Enclosure 2

(Ref. Technical Letter F500-L16-013)

MITRE

Center for Advanced
Aviation System Development

Cancún Airport

Feasibility of Independent Category I Instrument Landing System Approach Procedures

Prepared for

Aeropuertos y Servicios Auxiliares

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Principal Acronyms and Abbreviations

AAO	Adverse Assumption Obstacle
AIP	Aeronautical Information Publication
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
CAT	Category
DA	Decision Altitude
DH	Decision Height
DME	Distance Measuring Equipment
FAA	Federal Aviation Administration
ft	Feet
GIS	Geographic Information System
GQS	Glidepath Qualification Surface
HITL	Human-in-the-Loop
ICAO	International Civil Aviation Organization
IF	Intermediate Fix
ILS	Instrument Landing System
L/R	Left/Right
MAP	Missed Approach Point
MSL	Mean Sea Level
NAICM	Nuevo Aeropuerto Internacional de la Ciudad de México
NAVAIDs	Navigational Aids
NM	Nautical Mile
PANS-OPS	Procedures for Air Navigation Services – Aircraft Operations
PAOA	Parallel Approach Obstruction Assessment
PAOAS	Parallel Approach Obstruction Assessment Surface
PFAF	Precise Final Approach Fix
RVR	Runway Visual Range
SENEAM	Servicios a la Navegación en el Espacio Aéreo Mexicano

sm	Statute Mile
SOPs	Standard Operating Procedures
SRTM	Shuttle Radar Topography Mission
TERPS	Standards for Terminal Instrument Procedures
U.S.	United States
VDP	Visual Descent Point
WGS84	World Geodetic System 1984

1. Introduction

The MITRE Corporation (hereinafter referred to as MITRE) is assisting Aeropuertos y Servicios Auxiliares (ASA) and the aviation authorities of Mexico to turn into reality the construction of a new airport for Mexico City, hereinafter referred to as the Nuevo Aeropuerto Internacional de la Ciudad de México (NAICM). NAICM will have the capability to conduct independent triple approaches and triple departures, a specialized and complex operation that airports outside the U.S. do not currently conduct. These types of specialized operations have a number of Air Traffic Control (ATC) equipment and procedural requirements that must be met to accomplish them successfully and safely. Other important ATC matters, such as the design of the airspace, controller positions, and training must be considered as well.

At Cancún Airport (hereinafter referred to as Cancún), Servicios a la Navegación en el Espacio Aéreo Mexicano (SENEAM), with the assistance of MITRE, is planning to establish dual independent approach and departure test-bed operations to/from the existing parallel runways, which are appropriately spaced apart by 1420 m. Refer to Enclosure 5 of MITRE Technical Letter (F500-L15-021): *Independent Approaches to Two Runways at Cancún—Preliminary Runway Spacing Analysis and Air Traffic Control-Related Equipment Requirements (REVISED)*, dated 24 June 2015 for additional information.

Conducting independent test-bed operations at Cancún is critical. The experience gained will provide Mexican air traffic controllers and others with a more in-depth understanding and appreciation of the unique issues associated with transitioning to and conducting independent operations. This experience and knowledge can be leveraged into developing techniques, policies and procedures, which can later be applied at NAICM. Conducting independent test-bed operations at Cancún also provides a training opportunity for air traffic controllers on the handling and management of independent operations. As a result, the overall implementation of dual- and triple-independent operations at NAICM will be smoother with much less chance of experiencing problems that can impact the opening of NAICM.

To establish dual independent test-bed operations at Cancún, SENEAM needs to redesign the airspace, instrument procedures and develop appropriate processes to support those operations. Therefore, MITRE's instrument procedure design experts have developed preliminary, Category (CAT) I Instrument Landing System (ILS) approaches to support dual independent operations at Cancún for Runways 12L/R and Runways 30L/R. MITRE will develop preliminary dual independent departure procedures later in the project once the Cancún airspace redesign work reaches the appropriate stage. In support of test-bed operations, the instrument procedures designed by MITRE, which are preliminary in nature, will also support upcoming Human-in-the-Loop (HITL) simulations. All instrument procedures require validation by SENEAM.

Section 2 of this document provides background information on dual independent approaches. Section 3 discusses MITRE's overall instrument procedure development methodology. Section 4 provides an overview of the dual independent operational concept for Cancún. Section 5 provides the results of the preliminary design of CAT I ILS approach procedures that will be required for dual independent test-bed operations. Finally, Section 6 presents a summary of MITRE findings.

2. Background

Cancún is a major coastal airport with two parallel runways that are typically used to conduct segregated operations (i.e., arrivals to one runway and departures from the other runway). Both Runways 12L and 12R have published ILS approach procedures. However, neither Runway 30L nor Runway 30R has a published ILS approach procedure or any other type of approach with vertical guidance.

As previously mentioned, the parallel runways at Cancún are sufficiently spaced to permit dual independent approach operations. MITRE's scope of work includes the development of preliminary CAT I ILS approach procedures, in both directions, to support dual independent approach test-bed operations. Therefore, MITRE examined the feasibility of CAT I ILS approach procedures to Runways 12L/R and Runways 30L/R. However, it is important to mention that Mexican aviation authorities may decide to conduct dual independent approach test-bed operations to Runways 12L/R only. MITRE developed appropriate CAT I ILS approach procedures to Runways 30L/R in the event that dual independent approach test-bed operations are conducted to those runways in the future.

MITRE will also examine preliminary instrument departure procedures, in both directions, to support dual independent departure test-bed operations. This work will be conducted once the departure routes are better defined through more detailed airspace design work that is currently underway.

3. Methodology and Other Key Considerations

The following subsections provide general information on MITRE's instrument procedure development practices, obstacle databases, assumptions, and other important considerations pertaining to the development of the instrument approach procedures described in this document.

3.1. Methodology

The first step in the development and examination of any instrument procedure is the collection of relevant data. Once all appropriate information has been gathered, it is consolidated into a Master Basemap drawing within a computer aided design program (MITRE uses AutoCAD). A comprehensive peer review of the Master Basemap and other associated drawings is then accomplished. A well-structured drawing layer management system and naming convention is very important as it helps ensure consistency among drawings so that all specialists are using the same information.

A separate Master Procedures drawing, which references the Master Basemap and other appropriate drawings, is then used to formulate, test, and analyze various instrument procedure design options in order to determine feasibility. After the instrument procedures have been developed, a thorough peer review is conducted for accuracy and completeness.

A large multi-disciplinary team of MITRE experts participated in the development of the Master Basemap and Master Procedures drawings to support instrument procedure design work for Cancún. The most current or available aeronautical information and terrain data provided to MITRE have been entered. This included man-made obstacle information that was provided to MITRE by SENEAM, as this work did not include specialized surveys.

In accordance with MITRE's contract, all Cancún approach procedures were developed by MITRE in accordance with United States (U.S.) Standards for Terminal Instrument Procedures (TERPS). Additionally, U.S. ATC criteria and standards (e.g., turn-on-to-final altitude and communications transfer requirements) required to support dual independent approaches were also applied.

Mexico is in the process of moving towards using International Civil Aviation Organization (ICAO) Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) criteria for the development of instrument procedures. While both TERPS and PANS-OPS allow for the safe development of instrument procedures, there are differences in design and mitigation procedures should any surfaces associated with an ILS approach and/or related surface (e.g., visual surface) be penetrated. Therefore, Mexican aviation authorities should carefully consider the findings of this report, determine their relevance and significance, and take whatever actions necessary to comply with the criteria standard being applied today at Cancún.

Unless noted otherwise, all radials, bearings, and headings are shown in true north, altitudes are shown in feet (ft) relative to Mean Sea Level (MSL), coordinates are in World Geodetic System 1984 (WGS84), distances are in Nautical Miles (NM), and visibilities are in Statute Miles (sm). All ILS approach procedures utilized a glideslope angle of 3°.

3.2. Software Tools

MITRE uses a variety of software applications and other tools when designing instrument procedures, such as AutoCAD, PDToolKit, and the MITRE-developed Terminal Area Route Generation, Evaluation, and Traffic Simulation software.

PDToolKit is MITRE's primary instrument procedure design software to develop and evaluate conventional instrument procedures and conduct obstacle assessments. It makes use of AutoCAD's three-dimensional drawing capabilities and other functionality.

Other tools include:

- MSP GEOTRANS 3.4, a geographic translator available from the U.S. National Geospatial-Intelligence Agency Mensuration Service Program, which is used to convert geographic coordinates among a wide variety of coordinate systems, map projections, and datums.

- Global Mapper, a Geographic Information System (GIS) program that makes use of vector, raster, and elevation data, and provides viewing, conversion, and other general GIS features.

3.3. Data

The results of any instrument procedure design are dependent on the currency, accuracy, and completeness of data used to develop the instrument procedure. The following provides an overview of the data used by MITRE:

- **Mexico Aeronautical Information Publication (AIP)**: Mexico's AIP provides information on runway dimensions, Navigational Aids (NAVAIDs), the airway structure, Special Use Airspace, instrument procedures, etc. The AIP is MITRE's primary source of aeronautical data.

- **Federal Aviation Administration (FAA) GIS Data for Cancún Airport**: SENEAM had difficulty in obtaining information on man-made obstacles surrounding Cancún. Fortunately, they did provide obstacle data that were previously provided to them by the U.S. FAA. However, no information on the methodology used to collect the obstacle data or when the data was collected was provided to MITRE. Furthermore, MITRE did not receive information on accuracies associated with the data. Therefore, the obstacle data were used "as is." Nevertheless, MITRE feels that the data is useful for the level of preliminary procedure design work being conducted for Cancún to support upcoming HITL simulations, especially since the obstacle environment surrounding Cancún is not a significant problem.

  It is important to mention that the FAA obstacle data indicates that the elevation of Cancún's Air Traffic Control Tower (ATCT) is 105.64 m. MITRE assumed this elevation includes the top-height of any structures located on top of the ATCT itself. MITRE was informed by SENEAM, however, that the elevation of the ATCT is 102 m. For conservative planning purposes, MITRE used the higher ATCT elevation (i.e., 105.64 m). MITRE recommends that the MSL elevation of the ATCT be validated as the difference between the 105.64 m elevation MITRE used and the 102 m elevation provided by SENEAM could affect instrument procedure minima.

  Finally, MITRE recommends that a detailed obstacle survey be conducted along with appropriate flight inspection activities at the appropriate time (i.e., before test-bed operations commence) to ensure that unknown obstacles are not a problem for future procedures and/or airspace designs.

- **Shuttle Radar Topography Mission (SRTM) Data**: SRTM is MITRE's primary source of digital terrain data. The SRTM horizontal and vertical datums are WGS84 and Earth Gravitational Model 96 respectively. SRTM can be represented a number of ways for analytical and presentation purposes. It is important to note that SRTM terrain postings are based on a fixed grid system and, therefore, a higher elevation between postings may not be accounted for.

Where appropriate, MITRE used post-processed 3-arc second (~ 90 m postings) SRTM data from the Consortium for Spatial Information of the Consultative Group for International Agricultural Research. This post-processed SRTM data has been subjected to a number of steps to provide a seamless and complete digital elevation model of the world. MITRE applied a 16 m vertical accuracy adjustment to any SRTM terrain identified as a segment controlling obstacle.

In addition, MITRE added an Adverse Assumption Obstacle (AAO) of 200 ft to controlling segment terrain in areas where the FAA obstacle data did not extend. This was accomplished to account for any unidentified obstacles.

- **Electronic Airport Layout Plan**: MITRE received a rendering of the airport layout plan in AutoCAD (Plano Cancún proyectado.dwg) from SENEAM through Grupo Aeroportuario del Sureste, S.A.B. de C.V. The information within the AutoCAD drawing needed to be slightly modified to reconcile data discrepancies and geo-referencing issues.

3.4. Assumptions

To determine the feasibility of the instrument approach procedures, certain assumptions regarding important aeronautical factors were made:

- Radio, radar, and NAVAID coverage was assumed to be adequate to support the proposed instrument approach procedures.
- Air traffic controllers would use radar vectors as the primary means of navigation to the final approach courses.
- All appropriate equipment for a CAT I ILS (e.g., localizer, glideslope, approach lighting system) will be installed as necessary and meet operational requirements. Equipment and instrument approach procedures will be flight-inspected and certified for use.

  As previously mentioned, Mexican aviation authorities may decide to conduct test-bed operations in the Runway 12 direction only (i.e., using Runways 12L/R). <u>If the authorities confirm this decision, no CAT I ILS equipment is needed for Runways 30L/R.</u>
- FAA-surveyed obstacle data, provided by SENEAM, was used unless more current or verifiable data was available.
- MITRE identified penetrations to several U.S. TERPS surfaces. For example, the ATCT FAA surveyed elevation of 105.64 m penetrates the CAT I ILS missed approach surfaces to all runways. If the 102 m elevation provided by SENEAM is used, the ATCT penetrates the missed approach surfaces for all runways, except Runway 12R. It is not clear to MITRE if the Mexican authorities have approved the penetration of the ATCT to the existing ILS approach procedures. Therefore, MITRE assumed that the Mexican authorities have taken measures to allow the ATCT penetration to the missed approaches and, as a result, MITRE did not adjust the ILS approach minima, as shown in the approach profile figures in

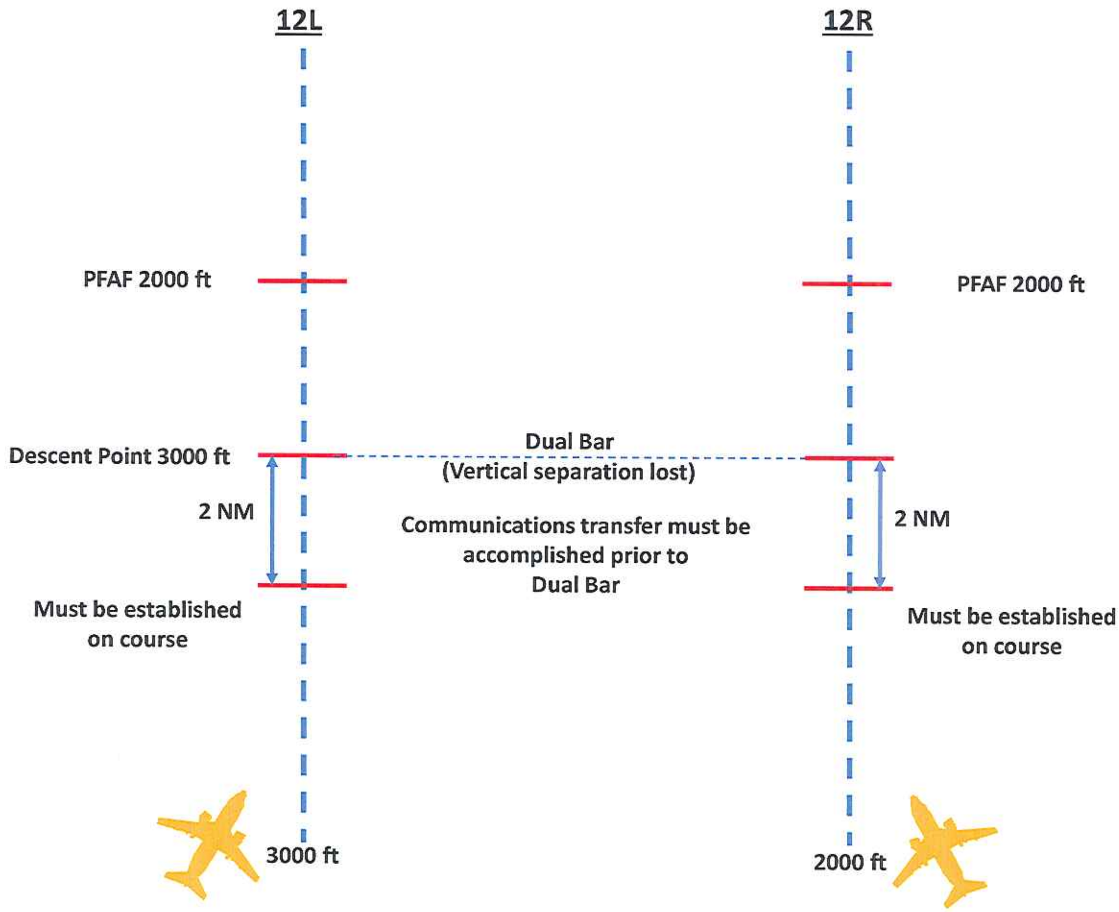
Section 5. However, Mexican authorities must confirm this assumption. In the event that minima must be adjusted for the ATCT penetration, the new minima considering the ATCT penetration are shown in Table 1.

For all other obstacle penetrations, described in Section 5, MITRE strongly recommends that SENEAM examine the penetrations identified by MITRE as soon as possible to determine their existence/validity, and take appropriate actions, as necessary. For this analysis, MITRE assumed that these obstacles were on airport property, are under the control of the airport authority, and will be removed, decreased in height, or lit as appropriate. Therefore, the approach minimums shown in Table 1 and Figures 9, 12, 15 and 18 do not reflect adjustments required to mitigate obstacle penetrations.

4. Dual Independent Operations

Dual independent operations require, at a minimum, appropriately designed arrival, approach, and departure procedures, extensive air traffic controller training, and well defined Standard Operating Procedures (SOPs). Denver International Airport outlines operating rules in their SOPs for conducting dual- as well as triple-independent operations. MITRE feels that Denver's SOPs provide an appropriate model for Cancún, and eventually NAICM. Of course, other models on how to conduct independent operations exist, but Denver's provides a straightforward, less complex environment for introducing independent operations in Mexico. Once Mexican air traffic controllers gain experience handling dual- as well as triple-independent operations, modifications to SOPs, specific to the needs of local requirements (i.e., Cancún and NAICM), may be appropriate.

A high-level overview of the concept of operations for a southeast flow at Cancún is shown in Figure 1. In a dual independent mode of operation, both aircraft will be at altitudes separated by at least 1000 ft during turn-on to final. Markings and fixes will be displayed on the controller's video map to provide points of reference when conducting independent operations. For example, a hash mark across the extended final approach course of both finals would indicate the location of the Dual Bar. The Dual Bar marks the location where vertical separation is lost between the two arrival streams. This is where the highest aircraft would begin descent. In MITRE's operational concept, all aircraft must be established on the final approach course 2 NMs prior to the Dual Bar. The 2 NM point would have a named fix with specific crossing altitudes and would provide a reference point for controllers to vector aircraft to intercept the final approach course. Transfer of communications must be accomplished prior to the Dual Bar.



PFAF = Precise Final Approach Fix

Figure 1. Southeast Dual Independent Approach Concept at Cancún

5. CAT I ILS Approach Procedures

CAT I ILS approach procedures are a mainstay in the procedure design world. They offer precision capability to low approach landing minimums. Even as the world transitions to Performance-Based Navigation, the ILS approach will continue to be a viable approach option well into the future. The following subsections discuss a number of issues related to the design of these instrument approach procedures.

5.1. Precipitous Terrain

Precipitous terrain is generally described as an area of steep or abrupt slopes, which can affect aircraft in flight, especially at lower altitudes, and should always be considered when developing instrument approach procedures. When such conditions exist, adjustments are made to increase the obstacle clearance requirements. However, the terrain surrounding Cancún is relatively flat. Therefore, no precipitous terrain adjustments were made.

5.2. Glidepath Qualification Surface (GQS)

The GQS is a trapezoidal inclined plane centered on the runway centerline, which limits the height of obstructions between the Decision Altitude (DA) and the approach end of the runway. It is applied to all precision approaches and/or approach procedures with vertical guidance. Penetrations to the GQS are not authorized except when mitigated and approved by the aviation authority. Note that ICAO does not have an equivalent surface.

The FAA considers certain obstacles as acceptable and excludes them from GQS evaluation when they have an effective height at or below an 80:1[1] surface which originates at the threshold and extends outward a distance of 1000 ft. Above-ground objects permitted by FAA airport design standards (e.g. frangible NAVAIDs) are considered acceptable obstacles and are excluded from GQS evaluation. MITRE noted that there are penetrations to the Runway 12R GQS that must be addressed.

5.3. Straight-In Visual Area

A Straight-In visual area assessment is applied to runways with approach procedures aligned with the runway centerline. There are two sloping surfaces (i.e., 20:1 and 34:1) associated with the Straight-In visual area. Required actions when either or both surfaces are penetrated are outlined below. The TERPS visual areas protect aircraft during the last stages of an approach procedure when pilots transition from instruments to visual guidance. Note that ICAO also has a visual segment surface evaluation.

The 20:1 and 34:1 Straight-In visual area surfaces have been evaluated for all four runway ends. MITRE identified penetrations to both the 20:1 and 34:1 Straight-In visual area surfaces for Runway 12R. Depending on the slope penetrated, the following actions are required:

1. Penetrations to the 34:1 Straight-In visual area:
    a. Visibility can be no lower than 4000 ft Runway Visual Range (RVR) or 3/4 sm.
2. Penetrations to the 20:1 Straight-In visual area:
    a. Lighted Obstacles: do not publish a Visual Descent Point (VDP) and limit visibility to no lower than 5000 ft RVR or 1 sm.
    b. Unlighted Obstacles: do not publish a VDP and limit visibility to no lower than 5000 ft RVR or 1 sm, and annotate the chart stating that the approach is not authorized at night.

[1] In procedure design, these surfaces are described as run over rise. For example, a 34:1 slope means that for every 34 ft of run the surface rises 1 ft.

5.4. Final Approach Surfaces

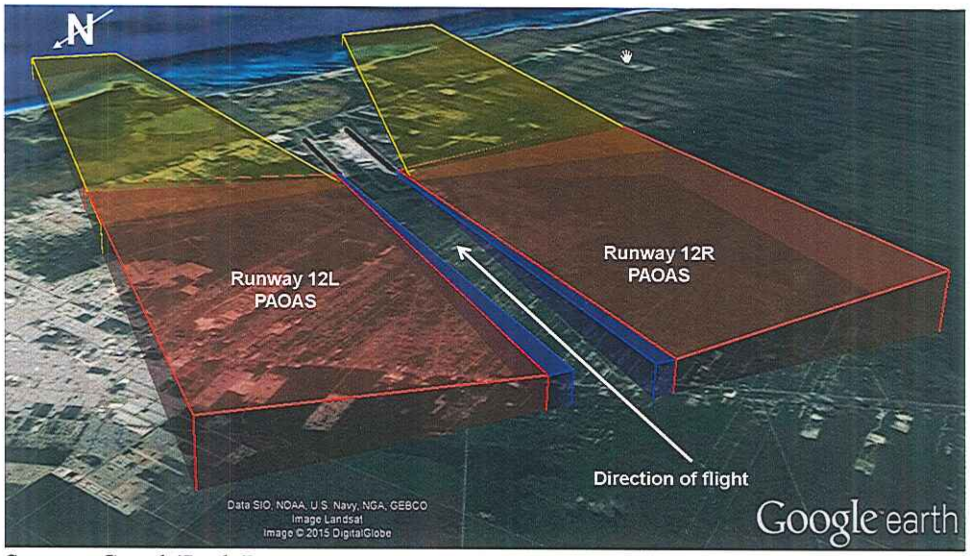
The final approach is that segment of the instrument approach in which alignment and descent for landing is made. It originates 200 ft from the landing threshold at threshold elevation and ends at the PFAF.

Lowest landing minimums are achieved when no obstacle penetrates the final approach surface. If the surface is penetrated by an existing obstacle, mitigation options include removing or lowering the obstacle, raising the glidepath angle, or displacing the landing threshold to eliminate the penetration. If the penetration cannot be eliminated, the DA must be increased appropriately.

MITRE has identified penetrations to all four CAT I ILS final segments. As previously mentioned, MITRE did not adjust the DA for any of the procedures. MITRE strongly recommends that SENEAM examine the penetrations identified by MITRE as soon as possible to determine their existence/validity, and take appropriate actions, as necessary. Figures depicting the location of the penetrating obstacle in relation to the final segment are provided farther below.

5.5. Parallel Approach Obstruction Assessment

A Parallel Approach Obstruction Assessment (PAOA) must be accomplished before independent parallel operations can be conducted. The purpose of the PAOA is to ensure an obstacle-free path is available for an aircraft on final approach to conduct an evasive maneuver (typically a command to turn and climb) should an aircraft on an adjacent final approach course blunder into its path. There were no penetrations to any of the Parallel Approach Obstruction Assessment Surfaces (PAOAS). Figure 2 shows the PAOAS for Runways 12L/R.



Source: GoogleEarth Pro

Figure 2. PAOAS for Runways 12L/12R

5.6. Missed Approach Surfaces

The missed approach segment is composed of two primary sections. Section 1 starts at the DA, extends for a distance of 9860 ft, and is composed of a series of sloping surfaces. Section 2 extends from the end of Section 1 to the clearance limit. It has a primary surface that rises at 40:1. The mitigating action for penetrations varies depending on the surface penetrated.

The Cancún ATCT is the most prominent obstacle on airport property. It is situated such that it penetrates all four ILS Section 1b missed approach surfaces (based on an elevation of 105.64 m, as per the FAA obstacle data provided to MITRE through SENEAM).

A similar situation exists at the Seattle-Tacoma International Airport in Seattle, in the state of Washington. A risk analysis of their ILS CAT I/II/III procedures determined that slower climbing aircraft were considered to be at a higher risk of getting in close proximity to the ATCT. Therefore, CAT A[2] aircraft operations were restricted by either not allowing them to fly the instrument approach or to fly the approach procedure, but to a higher DA in order to clear the ATCT. Category B, C, or D aircraft were allowed to operate to a DA of 200 ft or lower as appropriate. Note that this is just one case that MITRE is aware of, and there may be other examples and mitigation measures to consider. Nevertheless, MITRE recommends that SENEAM examine this matter as soon as possible and take appropriate actions, as necessary.

Figures depicting the location of the ATCT in relation to the missed approach segment are provided farther below.

Table 1 shows what the DA/Decision Height (DH)[3] and visibility would be if the ATCT were considered as a non-waivered penetration using both the ATCT height of 105.64 m and 102 m.

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[2] Aircraft categories are generally a function of weight and speed. Approach CAT A aircraft are those with an approach speed of 91 knots or less.

[3] Decision Height, is the height, specified in MSL, above the highest runway elevation in the touchdown zone at which a missed approach must be initiated if the required visual reference has not been established.

Table 1. Impact of ATCT Penetration to Missed Approaches on CAT I ILS Procedures

Runway	ATCT Height (m)	Surface Penetration (ft)	Adjusted DA/DH	Visibility
12L	105.64	43	257/235	RVR 2400 / ½ sm
12R	105.64	6	225/205	RVR 2400 / ½ sm
30L	105.64	63	271/252	RVR 2400 / ½ sm
30R	105.64	64	270/252	RVR 2400 / ½ sm
12L	102	31	246/225	RVR 2400 / ½ sm
12R	102	0	N/A	N/A
30L	102	51	264/242	RVR 2400 / ½ sm
30R	102	52	260/242	RVR 2400 / ½ sm

5.7. Other Key Considerations

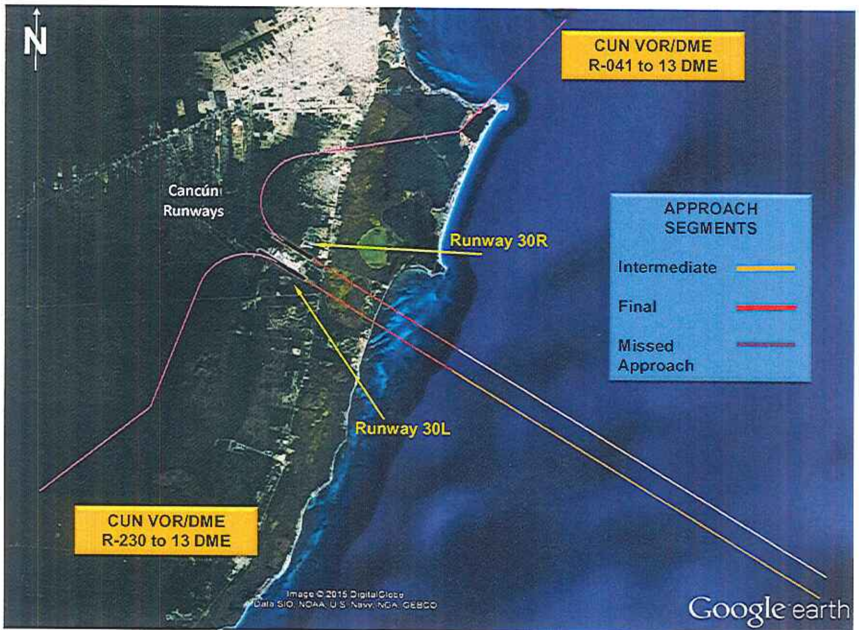
In general, instrument approach procedures are not only developed for a specific runway configuration, but also for specific modes of operation. Runway configurations intended to support dual independent approach procedures have a number of key procedure design requirements that must be considered. Although not all inclusive, the following requirements figured prominently in the design of dual independent approach procedures at Cancún.

- A key U.S. ATC requirement for dual independent approach procedures is that no two aircraft being vectored to adjacent final approach courses will be assigned the same altitude during turn-on. Aircraft will be assigned altitudes which differ by a minimum of 1000 ft (e.g., 2000 ft and 3000 ft).
- Communications transfer to the ATCT must be completed prior to losing vertical separation between aircraft.
- All missed approach courses must diverge by at least 45°.

5.8. Assessment of the CAT I ILS Approach Procedures

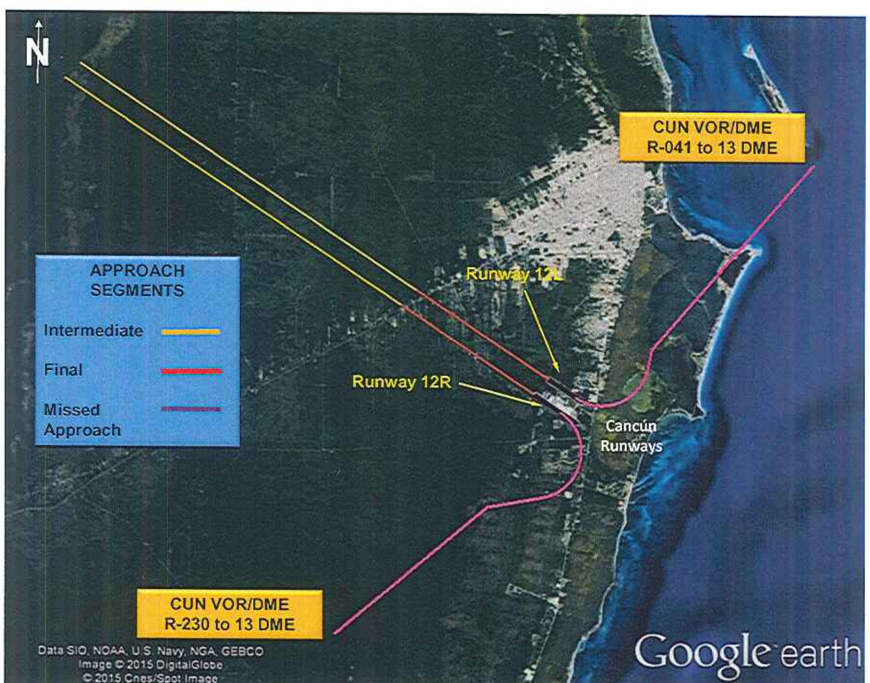
This section describes the results of MITRE's assessment of CAT I ILS approach procedures for Runways 12L/R and Runways 30L/30R. All instrument approach descriptions and profile view figures are from the Intermediate Fix (IF) to the missed approach clearance limit. Controlling obstacles are identified where appropriate and provided in the tables below. All obstacle heights reflected in the tables include the obstacle's raw height plus adjustments (e.g., for accuracy and rounding, if applicable).

Figures 3 and 4 show an overhead view of the CAT I ILS intermediate, final, and missed approach flight tracks for northwest flow (i.e., Runways 30L/R) and southeast flow (i.e., Runways 12L/R), respectively. Approach minimums depicted in Figures 9, 12, 15, and 18 are based on all obstacle penetrations being removed, decreased in height, or lit as appropriate.



Source: GoogleEarth Pro

Figure 3. CAT I ILS Intermediate, Final, and Missed Approach Nominal Flight Tracks, Northwest Flow



Source: GoogleEarth Pro

Figure 4. CAT I ILS Intermediate, Final, and Missed Approach Nominal Flight Tracks, Southeast Flow

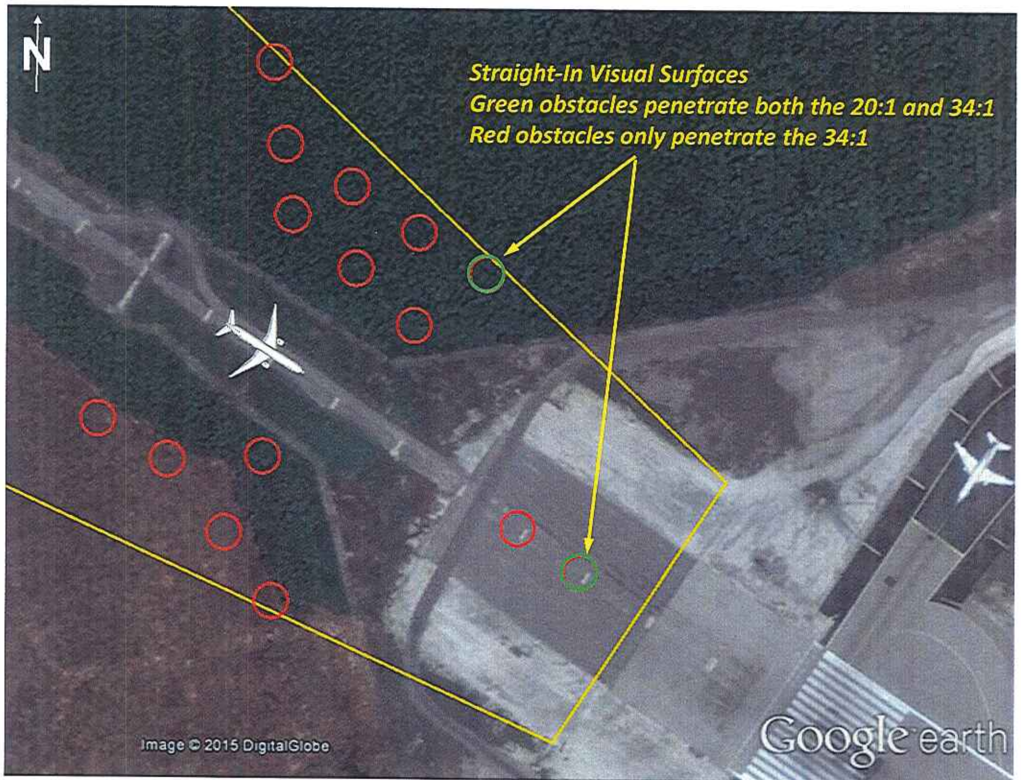
5.8.1. Runway 12R

MITRE has identified penetrations to the GQS, Straight-In visual area 20:1/34:1 slopes, final and missed approach segments for the CAT I ILS approach to Runway 12R. Figures 5 through 8 show these penetrations in relation to the surface being penetrated. While all of these penetrations warrant further investigation, the penetration of the missed approach surface by the ATCT is of particular concern. All other penetrations to the GQS, Straight-In visual surfaces and final segment appear to be on airport property and presumably can be rectified.

Source: GoogleEarth Pro

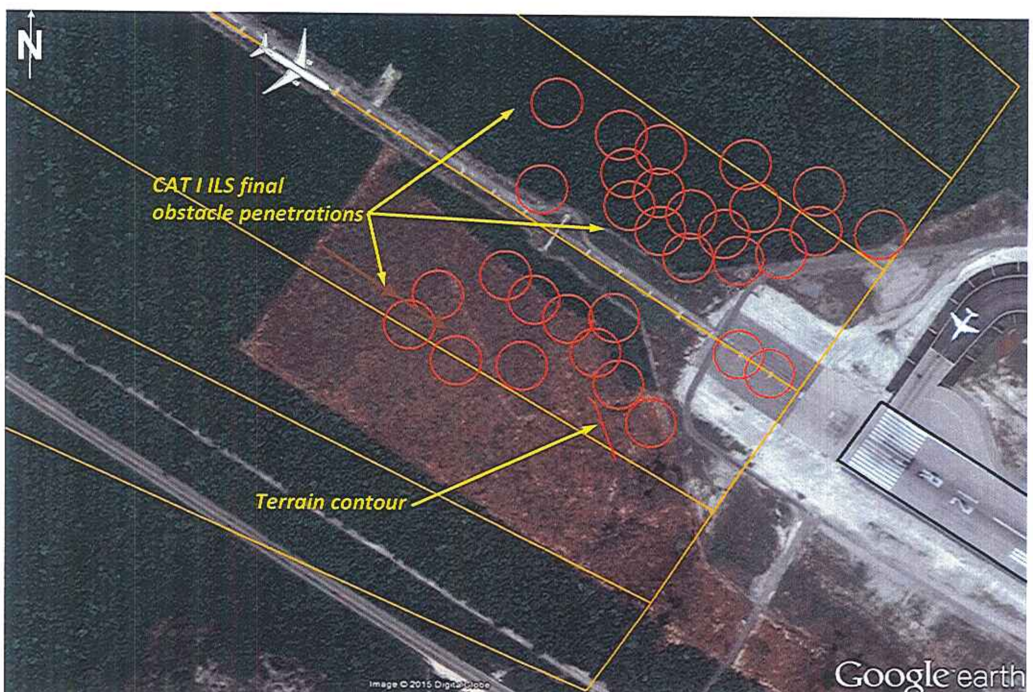
Note that the penetrations to the GQS are less than 1ft.

Figure 5. Runway 12R CAT I ILS GQS



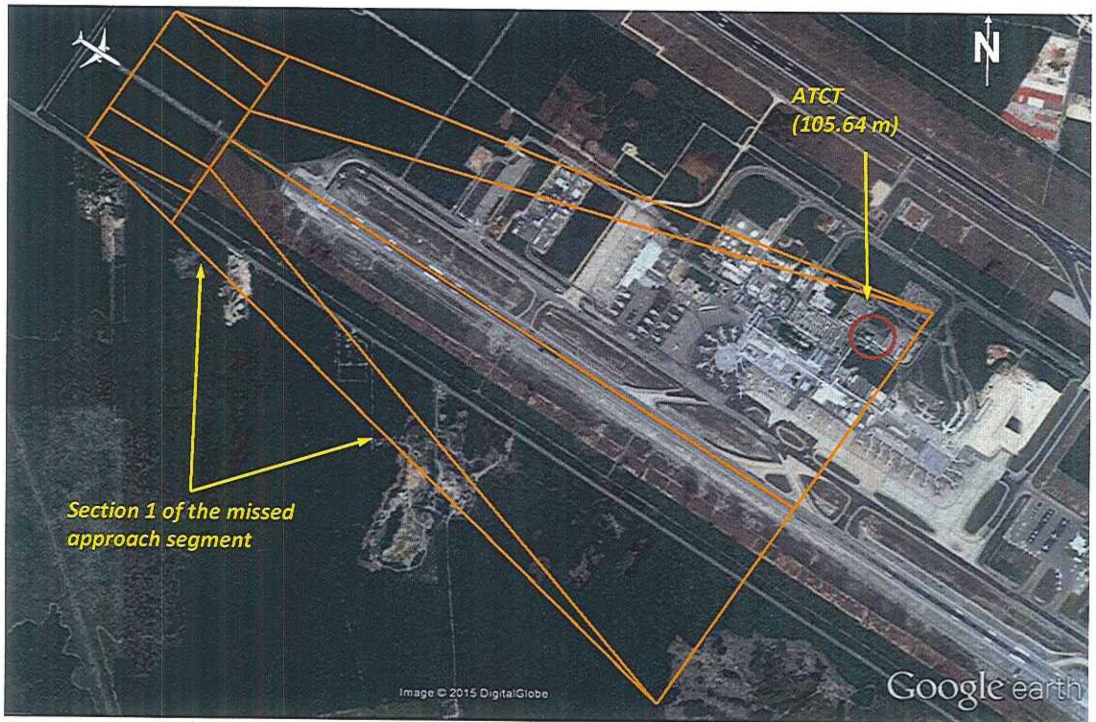
Source: GoogleEarth Pro

Figure 6. Runway 12R CAT I Straight-In Visual Areas, 20:1 and 34:1



Source: GoogleEarth Pro

Figure 7. Runway 12R CAT I ILS Final Approach



Source: GoogleEarth Pro

Figure 8. Runway 12R CAT I Missed Approach

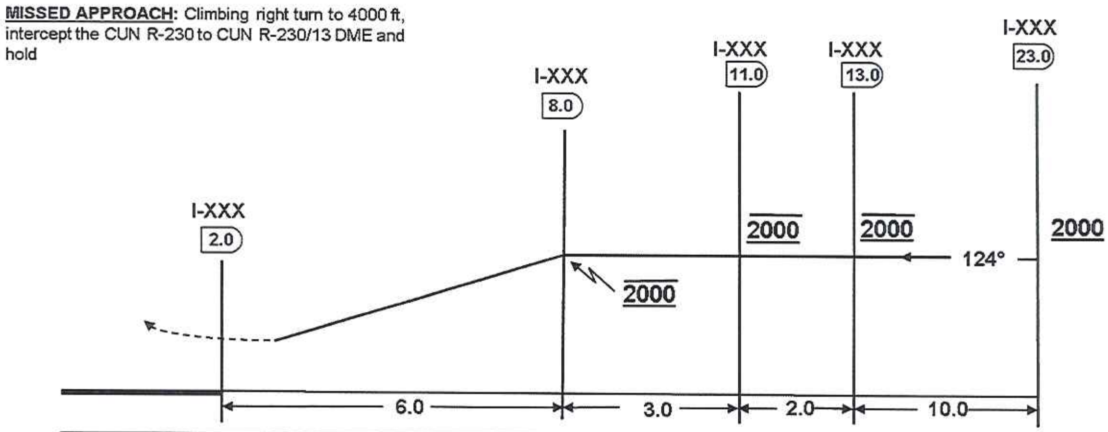
Intermediate Segment: The IF is located 23.0 DME[4] from the localizer at or above 2000 ft. The vectoring altitude for this approach is 2000 ft. Crossing restrictions at 2000 ft have been established 2 NM prior to the Dual Bar (13.0 DME) and at the Dual Bar (11.0 DME). Aircraft must be transferred to the ATCT prior to the Dual Bar.

Final Segment: The glideslope intercept altitude is 2000 ft at the PFAF, 8.0 DME from the localizer.

Missed Approach Segment: The missed approach segment commences at the Missed Approach Point (MAP). Missed approach instructions are described below in Figure 9.

The controlling obstacle for each segment are shown in Table 2.

[4] Distance Measurement Equipment (DME) are in NM



CATEGORY	A	B	C	D
S-ILS 12R	220/24 200			

Note: minimums are not adjusted to mitigate penetration of the ATCT to the missed approach surface, and any penetrations to the final, GQS and/or visual surfaces are assumed to be removed.

Figure 9. Runway 12R CAT I ILS: Profile View and Approach Minimums (Not Intended for Navigation/Publication)

Table 2. Runway 12R CAT I ILS: Segment Controlling Obstacles

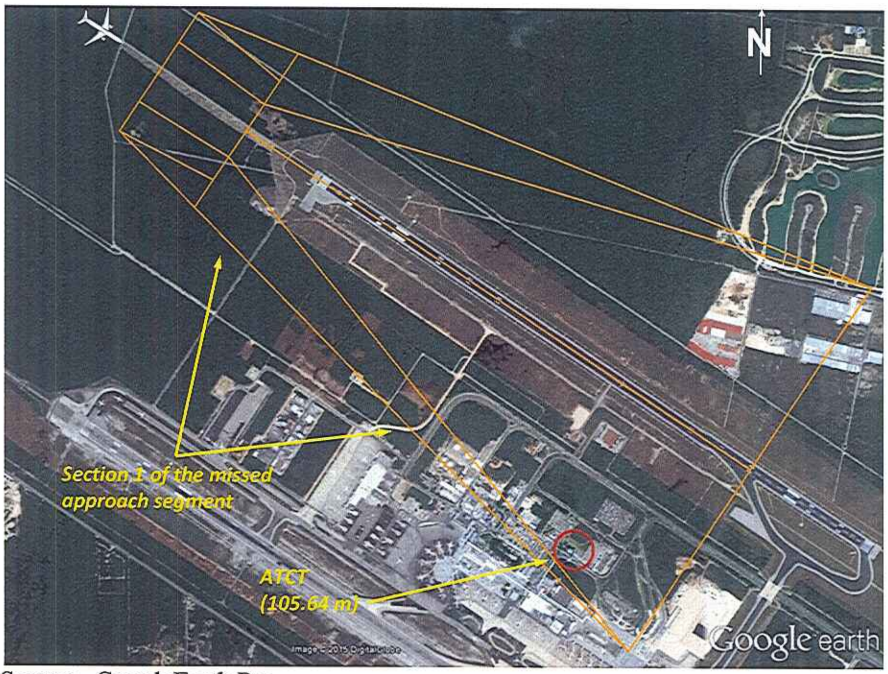
Segment	Description	Position		Elevation (ft MSL)
		Latitude	Longitude	
Intermediate	Terrain + AAO	21 11 30.87 N	87 13 31.69 W	344
Final	Clear of Obstacles			
Missed Approach	ATCT	21 2 26.38 N	86 52 15.59 W	347

5.8.2. Runway 12L

MITRE has identified penetrations to the final and missed approach segments for the CAT I ILS approach to Runway 12L. Figures 10 and 11 show these penetrations in relation to the surface being penetrated. While all these penetrations warrant further investigation, the penetration of the missed approach surface by the ATCT is of particular concern. All other penetrations to the final segment appear to be on airport property and presumably can be rectified.

Source: GoogleEarth Pro

Figure 10. Runway 12L CAT I ILS Final Approach



Source: GoogleEarth Pro

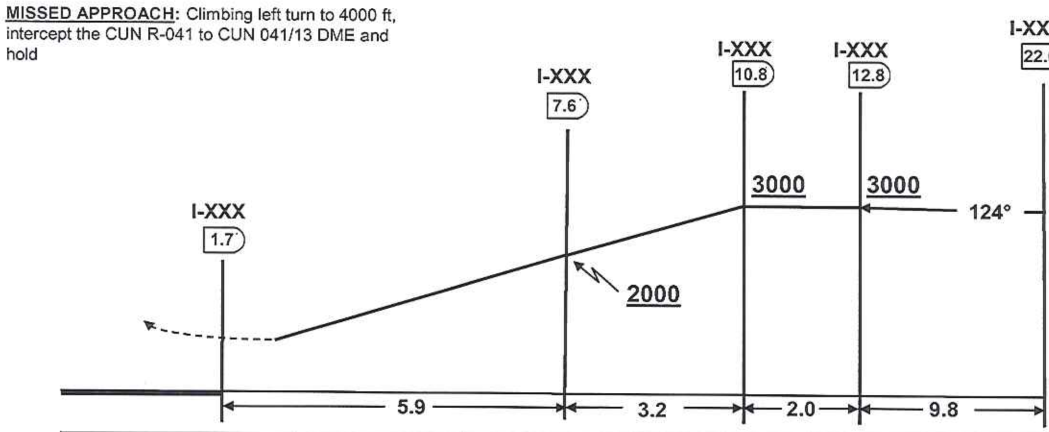
Figure 11. Runway 12L CAT I ILS Missed Approach

Intermediate Segment: The IF is located 22.6 DME from the localizer, at or above 3000 ft. The vectoring altitude for this approach is 3000 ft. Crossing restrictions at 3000 ft have been established 2 NM prior to the Dual Bar (12.8 DME) and at the Dual Bar (10.8 DME). Aircraft must be transferred to the ATCT prior to the Dual Bar.

Final Segment: The glideslope intercept altitude is 2000 ft at the PFAF, 7.6 DME from the localizer.

Missed Approach Segment: The missed approach segment commences at the MAP. Missed approach instructions are described below in Figure 12.

Segment controlling obstacles are shown in Table 3.



CATEGORY	A	B	C	D
S-ILS 12L	222/24 200			

Note: minimums are not adjusted to mitigate penetration of the ATCT to the missed approach surface, and any penetrations to the final are assumed to be removed.

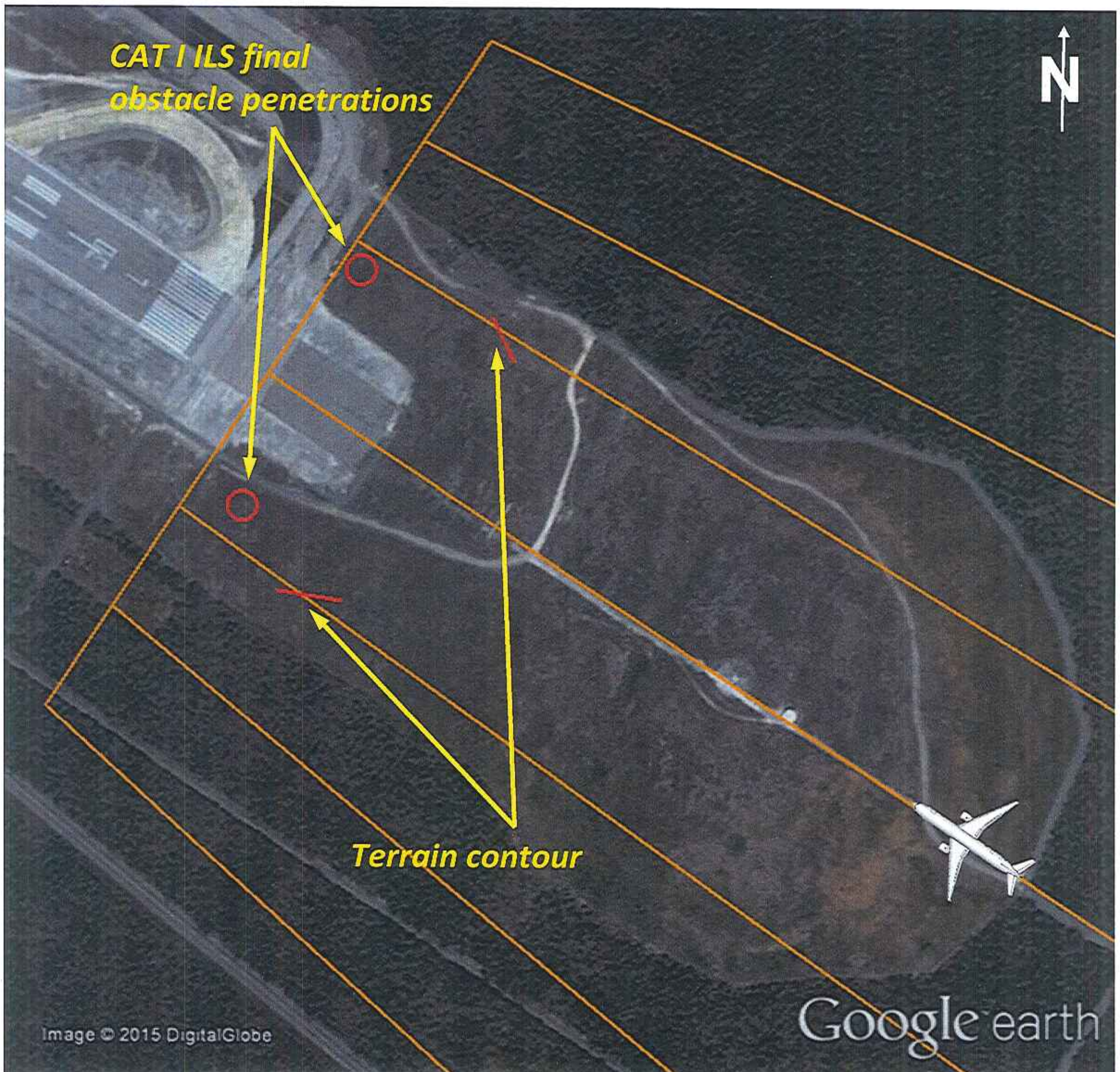
Figure 12. Runway 12L CAT I ILS: Profile View and Approach Minimums (Not Intended for Navigation/Publication)

Table 3. Runway 12L CAT I ILS: Segment Controlling Obstacles

Segment	Description	Position		Elevation (ft MSL)
		Latitude	Longitude	
Intermediate	Terrain + AAO	21 11 30.87 N	87 13 31.69 W	344
Final	Clear of Obstacles			
Missed Approach	ATCT	21 2 26.38 N	86 52 15.59 W	347

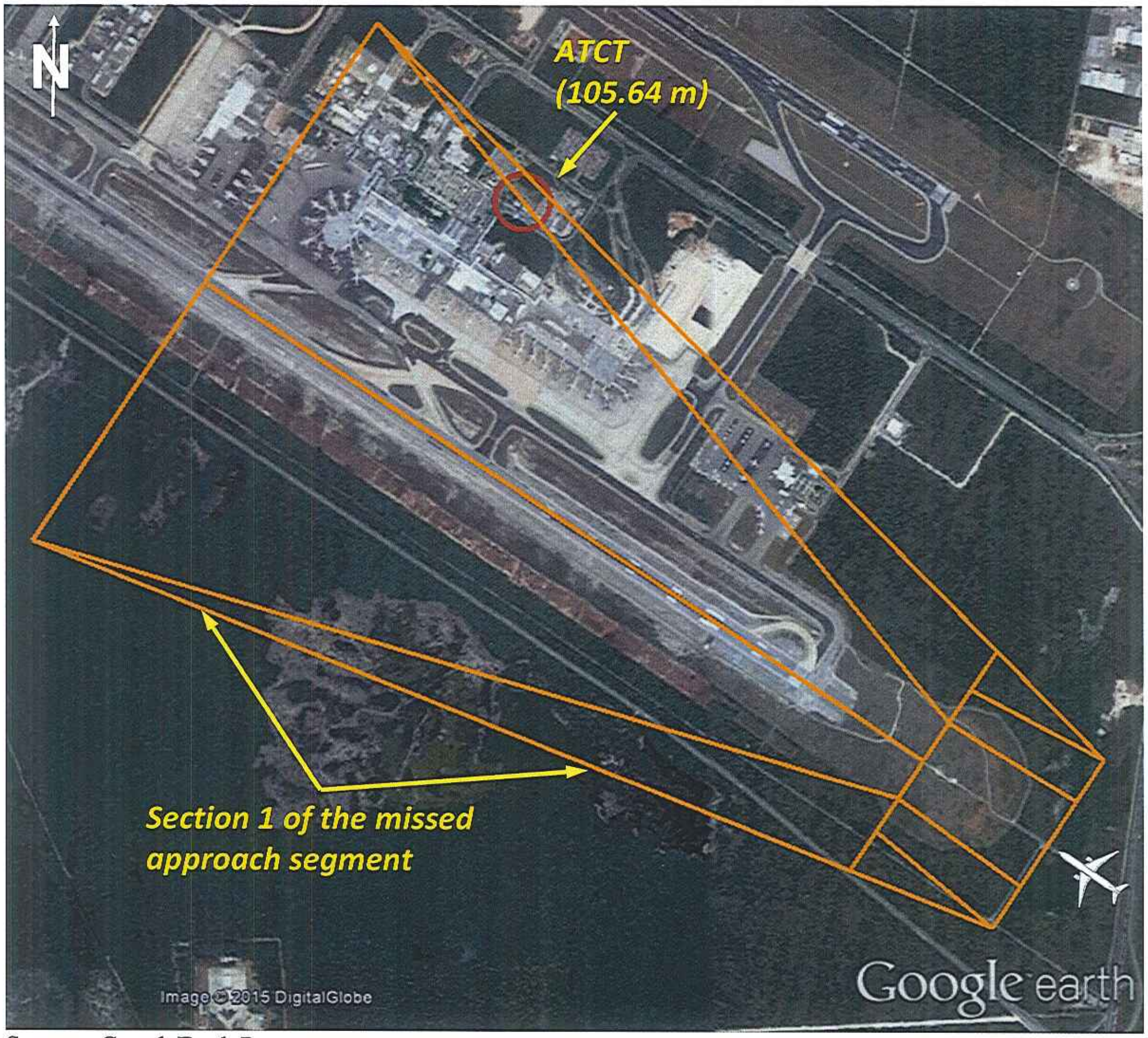
5.8.3. Runway 30L

MITRE has identified penetrations to the final and missed approach segments for the CAT I ILS approach to Runway 30L. Figures 13 and 14 show these penetrations in relation to the surface being penetrated. While all these penetrations warrant further investigation, the penetration of the missed approach surface by the ATCT is of particular concern. All other penetrations to the final segment appear to be on airport property and presumably can be rectified.



Source: GoogleEarth Pro

Figure 13. Runway 30L CAT I ILS Final Approach



Source: GoogleEarth Pro

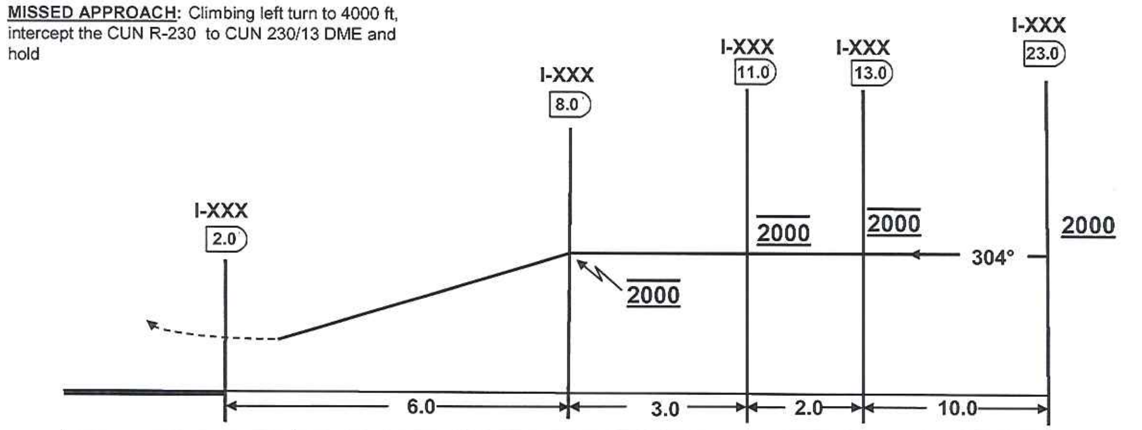
Figure 14. Runway 30L CAT I ILS Missed Approach

Intermediate Segment: The IF is located 23.0 DME from the localizer, at or above 2000 ft. The vectoring altitude for this approach is 2000 ft. Crossing restrictions at 2000 ft have been established 2 NM prior to the Dual Bar (13.0 DME) and at the Dual Bar (11.0 DME). Aircraft must be transferred to the ATCT prior to the Dual Bar.

Final Segment: The glideslope intercept altitude is 2000 ft at the PFAF, 8.0 DME from the localizer.

Missed Approach Segment: The missed approach segment commences at the MAP. Missed approach instructions are described below in Figure 15.

Segment controlling obstacles are shown in Table 4.



CATEGORY	A	B	C	D
S-ILS 30L	219/24 200			

Note: minimums are not adjusted to mitigate penetration of the ATCT to the missed approach surface, and any penetrations to the final are assumed to be removed.

Figure 15. Runway 30L CAT I ILS: Profile View and Approach Minimums (Not Intended for Navigation/Publication)

Table 4. Runway 30L CAT I ILS: Segment Controlling Obstacles

Segment	Description	Position		Elevation (ft MSL)
		Latitude	Longitude	
Intermediate	Waterway +Vessel	20 58 8.44 N	86 46 8.92 W	350
Final	Clear of Obstacles			
Missed Approach	ATCT	21 2 26.38 N	86 52 15.59 W	347

Note: A waterway is a regularly used route for ships. MITRE assumed that a 350 ft tall ship could be transitioning through the area to the southeast of Cancún under the Intermediate segment.

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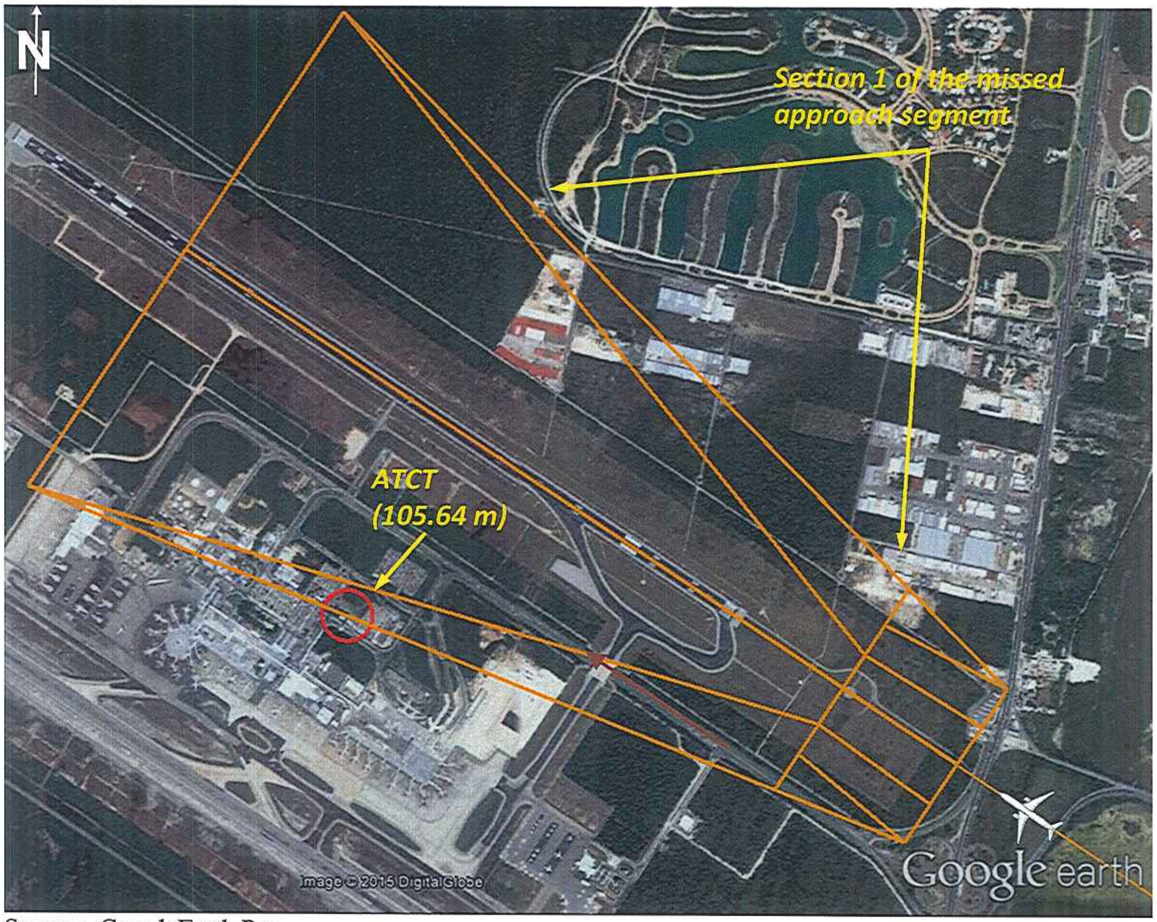
5.8.4. Runway 30R

MITRE has identified penetrations to the final and missed approach segments for the CAT I ILS approach to Runway 30R. Figures 16 and 17 show these penetrations in relation to the surface being penetrated. While all these penetrations warrant further investigation, the penetration of the missed approach surface by the ATCT is of particular concern. All other penetrations to the final segment appear to be on airport property and presumably can be rectified.

Source: GoogleEarth Pro

Figure 16. Runway 30R CAT I ILS Final Approach



Source: GoogleEarth Pro

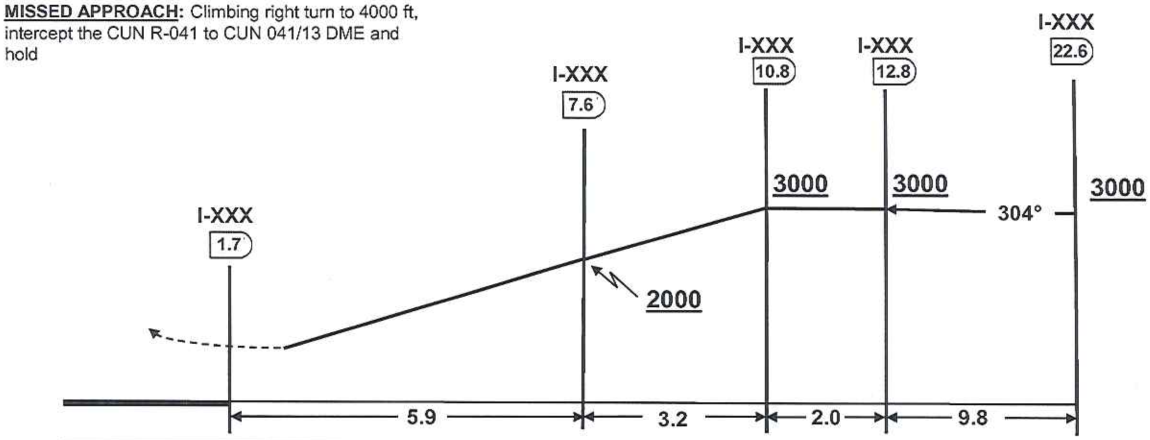
Figure 17. Runway 30R CAT I ILS Missed Approach

Intermediate Segment: The IF is located 22.6 DME from the localizer, at or above 3000 ft. The vectoring altitude for this approach is 3000 ft. Crossing restrictions at 3000 ft have been established 2 NM prior to the Dual Bar (12.8 DME) and at the Dual Bar (10.8 DME). Aircraft must be transferred to the ATCT prior to the Dual Bar.

Final Segment: The glideslope intercept altitude is 2000 ft, 7.6 DME from the localizer.

Missed Approach Segment: The missed approach segment commences at the MAP. Missed approach instructions are described below in Figure 18.

Segment controlling obstacles are shown in Table 5.



CATEGORY	A	B	C	D
S-ILS 30R	218/24 200			

Note: minimums are not adjusted to mitigate penetration of the ATCT to the missed approach surface, and any penetrations to the final are assumed to be removed.

Figure 18. Runway 30R CAT I ILS: Profile View and Approach Minimums (Not Intended for Navigation/Publication)

Table 5. Runway 30R CAT I ILS: Segment Controlling Obstacles

Segment	Description	Position		Elevation (ft MSL)
		Latitude	Longitude	
Intermediate	Waterway +Vessel	20 58 57.19 N	86 45 58.09 W	350
Final	Clear of Obstacles			
Missed Approach	ATCT	21 2 26.38 N	86 52 15.59 W	347

Note: A waterway is a regularly used route for ships. MITRE assumed that a 350 ft tall ship could be transitioning through the area to the southeast of Cancún under the Intermediate segment.

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6. Summary

MITRE examined the feasibility of dual independent CAT I ILS approaches for Runways 12L/R and Runways 30L/R at Cancún. The procedures that were developed and presented in this document are likely feasible. However, they are preliminary, in part because of the following findings:

- Runway 12R
  - Penetrations exist to the GQS
  - Penetrations exist to the Straight-In visual area surfaces (i.e., 20:1 and 34:1)
  - Penetrations exist to the final segment
  - Penetration exist to the missed approach segment (i.e., by the ATCT)
- Runways 12L, 30L and 30R
  - Penetrations exist to the final segment
  - Penetration exist to the missed approach segment (i.e., by the ATCT)

MITRE recommends that SENEAM examine the penetrations identified by MITRE to determine their existence and validity, and take appropriate actions to ensure a safe and efficient environment for aircraft operations. MITRE also requests that SENEAM inform MITRE of the results of its examination of these penetrations so that the matter can be closed or examined in more detail.

Other principal factors pertaining to the final assessment of the instrument procedures described in this document are as follows:

- The final step will be a flight inspection by the Mexican aviation authorities to ensure that undetected obstacles and other safety and operational factors do not affect procedural designs before commencing test-bed operations.
- All of MITRE's procedure design work must be validated by SENEAM, followed by approval from the Dirección General de Aeronáutica Civil.

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FAA, 2014, *Air Traffic Control*, FAA JO 7110.65V, FAA, Washington, District of Columbia, U.S.A.

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