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Subject: Technical Letter: Height of NAICM Aircraft on Approach and Departure Over Lago Nabor Carrillo

Dear Dr. Alcocer:

This document is in response to your request regarding information on the height of aircraft as they pass over Lago Nabor Carrillo while approaching and departing to/from Nuevo Aeropuerto Internacional de la Ciudad de México (NAICM). As MITRE understands it, this information could be useful to CONAGUA in determining the overall benefits of reducing the width of Lago Nabor Carrillo (from its northern edge) to potentially help mitigate bird hazard risks to aircraft operations at NAICM by removing water away from the airport’s operational areas. The objective of this Technical Letter is to describe the methodology used by MITRE to determine the height of aircraft over Lago Nabor Carrillo versus the lake’s width. Closing remarks are also provided.

Methodology

MITRE determined the height in meters Above Ground Level (AGL) of aircraft conducting an Instrument Landing System (ILS) approach to the runways at NAICM that would require aircraft to pass over Lago Nabor Carrillo (i.e., landing to the north). AGL in this case means the approximate height above the ground edges of the lake, regardless of the lake’s water surface height (there is more on this below).

Similarly, MITRE determined the height in meters AGL of aircraft departing the runways at NAICM (i.e., straight-out departures under normal conditions with all engines operating) that would require aircraft to pass over Lago Nabor Carrillo (i.e., departing to the south). The runways that MITRE considered were 36L/18R, 36R/18L, 01L/19R, and 01R/19L because these runways are the ones whose extended centerlines pass over the lake (see Figure 1).
To conduct this analysis, MITRE used the planned runway configuration\(^1\) and runway threshold elevations at NAICM\(^2\). It is important to note that changes to runway locations or elevations (see footnote 2), may affect MITRE’s results. To determine the height of aircraft above Lago Nabor Carrillo, MITRE used the highest ground elevation identified within or along the edge of the lake using information from a satellite-based photogrammetric survey commissioned by MITRE. The highest ground elevation identified was 2231.00 m above Mean Sea Level (MSL).

For approaches, MITRE assumed that aircraft would fly on a three-degree glideslope associated with the ILS to each of the above-mentioned runways. The height of aircraft was determined at the northern edge of Lago Nabor Carrillo. The height of aircraft at additional points, which represent the displacement of the long northern edge of the lake towards its long southern edge in 152.4-m (500-ft) increments, until reaching either the long southern edge or the western edge (in the case of Runways 36L/18R and 36R/18L) of the lake, was also determined.

It is important to note that there are many factors that can affect the height of an aircraft while approaching a runway. For example, an aircraft on approach may be above or below the glideslope or possibly using visual cues (e.g., the runway threshold environment or other visual approach aids) instead of the glideslope.

For departures, MITRE assumed that aircraft would be airborne after utilizing 70 percent of the runway. The 70 percent runway utilization assumption represents a more realistic point at which aircraft typically become airborne versus the physical end of the runway. For conservative planning purposes, MITRE assumed a climb gradient of 60.96 m (200 ft) per nautical mile, which is based on the lowest possible climb gradient requirement that could be used. However, aircraft would realistically climb at a higher rate. The location of the height of departing aircraft over Lago Nabor Carrillo was determined in a manner similar to what was done for approaching aircraft.

Note that there are several factors that can affect an aircraft’s takeoff and climb performance, such as aircraft characteristics (e.g., size, number and type of engines), airline operating procedures, environmental conditions, and other operational considerations, including a one-engine failure (which was not considered in this study).

**Results**

Figure 1 provides an overview of the NAICM runways, their extended runway centerlines, as well as Lago Nabor Carrillo. Figure 2 shows the height of aircraft passing

\(^1\) Note that in the case of Runway 01L/19R, MITRE utilized the runway location proposed by Arup (a Master Planner contracted by Grupo Aeroportuario de la Ciudad de México—GACM), which is farther south than the MITRE-proposed runway location.

\(^2\) Runway threshold elevations (provided by GACM): 36L = 2228.50 m; 01R = 2232.00 m.
Future runway threshold elevations (estimated by MITRE): 36R = 2227.00 m; 01L = 2227.00 m.
Elevations are above Mean Sea Level (MSL). **IMPORTANT: if GACM modifies these runway threshold elevations, this report’s conclusions may change.**
over Lago Nabor Carrillo while flying on a three-degree glideslope associated with an ILS approach to each runway being considered by MITRE in this analysis.

![Figure 1. Overview of NAICM Runways and Lago Nabor Carrillo](image)

As can be seen in Figure 2, the lowest height of an aircraft on approach to the north when it passes at the northern edge of Lago Nabor Carrillo is 184 m AGL (for Runway 01L). Note that for every 152.4 m that the northern edge of the lake is perpendicularly displaced to the south, the height of a landing aircraft increases by 8.7 m (heights are rounded to the nearest integer).

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Note: aircraft height calculations are based on a three-degree glideslope. Heights are rounded to the nearest integer.

Figure 2. Aircraft Height on Approach to NAICM Over Lago Nabor Carrillo

Figure 3 shows the height of aircraft passing over Lago Nabor Carrillo while on a departure from each runway being considered by MITRE in this analysis. As can be seen in Figure 3, the lowest height of an aircraft when it is at the northern edge of Lago Nabor Carrillo is 148 m AGL (for Runway 19R). Note that for every 152.4 m that the northern edge of the lake is perpendicularly displaced to the south, the height of a departing aircraft increases by 5.4 m (heights are rounded to the nearest integer).
Figure 3. Aircraft Height on Departure from NAICM Over Lago Nabor Carrillo

Closing Remarks

This analysis shows that reducing the size of Lago Nabor Carrillo by displacing the northern edge of the lake to the south would increase the height of aircraft above the lake. However, it is not clear how much of a reduction in bird hazard risk this would provide. Therefore, this matter should be discussed further with appropriate experts.

In the case of approaches, if the width of the lake were reduced by half (by displacing the northern edge towards the south), aircraft approaching Runway 01L would reach the displaced northern edge at a height of 248 m AGL, rather than at a height of 184 m AGL (a difference of around 64 m). In the case of departures, if the width of the lake were reduced by half, aircraft departing Runway 19R would reach the displaced northern edge at a height of 188 m AGL, rather than at a height of 148 m AGL (a difference of around 40 m). Analysis has shown that almost all the incidents resulting in aircraft hull loss occur under a height of 152 m AGL.
Reducing the size of Lago Nabor Carrillo would likely help in implementing appropriate mitigation measures to reduce the number of birds at the lake for reasons other than AGL height. For example, reducing the size of the lake may allow for the practical use of barriers (perhaps such as nets) that could prevent access to the lake by birds or the use of other mitigation techniques that otherwise would not be feasible given the current large dimensions of Lago Nabor Carrillo. *This is an important factor that should be considered by authorities and bird mitigation experts when determining how best to reduce the number of birds at Lago Nabor Carrillo to minimize risks to aircraft operations at NAICM.*

Please do not hesitate to contact me if you have any questions.

Sincerely,

Ing. Robert W. Kleinhans
Project Technical Coordinator

cc:
Lic. Yuriria Mascott, SCT
Mtro. Roberto Ramirez, CONAGUA
Dr. Bernardo Lisker, MITRE