MITRE

3 March 2017
F500-L17-042

Ing. Enrique Lavin
Director de Planeación Evaluación y Vinculación
Grupo Aeroportuario de la Ciudad de México (GACM)
Insurgentes Sur 2453, Piso 2
Col. Tizapán, Del. Álvaro Obregón
C.P. 01090, México, D.F.,
México

Subject: Technical Letter: Comments on the ILS Specifications

Dear Ing. Lavin:

During the recent visit to Mexico by a MITRE team, it became clear that despite repeated warnings by MITRE alerting GACM that runways should not be built before Instrument Landing Systems (ILSs) are tested, not even a mobile, experimental ILS Category III, with the required characteristics has been purchased.

While MITRE's project does not include provisions to review equipment specifications, in the summer of 2016, Ing. Luis Sánchez, then a member of GACM, made a request that MITRE double checks specifications issued by GACM. MITRE accepted to do so because:

1. MITRE issued the initial signal coverage requirements of the ILS to support development of the new airport
2. MITRE needs to confirm formally that the ILS should or not be Category III
3. MITRE has contractual provisions that require it (and a tradition that follows), to collaborate with its sponsors as much as possible

Ing. Sánchez sent MITRE an electronic version in Spanish and one in English. The latter is important because vendors may use, despite Mexico's best wishes, the English version, and contradictions can lead to serious problems.

As a result, on 12 August 2016, MITRE provided comments on the specifications through Technical Letter F500-L16-041. MITRE sent that letter (which is copied behind this new letter) to all appropriate aviation organizations. As MITRE had no idea whether SENEAM had or had not reviewed the documents MITRE received, MITRE wrote on the very first page of that letter: "it is important to note that SENEAM, as the expert in navigational system acquisition matters in Mexico, is in a good position to complement MITRE's recommendations."

Dr. Bernard Lisker, MITRE's International Director, called Ing. Sánchez and requested, to close the loop, that the comments are integrated to the specifications, as MITRE found some issues in the specifications. For example, the Glide Slope (GS) signal, and this is only one example, does not need to reach out 40 NM but only 28 NM. Adding 12 NM to the GS reach could change pricing significantly and, in a worst scenario, become an impossible request, which would only add time to any tender and bidding process. Unfortunately, despite repeated requests, MITRE never received the integrated document, and based on what was found out during the visit to GACM, MITRE's comments were never fully integrated to the specification tender.

It is important to emphasize that MITRE is not sure that the Spanish *paper version* provided to MITRE during its visit to GACM in February 2017 is the same as the *electronic version* provided by Ing. Sánchez to MITRE in mid-2016. What is sure is that MITRE's comments are not considered in the most recent paper copy, except for a few minor matters. Also, there is no assurance that the English version was ever corrected. Next, I want to make sure that there is no impression that MITRE reviewed the document more than one time. Only one formal review of the 2016 document was made by MITRE. However, there was no reply in the form of a new document. The loop was not closed. MITRE needs to watch its liability and that is why the topic was brought back again. During the past few days MITRE simply compared its comments on Ing. Sánchez' electronic document vs. the paper document received by MITRE at GACM a few days ago.

As delayed as the ILS purchase already is, it is essential that the specifications are treated carefully. At this time, MITRE considers its revision completed. See the letter behind this letter. SENEAM may want to take another look at the document. At the same time, if SENEAM or GACM would like that MITRE takes a final look at a true final, corrected document, MITRE would do it with pleasure.

Please let me know if you need any other clarifications,

Sincerely,

Ing. Robert W. Kleinhans
Project Technical Coordinator

cc Ing. Ricardo Tapia, GACM Liaison
Dr. Bernard Lisker, MITRE

MITRE

12 August 2016
F500-L16-041

Ing. Luis Sánchez Estrada
Subdirector de Normatividad y Procesos Aeroportuarios
Grupo Aeroportuario de la Ciudad de México (GACM)
Avenida 602, Número 161
Delegación Venustiano Carranza
15620 México, D.F.
México

Subject: NAICM Category III Instrument Landing System Acquisition Proposal and Initial Runway Visual Range Data Analysis

Dear Ing. Sánchez:

This document is in response to your conversations with Dr. Bernardo Lisker regarding the acquisition of a Category (CAT) III capable Instrument Landing System (ILS) for the Nuevo Aeropuerto Internacional de la Ciudad de México (NAICM). On 22 July 2016, you sent Dr. Lisker, via e-mail, a document pertaining to the above-mentioned system acquisition, in both Spanish and English. The document, named (in English) *Technical Annex: Procurement of A New Mobile Instrument Landing System (ILS) CAT III Portable-Mobile-Semi-Deployable for the New International Mexico City Airport* (hereinafter referred to as the "acquisition document") includes technical specifications and other requirements for the acquisition and installation of ILS equipment to conduct flight inspections and eventually support future NAICM operations.

MITRE reviewed the English version of the above-mentioned document and, as requested, is providing through this document feedback regarding the acquisition of the CAT III ILS. Additionally, this document includes information on MITRE's initial analysis of visibility data obtained through a Runway Visual Range (RVR) system located at the NAICM site. This initial analysis of RVR data is intended to provide authorities with a better understanding of the need for CAT II and/or III ILS approaches at NAICM.

Technical specifications, acquisition, and installation of ILS equipment are all areas outside MITRE's area of principal expertise and outside the scope of MITRE's contract in Mexico. Therefore, MITRE is not able to review or provide feedback on some of the technical specifications contained in the above-mentioned acquisition document. Nevertheless, the MITRE team reviewed the acquisition document and provided its opinion, where appropriate, on matters pertaining to the unique operational situation at NAICM. This being the case, MITRE's liability does not extend to opinions or recommendations provided in this document.

Finally, it is important to note that SENEAM, as the expert in navigational system acquisition matters in Mexico, is in a good position to complement MITRE's recommendations.

CAT III ILS Acquisition Document Feedback

- Localizer Signal Coverage: high terrain and other airspace/procedure design requirements cause the final approaches at NAICM to be very long. Therefore, the localizer should be flight-inspected to a distance of 40 nautical miles (NM) from the approach end of the respective runway along the ILS vertical approach path.

  The acquisition document requires that the localizer signal covers 40 NM. MITRE recommends that the specification document clearly state that the localizer signal provide coverage to a distance of 40 NM from the approach end of the runway (which equates to approximately 43 NM from the ILS localizer transmitter) along the ILS vertical approach path. (Note that some of the runways at NAICM may be as long as 5000 m)

  The acquisition document does not mention what height above the transmitter the localizer signal must reach along the ILS vertical approach path. The localizer signal should be able to provide guidance to aircraft that are at a height of approximately 9000 ft above the transmitter 40 NM from the approach end of the runway along the ILS vertical approach path. Additionally, the localizer signal should be able to provide guidance to aircraft that are at a height of approximately 4200 ft and higher above the transmitter from 19 NM to 40 NM from the approach end of the runway to cover the intermediate level segment of the approach leading to intercept the glideslope signal.

- Glideslope Signal Coverage: due to the above-mentioned terrain and airspace/procedure design requirements, the glideslope should be flight-inspected to a distance of 28 NM from the approach end of the respective runway. Note, however, that the acquisition document states that the glideslope coverage requirement should be 40 NM. MITRE does not have an issue with this requirement since it provides an additional margin of operational flexibility, but this exceeds planned approach procedure requirements.

  Next, as with the localizer signal, the acquisition document does not mention what height above the transmitter the glideslope signal must reach along the ILS vertical approach path. The glideslope signal must also be able to reach a height of approximately 9000 ft above the transmitter along the ILS vertical approach path.

- Distance Measuring Equipment (DME) Signal Coverage: the DME should be able to meet the operational requirements of the ILS approaches being planned for NAICM. The acquisition document requires the DME coverage to be the same as the localizer (i.e., 40 NM). MITRE recommends that the specification document clearly state that the DME signal provide coverage to a distance of 40 NM from the approach end of the respective runway (which equates to approximately 43 NM from the ILS localizer transmitter) along the ILS approach path.

- Pre-commissioning (Site Evaluation) Flight Inspection Activities: due to the long ILS final approaches at NAICM, it is important to conduct pre-commissioning flight inspection activities as soon as possible, before runways are constructed,

using actual ILS equipment (or equivalent equipment judged sufficient by appropriate experts). MITRE has insisted on this for a long while. This will provide an initial assessment as to whether or not appropriate signal reception can be achieved and confirm, to the extent possible, that other issues such as magnetic effects do not cause problems. The manufacturer of the ILS system should be involved in the inspection process, since expertise specific to the equipment would be desirable considering the unique situation at NAICM (i.e., long ILS final approaches in complex terrain).

The acquisition document states that three different runway thresholds (*cabeceras*) will be tested. MITRE recommends that the manufacturer determine if ILS system testing on only three of the six runway thresholds is appropriate to ensure that ILS system signal reception on all six runway thresholds can be achieved. If not, it may be necessary to conduct ILS system testing for all six runway thresholds. **It would be unacceptable to find out after the runways are constructed that ILS approaches may not be conducted due to equipment signal issues.**

- Potential Signal Interference: proposed airport facilities and other airport components, including buildings, can potentially cause signal interference with an ILS system. Therefore, it is important to ensure that proposed buildings, roads, parking facilities, taxiing/holding aircraft (e.g., aircraft tails interfering as they taxi), etc. are located in a manner that do not interfere/degrade ILS system signal quality. Therefore, the location of airport facilities and other airfield developments should be closely coordinated with the companies responsible for installing ILS equipment to ensure that facilities do not cause issues (e.g., electromagnetic affects, reflections, etc.). This also may involve conducting appropriate flight inspections, as well as other studies and testing.

- References: Section 3.2, Localizer, of the acquisition document, includes what appears to be section reference numbers (e.g., 2.2.3.2, 2.2.3.3, 2.2.3.5, etc.) that possibly are intended to refer to International Civil Aviation Organization (ICAO) Annex 10, Aeronautical Telecommunications, Volume 1, Radio Navigation Aids. However, those sections do not exist in ICAO Annex 10. Therefore, it is not clear to what document those section references are referring.

- Operational Usage: the acquisition document refers to the equipment to be procured as a "portable-mobile-semi-deployable" CAT III ILS. Section 2.19 of the acquisition document states that after testing, final installation of the CAT III ILS will be conducted on a runway at NAICM to be designated by SENEAM. The manufacturer should ensure that the "portable-mobile-semi-deployable" CAT III ILS that is being provided can in fact be permanently installed and appropriately used for actual operations when NAICM opens.

Initial RVR Data Analysis on CAT II/III ILS Approaches

MITRE previously conducted a detailed analysis of weather conditions at the NAICM site on the basis of over five years of data (i.e., 1 May 2009 to 11 October 2014) from an

on-site Automated Weather Observing System (AWOS) located near El Caracol. MITRE's analysis of AWOS data showed that poor weather conditions that would require CAT II or III ILS approaches were rare and typically occurred during the winter months. For example, in December 2013, the month with the most frequent poor weather, over a 24-hour-day period, a total of 8.5 hours of weather that would require CAT II or CAT III ILS approaches was observed during three days, as follows:

- 1 December 2013 - 6.5 hours, from 3:00 am to 9:30 am (local time)
- 5 December 2013 - 1.5 hours, from 6:00 am to 7:30 am (local time)
- 11 December 2013 - 0.5 hours, from 8:00 am to 8:30 am (local time)

However, MITRE explained over two years ago that AWOS-based analyses, such as MITRE's, were not sufficient in order to appropriately determine the need for CAT II/III ILS approaches at NAICM. Through RVR data, the percentage of time that poor visibility conditions exist that would require CAT II or III ILS approaches, as well as what hours those approaches would likely need to be conducted, can be determined.

SENEAM has provided MITRE with visibility data from an RVR system located at the NAICM site near El Caracol since 1 January 2016. The RVR system collects visibility data every minute, 24 hours a day. To date, MITRE has received RVR data from 1 January 2016 through 30 June 2016.

Note that due to power supply and RVR sensor-related issues, some of the RVR data had to be modified by SENEAM. For example, when the power supply to the RVR system was interrupted (and the data recording stopped), SENEAM complemented the data gaps by checking the visibility data for the same time period using weather information from nearby Mexico City International Airport (AICM). During these time periods, the visibility at AICM exceeded 6000 ft, so SENEAM assumed that the same visibility conditions existed at NAICM. Also, due to a background luminance sensor issue (occurring during nighttime at certain visibility conditions), some manual adjustments were made by SENEAM to correct the visibility data output. <u>MITRE is not an expert in RVR systems. Its analyses assume that the data being provided are correct and reliable for analytical purposes.</u>

As previously mentioned, poor weather conditions typically occur in the Mexico City area during the winter months. Therefore, MITRE analyzed RVR data for the months of January 2016 through March 2016. Note that SENEAM did not make any modifications to the January 2016 data. For February 2016 and March 2016, however, SENEAM had to modify 2.5% and 20.5% of the data, respectively.

The results of MITRE's analysis of RVR data for January 2016 through March 2016 show that weather that would require CAT II or III ILS approaches at NAICM was uncommon. More specifically, there were only two days in January when weather conditions occurred that would require CAT II ILS approaches to be conducted: 1 January and 19 January, which accounted for a total of 47 minutes. Weather conditions that would require CAT III ILS approaches did not occur during the January 2016 through March 2016 period.

Although the frequency of CAT II weather occurrence is low, the time of its occurrence and duration is an important consideration. For example, on 19 January, weather conditions requiring CAT II ILS approaches occurred for 44 minutes over a period from 6:22 am until 7:46 am (local time). The 44 minutes of low visibility occurred sporadically during this time period. In an actual operational environment, the airport would have most likely needed to conduct CAT II ILS approaches during the entire period, and perhaps longer. Therefore, without at least CAT II ILS approach capability the airport would have likely been closed for well over 1 hour during an important operational time for the airport (e.g., morning arrival and departure peaks).

At a large, high-volume international commercial airport such as NAICM, the closure of the airport to arrivals for even a short amount of time would cause major operational disruptions. For example, when conducting balanced triple independent operations (i.e., 50% arrivals and 50% departures), NAICM has the capability to accommodate approximately 70 arrivals per hour. Even though this arrival rate may be less during CAT II or III weather conditions, not having CAT II/III ILS approach capabilities could result in a significant number of aircraft being delayed, which would cause further delays throughout the entire NAICM-related aviation system. **Furthermore, MITRE has been unofficially informed that only one runway is being planned for CAT II/III ILS approaches at NAICM. Therefore, during poor weather conditions the airport would be limited to only one stream of arrivals. As a result, a large number of arrivals would be delayed. This is a major concern.**

MITRE's RVR-related results are based on only three months of weather data. Additional RVR data should be analyzed, especially considering the upcoming winter period, in order to obtain more robust results. Therefore, MITRE will continue to analyze RVR data as it is received and provide another update of low visibility occurrences in early 2017. At that time, Mexican aviation authorities will be better informed to make a decision on the need for CAT II/III ILS approach procedures, as well as how many runways should be equipped with CAT II/III ILS approach capabilities. For example, the above-mentioned RVR analysis could indicate that poor weather conditions requiring CAT II and/or III ILS approaches occurs more frequently during key operational time periods and, as a result, additional CAT II/III ILS approach runways may be needed. It is essential that the RVR electrical supply to the RVR this winter is robust and the system receives, unlike occurrences in 2015, immediate maintenance as needed.

Closing Remarks

Please review MITRE's comments, above, on ILS specifications in the acquisition document. Some of the specifications are fine, other exceed requirements. There are also some omissions. All comments are limited to specifications within MITRE's field of knowledge.

Once the new CAT III ILS equipment arrives, Mexican aviation authorities should conduct pre-commissioning flight inspection activities and other testing of the ILS equipment as soon as possible at the NAICM greenfield site to determine with the greatest possible confidence if the ILS equipment can meet operational signal reception

requirements and to examine other technical matters for CAT I, II, and III ILS procedures. **The runways to be selected for testing should be coordinated well in advance with MITRE.**

It is important to mention that the flight inspection activities and other testing at this stage are only intended to identify potential issues or limitations with ILS equipment signals with respect to operational requirements. Final flight inspection activities and other testing will be required later, once all the runways and airport buildings are constructed and ILS equipment has been permanently installed.

If the results of the above-mentioned flight inspection activities and other testing show that the ILS equipment can meet operational signal reception requirements and other technical matters, then SENEAM can purchase additional sets of ILS equipment at the appropriate time for installation on all other runway ends (**a total of six ILS systems**). Also, the need to purchase CAT II/III ILS systems can be revisited beforehand after additional NAICM RVR data obtained during the upcoming winter months has been analyzed by the spring of 2017.

The ILS equipment provider should be involved early on and at all appropriate stages of the airport planning and development process so that studies, testing and flight inspection activities can be conducted regarding planned facilities and other airport components. As a result, problems that could affect ILS equipment siting and signal reception can be addressed and resolved early on.

Please do not hesitate to contact me if you need any additional assistance.

Sincerely,

Ing. Robert W. Kleinhans
Project Technical Coordinator

cc:
Dr. Bernardo Lisker