MITRE

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Dirección General de Aeronáutica Civil (DGAC)
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Subject: ***Centro de Gestión de Residuos Sólidos en el Bordo Poniente*: Feedback Regarding Aeroméxico's Takeoff Performance Analysis**

Dear CTA. Peláez:

The MITRE Corporation (MITRE) is assisting Grupo Aeroportuario de la Ciudad de México (GACM) and the aviation authorities of Mexico in the development of a new airport to serve Mexico City, referred to in this document as Nuevo Aeropuerto Internacional de la Ciudad de México (NAICM), to replace the current Aeropuerto Internacional de la Ciudad de México (AICM). As part of that support, MITRE conducts assessments of ideas proposed by stakeholders (e.g., construction of buildings and facilities in the vicinity of NAICM) when requested by certain Mexican authorities, and provides aeronautically-related feedback to assist them in their decision-making process.

In response to a high-priority request in the summer of 2016 by Lic. Yuriria Mascott, Undersecretary of Transportation, and yourself, MITRE designated a team of experts to conduct an assessment of the potential impact of a proposed facility named *Centro de Gestión de Residuos Sólidos en el Bordo Poniente* (hereafter referred to as the "facility") to be constructed near AICM and NAICM. Refer to Enclosure 1 to Technical Letter F500-L17-030: *Assessment of Centro de Gestión de Residuos Sólidos en el Bordo Poniente: Options 3, 4.1, 4.2, and 5*, dated 11 January 2017, which describes MITRE's assessment of the proposed facility. One of MITRE's recommendations to the authorities was that at least a major airline operating at AICM should conduct analyses of the facility (at all proposed locations) utilizing their respective takeoff practices and procedures considering an engine failure for operations at both AICM and NAICM, to determine if the facility would cause any issues and/or restrict aircraft payload and range capabilities.

This matter was discussed between you and Dr. Bernardo Lisker during a 17 February 2017 meeting in Mexico City. At that time, it was agreed that MITRE would provide information to assist you with the coordination of an appropriate takeoff performance analysis considering an engine failure by Aeroméxico. As a result, the MITRE team compiled relevant information needed by Aeroméxico to conduct the analysis and sent it to you via e-mail on 6 March 2017. The results of the analysis by Aeroméxico were sent back to MITRE by you via e-mail on 18 March 2017. Since then, MITRE studied the results of the analysis that you sent.

The objective of this document is to provide you with MITRE's feedback and opinion regarding the results of Aeroméxico's takeoff performance analysis.

This assessment (on engine failure operations as opposed to normal operations) is informally provided, as it is outside the scope of MITRE's contractual work.

Background

Civil air carrier aircraft must satisfy certain performance requirements on takeoff. These include accelerate-stop distance, takeoff distance, and the clearing of terrain and obstacles after takeoff. The takeoff performance calculations must include consideration for ambient atmospheric conditions (e.g., temperature, humidity, airport elevation, and wind). In addition, these takeoff performance requirements must be satisfied assuming an engine failure at the most critical point during takeoff. If these performance requirements cannot be satisfied at the Maximum Brake-Release Weight[1] (MBRW), then either the weight of the aircraft must be reduced or takeoff must be delayed until suitable ambient conditions exist. The subsequent MBRW then determines the range/payload tradeoff options available for operations.

Takeoff performance calculations are normally performed by airlines using proprietary software from the aircraft manufacturer and are specific to the make, model, and engine type of the aircraft, as well as the takeoff runway and obstacles in the takeoff path. Thus, each airline must perform takeoff performance calculations for each aircraft/engine combination for each takeoff from each specific runway.

Air Traffic Control provides departure paths in the form of radar vectors or Standard Instrument Departures for normal operations[2]. An engine failure during takeoff is a non-normal event and one in which an aircraft may not be able to climb at a sufficient rate to maintain obstacle clearance. For such a non-normal event, an emergency takeoff procedure, designed by the airlines, can be developed to ensure obstacles can be cleared and to maximize the allowable MBRW. For example, an airline can design an engine failure takeoff procedure that avoids obstacles or terrain located off the departure end of the runway.

Key Considerations and Analysis

MITRE was presented with various proposals for the location of the facility to the south of the NAICM site. For analytical purposes, MITRE considered 40-meter-high smokestacks (i.e., approximately 2275 m above Mean Sea Level [MSL]) at each of the proposed locations, as per information previously provided by you. Per analyses already reported by MITRE back in January, smokestacks at those locations do not appear to interfere with normal instrument approach and departure procedures at either AICM or NAICM (at the latter airport, both conventional and satellite-based navigation procedures were considered by MITRE). However, there is concern that the smokestacks could affect takeoff performance under an engine-failure situation and impact the range and payload of airline operations. Since takeoff performance

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[1] The MBRW is the maximum weight authorized at brake release for takeoff, or at the start of the takeoff roll.

[2] Procedure design criteria are predicated on normal aircraft operations and performance (e.g., all engines operating).

calculations are accomplished by the airlines, it was necessary for you to request assistance from the airlines.

As previously mentioned, MITRE provided information (e.g., relevant NAICM runway lengths, elevations, and coordinates) to the DGAC to assist with the coordination of an appropriate takeoff performance analysis by Aeroméxico (the airline that you suggested) for both AICM and NAICM. Aeroméxico was asked to determine at what distance from the departure end of each runway being considered an obstacle with an elevation of 2275 m above MSL would cause a reduction in MBRW during takeoff for both straight and turning procedures. If the proposed smokestack locations were farther from the departure end of the runways than the distance calculated by Aeroméxico, then the smokestack locations would have no impact on takeoff performance calculations.

In conducting the analysis, Aeroméxico was asked to utilize the "critical" aircraft for its calculations, critical being here the aircraft with the worst takeoff performance during a reasonably hot day with reasonably unfavorable tailwind conditions. Additionally, Aeroméxico was asked to determine if other aircraft should be analyzed (for example, future aircraft that may have more limited performance). Finally, in the case of NAICM, MITRE recommended that Aeroméxico assume, for calculation purposes, the existence of a 300-m clearway/stopway beyond the departure end of each runway and a runway slope of zero. For AICM, Aeroméxico was asked to use the runway data known to it and, similarly, relatively hot temperature and tailwind conditions.

Summary of Results

Aeroméxico provided the results contained in Appendix A, which show the minimum distance required for aircraft to clear an obstacle with an elevation of 2275 m MSL during a takeoff situation (including a potential engine failure). Appendix B shows the distances to the proposed facility locations from the departure end of Runway 17R (Runway "1", counting parallel runways from west to east), Runway 17L (Runway "2"), Runway 19R (Runway "5"), and Runway 19L (Runway "6") at NAICM. Appendix C shows the distances from the departure end of Runway 05L and Runway 05R at AICM.

Impact of Proposed Facility Locations on NAICM

Based on the data provided by Aeroméxico in Appendix A (see the part of the table titled "NUEVO AICM"), none of the proposed facility locations depicted in Appendix B affect takeoff performance at NAICM.

As an example, the largest distance in Appendix A for the NAICM runways examined is 5200 m, which applies to a turning takeoff procedure from Runway 17R for a Boeing B787-8 and a Boeing B737-800. Note from Appendix B that all proposed facility locations potentially affecting Runway 17R takeoffs are more than 7000 m from Runway 17R. Therefore, an aircraft conducting a turning takeoff procedure would be higher than the 2275 m MSL smokestack at 5200 m from the departure end of Runway 17R by the time it reaches any of the proposed facility locations.

As a second example, the closest distance from the departure end of Runway 19L to Option 4.1 is 4805 m, as shown in Appendix B. However, as can be seen in Appendix A, the

largest distance for 19L is 4700 m, which applies to a turning takeoff procedure for a Boeing B787-8. Therefore, an aircraft utilizing Runway 19L will exceed the 2275 m MSL smokestack height before reaching Option 4.1.

An inspection of the required distances from each runway end to clear a 2275-m obstacle shows that in every case the measured distance from runway end to facility location is greater than the required distance.

Impact of Proposed Facility Locations on AICM

Based on the data provided by Aeroméxico in Appendix A (see the part of the table titled "MEX"), none of the proposed facility locations depicted in Appendix C, except for Option 5, affect takeoff performance at AICM.

Note from the table in Appendix A that the largest distance is 4850 m, which applies to a turning takeoff procedure from Runway 05L for a Boeing B737-800. All proposed facility locations, except for Option 5, are farther than 4850 m from the departure end of either Runway 05L or Runway 05R at AICM, as shown in Appendix C. Thus, an aircraft taking off from AICM would exceed the obstacle height of 2275 m MSL no later than 4850 m from either runway at AICM.

Option 5 is the only proposed facility location that poses a potential problem for a takeoff procedure from AICM. However, note from Appendix C that the Option 5 location is approximately 45° to the right of the Runway 05L and Runway 05R centerlines. Thus, if Option 5 should be seriously considered, <u>it is important that the airlines and SENEAM ensure whether a hard-right turn toward Option 5 is preventable</u>. If so, Option 5 would not pose a difficulty for takeoff procedures from AICM.

<u>MITRE's Opinion</u>

Based on the data provided by Aeroméxico shown in Appendix A (<u>please consider that this analysis is based on the results by Aeroméxico alone</u>), a maximum smokestack height of 2275 m MSL, and the proposed locations of the facility shown in Appendix B and Appendix C, none of the proposed facility locations should affect takeoff procedures at either NAICM or AICM. <u>If, however, Option 5 is to be selected, please refer to the last paragraph of the previous section</u>.

Next, even though the proposed facility locations should generally not impact takeoff procedures, it is important that MITRE's previous assessment of the proposed facility locations be considered as it provides useful information to aid authorities and other stakeholders in their decision-making process (Enclosure 1 to Technical Letter F500-L17-030, cited on page 1 of this report). Hence, MITRE's final, overall opinion on the best locations to build the facility is as follows:

- Options 4.1 and 4.2 are located the farthest away from the extended centerlines of any of the NAICM runways and are also located far from AICM. <u>In that respect, they clearly constitute the best options to build the facility from an aeronautical standpoint</u>.
- Option 5 is the location closest to AICM, being approximately 2995 m from the departure end of Runway 05R. In that respect, this option is not as good as Options 4.1 and 4.2. It simply is the next best option to build the facility.

- Option 3 is the least desirable location to build the facility since the extended centerline of Runway 35R/17L at NAICM passes right above the facility. Also, a facility located at Option 3 would be relatively close to the extended centerline of Runway 35L/17R at NAICM. Thus, aircraft arriving to NAICM would be regularly flying directly over and/or close to a facility located at Option 3.

Finally, due to the importance of the location of the facility and its potential long-term navigational impact, MITRE strongly recommends that SENEAM review this document and be involved as well in the overall decision-making process.

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

Sincerely,

Ing. Robert W. Kleinhans
Project Technical Coordinator

cc:
Lic. Yuriria Mascott Pérez, SCT
Dr. Bernardo Lisker, MITRE

Appendix A

Takeoff Calculations Provided by Aeroméxico

Figure A-1 shows the results of the takeoff performance analysis that was conducted by Aeroméxico. The distances provided represent the minimum distance required for aircraft to clear an obstacle with an elevation of 2275 m MSL during and engine-failure situation.

GERENCIA DE INGENIERIA DE OPERACIONES
AEROMEXICO

DISTANCIA EN METROS PARA LIBRAR OBSTACULO DE 2,275 M SNMM

		787-9		787-8		737-800		E190	
		Straight	Turning	Straight	Turning	Straight	Turning	Straight	Turning
NUEVO AICM	RWY 01 17R	3,000	4,850	3,350	5,200	3,350	5,200	2,700	4,150
	RWY 02 17L	2,500	4,350	2,900	4,750	2,800	4,650	2,150	3,600
	RWY 05 19R	2,900	4,650	2,950	4,550	2,900	4,550	2,700	4,150
	RWY 06 19L	2,800	4,650	2,950	4,700	2,900	4,650	2,450	3,900
MEX	RWY 05R	2,800	4,450	3,000	4,550	3,050	4,750	3,100	4,550
	RWY 05L	2,950	4,550	3,050	4,650	3,150	4,850	3,150	4,600

Distancias obtenidas considerando:

- Librar obstáculo de 2,275 m (7,464 ft.) sobre el nivel medio del mar.
- Viento de -5 kts, temperatura de 28 °C y QNH de 30.30 in Hg.
- Salida con falla de motor en linea recta y con viraje de 90° (adoc. técnica de vuelo)
- Todas la mejoras disponibles (V1 optima, ascenso mejorado, CG alterno, etc.) para mayor TOW posible.
- Obstáculos naturales existentes en trayectorias de despegue.
- Valor de elevación proporcionado para cada cabecera de acuerdo a especificaciones recibidas.
- Las distacias sobreadas por pista (en azul) cubren toda la flota Aeroméxico; con el obstáculo a una distacia menor, el peso de despegue de alguno de los equipos se vería afectado.
- Las distacias "Straight" y "Turning" estan medidas de acuerdo a la trayectoria de vuelo, conforme a las imágenes anexas.

Note: the information shown in this figure was provided by Aeroméxico and is being shown "as is".

Figure A-1. Minimum Distances Required to Clear a 2275 m MSL Obstacle Considering an Engine Failure

Appendix B

Distances from NAICM Runways to Proposed Facility Locations

Figure B-1 shows the distances from the departure end of Runway 17R (Runway "1"), Runway 17L (Runway "2"), Runway 19R (Runway "5"), and Runway 19L (Runway "6") at NAICM to the proposed facility locations.

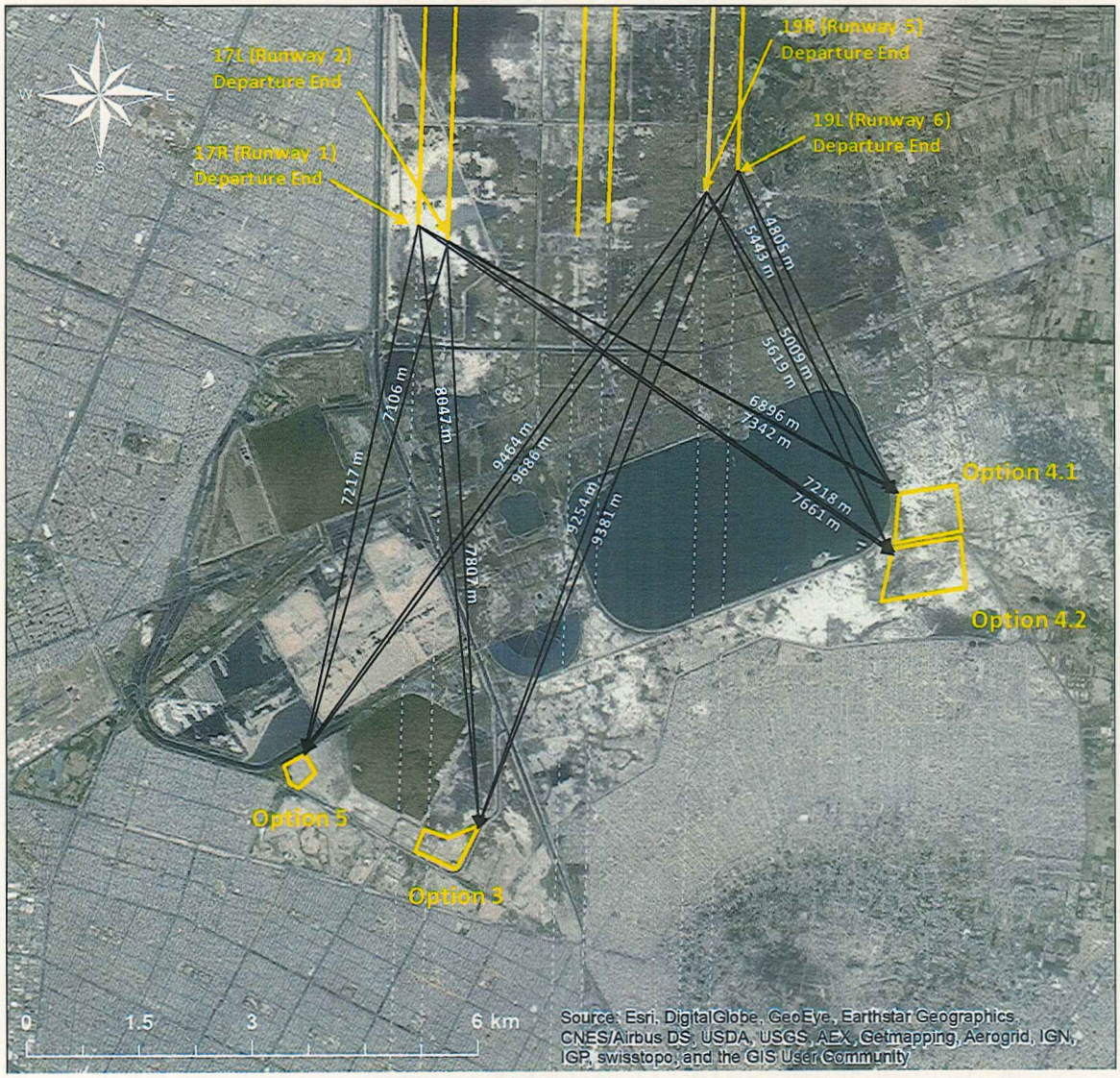

Figure B-1. Distances from NAICM Runways to Proposed Facility Locations

Appendix C

Distances from AICM Runways to Proposed Facility Locations

Figure C-1 shows the distances from the departure end of Runway 05R and Runway 05L at AICM to the proposed facility locations.

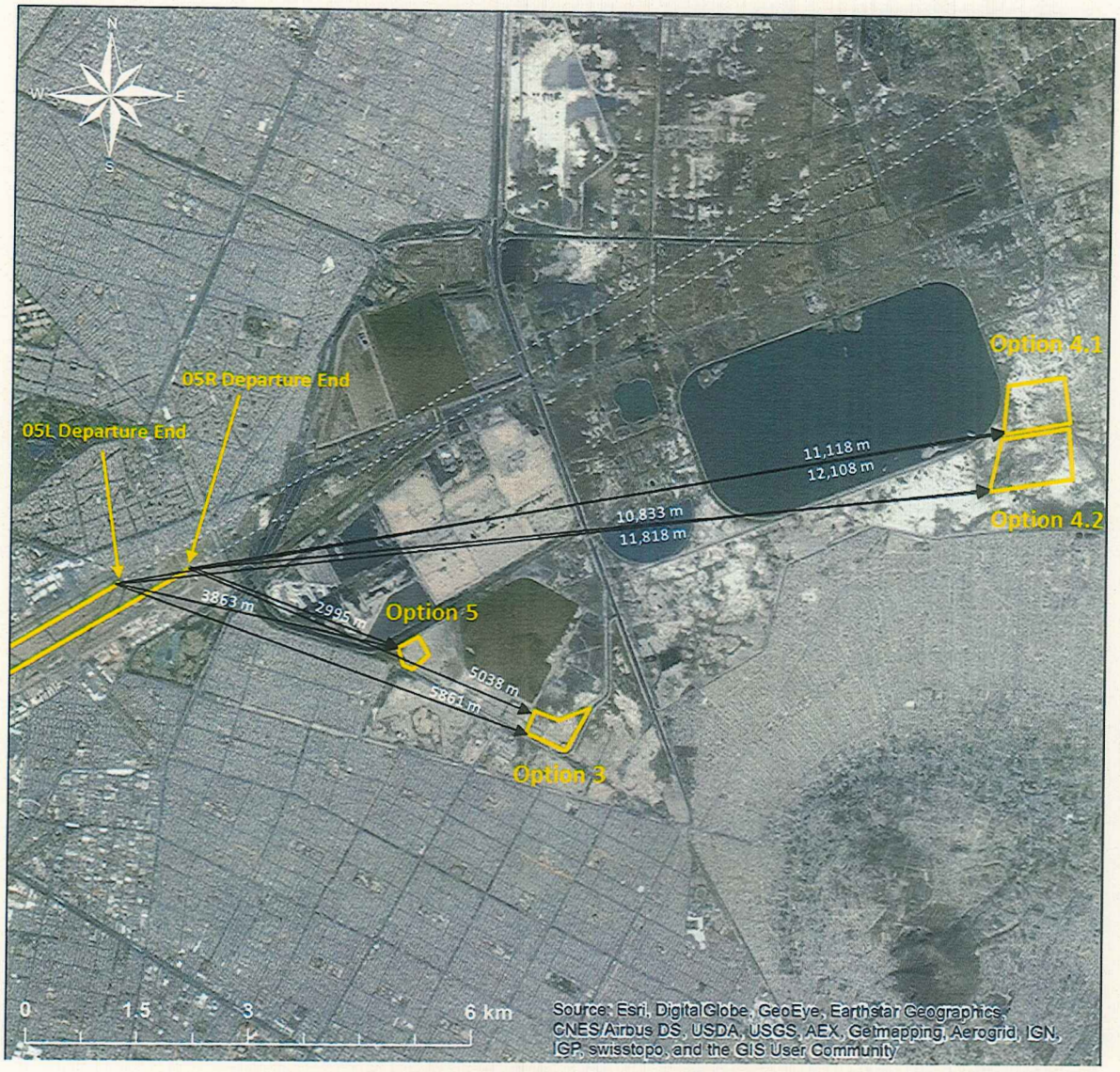

Figure C-1. Distances from AICM Runways to Proposed Facility Locations