves to allow failure at two points, where the tow head mates with the attachment lug. The findings on Apron 8 indicate that the tow proceeded with one shear pin completely broken, the second shear pin sheared at least at the lower point and the retaining pin sheared at the upper point.

During the field investigation, the remaining part of the retaining bolt was found on RWY 23 (Figures 6 and 7) and the head of the second shear pin was found on TWY K (Kilo) (Figures 8 and 9).

Figure 6: The remaining part of the retaining bolt (circled) found on RWY 23.

The aircraft crossed the runway from left to right. TWY K (Kilo) commences just beyond the gutter.

Figure 7: Close-up view of the remaining part of the retaining bolt found on RWY 23.

Figure 8: The head of the second shear pin found on TWY K (Kilo).

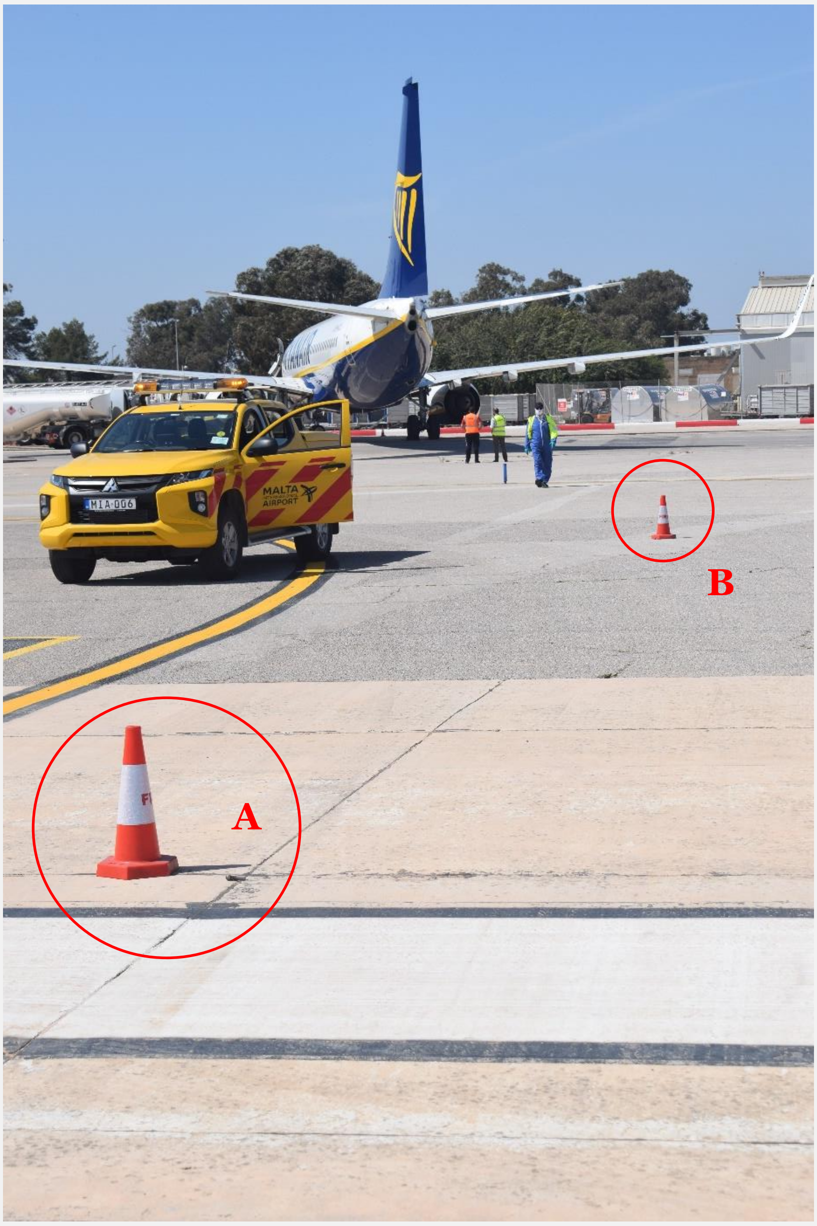

Figure 9: The retaining bolt on RWY 23 (marked 'A') and the head of the second shear pin on TWY K (Kilo) (marked 'B') in relation to the aircraft at rest.

The findings indicate that the tow proceeded from TWY I (India) on the top part of one shear pin and the bottom part of the retaining bolt. The bent retaining bolt without the head was probably held in place under continuous tension on the tow bar, falling out when the dynamics did not further keep it in place. The tow then proceeded on only the upper part of one shear pin, which gave way as the tug commenced to turn the aircraft to the left on

TWY K (Kilo). Figure 9 indicates that the aircraft commenced the turn, then proceeding straight as nose-wheel steering is disabled during tow to allow the nose-wheel to caster.

Surveillance video shows the tug accelerating in the turn, both on Apron 8 and TWY K (Kilo). This, in conjunction with the size of the tug, contributed to the loads on the shear pins and the ultimate failure of the top half of the shear pin on TWY K (Kilo).

During the interview of the tow crew at the BAAI premises, the brake operator reported that he switched on the APU prior to the start of the tow. During the tow he was seated on the left-hand seat in the cockpit but did not have the seat positioned properly to allow the brakes to be applied effectively. He reported that as soon as he realized that the tow bar had detached, he attempted to press the brakes. Surveillance video footage indicates that the aircraft did not decelerate in the 18 seconds between tow bar detachment and collision with the parked fuel tankers.

Following the collision, the brake operator was fearful of a fire and attempted to vacate the aircraft quickly, opening Exit Door L1 (Figure 10). He opened the door and was then told to switch off the APU by RFFS crew, who had, by this time, arrived at the scene. The brake operator returned to the cockpit to switch the APU off. He then vacated the aircraft via a ladder placed against the aircraft by RFFS crew.

Figure 10: Exit Door L1 on the accident aircraft open.

In the field investigation, the cockpit was found to be not correctly configured for tow and indicated that, after the collision, the normal APU shut-down procedure was not followed. The APU switch on the Overhead Panel was found in the 'ON' position; the AC Power switch 'ON' and the Battery Power switch 'OFF'. On the Boeing 737-800, DC Power provides power to the APU ECU and when this is turned off, the APU shuts down. The 'APU GEN' switches were 'ON' and the 'BUS TRANS' switch was on 'AUTO' (normal position), indicating that the electrical power generators on the APU were connected to the AC bus. The APU Fire switch on the Central Pedestal was in the normal (down) position.

Figure 11: The APU switch found in the ''ON'' position during the field investigation.

Figure 12: The battery power switch found in the ''OFF'' position during the field investigation.

For the Battery switch to be in the ''OFF'' position, the switch guard will be open as shown in the figure.

During the field investigation, the APU was found not to be running but the APU air-inlet door was found in the open position (Figure 13), indicating that the APU was not shut down as per normal procedure. This is consistent with the APU being switched off by selecting the Battery Power switch to ''OFF'' (Figure 12).

Figure 13: The APU inlet door in the open position with the APU shut down.

The aircraft operator reported that the aircraft involved in the accident had last operated a flight that landed at LMML at 1430hrs on 1st April 2021. The aircraft was therefore on the ground for more than 20 hours before the start of tow from Apron 8. The Boeing 737-800 brake accumulator is capable of providing brake pressure for eight hours and can be used to apply brake pressure when charged. Since the tow occurred more than 20 hours after the last operation of the aircraft, the hydraulic system should have been energized to provide braking capacity during tow. When asked if the hydraulic pumps were switched on before starting the tow, the brake operator replied that he did not switch the hydraulic system on. Consequently, the tow was started without the braking system of the aircraft being operational.

Figure 14: The electrical hydraulic pumps found in the "OFF" position during the field investigation.

The lack of brake pressure was a contributing factor for the brake operator not being able to apply the brakes effectively.

The brake operator also reported that he did not check for a fire or fuel spillage before opening Exit Door L1 and that none of the emergency slides were armed before starting the tow. Given the proximity of the L1 Exit Door to the fuel tankers and the possibility of fire, the aircraft should have been exited immediately from the starboard rear door (Service Door R2) by deploying the emergency slide. Once the RFFS crew arrived on site, they should have directed the brake operator to close Exit Door L1 and to exit from Service Door R2.

The company carrying out the towing operation was found to have standard operating procedures (SOPs) in place, but these did not detail the specific actions required of the crew. The company had an adequate management structure in place at the time of the accident.

The tow crew were found to be in possession of the mandatory licenses and were experienced in their respective roles. No defects on aircraft or towing equipment that could have caused or contributed to the accident were found. Laboratory tests carried out for metal fatigue concluded that the shear pins did not fail due to metal fatigue. Weather and airfield surface conditions were not a contributing factor.

The crew reported that, during their training as licensed engineers, no type-specific training relating to operating procedures or life supervised experience was given to brake operators for tow operations.

The tow crew also reported that communication between them was via hand signal only as the crew were not provided with any other means of communication. Timely and effective communication among the tow crew is very important. In addition, every team member of the tow crew has the responsibility to call for a stop to the towing of the aircraft if it is deemed unsafe to continue. This further underlines the value of effective communication means during aircraft movement to prevent accidents.

5. Conclusions

Aircraft towing is a routine operation that, despite its relatively mundane nature, requires careful operation and stringent safety procedures to ensure that incidents and accidents are avoided. This accident occurred due to a lack of adherence to such procedures, including:

1) Proper flight deck checks and aircraft setup for a towing procedure;
2) Adequate coordination between ground staff and the tug driver to ensure a safe environment that avoids the need of sudden braking by the tug;
3) Careful checking of the shear pins following a sudden or sharp braking event;
4) Correct seating of the brake operator in the pilot's seat during tow to be able to apply brakes in an effective and timely manner in the event of tow bar detachment.

In addition, the lack of training on aircraft operating procedures and emergency evacuation procedures given to the tow crew jeopardized the safe securing of the aircraft and safe evacuation after the accident.

In conclusion, the cause of the accident was identified to be:

- A lack of training, clear procedures and inadequate level of attention given to safety during operation.

6. Recommendations

The BAAI is of the view that a 'read-and-do' checklist for tow crews, which includes general safety checks; checks for the correct operation and emergency shut-down of systems operated by the tow crew; and checks relating to the preparation of the aircraft for an emergency evacuation, will significantly improve safety during tow operations. This checklist would ensure, amongst others, that:

1. The correct shear pins in the tow bar are in place and not damaged;
2. Aircraft brakes are available throughout the duration of the tow;
3. Aircraft electrics are switched on if required and operational as necessary;
4. The cockpit seat is correctly adjusted to allow for effective operation of brakes;
5. The view from the cockpit seat is unobstructed;
6. Effective communication is established between the brake operator and the rest of the tow crew and, in particular, with the tug driver;
7. The aircraft can be safely secured and evacuated in the event of an emergency.

The follow recommendations are being made:

<u>OF GLOBAL CONCERN:</u>

To tow operators:

1. To provide an appropriate 'read-and-do' checklist to tow crews that includes general safety checks; checks for the correct operation and emergency shut-down of systems if operated by the tow crew; and checks relating to the preparation of the aircraft for an emergency evacuation.

2. To ensure that tow crews adhere to the established procedure of checking the state of shear pins following abrupt manoeuvres such as sudden braking.

3. To ensure that the aircraft is appropriately configured during tow manoeuvres and that brake operators are familiar with emergency evacuation procedures.

OF GLOBAL CONCERN (continued):

To authorities concerned:

4. To publish minimum training and competency requirements for aircraft tow operators at certified airports.

5. To require tow operators to make an appropriate 'read-and-do' checklist for tow operations available to tow crews.

Note:

In an effort to enhance safety and efficiency, the tow operator has revised its SOPs for towing operations.

The manufacturer informed the BAAI that company policy is to provide specific guidance and requirements to the airlines via the Aircraft Maintenance Manual (AMM). This establishes the minimum requirements the manufacturer expects airlines and operators to adhere to for safe towing operations. In line with this, it is planning to update the 737NG AMM to incorporate minimum requirements for tow operations in the next revision cycle of October 2022; and to then follow on with updates of the AMMs of all the other models it manufactures. The relevant excerpt from the communication is attached in Appendix I.

ABBREVIATIONS

AC	-	Alternating Current
AMM	-	Aircraft Maintenance Manual
APU	-	Auxiliary Power Unit
ECU	-	Electronic Control Unit
RFFS	-	Rescue and Fire Fighting Service
BAAI	-	Bureau of Air Accident Investigation
LMML	-	Malta International Airport ICAO Code
DC	-	Direct Current
RWY	-	Runway
SOP	-	Standard Operating Procedure
TWY	-	Taxiway

APPENDIX I

EXCERPT FROM COMMUNICATION WITH THE MANUFACTURER

‘Regarding a specific read and do checklist to tow operators: Because [*the manufacturer*] *does* not traditionally advise tow operators directly and their specific checklists/procedures are coordinated with their airline customers or internally at the airline itself, [*the manufacturer’s*] policy is to provide specific guidance and requirements to the airlines via the Maintenance Manual. This establishes minimum requirements [*the manufacturer*] expects airlines to adhere to for safe towing operations, and the airline then should establish its procedures from these requirements both internally and with contractors. As an example, we use a similar approach for maintenance engine runs where we define requirements within the Maintenance Manual for the operator to leverage. Our maintenance engineering team informed me that our planned update for the 737NG AMM will target the next revision cycle in Oct. 2022, and more broadly all models will follow.’