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México

Subject: Assessment of Tanque Chiconautla and Depósito Chiconautla

Dear Capt. López Meyer:

I respectfully submit to you this technical letter that provides information regarding the potential impact to aeronautical operations at the proposed Nuevo Aeropuerto Internacional de la Ciudad de México (NAICM) caused by two nearby water storage tanks (one existing and one proposed) in the vicinity of the Chiconautla hill (hereafter referred to as “Chiconautla”).

In May 2014, ASA provided information from Comisión Nacional del Agua (CONAGUA) to MITRE about two water storage tanks in the vicinity of Chiconautla: Tanque Chiconautla, an existing water storage tank, and Depósito Chiconautla, a proposed water storage tank. The close proximity of the two water storage tanks to the proposed runways at NAICM has raised concerns regarding potential impacts on aircraft operations and procedures. Therefore, ASA requested that MITRE analyze the potential impact of Tanque Chiconautla and Depósito Chiconautla on aircraft operations at NAICM.

The objective of MITRE’s assessment was to determine whether Tanque Chiconautla and Depósito Chiconautla will have any adverse effects on future aircraft operations at NAICM. MITRE’s assessment includes a determination of whether the water storage tanks impact key instrument approach and departure procedures and International Civil Aviation Organization (ICAO) Annex 14 Obstacle Limitation Surfaces (OLS). Other important items such as national engine-out obstacle evaluation areas, Parallel Approach Obstruction Assessment Surfaces (PAOAS) and minimum vectoring altitudes were also considered.

Background and Data

On 20 May 2014, ASA’s initial data transmission to MITRE included three files containing information about the two water storage tanks:

- Depósito Chiconautla.pdf, which contains a drawing of the proposed water storage tank, as well as coordinate and elevation data;
- INFORMACION TANQUE CHICONAUTLA.xlsx, which contains coordinate and elevation data for the existing Tanque Chiconautla; and
- Tanque existente Chiconautla.kmz, which provides the geographic location of the existing Tanque Chiconautla in Google Earth.

After receiving the above-mentioned files, MITRE reviewed the information and on 21 May 2014, requested confirmation of the highest elevation of Tanque Chiconautla, the highest elevation of Depósito Chiconautla, and the footprint of Depósito Chiconautla. In addition, MITRE requested confirmation of whether there are any other structures associated with the water storage tanks that may have a higher elevation than the elevations provided for the respective tanks.

On 26 May 2014, ASA provided the confirmation of the elevation and footprint data for the water storage tanks, and on 5 September 2014, provided feedback from CONAGUA indicating that no other structures higher than the height of the two water storage tanks (both Tanque Chiconautla and Depósito Chiconautla) exist or are being planned.

The coordinates of Tanque Chiconautla (based on the above-mentioned data) are shown in Table 1. It is important to note that Tanque Chiconautla is a circular object with a 46 m diameter with a center at the specified coordinates. The height of Tanque Chiconautla is 7 m Above Ground Level (AGL).

Table 1. Tanque Chiconautla Coordinates

<table>
<thead>
<tr>
<th>Tanque Chiconautla</th>
<th>Universal Transverse Mercator (UTM) Coordinates (meters)</th>
<th>World Geodetic System 1984 (WGS 84) Coordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easting</td>
<td>Northing</td>
<td>Latitude</td>
</tr>
<tr>
<td>Center</td>
<td>501491.0300</td>
<td>2173371.7300</td>
</tr>
</tbody>
</table>

Information about Depósito Chiconautla is contained in the file “Depósito Chiconautla.pdf.” The proposed water storage tank is rectangular in shape and has a height of 8.5 m AGL. “TABLA DE COORDENADAS” in the “Depósito Chiconautla.pdf” provides coordinates for eight points: P1 through P8, in which P1 through P4 are inside points P5 through P8. Therefore, for the purposes of this assessment, MITRE considered points P5, P6, P7, and P8 as the outermost extents of the footprint for Depósito Chiconautla. Coordinates associated with those points are shown in Table 2 (latitude and longitude information was derived by MITRE based on the data provided in “Depósito Chiconautla.pdf”).

Table 2. Depósito Chiconautla Coordinates

<table>
<thead>
<tr>
<th>Depósito Chiconautla</th>
<th>UTM Coordinates (meters)</th>
<th>WGS 84 Coordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Easting</td>
<td>Northing</td>
</tr>
<tr>
<td>P5</td>
<td>503976.6710</td>
<td>2172864.9672</td>
</tr>
<tr>
<td>P6</td>
<td>504016.4142</td>
<td>2173323.3565</td>
</tr>
<tr>
<td>P7</td>
<td>504094.4421</td>
<td>2172839.0955</td>
</tr>
<tr>
<td>P8</td>
<td>504131.5123</td>
<td>2173329.8045</td>
</tr>
</tbody>
</table>
Methodology

MITRE conducted an assessment of Tanque Chiconautla andDepósito Chiconautla based on the above-mentioned information provided by ASA, which included elevation information for each of the water storage tanks. For conservative planning purposes, MITRE assessed the entire Tanque Chiconautla structure at an elevation of 2428 meters (m) above Mean Sea Level (MSL), which is the ASA-provided elevation of 2412 m MSL with 16 m added to account for possible vertical accuracy tolerances in the terrain data. Similarly, for Depósito Chiconautla, MITRE assessed the entire water storage tank at an elevation of 2418 m MSL, which is the ASA-provided elevation of 2402 m MSL with 16 m added to account for possible vertical accuracy tolerances in the terrain data.

For the purposes of this assessment, MITRE evaluated the impact of Tanque Chiconautla andDepósito Chiconautla on the NAICM proposed runway configuration shown below in Figure 1, referred to as theMITRE-Recommended Runway Configuration(July 2012), that was proven feasible during a previous project.

![Source Imagery: Google Earth Pro](image_url)

**Figure 1.** Tanque Chiconautla and Depósito Chiconautla in Relation to NAICM
MITRE used instrument procedure design and obstacle assessment analytical tools, such as PDToolkit, PHX, MITRE’s Terminal Area Route Generation, Evaluation, and Traffic Simulation (TARGETS), and other specialized software to evaluate Tanque Chiconautla and Depósito Chiconautla. The following evaluations were conducted:

- **Evaluation of Tanque Chiconautla and Depósito Chiconautla on ICAO Annex 14 OLS**: MITRE evaluated the impact of the two water storage tanks against all of the ICAO Annex 14 OLS. The relevant surfaces within which Tanque Chiconautla and Depósito Chiconautla fall are the Approach and Take-off Climb surfaces.

- **Evaluation of Tanque Chiconautla and Depósito Chiconautla on instrument approach and departure procedures**: There are many factors that must be considered in the development of instrument procedures, especially when considering triple independent operations to parallel runways. ICAO does not publish standards for independent approaches to three parallel runways. Therefore, MITRE based its instrument procedure designs for NAICM on United States (U.S.) Standard for Terminal Instrument Procedures (TERPS), which are also used in Mexico.

- **Evaluation of Tanque Chiconautla and Depósito Chiconautla on potential engine-out obstacle assessment areas**: MITRE investigated if either of the two water storage tanks would be located within potential U.S. or ICAO engine-out obstacle assessment surface areas, which could potentially result in adverse operational impacts on future aircraft operations.

  It is important to note, however, that individual airlines are responsible for developing their own engine-out procedures. Therefore, the engine-out procedures and their associated obstacle assessment surface areas considered by MITRE for its assessment of Tanque Chiconautla and Depósito Chiconautla may be different than the procedures and surfaces developed by airlines.

- **Evaluation of Tanque Chiconautla and Depósito Chiconautla on the PAOAS**: The purpose of the PAOAS is to ensure an obstacle-free path for an aircraft on final approach that needs to conduct an evasive maneuver (typically a command to turn and climb) to avoid another aircraft on final approach to an adjacent runway that blunders into its path. MITRE conducted an analysis to determine whether Tanque Chiconautla or Depósito Chiconautla would penetrate the PAOAS.

- **Evaluation of Tanque Chiconautla and Depósito Chiconautla on the Minimum Vectoring Altitude Chart (MVAC)**: An MVAC depicts the lowest altitudes at which

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air traffic controllers can radar vector aircraft. MITRE, in close coordination with Servicios a la Navegación en el Espacio Aéreo Mexicano (SENEM), developed a new MVAC to support future NAICM operations. MITRE examined Tanque Chiconautla and Depósito Chiconautla to determine if either would require the altitude of an MVAC sector to be raised to ensure appropriate clearance of aircraft over the structure.

**Evaluation of Tanque Chiconautla and Depósito Chiconautla on ICAO Annex 14 OLS**

MITRE evaluated the impact of Tanque Chiconautla and Depósito Chiconautla against all ICAO Annex 14 OLS. It is important to note that Tanque Chiconautla and Depósito Chiconautla are located outside of the lateral confines of the Inner Horizontal and Conical surfaces; thus, the relevant ICAO Annex 14 surfaces to this assessment are the Approach and Takeoff Climb surfaces.

The approach surface defines the volume of airspace that should be kept free from obstacles to protect an airplane in the final phase of the approach-to-land maneuver. The approach surface is an inclined plane preceding the threshold, it has a slope of 2% (50:1) for the first 3000 m, and then the slope increases to 2.5% (40:1) until it intersects either a horizontal plane 150 m above the threshold elevation or the horizontal plane passing through the top of any object that governs the obstacle clearance limit (See Figure 2). The total length of the approach surface is 15,000 m. The approach surface has an inner edge of 300 m starting 60 m from the threshold and extending at 15% divergence rate on both sides to 4800 m at the outer edge.

![Figure 2. ICAO Annex 14 Approach Surface](image)

As per the above-mentioned ICAO Annex 14 OLS criteria, the 2.5% slope of the approach surfaces, in the area of Tanque Chiconautla and Depósito Chiconautla, was extended due to existing terrain and/or vegetative obstructions associated with Chiconautla,
which govern the obstacle clearance limit\(^4\). These extended approach surfaces were used to evaluate Tanque Chiconautla and Depósito Chiconautla.

MITRE analyzed the potential impact of Tanque Chiconautla on the proposed approach surfaces to all runways at NAICM. However, Tanque Chiconautla is only located within the lateral confines of the approach surfaces to the following runways: 17R, 17L, 18R, 18L, and 19R. It does not penetrate any of the approach surfaces.

MITRE also analyzed the potential impact of Depósito Chiconautla on the proposed approach surfaces to all runways at NAICM. However, Depósito Chiconautla is only located within the lateral confines of the approach surfaces for the following runways: 18L, 19R and 19L; however, it, too, does not penetrate any of the approach surfaces.

Therefore, neither Tanque Chiconautla nor Depósito Chiconautla impact the ICAO Annex 14 approach surfaces.

Figure 3, below, shows the approach surface to Runway 18L. This is one example in which both Tanque Chiconautla and Depósito Chiconautla are located within the lateral confines of the approach surface, but do not penetrate the surface.

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\(^4\) Note: The decision by aviation authorities regarding the grading (including to what extent) of Chiconautla is pending. As a result, the terrain and/or vegetative obstructions that govern the obstacle clearance limit are subject to change.
The Take-off Climb surface defines a volume of airspace designed to protect aircraft on take-off by indicating which obstacles should be removed if possible or marked, lighted, and published. The Take-off Climb surface is an inclined plane starting at 60 m from the threshold or at the end of the clearway, if provided, with a slope of 2% (50:1). The surface has an inner edge of 180 m and diverges on each side at a rate 12.5%. The final width for a straight-out take-off path is 1200 m and 1800 m if the intended flight track includes changes of heading greater than 15° or greater in Instrument Meteorological Conditions (IMC) or Visual Meteorological Conditions (VMC) at night.

MITRE analyzed the potential impact of Tanque Chiconautla and Depósito Chiconautla on all proposed Take-off Climb surfaces from all runways at NAICM. Tanque Chiconautla is only located within the lateral confines of the Take-off Climb surfaces for Runways 36L and 36R and does not penetrate either surface (See Figure 4). Depósito Chiconautla is located outside of the lateral confines of all proposed Take-off Climb surfaces. It is important to note that the departure tracks that serve as the basis for the Take-off Climb surfaces for the easternmost and westernmost pair of runways turn prior to Tanque Chiconautla and Depósito Chiconautla. Therefore, Tanque Chiconautla and Depósito Chiconautla do not impact the ICAO Annex 14 Take-off Climb surfaces.

Source Imagery: Google Earth Pro

Figure 4. NAICM Runways 36L/R Take-off Climb Surfaces
While not required, in order to provide an added margin of safety, it may be desirable to increase the visual recognition of both Tanque Chiconautla and Depósito Chiconautla through proper marking and lighting.

Also, where appropriate, aeronautical charts (AIP, approach and departure procedures, etc.) and records can be updated to reflect the location, height, marking, and lighting of both Tanque Chiconautla and Depósito Chiconautla.

**Evaluation of Tanque Chiconautla and Depósito Chiconautla on Instrument Approach and Departure Procedures**

MITRE evaluated the impact of Tanque Chiconautla and Depósito Chiconautla on instrument approach and departure procedures, which included Instrument Landing System (ILS) Category (CAT) I, ILS CAT II/III, and Required Navigation Performance (RNP) Authorization Required (AR) approach and missed approach procedures to the relevant runways at NAICM. Standard Instrument Departure (SID) procedures were also assessed to determine if Tanque Chiconautla or Depósito Chiconautla would cause an increase in climb gradient requirements.

MITRE examined the following northbound approaches for potential penetrations by Tanque Chiconautla and Depósito Chiconautla to the missed approach surfaces:

- ILS Runway 35L CAT I
- ILS Runway 35L CAT II/III
- ILS Runway 35R CAT I
- ILS Runway 35R CAT II/III
- ILS Runway 36L CAT I
- ILS Runway 36L CAT II/III
- ILS Runway 36R CAT I
- ILS Runway 36R CAT II/III
- ILS Runway 01L CAT I
- ILS Runway 01L CAT II/III
- ILS Runway 01R CAT I
- ILS Runway 01R CAT II/III

The ILS Runway 36L CAT I approach represents a northbound missed approach in which Tanque Chiconautla and Depósito Chiconautla are within the lateral confines of the missed approach surface, as shown in Figure 5. However, they do not penetrate the surface. Similarly, MITRE analyzed all of the above-mentioned northbound missed approaches and determined that Tanque Chiconautla and Depósito Chiconautla would not impact these procedures.
MITRE also examined the following southbound approaches (for which the potential issues could be the penetration by Tanque Chiconautla and Depósito Chiconautla to the final approach surface):

- ILS Runway 17R CAT I
- ILS Runway 17R CAT II/III
- ILS Runway 17L CAT I
- ILS Runway 17L CAT II/III
- ILS Runway 18R CAT I
- ILS Runway 18R CAT II/III
- ILS Runway 18L CAT I
- ILS Runway 18L CAT II/III
- ILS Runway 19R CAT I
- ILS Runway 19R CAT II/III
- ILS Runway 19L CAT I
- ILS Runway 19L CAT II/III

The ILS Runway 18L CAT I and CAT II/III approaches share the same final approach segment surfaces and represent a southbound approach in which Tanque Chiconautla and Depósito Chiconautla are within the lateral confines of the surface, as shown in Figure 6. Similarly, MITRE analyzed all of the above-mentioned southbound approaches and
determined that Tanque Chiconautla and Depósito Chiconautla would not impact these procedures.

Source Imagery: Google Earth Pro

Figure 6. ILS Runway 18L CAT I and CAT II/III Final Approach

Next, MITRE evaluated the RNP AR approach procedures to the relevant runways at NAICM, which included the following northbound approaches (for which the potential issues could be the penetration by Tanque Chiconautla and Depósito Chiconautla to the missed approach surface):

- RNP AR Runway 35L
- RNP AR Runway 35R
- RNP AR Runway 36L
- RNP AR Runway 36R
- RNP AR Runway 01L
- RNP AR Runway 01R

The RNP AR Runway 36L missed approach represents a northbound approach in which Tanque Chiconautla and Depósito Chiconautla are within the lateral confines of the missed approach surface, as shown in Figure 7. However, they do not penetrate the surface. Similarly, MITRE analyzed all of the above-mentioned northbound missed approaches and determined that Tanque Chiconautla and Depósito Chiconautla would not impact these procedures.
Figure 7. RNP AR Runway 36L Missed Approach

MITRE evaluated the RNP AR southbound approach procedures, including:

- RNP AR Runway 17L
- RNP AR Runway 17R
- RNP AR Runway 18L
- RNP AR Runway 18R
- RNP AR Runway 19L
- RNP AR Runway 19R

The RNP AR Runway 19R approach represents a southbound approach in which Depósito Chiconautla is within the lateral confines of the final segment, as shown in Figure 8. However, Tanque Chiconautla is outside of the lateral confines of the final segment. Neither Tanque Chiconautla nor Depósito Chiconautla penetrates the surface. MITRE analyzed all of the above-mentioned southbound approaches and determined that Tanque Chiconautla and Depósito Chiconautla would not impact these procedures.
MITRE evaluated the applicable northbound conventional and RNAV departure procedures (note: there are multiple departure procedures from each runway) at NAICM. Figure 9 shows the departure surface for Runway 36L in the vicinity of Tanque Chiconautla and Depósito Chiconautla. Both water storage tanks are located within the lateral confines of the departure surface, but are lower in elevation than the surface. Therefore, neither Tanque Chiconautla nor Depósito Chiconautla impacts any of the departure procedures at NAICM.
Source Imagery: Google Earth Pro

Figure 9. Runway 36L Departure Initial Climb Area

Evaluation of Tanque Chiconautla and Depósito Chiconautla on Potential Engine-out Obstacle Assessment Areas

MITRE determined if Tanque Chiconautla and Depósito Chiconautla would be located within or in the vicinity of notional U.S. or ICAO engine-out obstacle assessment areas, which could potentially result in adverse operational impacts on future aircraft operations. MITRE assumed that aircraft that experience an engine failure prior to Chiconautla would turn to avoid the hill and most likely avoid the water storage tanks as well. However, MITRE evaluated Tanque Chiconautla and Depósito Chiconautla against notional engine-out obstacle assessment areas for all runways at NAICM. Figure 10 shows notional U.S. and ICAO engine-out obstacle assessment areas for Runway 01R in relation to Tanque Chiconautla and Depósito Chiconautla. (Note: The notional procedure and associated assessment areas depicted in Figure 10 is only one example of how an engine-out procedure could be potentially conducted from Runway 01R.) Neither water storage tank is located within the lateral confines of the notional U.S. or ICAO engine-out obstacle assessment areas examined by MITRE. Therefore, given the above-mentioned assumptions, Tanque Chiconautla and Depósito Chiconautla should not impact these notional engine-out obstacle assessment areas.
It is important to reiterate that airlines are responsible for developing their own engine-out procedures. Therefore, the engine-out procedures and their associated obstacle assessment areas considered by MITRE for its assessment of Tanque Chiconautla and Depósito Chiconautla may be different than the procedures and surfaces developed by airlines. This cannot be considered a definitive analysis.

Source Imagery: Google Earth Pro

Figure 10. Runway 01R Engine-Out Obstacle Assessment Areas

Evaluation of Tanque Chiconautla and Depósito Chiconautla on the PAOAS

MITRE conducted an analysis to determine whether Tanque Chiconautla or Depósito Chiconautla would penetrate the PAOAS at NAICM. More specifically, MITRE examined CAT I and CAT II/III PAOAS for both northbound and southbound procedures. Tanque Chiconautla and Depósito Chiconautla do not impact the PAOAS at NAICM.

Evaluation of Tanque Chiconautla and Depósito Chiconautla on the MVAC

Tanque Chiconautla and Depósito Chiconautla are located within Sector C of the proposed MITRE-SENEM MVAC. The minimum vectoring altitude for Sector C is
10,400 feet (ft). The controlling obstacle for the sector is terrain at an elevation of 9180 ft (2798 m), over 1200 ft higher than the either Tanque Chiconautla or Depósito Chiconautla. Therefore, there are no impacts to the MVAC.

**Closing Remarks**

MITRE's assessment determined that Tanque Chiconautla and Depósito Chiconautla should not have adverse effects on future aircraft operations at NAICM. It is important to note, however, that MITRE is expecting to receive new and more robust photogrammetric survey data of NAICM and its surroundings, including Chiconautla and the water storage tank areas. While MITRE does not anticipate this new survey data to affect the overall findings for Tanque Chiconautla and Depósito Chiconautla, changes may be required to the procedures and obstacle assessment surfaces used in this report.

It is also important to note that the appropriate aviation authorities of Mexico need to provide final approval of the construction of Depósito Chiconautla in relation to future operations at NAICM, as well as current operations in the Mexico City area, which were not assessed here (note that Depósito Chiconautla will be constructed many years before NAICM opens). Finally, as an added margin of safety, MITRE recommends that consideration be given to installing appropriate markings and obstacle lights at Tanque Chiconautla and Depósito Chiconautla to improve conspicuity. Also, the appropriate aeronautical charts should be updated, as necessary.

Finally, although Depósito Chiconautla should not have adverse effects on future aircraft operations at NAICM, it would be more desirable to locate any new water storage tanks outside of the immediate vicinity of NAICM, clearly away from future flight paths.

Please do not hesitate to contact me if you need any clarification or any other assistance.

Sincerely,

Ing. Robert W. Kleinhaus
Project Technical Coordinator

cc: Dr. Bernardo Lisker, MITRE