MITRE

2 March 2015
F500-L15-012

Lic. y P.A. Gilberto López Meyer
Dirección General de Aeronáutica Civil
Boulevard Adolfo López Mateos, No. 1990
Col. Los Alpes Tlacopac
01010 México, D.F.
México

Subject: Approach Tracks and Noise at AICM: A General Assessment

Dear Capt. López Meyer:

As per your request, a MITRE team has investigated the issue of aircraft arrivals to Runway 05R at the Aeropuerto Internacional de la Ciudad de México (AICM) from the Mateo (SMO) Very High Frequency (VHF) Omnidirectional Range (VOR)/Distance Measuring Equipment (DME) based on three radials (160°, 164°, and 168°[1]) from SMO. This document provides a description of the investigation and its results.

The objective of MITRE's assessment is to provide information to Mexican aviation authorities concerning the flight tracks and profiles of aircraft flying from SMO to AICM Runway 05R in order to provide insight into noise complaints.

Background

Over the last year or so, changes have been made to the instrument approach procedures to Runway 05R at AICM. Initially, flights arriving over SMO traveled along the 160° radial before turning left to intercept the final approach course. Then, in 2014 the radial from SMO was first changed to 168° and later in the year to 164°.

Often times, when the flight path of aircraft is changed, some residential areas experience relief from noise exposure, while other residential areas may perceive a worsening of noise exposure, even if the noise level itself is within acceptable criteria. The recent change in the Runway 05R instrument approach procedure has generated complaints from Mexico City communities such as Lomas Virreyes and Lomas de Chapultepec. In order to better understand the reason for these complaints, the Dirección General de Aeronáutica Civil (DGAC) requested that MITRE perform a general study of the flight tracks and typical aircraft heights above ground level (AGL) for each of the three above-mentioned approach procedures and their potential impact on noise exposure.

[1] All bearings are with respect to magnetic north.

Methodology

MITRE utilized one of its cockpit simulators at its Air Traffic Management (ATM) Laboratory, as well as its previously developed computerized visualization and simulation model of AICM and the Mexico City terminal area to simulate the flight of a commercial aircraft executing each of the above-mentioned approach procedures to Runway 05R. Current and previously published Aeronautical Information Publication (AIP) Instrument Approach Charts (IACs) for the Instrument Landing System (ILS) approach to Runway 05R were used, as follows:

- 160°: ILS/DME PISTA 05R, AD-MMMX-ILS-1, ANEXO AL SUP 06/12 21-SEP-2012
- 168°: ILS/DME PISTA 05R, AD-MMMX-ILS-1, ANEXO 1 AL SUP AIRAC 22/14 24-JUL-2014
- 164°: ILS/DME PISTA 05R, AD-MMMX-ILS-1, 16-OCT-2014 AMDT AIRAC 02/14

According to the above-referenced IACs, aircraft on approach to Runway 05R using either the 160° or 164° radial cross SMO (or exit the holding pattern there) at or above 12,000 ft above mean sea level (MSL). Aircraft on approach using the 168° radial cross SMO (or exit the holding pattern there) at or above 13,000 ft MSL.

MITRE consulted with Servicios a la Navegación en el Espacio Aéreo Mexicano (SENEAM) concerning the aircraft flight characteristics and profiles used on these procedures. As a result of this consultation, SENEAM's Director General, Ing. Claudio Arellano, provided MITRE important information through the help of CTA Bruce Magallón.

Based on information from SENEAM, aircraft typically cross the SMO VOR/DME between 12,000 ft MSL and 13,000 ft MSL at a speed of 180 knots (kt) Indicated Air Speed (IAS). From SMO, aircraft reduce their speed to 160 kt IAS (or their minimum maneuvering speed), and the large majority of aircraft descend at an appropriate, more or less steady rate until they intercept the final approach (i.e., intercept the localizer) at approximately 8800 ft MSL, as per the published procedures. At the final approach fix (FAF), aircraft reduce speed to their appropriate landing speed.

In the simulated cockpit flights conducted by MITRE, aircraft crossed SMO at the minimum altitude of 12,000 ft MSL (for the procedures using the 160° and 164° radials) or 13,000 ft MSL (for the procedure using the 168° radial). These altitudes were used to examine a worst-case scenario from an aircraft height AGL perspective. It is important to note, however, that aircraft may cross SMO at higher altitudes. From SMO, as per the IACs, aircraft descend to either 9700 ft MSL (for the procedures using the 160° and 164° radials) or 10,200 ft MSL (for the procedure using the 168° radial), before turning onto final approach. Figure 1 shows the three ground tracks (i.e., the paths along the ground directly under the aircraft flight tracks) that were flown by MITRE.

During the simulated flight, aircraft flight parameters (e.g., altitude and speed) were recorded in order to enable both playback of the flight as well as, more importantly, post-processing of the parameters to extract and calculate the ground track as well as the aircraft height AGL. In addition to specialized tools within the ATM Laboratory, commercial products such as Global Mapper and Google Earth Pro were used to process and display the aircraft ground tracks and height AGL.

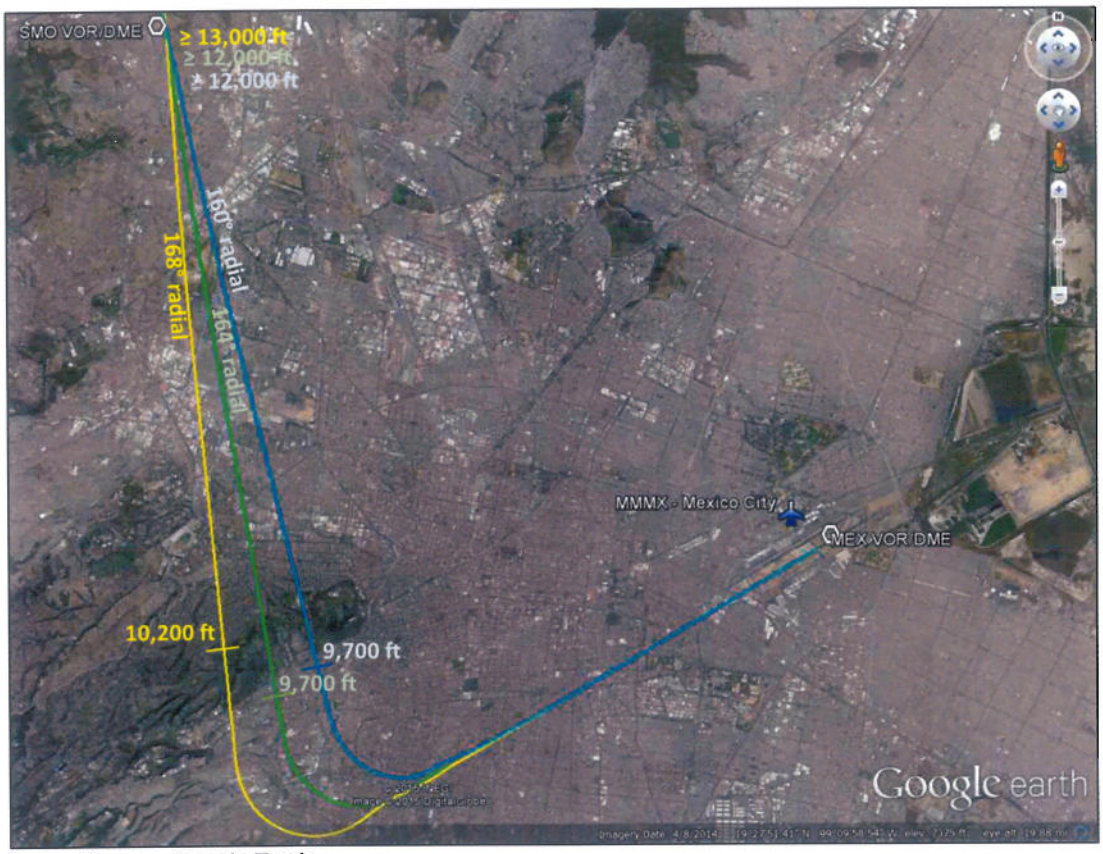


Image Source: Google Earth

Figure 1. Plan View of Aircraft Ground Tracks Flown by MITRE

Limitations

The following are limitations of MITRE's general assessment:

- Ground elevation data, which were used to determine aircraft height AGL, were derived from Shuttle Radar Topography Mission (SRTM) digital elevation data, which has a vertical accuracy of approximately ± 16 m.
- Aircraft performance, operating procedures, avionics, and pilot techniques vary from flight to flight and can cause significant navigation error. Wind and weather conditions, which were not considered by MITRE, also affect aircraft operations. Therefore, actual individual flights to AICM may be on different flight tracks and profiles than those shown in this assessment.
- A formal noise modeling analysis was not performed.

Results

A detailed plan view of the three ground tracks, concentrating in the region close to the areas originating noise complaints is shown in Figure 2. Figure 3 shows this same view with the addition of the aircraft flight tracks and height (shown in AGL) at various points. Figure 4 shows the same information, but from an angled profile view looking towards the east.

As can be seen in the figures, the height (AGL) of the aircraft passing near Lomas Virreyes and Lomas de Chapultepec is approximately 800 m to 950 m (2625 ft to 3117 ft), with the westernmost (168° radial) track being slightly higher than the middle (164° radial) track. The easternmost (160° radial) track is at approximately 750 m to 790 m (2461 ft to 2592 ft) as it overflies the Chapultepec Park area.

Image Source: Google Earth

Figure 2. Plan View of Ground Tracks, Detailed View

Image Source: Google Earth

Figure 3. Plan View of Ground and Flight Tracks, with Aircraft Height

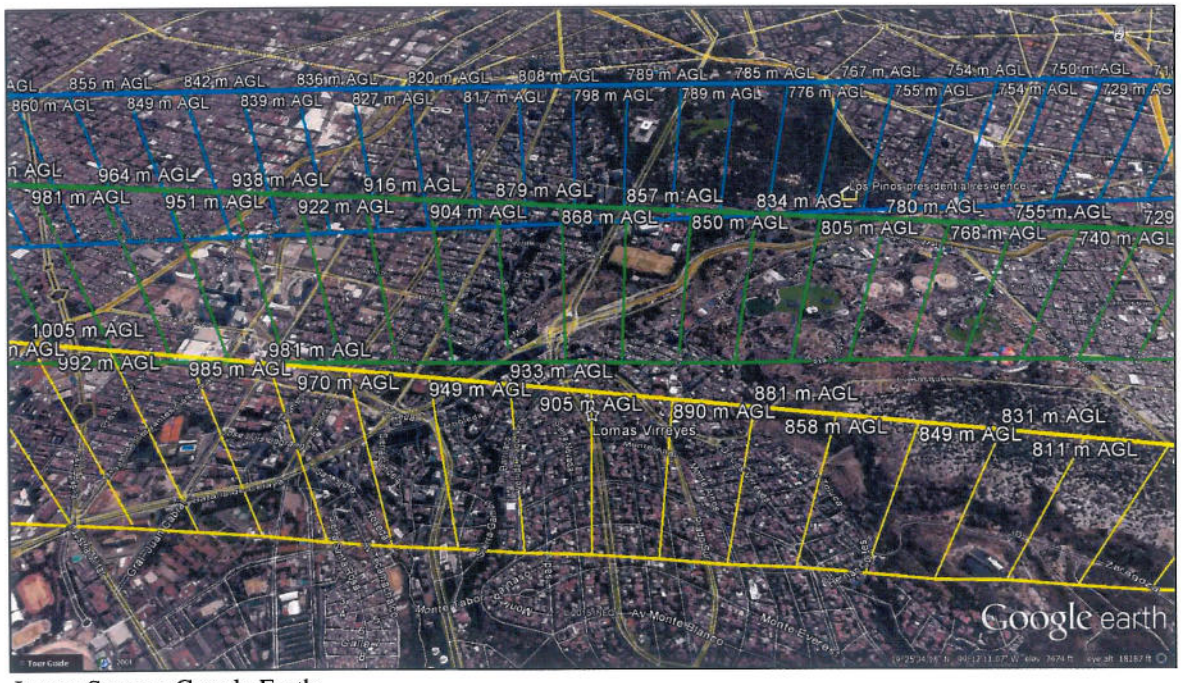


Image Source: Google Earth

Figure 4. Angled Profile View of Ground and Flight Tracks, with Aircraft Height

In 2001, MITRE performed a noise analysis of AICM considering 847 daily operations recorded on 10 August 2001. This date was a Friday during one of the two peak months of the year (in that year AICM handled close to 287,000 operations). In

contrast, AICM handled approximately 368,000 operations in 2013, an increase of approximately 28%. MITRE does not have information on the total annual operations for 2014, although they are expected to be higher.

Based on MITRE's experience, the increase in traffic from 2001 to 2014 with all else unchanged (e.g., traffic mix, proportion of daytime operations vs. nighttime operations) should result in an increase in noise of perhaps around 1.5 A-weighted decibels (dBA). However, many of the very noisy aircraft that were prevalent in the 2001 fleet mix, such as early model McDonnell Douglas DC-9 and Boeing 727-200 aircraft, do not operate anymore at AICM (or operate very rarely). The elimination of these noisy aircraft from the fleet mix would result in a reduction in noise exposure that is likely to be much greater than the 1.5 dBA increase due to the higher traffic level. That is, current noise exposure is expected to be a bit lower than that shown in MITRE's 2001 study.

MITRE's 2001 noise analysis estimated that the Day/Night Average Sound Level (DNL or L_{dn})[2] noise exposure for the area in Chapultepec Park underlying arrivals on a similar approach procedure would be between 55 and 57 dBA (see Figure 5), which is a noise level considered clearly acceptable by most current standards for residential land use. Therefore, given the above-mentioned considerations, it should be expected that an updated noise modeling study based on current traffic levels and fleet mix, and a 160° radial, would likely yield noise levels for these residential areas that are less than or equal to 55 dBA.

A review of other noise analyses performed by MITRE for large airports show similar results, with 55 dBA noise contours extending to the point where aircraft on the nominal approach path are approximately 800 m AGL, which is similar to the height of aircraft over the Chapultepec Park area.

Finally, to reinforce the analysis above, MITRE compared the height of aircraft over the Secretaría de Comunicaciones y Transportes (SCT) building, which is located along the final approach to Runway 05R, with the height of aircraft over the areas originating noise complaints on the 168° and 164° approach radials. The AGL height of aircraft passing the SCT building is approximately 400 to 450 m, compared to the previously mentioned height of 750 to 950 m of aircraft passing over the noise sensitive areas. As the 2001 noise analysis showed that the SCT building was located within the 60 dBA noise contour (as shown in Figure 5), it follows that it is likely that noise sensitive areas overflown by aircraft at an AGL height double that over the SCT building, should be impacted by acceptable noise levels.

---

[2] DNL is a 24-hour cumulative sound level metric, described in A-weighted in decibels (dBA). This cumulative metric is derived from all aircraft operations during a 24-hour period that usually represents an airport's average annual operational day, but can also represent a peak day. DNL adds a 10 dBA noise penalty to each aircraft operation occurring during nighttime hours (normally 10 pm to 7 am).

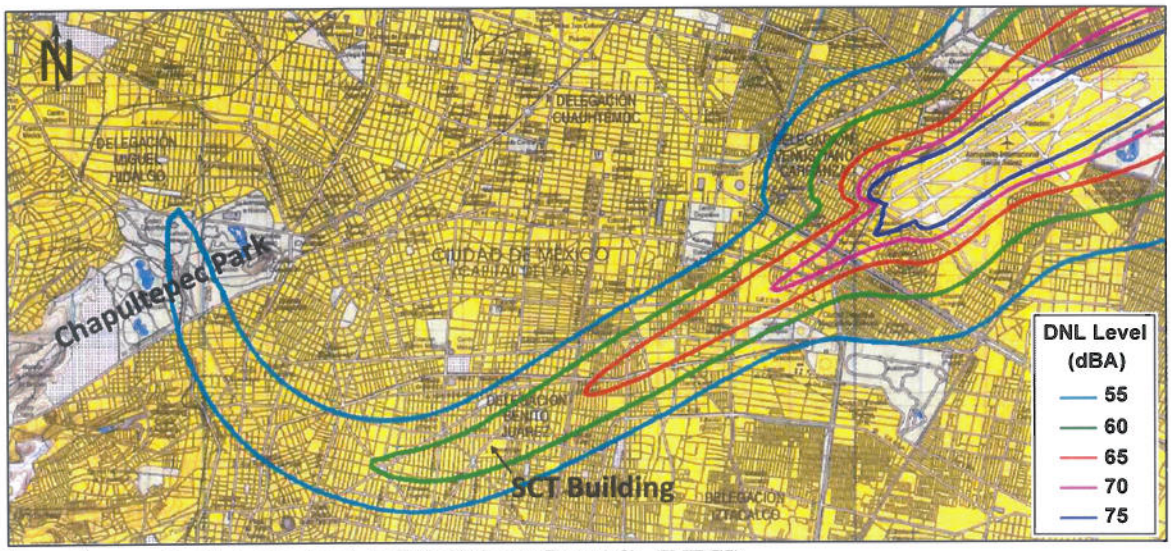
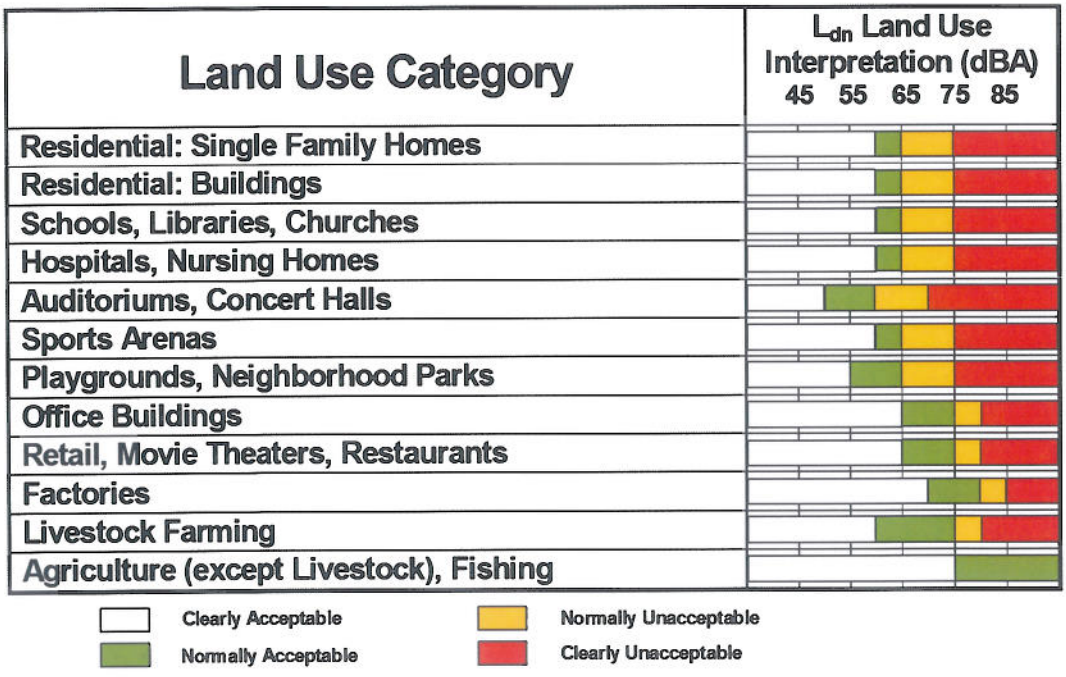


Image Source: Instituto Nacional de Estadística y Geografía (INEGI)

Figure 5. Results of MITRE's 2001 Noise Analysis

Closing Remarks

Based on the estimated height of aircraft passing close to areas originating noise complaints, MITRE's 2001 noise analysis of AICM, and MITRE's experience in modeling noise at many international airports, it can be surmised that noise exposure in the areas of concern, given the 168° and 164° approach radials, is well within clearly acceptable residential land use aircraft noise criteria (see Figure 6).



Source: United States Department of Housing and Urban Development (HUD)

Figure 6. Sample Land Use Guidelines

Although there is a slight difference in the AGL height of the three flight tracks under investigation, the differences are not large enough to cause a significant difference in resulting noise exposure on the ground. Nonetheless, residents that now hear (or see) aircraft overflying their neighborhoods can be expected to voice complaints, as there were previously no aircraft passing over their residential areas.

It is important to state that while the conclusions of this briefing are based on a careful assessment that is probably correct, they do not constitute formal noise modeling.

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

Sincerely,

Ing. Robert W. Kleinhans
Project Technical Coordinator

cc – Ing. Claudio Arellano