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MITRE

Center for Advanced
Aviation System Development

Preliminary Minimum Vectoring Altitude Chart (MVAC) for NAICM/Toluca

Development Guidelines

Delivered to

Servicios a la Navegación en el Espacio Aéreo Mexicano

February 2016

1.0 Introduction

This document presents guidelines that MITRE developed for use by Mexican aviation authorities in the development of new Minimum Vectoring Altitude Charts (MVACs). The document also describes MITRE's work regarding the development of a future MVAC to support Nuevo Aeropuerto Internacional de la Ciudad de México (NAICM) and an expanded Toluca Airport.

2.0 Background

Every Air Traffic Control (ATC) facility that provides radar vectoring services has an MVAC. The MVAC depicts the lowest altitude (i.e., above a predetermined minimum obstacle clearance requirement) within a given area or sector at which air traffic controllers can radar vector aircraft. Procedure designers need to consider the sector altitudes when developing instrument procedures so as to harmonize the transition from radar vectoring an aircraft to establishing that aircraft onto an instrument procedure (e.g., an Instrument Landing System [ILS] approach).

During the initial stages of MITRE's NAICM-related procedure design work, it became apparent that the existing Mexico City Terminal Maneuvering Area (TMA) MVAC would not adequately support the anticipated future instrument procedures at NAICM combined with an expanded Toluca Airport.

As a result, MITRE began working on the development of guidelines that could support the development of MVACs throughout Mexico. The guidelines are based on criteria used by the United States (U.S.) Federal Aviation Administration (FAA), but include modifications based on the needs and requirements of Servicios a la Navegación en el Espacio Aéreo Mexicano (SENEAM).

These guidelines served as the basis for the development of an MVAC for the future Mexico City TMA (i.e., primarily to support NAICM and Toluca). SENEAM personnel were involved throughout the entire MVAC study process. Their participation was essential and very productive. As a result, SENEAM accepted the MVAC design guidelines, as well as the overall design of the NAICM/Toluca MVAC.

The MVAC guidelines are intended to provide a basic framework for the development of MVACs in Mexico. It is important to mention that each and every airport presents its own unique challenges that can affect the way an MVAC is designed. Additionally, new technologies are being introduced which may necessitate changes in criteria subsequently affecting how MVACs are designed in the future. Therefore, the MVAC guidelines contained in this document should be reviewed and updated as appropriate.

3.0 Overall Considerations

This part discusses key considerations used by MITRE in the development of the MVAC guidelines, as well as the design of the NAICM/Toluca MVAC. More specific technical considerations regarding the actual design of the NAICM/Toluca MVAC are described in their respective parts later in this section.

Obstacle Data

MVACs allow air traffic controllers to vector aircraft at altitudes that ensure clearance from obstructions and, as in the case of Mexico, at altitudes that ensure radar and radio coverage and reception. The altitudes depicted on the charts ensure obstacle clearance based on avialable databases of terrain, man-made, and natural objects. Therefore, it is essential that the MVAC designers have the most up-to-date obstacle information.

For the development of the NAICM/Toluca MVAC, MITRE utilized satellite-based survey data of the areas surrounding the new NAICM airport site. Generally speaking, the surveys provided various types/levels of data encompassing an area of 45 km around the above-mentioned areas. An existing, older photogrammetric survey of Toluca Airport and its immediate surroundings was also used. Although not current, the Toluca survey still provided useful information. Other supporting obstacle data from other sources were utilized as well. MITRE also utilized Shuttle Radar Topography Mission (SRTM) terrain data as well as topographic maps (i.e., spot elevations).

The existing Mexico City TMA make use of multiple Airport Surveillance Radar (ASR) sites (i.e., multi-sensors) to present aircraft information for use by air traffic controllers. The type of radar configuration being used (i.e., single-sensor or multi-sensor) determines the amount of obstacle buffer to apply when calculating the Minimum Vectoring Altitude (MVA) of a sector. For a single-sensor configuration, the Obstacle Evaluation Area (OEA) buffer expands outward at least 3 NM from those portions of the boundary within 40 NM of the radar antenna and at least 5 NM outward from those portions of the boundary equal to or greater than 40 NM from the radar antenna.

In a multi-sensor configuration, the OEA buffer is 5 NM regardles of distance. For the NAICM/Toluca case, this became a significant issue due to high terrain in critical areas that created high MVA sector altitudes. In order to achieve compatability with instrument approach procedures it was imperative that sector altitudes, needed to support vectoring to instument approch procedures, be as low as possible.

Therefore, on the basis of discussions with SENEAM, the NAICM/Toluca MVAC was based on a single-sensor radar configuration from a future ASR to be installed at the NAICM site and the Toluca ASR.

One significant difference in MVAC criteria between the U.S. and Mexico is that in Mexico sector altitudes must ensure aircraft are within radar and radio coverage. This is important because MVAs should be established high enough to ensure that radio and radar coverage can be provided in order to safely communicate with pilots and to monitor the position of the aircraft being vectored. To support MITRE's NAICM/Toluca MVAC work, SENEAM provided information regarding radio and radar coverage for the areas being examined.

SENEAM and MITRE then jointly considered radio and radar coverage matters in its MVAC design work. For example, MITRE examined existing MVA charts and discussed coverage matters with local air traffic controllers to ensure that proposed sector altitudes would meet radar and radio coverage. It is important to note, however, that radar software configuration changes and actual flight checks will eventually be required to ensure that appropriate radio and radar coverage can be provided in a single-sensor mode ASR system configuration to support the NAICM/Toluca MVAC design. Discussions with radar software experts indicate that this concept should be achievable. This matter was discussed at length with officials from SENEAM who agreed with the assumption that the MVAC should be designed based on a single-sensor radar configuration.

Required Obstacle Clearance

Another critical issue that needed to be agreed upon was the application of 1000 ft or 2000 ft of vertical Required Obstacle Clearance (ROC). Generally, in non-mountainous areas 1000 ft of ROC is acceptable. Even in mountainous areas, where 2000 ft of ROC is the norm, it is permissible to lower the ROC to 1000 ft to achieve compatability with approach procedures. However, when procedures are designed for use in mountainous areas or when precipitous terrain conditions exist, consideration must be given to induced altimeter error and pilot control problems (e.g., caused by turbulence). Due to the challenging nature of the terrain environment in the NAICM/Toluca area this became a significant issue. Mexico, however, does not specifically define mountainous terrain areas or areas where precipitous terrain conditions exist. Therefore, MITRE coordinated with local air traffic controllers from the Mexico City ATC facility who were thoroughly familiar with the operational environment at each airport to reach a consensus on which sectors for each chart required the application of 1000 ft or 2000 ft of ROC.

4.0 MVAC Guidelines for Mexico

This part describes the MVAC guidelines created by MITRE in close coordination with SENEAM experts. The guidelines were prepared in a report-type format to assist Mexican aeronautical officials in structuring and developing a more formal internal document. In that context, the guidelines have their own Table of Contents and numbering system (different from the numbering convention used in the rest of this report). Of course, Mexican authorities may wish to utilize their own internal document format and structure.

It is important to mention that the guidelines described below are not intended to be used immediately and officially to design MVACs throughout Mexico. These guidelines are primarily intended to be used by the aviation authorities of Mexico as the basis to create an official, Dirección General de Aeronáutica Civil (DGAC)-approved MVAC development document. MITRE strongly advises caution and a deep review, before final approval is given.

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SECTION 1

Introduction

1.0. Purpose of these Guidelines

The purpose of these guidelines is to establish a set of standards which can be used for the development of MVACs.

1.1 Reference Documents

The majority of the information used for the development of these guidelines came from United States (U.S.) Federal Aviation Administration (FAA) and International Civil Aviation Organization (ICAO) documents:

a. FAA Order (FAAO) 8260.3B (*United States Standards for Terminal Instrument Procedures* [*TERPS*])

b. Notice Joint Order (JO) 7210.725 (*Minimum Vectoring Altitude Charts*)

c. JO 7210.37 (*Enroute Minimum Instrument Flight Rules (IFR) Altitude Sector Charts*)

d. FAAO 8260.19 (*Flight Procedures and Airspace*)

e. International Civil Aviation Organization (ICAO) Document 8168 Volume 1 (*Flight Procedures)*

f. ICAO Document 8168 Volume 2 (*Construction of Visual and Instrument Flight Procedures)*

SECTION 2

General Information

2.0 **Surveillance Radar** is a system that displays direction and distance information with suitable accuracy, continuity, and integrity to safely provide air traffic control services.

2.1 **Single-Sensor** describes an environment which is based on the input of a single radar site and includes single-sensor long-range radar mode. The chart may apply to the entire radar display or within a defined area on the radar display.

2.2 **Multi-Sensor** describes an environment which is based on the input of multiple radar sites (e.g., Mosaic Mode, multi-sensor).

2.3 **Monopulse Secondary Surveillance Radar (MSSR)** is an improved version of the traditional Secondary Surveillance Radar (SSR). Specifically, the SSR antenna was modified to a Large Vertical Aperture (LVA) type where a series of many dipoles independently read the reply from a flight. The radar then calculates the received difference in strength and phase (delay) of each one. The mathematical result calculates and resolves simultaneous replies from various flights with a directional angular difference of approximately 0.5 degrees (traditional SSRs could not see the difference within an angle of some 3 degrees). The mathematical model calculates an aircraft's position using a single pulse (maximum 15 possible) in the reply signal, hence the term *Mono*.

SECTION 3

Common Minimum Vectoring Altitude Chart Development Practices

3.0 **Minimum Vectoring Altitude Charts** specify the lowest Mean Sea Level (MSL) altitude that air traffic controllers can radar vector aircraft safely.

3.1.1 An MVAC shall be established in controlled airspace unless operational requirements otherwise dictate.

3.1.2 At a minimum, the MVAC must accommodate the facility's delegated area of control as well as adjacent airspace where control responsibility is assumed due to early handoffs or track initiation.

3.1.3 In addition to the appropriate obstacle clearance requirements, Minimum Vectoring Altitude (MVA) sector altitudes must also meet radar/radio coverage requirements.

3.1.4 The appropriate lateral and vertical obstacle clearance requirements are described in later paragraphs and sections of this document.

3.1.5 Sector altitudes shall be displayed in hundreds of feet Mean Sea Level (MSL).

3.2 **Single-Sensor.** Although not specifically required, centering the MVAC on the radar antenna is a recommended practice. Doing so more easily facilitates distance measurements. Define sector boundaries by bearings, point-to-point lines, arcs, and/or circles relative to a specified point or points (e.g., radar antenna, NAVAID, fix, latitude/longitude coordinate, etc.).

3.3 **Multi-Sensor**. In a multi-sensor environment it is not necessary to center the chart on any particular radar antenna as the standard lateral separation is 5 NM regardless of the location of any particular sensor (versus 3 NM for a single-sensor configuration). Sector boundaries may be defined by bearings, point-to-point lines, arcs, and/or circles relative to a specified point or points (e.g., radar antenna, NAVAID, fix, latitude/longitude coordinate, etc.).

4.2 **Obstacle Evaluation Area.** The sector OEA includes the volume of airspace contained within its defined boundaries. Except for isolation areas each sector includes a buffer equal to the minimum required lateral clearance based on the radar environment (e.g., single- or multi-sensor). While adjacent sectors may share common boundaries, each sector OEA is stand-alone and evaluated separately. Figure 2 shows two sectors with a common boundary.

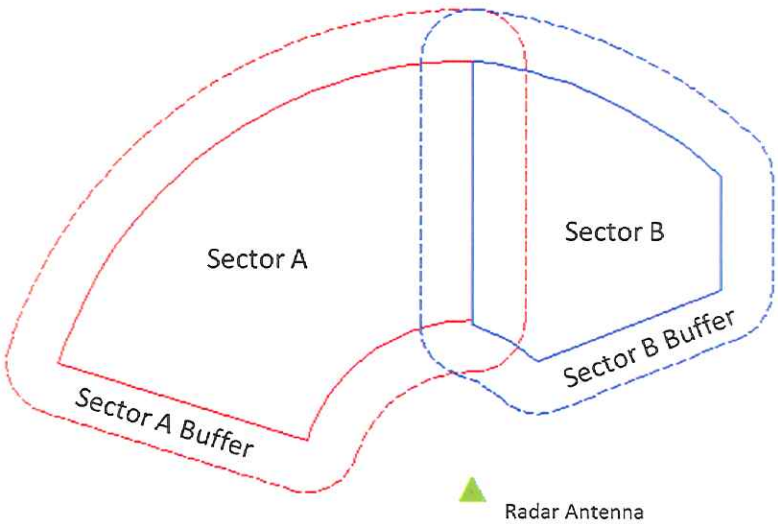

Figure 2. Sector and Buffer Areas Evaluated Individually

4.2.1 **a. (1) Single-Sensor.** The OEA buffer expands outward at least 3 NM from those portions of the boundary within 40 NM* of the radar antenna and at least 5 NM outward from those portions of the boundary equal to or greater than 40 NM* from the radar antenna. See Figure 3.

When a contiguous sector crosses 40 NM* from the radar antenna, the sector is effectively divided into sub-sectors at the 40 NM* arc and normal OEA/buffers applied to each, except buffers expanding into the sector may be truncated at the boundary. The highest altitude from each sub-sector applies. See Figure 4.

**60 NM for approved full time reinforced MSSR systems.*

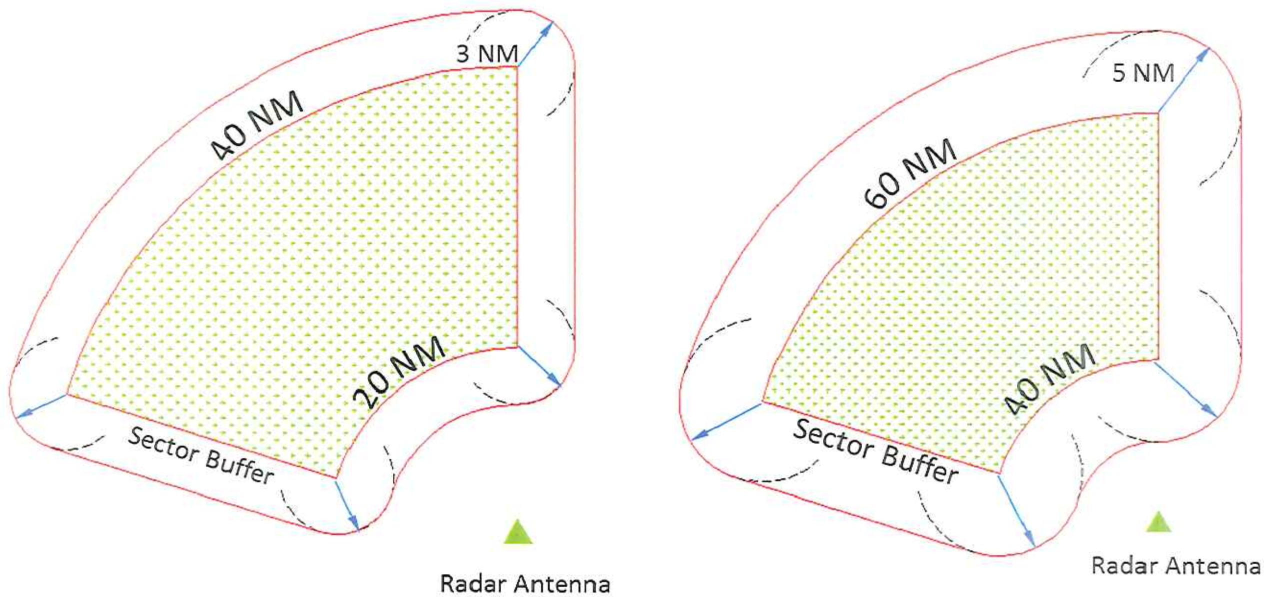

Figure 3. Single-Sensor Configuration Buffer Area Sizes Based on Distance from Radar Antenna

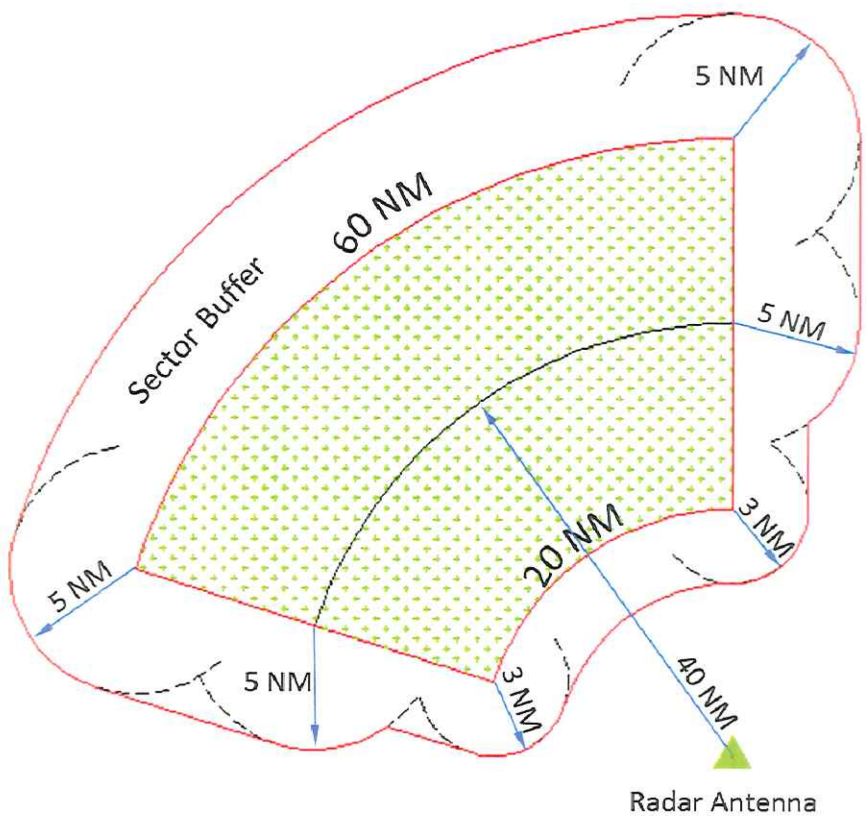

Figure 4. Buffer Area Extending Beyond 40 NM from Radar Antenna Based on Single-Sensor Configuration

4.2.1 **a. (2) Multi-Sensor**. The OEA includes a buffer extending at least 5 NM outward from the boundary, regardless of distance from the radar antenna or MVAC center. In a multi-sensor environment the OEA is always 5 NM. Figure 5 depicts a polygonal sector with a 5 NM buffer applied. Two objects have been isolated within a 5 NM radius (8400 ft and 9100 ft), which allows the overall sector altitude to be lowered to 6500 ft (65).

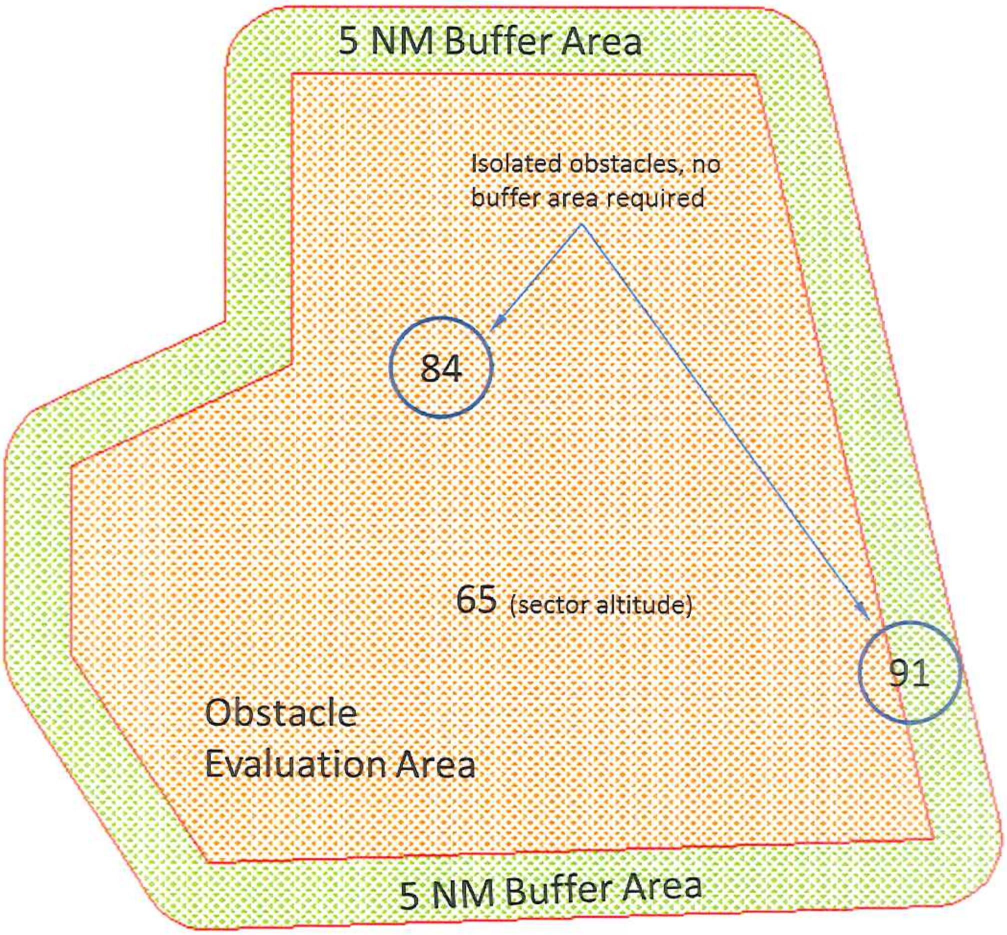

Figure 5. Multi-Sensor Configuration Buffer Areas

4.3 **Isolating Obstacles**. Any obstacle may be isolated to *lower* the MVA in one or more standard sectors. The OEA buffers of neighboring sectors still apply in the isolation area, but *exclude* the specific feature being isolated. Truncate an isolation area at the sector boundary when it expands into a sector requiring a higher MVA. The dimensions of the isolation area depend on the type of feature being isolated and whether in a single- or multi-sensor environment.

4.3.1 **a. Point Feature** (antennas, towers, high-rise buildings, etc.). The isolation area is based on a radius centered on the point feature itself and provides at least the minimum lateral clearance applicable to the radar adaptation. Isolation areas for multiple point features (i.e., antenna or wind farms) may be combined, however the minimum required lateral clearance must be provided from each feature and the MVA must equal the highest required for any individual feature. Figure 6 depicts how multiple point features would be addressed in a multi-sensor situation.

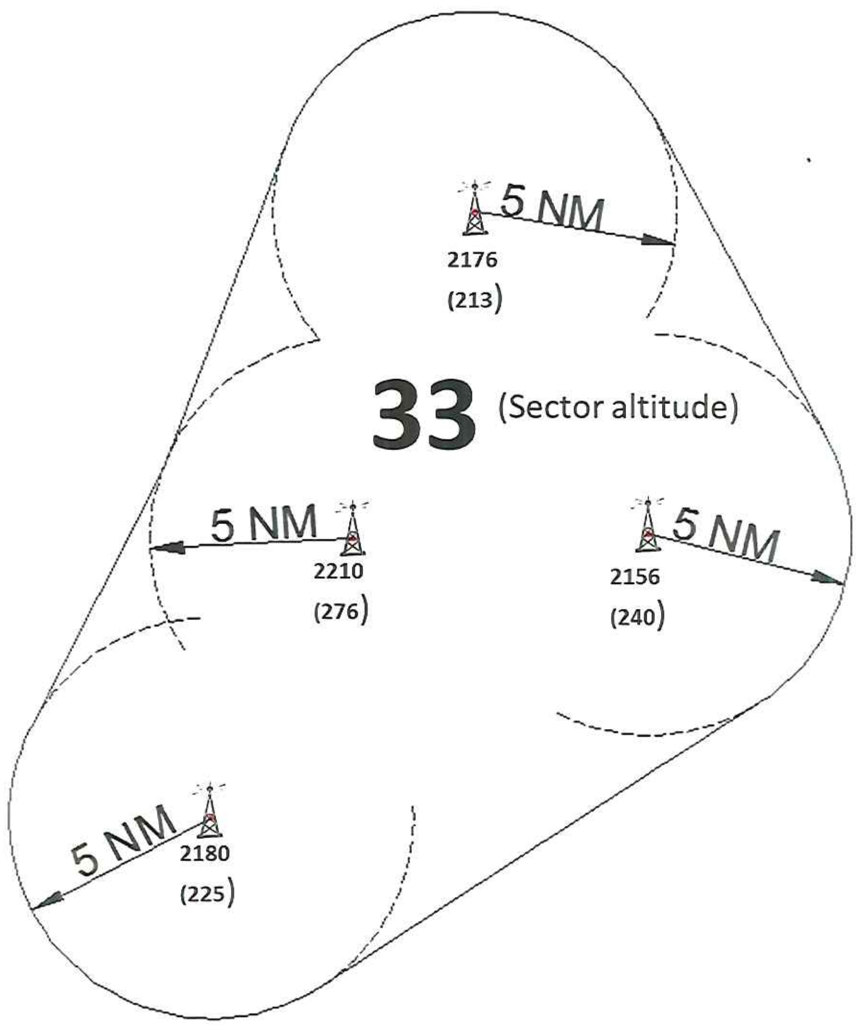

Figure 6. Isolation Area for Multiple Point Features Based on a Multi-Sensor Configuration

4.3.1 **a. (1) Single-Sensor**. The isolation area boundary is a 3 NM radius when the feature is 35 NM# or less from the radar antenna, and a 5 NM radius when the feature is more than 35 NM# from the radar antenna. See Figure 7. When operationally advantageous, the boundary may be reduced to less than 5 NM for those portions of the isolation area within 40 NM* from the radar antenna, but not less than the minimum required lateral clearance. See Figure 8.

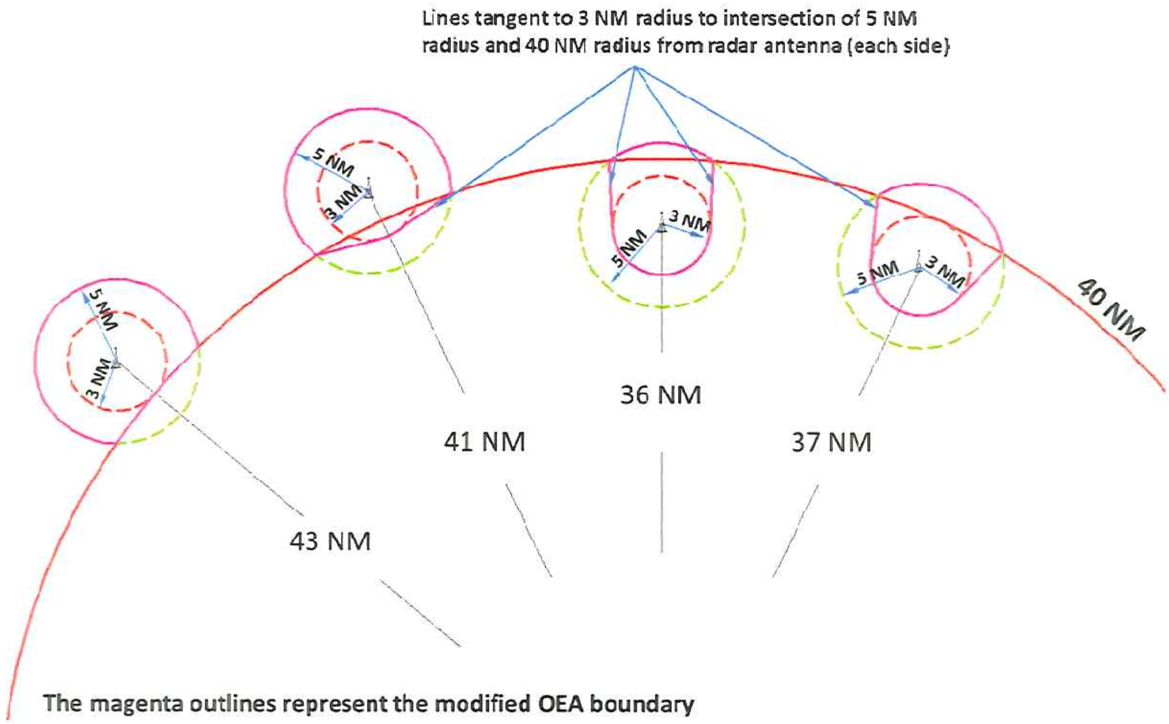

Figure 8. Isolation Area, Point Feature, Example OEA Construction > 35 NM from Radar Antenna

4.3.1 **b. Zone Feature** (e.g., distinct terrain, topographical contours, etc.). When determining the sector boundaries first define the dimensions of the feature to be isolated (e.g., mountain from 4700 ft contour and above).

4.3.1 **b. (1) Single-Sensor**. Establish the isolation area boundary 3 NM from those portions of the zone feature that are 35 NM or less from the radar antenna and 5 NM from those portions of the zone feature that are more than 35 NM from the radar antenna. When operationally advantageous, the boundary may be reduced to less than 5 NM for those portions of the isolation area within 40 NM from the radar antenna, but not less than the minimum required lateral clearance. See Figures 9 and 10.

4.3.1 **b. (2) Multi-Sensor**. Isolation area boundary is 5 NM from the feature, regardless of distance from the radar antenna.

authorities. However, air traffic controllers, pilots and other experts should be consulted before any final decisions are made.

4.4.1 a. **Non-Mountainous Terrain**. Apply a minimum of 1000 ft of ROC over obstacles.

4.4.1 b. **Mountainous Terrain**. Apply 2000 ft of ROC over obstacles.

4.4.1 c. **Precipitous Terrain**. Apply additional ROC as deemed appropriate.

4.4.2 When a sector/buffer/isolation area overlies both non-mountainous and mountainous terrain, consider revising sector boundaries. Otherwise, apply the appropriate ROC based on the location of the obstacle. See Figure 11.

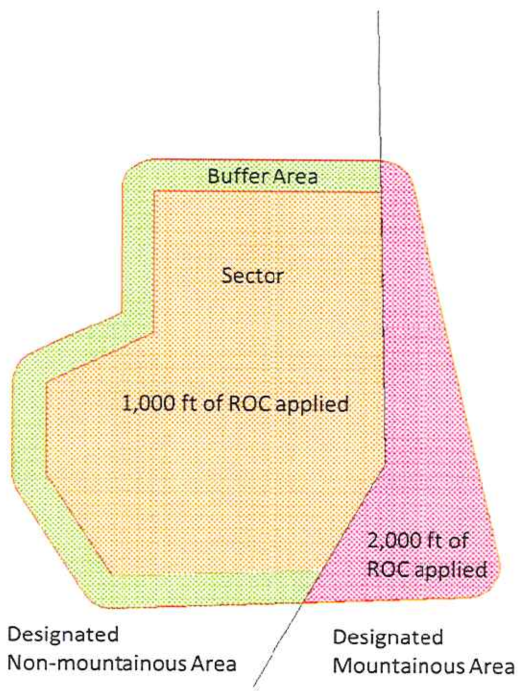

Figure 11. Sector/Buffer Overlying both Mountainous and Non-Mountainous Areas

4.4.3 Precipitous Terrain in Designated Mountainous Terrain Areas. No increase in ROC for precipitous terrain is required if 2000 ft of ROC is used. ROC may only be reduced when lower altitudes are required to achieve compatibility with terminal routes, or to permit vectoring to an instrument approach procedure, and where precipitous terrain does not cause any adverse effects.

4.4.4 ROC Reduction

4.4.4 **a.** ROC shall never be less than 1000 ft.

4.4.4 b. ROC may only be reduced when the reduction has been requested and approved. All ROC reductions should be properly documented.

4.4.4 c. Whenever a ROC reduction is taken, the rationale/justification for the reduction must be included in the MVAC justification package. ROC reductions should only be requested when there is a demonstrated operational need.

The ***Air Traffic Services Adjoint Director General*** will determine if the ROC reductions are appropriate. This determination shall include an investigative query using a data source, such as the Center for Aeronautical Weather Forecasts and Analysis (***Centro de Análisis y Pronósticos Meteorológicos Aeronáuticos*** [CAPMA]), aircraft operators, air traffic controllers at the relevant facility, and/or other interested parties. Examples of adverse effects include ground proximity warnings reported in the subject area, history of turbulence experienced at the minimum altitude requested, etc. ROC reductions should be avoided where reported ground proximity warnings relate to both existing MVA sector altitude ROC reductions and rapid terrain elevation changes.

4.5 Adverse Assumption Obstacle (AAO) Considerations.

4.5.1 Apply 200 ft AAO to all terrain, **except** where appropriate data is available or where applying 2000 ft of unreduced ROC, around the following areas:

4.5.1 a. **In cases where no runway is longer than 3200 ft:** 10,000 ft radius from **all** runway ends.

4.5.1 b. **In cases where one runway is longer than 3200 ft:** 20,000 ft radius from **all** runway ends.

4.5.1 c. **Helipad:** For heliports with one helipad, use a radius of 5000 ft from the center of the helipad. When multiple helipads exist, use the center of each helipad. Then join the extremities of the adjacent arcs with lines drawn tangent to the arcs.

4.5.2 When an AAO is the controlling obstacle for a sector and an operational need is demonstrated/approved (e.g., altitude is necessary to support vectoring to the ILS glideslope), round the resulting altitude to the nearest 100 ft increment (i.e. 3049 ft rounds to 3000 ft) providing the minimum amount of ROC is maintained for other non-AAO obstacles.

Note: when an operational need has been demonstrated and approved it must be documented in the appropriate forms "Remarks" section (see Appendix 1 for an example of a form with a "Remarks" section).

4.6 **Vegetation.** Ensure an allowance has been included in all terrain values. Contact any appropriate authorities to ascertain the maximum mean height of vegetation and then apply this allowance uniformly to the entire terrain model. In areas without widespread vegetation, areas where the maximum tree height varies significantly from one part of the chart to another, or when SRTM data is used, it may be more appropriate to specify sector altitudes that ensure clearance above terrain plus known tree heights. Document the application of this process.

4.7 **Airspace.** Establish sector altitudes (to include isolation areas) at or above the floor of controlled airspace.

4.8 **Altitude Selection.** Specify sector altitudes (to include isolation areas) in 100-ft increments. Altitudes must provide the minimum ROC over the highest obstacle in the OEA.

Exception: sector altitudes based on terrain + AAO may be rounded to the <u>*nearest*</u> *100-ft provided minimum ROC is maintained for other non-AAO obstacles.*

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SECTION 5

Documentation

5.0 **Purpose.** The purpose of this section is to stress the need for proper documentation when designing and/or modifying an MVAC. Each MVAC package should be thoroughly documented. Additionally, some form of periodic review (e.g., annually) should be established. There should also be a process of communication between SENEAM and ATC facilities when changes to obstacle situations occur (e.g., new construction, demolition of existing structures, etc.).

5.1 **Review and Approval.** MVACs should be reviewed and certified on, for example, an annual basis or as new obstacle information dictates using approved forms and other documents. Form 7120-9, En Route Minimum IFR/Minimum Vectoring Altitude Obstruction, has been included as an example of the type of documentation used in the U.S. See Appendix 1 and Appendix 2.

5.1 **a.** The ***Director of Air Traffic Services*** shall assure that MVA charts are reviewed at least annually to ensure chart currency and simplicity. Charts shall be revised immediately when changes affecting minimum vectoring altitudes occur. For annual review or other necessary changes, charts shall be prepared as prescribed in subparagraphs 5.1b through 5.1e below. Air traffic managers shall certify the charts through the appropriate ***Technical Operations Service Area Director*** for both annual reviews and revisions.

5.1 **b.** Draw the MVA chart on Mexico's Instituto Nacional de Estadística Geografía e Informática (INEGI)-made Visual Approach Charts or an electronic equivalent.

5.1 **c.** Depict the MVA in each area.

5.1 **d.** Document the controlling obstructions on the appropriate forms.

5.1 **e.** Attach the facility and radar name on MVA charts and include the edition and date of the Visual Approach Chart used to prepare the MVA chart. Forward the MVA chart to the ***Director of Air Traffic Services*** for review and approval.

5.1 **e.1.** A copy of the approved MVA chart and other included documentation will be provided to the air traffic facility unit for their records.

5.1 **e.2.** A copy of the approved MVA chart shall be sent to the ***Jefatura de Datos Aeronáuticos*** to develop the radar video map.

5.1 **e.3.** A copy of the approved MVA chart shall be sent to the ***Director of Air Navigation and Information Services*** to permit the publication of the chart in the Aeronautical Information Publication (AIP).

Appendices

Appendix 1: Sample of U.S. FAA Form 7210-9: En Route Minimum IFR/Minimum Vectoring Altitude Obstruction Documentation

Appendix 2: Sample of Completed U.S. FAA Form 7210-9: En Route Minimum IFR/Minimum Vectoring Altitude Obstruction Documentation

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Appendix 1

Figure 1A below provides an example of a U.S. FAA form used to document how MVAC chart sector altitudes were determined. Each column of the form is described below.

Report

Report Name:	FAA Form 7210-9
Description:	Lists all data required for FAA Form 7210-9.
Author:	MM155873-PC
Creation Date:	8/6/2010 2:10:42 PM
Project File:	None Defined
Parameters:	MVA/MIA Source =

Area	Obs_Type (DOF =)	Latitude	Longitude	Elev (Acc H/V)	ROC / Reduction	Airspace + Buffer	Alt Adjust	Calc Min Alt	Specified MVA/MIA	Dual Alt	Remarks

Obstruction Type	
OBS	A real obstacle
TER	Terrain
AAO	Adverse Assumed Obstacle
TER/AS	AGL airspace (set by terrain)
AS	MSL airspace

Approved by

Air Traffic Manager Date

FPO Manager Date

XX Shows when the specified MVA/MIA is lower than the calculated minimum altitude.
* Designates the obstruction clearance altitude in the dual altitude column.

Figure 1A. Sample of U.S. FAA Form 7210-9: En Route Minimum IFR/Minimum Vectoring Altitude Obstruction Documentation

- Area — Identify the sector name (e.g., Sector A or Sector 1)
- Obs Type — Type of obstacle (e.g, "TER" for terrain)
- Latitude — Latitude of controlling obstacle
- Longitude — Longitude of controlling obstacle
- Elev (Acc H/V) — MSL elevation of obstacle plus Accuracy (ACC) Height Value (H/V)
- ROC/Reduction — The amount of ROC applied followed by any ROC reduction
- Airspace Buffer — This is not applicable in Mexico. However, this column could be used to indicate the minimum radar/radio coverage altitude
- Alt Adjust — Any altitude adjustments made
- Calc Min Alt — Resulting minimum sector altitude (raw value)
- Specified MVA/MIA — Final selected sector altitude. (MIA is the enroute version of an MVAC.)
- Dual Alt — List any other altitude (e.g., cold weather)
- Remarks — List any appropriate comments (e.g., ROC adjustment justification)

Appendix 2

Figure 2A provides an example of a completed MVAC chart form. It is intended to demonstrate the type of information that should be collected and recorded as part of a complete MVAC package.

Report Name: FAA Form 7210-9
Description: Lists all data required for FAA Form 7210-9.

Author:
Creation Date:
Project File:
Parameters:

Area	Obs_Type (DOF #)	Latitude	Longitude	Elev (Acc H/V)	ROC / Reduction	Airspace + Buffer	Alt Adjust	Calc Min Alt	Specified MVA/MIA	Dual Alt	Remarks
A	AAO	19 33 37.63N	98 57 44.15W	5047	2000/-1000	1200	-47	6000	6000		See attached for ROC reduction justification. AAO rounding authorized for glideslope intercept requirements.
AA	AAO	19 41 19.23N	99 33 43.67W	11434	2000/-1000	1200	-34	12400	12400		See attached for ROC reduction justification. AAO rounding authorized for glideslope intercept requirements.
B	AAO	19 15 35.33N	99 42 52.44W	5222	2000/-1000	1200	-22	6200	6200		See attached for ROC reduction justification. AAO rounding authorized for glideslope intercept requirements.
BB	AS	19 31 19.01N	99 03 51.55W	12543	2000/0	14800	57	14800	14800	148*146	
C	AAO	18 48 09.03N	97 50 28.04W	6779	2000/-1000	1200	21	7800	7800		See attached for ROC reduction justification.
CC	AS	19 27 05.12N	99 05 43.24W	11739	2000/0	13800	61	13800	13800		
D	AAO	19 13 02.36N	99 4544.64W	7024	2000/-1000	1000	-24	8000	8000		See attached for ROC reduction justification. AAO rounding requested for glidepath intercept requirements.

Figure 2A. Sample of Completed FAA Form 7210-9: En Route Minimum IFR/Minimum Vectoring Altitude Obstruction Documentation

5.0 NAICM/Toluca MVAC

This part describes MITRE's work regarding the development of an MVAC to support NAICM and an expanded Toluca Airport.

The following provides background on MITRE's NAICM/Toluca MVAC work, a description of the data used, and an explanation of MVAC development methodology. Sector altitude determination and coordinates are also provided. Please note that MITRE was informed that all existing and planned radar systems in Mexico are approved full-time reinforced MSSR systems.

MVAC Guidelines. The NAICM/Toluca MVAC was created considering the previously mentioned MVAC guidelines.

MVAC Sector Coordinates. The MVAC is based on the potential location of a NAICM Airport Surveillance Radar (ASR) (19 33 00.00N / 99 00 00.00W), and the location of the Toluca ASR (19 19 11.70N / 99 33 07.00W). Sectors "A-H" are based off the NAICM ASR, sectors "I-O" are based off the Toluca ASR.

MVAC Sector Altitudes. All necessary information needed to validate sector altitudes has been provided.

Data

Accurate and comprehensive data is essential when developing an MVAC. The following paragraphs briefly describe the key data sources used by MITRE in the development of the NAICM/Toluca MVAC.

Aeronautical Information Publication (AIP) of Mexico: The AIP served as MITRE's primary source of aeronautical data.

Shuttle Radar Topography Mission (SRTM) Digital Terrain Elevation Data (DTED): SRTM DTED is a uniform matrix of elevation values indexed to specific points on the ground and is one of MITRE's primary sources of digital terrain data. The horizontal datum used is the World Geodetic System 1984 (WGS 84) and the vertical datum used is Mean Sea Level (MSL), as determined by the WGS 84 Earth Gravitational Model (EGM 96) geoid. SRTM DTED can be manipulated a number of ways for analytical and presentation purposes.

Topographic Maps: SRTM DTED are terrain postings based on a fixed grid system and, therefore, it is possible that a higher elevation point between postings may not be accounted for. To compensate for this issue, terrain points (spots and peaks) obtained from topographic maps identified additional terrain features that may not be included in the SRTM DTED. Using charts obtained from INEGI, MITRE established a systematic method to identify and record additional terrain points to supplement the SRTM DTED data.

Satellite-Based Photogrammetric Survey: results from a satellite-based photogrammetric survey of the areas surrounding NAICM were used. The survey provided a snapshot of highly accurate information on terrain and man-made obstacles. While the survey provided a highly accurate assessment of terrain and man-made obstacles it is only up to the point it was completed. A complete reassessment of the obstacle environment should be completed to ensure no new obstacles have been built that could impact implementation of the MVAC.

Other Provided Data: information on other man-made objects (e.g., antennas, towers, etc.) provided by the DGAC was utilized.

It was assumed that no new man-made objects of significance have been added. The absence of new man-made obstacles should be confirmed prior to implementing the MVAC.

Methodology

Using computer programs, such as AutoCAD (a three-dimensional computer-aid design software that can accurately design, draw, and display models of airspace and obstacles), MITRE developed a preliminary MVAC that would complement its procedure design work at NAICM (i.e., triple independent approaches and departures) and Toluca (e.g., dual independent approaches and departures). Afterwards, MITRE held several meetings and workshops with SENEAM MVAC design experts and air traffic controllers to discuss and review the MVAC until reaching the final design shown later in this part.

Two radar coverage analyses were conducted: one based on a new potential radar location for NAICM (provided by MITRE), and another based on a radar location for Toluca (provided by SENEAM). Radio coverage analyses for the NAICM and Toluca areas were also conducted. This information was then used by MITRE and SENEAM to reassess sector altitudes.

Other Considerations

On the basis of discussions with SENEAM, the NAICM/Toluca MVAC is based on a single-sensor radar configuration from the NAICM and Toluca ASR locations. The MVACs for the NAICM and Toluca areas were then combined to form a single MVAC that would be used for the overall TMA.

Additionally, the radar and radio coverage charts prepared by SENEAM were also based on the individual NAICM and Toluca ASRs. Therefore, the radar and radio coverage charts used by MITRE and SENEAM in determining minimum sector altitudes will not reflect the same levels of coverage as that provided by a multi-sensor configuration. This matter was discussed at length with officials from SENEAM who agreed on the assumption that the NAICM/Toluca MVAC should be designed based on a single-sensor radar configuration (i.e., the NAICM portion of the MVAC from the NAICM ASR and the Toluca portion from the Toluca ASR).

It is important to note that radar software configuration changes and actual flight checks will eventually be required to ensure that appropriate radio and radar coverage can be provided in a single-sensor mode ASR system configuration to support the NAICM/Toluca MVAC design.

Figure 5-1 below shows the NAICM/Toluca MVAC. Table 5-1 provides information for each sector, and explains how the sector altitude was determined. Table 5-2 describes the boundary of each individual sector. (Note that this section has its own unique Figure and Table numbering system to differentiate it from the MVAC guideline figures previously discussed.)

SECTOR "C"

ID	Start Point	Via	End Point
1	R-330.00/2.00 NM (19° 34' 50.88" N (19° 34.848' N) / 099° 00' 49.66" W (099° 00.828' W))	Radial	R-330.00/10.00 NM (19° 42' 14.35" N (19° 42.239' N) / 099° 04' 08.48" W (099° 04.141' W))
2	R-330.00/10.00 NM (19° 42' 14.35" N (19° 42.239' N) / 099° 04' 08.48" W (099° 04.141' W))	CW Range	R-140.00/10.00 NM (19° 24' 34.79" N (19° 24.580' N) / 098° 54' 14.27" W (098° 54.238' W))
3	R-140.00/10.00 NM (19° 24' 34.79" N (19° 24.580' N) / 098° 54' 14.27" W (098° 54.238' W))	Radial	R-140.00/17.00 NM (19° 18' 41.03" N (19° 18.684' N) / 098° 50' 12.62" W (098° 50.210' W))
4	R-140.00/17.00 NM (19° 18' 41.03" N (19° 18.684' N) / 098° 50' 12.62" W (098° 50.210' W))	CC Range	R-235.00/17.00 NM (19° 24' 58.62" N (19° 24.977' N) / 099° 15' 52.85" W (099° 15.881' W))
5	R-235.00/17.00 NM (19° 24' 58.62" N (19° 24.977' N) / 099° 15' 52.85" W (099° 15.881' W))	Radial	R-235.00/2.00 NM (19° 32' 03.44" N (19° 32.057' N) / 099° 01' 52.18" W (099° 01.870' W))
6	R-235.00/2.00 NM (19° 32' 03.44" N (19° 32.057' N) / 099° 01' 52.18" W (099° 01.870' W))	CC Range	R-330.00/2.00 NM (19° 34' 50.88" N (19° 34.848' N) / 099° 00' 49.66" W (099° 00.828' W))

SECTOR "D"

ID	Start Point	Via	End Point
1	R-70.00/10.00 NM (19° 35' 13.29" N (19° 35.222' N) / 098° 49'40.39" W (098° 49.673' W))	Radial	R-70.00/27.00 NM (19° 38' 58.49" N (19° 38.975' N) / 098° 32'06.46" W (098° 32.108' W))
2	R-70.00/27.00 NM (19° 38' 58.49" N (19° 38.975' N) / 098° 32'06.46" W (098° 32.108' W))	CW Range	R-120.00/27.00 NM (19° 16' 35.84" N (19° 16.597' N) / 098° 37'15.73" W (098° 37.262' W))
3	R-120.00/27.00 NM (19° 16' 35.84" N (19° 16.597' N) / 098° 37'15.73" W (098° 37.262' W))	Radial	R-120.00/25.00 NM (19° 17' 48.83" N (19° 17.814' N) / 098° 38'56.63" W (098° 38.944' W))
4	R-120.00/25.00 NM (19° 17' 48.83" N (19° 17.814' N) / 098° 38'56.63" W (098° 38.944' W))	CW Range	R-140.00/25.00 NM (19° 11' 54.08" N (19° 11.901' N) / 098° 45'41.10" W (098° 45.685' W))
5	R-140.00/25.00 NM (19° 11' 54.08" N (19° 11.901' N) / 098° 45'41.10" W (098° 45.685' W))	Radial	R-140.00/10.00 NM (19° 24' 33.76" N (19° 24.563' N) / 098° 54'16.00" W (098° 54.267' W))
6	R-140.00/10.00 NM (19° 24' 33.76" N (19° 24.563' N) / 098° 54'16.00" W (098° 54.267' W))	CC Range	R-70.00/10.00 NM (19° 35' 13.29" N (19° 35.222' N) / 098° 49'40.39" W (098° 49.673' W))

SECTOR "E"

ID	Start Point	Via	End Point
1	R-140.00/25.00 NM (19° 11' 54.08" N (19° 11.901' N) / 098° 45'41.10" W (098° 45.685' W))	Polyline	R-153.00/39.00 NM (18° 56' 09.74" N (18° 56.162' N) / 098° 46'03.12" W (098° 46.052' W))
2	R-153.00/39.00 NM (18° 56' 09.74" N (18° 56.162' N) / 098° 46'03.12" W (098° 46.052' W))	Polyline	R-145.00/50.00 NM (18° 48' 35.08" N (18° 48.585' N) / 098° 35'24.27" W (098° 35.404' W))
3	R-145.00/50.00 NM (18° 48' 35.08" N (18° 48.585' N) / 098° 35'24.27" W (098° 35.404' W))	CC Range	R-70.00/50.00 NM (19° 44' 00.39" N (19° 44.006' N) / 098° 08'19.38" W (098° 08.323' W))
4	R-70.00/50.00 NM (19° 44' 00.39" N (19° 44.006' N) / 098° 08'19.38" W (098° 08.323' W))	Radial	R-70.00/27.00 NM (19° 38' 58.49" N (19° 38.975' N) / 098° 32'06.46" W (098° 32.108' W))
5	R-70.00/27.00 NM (19° 38' 58.49" N (19° 38.975' N) / 098° 32'06.46" W (098° 32.108' W))	CW Range	R-120.00/27.00 NM (19° 16' 35.84" N (19° 16.597' N) / 098° 37'15.73" W (098° 37.262' W))
6	R-120.00/27.00 NM (19° 16' 35.84" N (19° 16.597' N) / 098° 37'15.73" W (098° 37.262' W))	Radial	R-120.00/25.00 NM (19° 17' 48.83" N (19° 17.814' N) / 098° 38'56.63" W (098° 38.944' W))
7	R-120.00/25.00 NM (19° 17' 48.83" N (19° 17.814' N) / 098° 38'56.63" W (098° 38.944' W))	CW Range	R-140.00/25.00 NM (19° 11' 54.08" N (19° 11.901' N) / 098° 45'41.10" W (098° 45.685' W))

SECTOR "F"

ID	Start Point	Via	End Point
1	R-144.00/24.00 NM (18° 58' 06.99" N (18° 58.116' N) / 099° 20'50.37" W (099° 20.840' W))	Polyline	R-200.00/38.00 NM (18° 59' 03.16" N (18° 59.053' N) / 099° 18'19.07" W (099° 18.318' W))
2	R-200.00/38.00 NM (18° 59' 03.16" N (18° 59.053' N) / 099° 18'19.07" W (099° 18.318' W))	Radial	R-200.00/35.00 NM (19° 01' 44.03" N (19° 01.734' N) / 099° 16'52.58" W (099° 16.876' W))
3	R-200.00/35.00 NM (19° 01' 44.03" N (19° 01.734' N) / 099° 16'52.58" W (099° 16.876' W))	Radial	18° 56' 18.32" N (18° 56.305' N) / 098° 46' 07.25" W(098° 46.121' W)
4	18° 56' 18.32" N (18° 56.305' N) / 098° 46' 07.25" W(098° 46.121' W)	Polyline	R-153.00/39.00 NM (18° 56' 09.74" N (18° 56.162' N) / 098° 46'03.12" W (098° 46.052' W))
5	R-153.00/39.00 NM (18° 56' 09.74" N (18° 56.162' N) / 098° 46'03.12" W (098° 46.052' W))	Polyline	R-145.00/50.00 NM (18° 48' 35.08" N (18° 48.585' N) / 098° 35' 24.27" W (098° 35.404' W))
6	R-145.00/50.00 NM (18° 48' 35.08" N (18° 48.585' N) / 098° 35' 24.27" W (098° 35.404' W))	CC Range	R-169/50NM (18° 42' 54.3" N (18° 42.905') / 098° 56' 29.8" W (098° 56.496' W))
7	R-169/50NM (18° 42' 54.3" N (18° 42.905') / 098° 56' 29.8" W (098° 56.496' W))	CC Range	R-140.00/50.00 NM (18° 37' 03.77" N (18° 37.063' N) / 099° 04'26.55" W (099° 04.442' W))
8	R-140.00/50.00 NM (18° 37' 03.77" N (18° 37.063' N) / 099° 04'26.55" W (099° 04.442' W))	Polyline	R-144.00/24.00 NM (18° 58' 06.99" N (18° 58.116' N) / 099° 20'50.37" W (099° 20.840' W))

SECTOR "G"

ID	Start Point	Via	End Point
1	R-200.00/17.00 NM (19° 17' 47.52" N (19° 17.792' N) / 099° 08' 09.57" W (099° 08.160' W))	Radial	R-200.00/35.00 NM (19° 01' 40.95" N (19° 01.682' N) / 099° 16' 46.32" W (099° 16.772' W))
2	R-200.00/35.00 NM (19° 01' 40.95" N (19° 01.682' N) / 099° 16' 46.32" W (099° 16.772' W))	Polyline	18° 56' 18.32" N (18° 56.305' N) / 098° 46' 07.25" W (098° 46.121' W)
3	18° 56' 18.32" N (18° 56.305' N) / 098° 46' 07.25" W (098° 46.121' W)	Polyline	R-140.00/25.00 NM (19° 11' 56.62" N (19° 11.944' N) / 098° 45' 36.79" W (098° 45.613' W))
4	R-140.00/25.00 NM (19° 11' 56.62" N (19° 11.944' N) / 098° 45' 36.79" W (098° 45.613' W))	Polyline	R-140.00/17.00 NM (19° 18' 41.03" N (19° 18.684' N) / 098° 50' 12.62" W (098° 50.210' W))
5	R-140.00/17.00 NM (19° 18' 41.03" N (19° 18.684' N) / 098° 50' 12.62" W (098° 50.210' W))	CW Range	R-200.00/17.00 NM (19° 17' 47.52" N (19° 17.792' N) / 099° 08' 09.57" W (099° 08.160' W))

SECTOR "H"

ID	Start Point	Via	End Point
1	R-235.00/17.00 NM (19° 24' 58.62" N (19° 24.977' N) / 099° 15' 52.85" W (099° 15.881' W))	Polyline	19° 14' 35.16" N (19° 14.586' N) / 099° 26' 11.46" W (099° 26.191' W)
2	19° 14' 35.16" N (19° 14.586' N) / 099° 26' 11.46" W (099° 26.191' W)	Polyline	19° 12' 35.11" N (19° 12.585' N) / 099° 26' 37.88" W (099° 26.631' W)
3	19° 12' 35.11" N (19° 12.585' N) / 099° 26' 37.88" W (099° 26.631' W)	Polyline	19° 00' 42.62" N (19° 00.710' N) / 099° 24' 52.23" W (099° 24.870' W)
4	19° 00' 42.62" N (19° 00.710' N) / 099° 24' 52.23" W (099° 24.870' W)	Polyline	18° 58' 06.94" N (18° 58.116' N) / 099° 20' 50.48" W (099° 20.841' W)
5	18° 58' 06.94" N (18° 58.116' N) / 099° 20' 50.48" W (099° 20.841' W)	Polyline	R-200.00/38.00 NM (18° 58' 59.82" N (18° 58.997' N) / 099° 18' 12.28" W (099° 18.205' W))
6	R-200.00/38.00 NM (18° 58' 59.82" N (18° 58.997' N) / 099° 18' 12.28" W (099° 18.205' W))	Radial	R-200.00/17.00 NM (19° 17' 47.52" N (19° 17.792' N) / 099° 08' 09.57" W (099° 08.160' W))
7	R-200.00/17.00 NM (19° 17' 47.52" N (19° 17.792' N) / 099° 08' 09.57" W (099° 08.160' W))	CW Range	R-235.00/17.00 NM (19° 24' 58.62" N (19° 24.977' N) / 099° 15' 52.85" W (099° 15.881' W))

SECTOR "I"

ID	Start Point	Via	End Point
1	R-260.00/9.00 NM (19° 18' 43.08" N (19° 18.718' N) / 099° 42' 37.18" W (099° 42.620' W))	Radial	R-260.00/14.00 NM (19° 18' 26.97" N (19° 18.450' N) / 099° 47' 53.92" W (099° 47.899' W))
2	R-260.00/14.00 NM (19° 18' 26.97" N (19° 18.450' N) / 099° 47' 53.92" W (099° 47.899' W))	CW Range	R-335.00/14.00 NM (19° 32' 33.58" N (19° 32.560' N) / 099° 37' 41.85" W (099° 37.698' W))
3	R-335.00/14.00 NM (19° 32' 33.58" N (19° 32.560' N) / 099° 37' 41.85" W (099° 37.698' W))	Radial	R-335.00/5.00 NM (19° 23' 58.10" N (19° 23.968' N) / 099° 34' 45.07" W (099° 34.751' W))
4	R-335.00/5.00 NM (19° 23' 58.10" N (19° 23.968' N) / 099° 34' 45.07" W (099° 34.751' W))	CW Range	R-28.00/5.00 NM (19° 23' 18.36" N (19° 23.306' N) / 099° 30' 04.98" W (099° 30.083' W))
5	R-28.00/5.00 NM (19° 23' 18.36" N (19° 23.306' N) / 099° 30' 04.98" W (099° 30.083' W))	Polyline	R-118.00/6.00 NM (19° 15' 44.35" N (19° 15.739' N) / 099° 27' 55.29" W (099° 27.922' W))
6	R-118.00/6.00 NM (19° 15' 44.35" N (19° 15.739' N) / 099° 27' 55.29" W (099° 27.922' W))	Polyline	19° 14' 35.16" N (19° 14.586' N) / 099° 26' 11.46" W (099° 26.191' W)
7	19° 14' 35.16" N (19° 14.586' N) / 099° 26' 11.46" W (099° 26.191' W)	Polyline	R-130.00/9.00 NM (19° 12' 35.14" N (19° 12.586' N) / 099° 26' 37.85" W (099° 26.631' W))
8	R-130.00/9.00 NM (19° 12' 35.14" N (19° 12.586' N) / 099° 26' 37.85" W (099° 26.631' W))	CW Range	R-260.00/9.00 NM (19° 18' 43.08" N (19° 18.718' N) / 099° 42' 37.18" W (099° 42.620' W))

SECTOR "J"

ID	Start Point	Via	End Point
1	R-345.00/35.00 NM (19° 53' 59.09" N (19° 53.985' N) / 099° 38' 17.15" W (099° 38.286' W))	Polyline	19° 53' 49.67" N (19° 53.828' N) / 099° 33' 44.70" W (099° 33.745' W)
2	19° 53' 49.67" N (19° 53.828' N) / 099° 33' 44.70" W (099° 33.745' W)	Polyline	19° 25' 55.32" N (19° 25.922' N) / 099° 14' 00.83" W (099° 14.014' W)
3	19° 25' 55.32" N (19° 25.922' N) / 099° 14' 00.83" W (099° 14.014' W)	Polyline	19° 24' 58.62" N (19° 24.977' N) / 099° 15' 52.85" W (099° 15.881' W)
4	19° 24' 58.62" N (19° 24.977' N) / 099° 15' 52.85" W (099° 15.881' W)	Polyline	19° 14' 35.16" N (19° 14.586' N) / 099° 26' 11.46" W (099° 26.191' W)
5	19° 14' 35.16" N (19° 14.586' N) / 099° 26' 11.46" W (099° 26.191' W)	Polyline	R-118.00/6.00 NM (19° 15' 44.35" N (19° 15.739' N) / 099° 27' 55.29" W (099° 27.922' W))
6	R-118.00/6.00 NM (19° 15' 44.35" N (19° 15.739' N) / 099° 27' 55.29" W (099° 27.922' W))	Polyline	R-28.00/5.00 NM (19° 23' 18.36" N (19° 23.306' N) / 099° 30' 04.98" W (099° 30.083' W))
7	R-28.00/5.00 NM (19° 23' 18.36" N (19° 23.306' N) / 099° 30' 04.98" W (099° 30.083' W))	CCRange	R-335.00/5.00 NM (19° 23' 58.10" N (19° 23.968' N) / 099° 34' 45.07" W (099° 34.751' W))
8	R-335.00/5.00 NM (19° 23' 58.10" N (19° 23.968' N) / 099° 34' 45.07" W (099° 34.751' W))	Radial	R-335.00/24.00 NM (19° 42' 06.27" N (19° 42.104' N) / 099° 40' 58.63" W (099° 40.977' W))
9	R-335.00/24.00 NM (19° 42' 06.27" N (19° 42.104' N) / 099° 40' 58.63" W (099° 40.977' W))	Polyline	R-345.00/35.00 NM (19° 53' 59.09" N (19° 53.985' N) / 099° 38' 17.15" W (099° 38.286' W))

SECTOR "K"

ID	Start Point	Via	End Point
1	R-335.00/24.00 NM (19° 42' 06.27" N (19° 42.104' N) / 099° 40' 58.63" W (099° 40.977' W))	Polyline	R-320.00/24.00 NM (19° 39' 23.46" N (19° 39.391' N) / 099° 46' 58.00" W (099° 46.967' W))
2	R-320.00/24.00 NM (19° 39' 23.46" N (19° 39.391' N) / 099° 46' 58.00" W (099° 46.967' W))	Polyline	R-320.00/35.00 NM (19° 48' 38.46" N (19° 48.641' N) / 099° 53' 20.04" W (099° 53.334' W))
3	R-320.00/35.00 NM (19° 48' 38.46" N (19° 48.641' N) / 099° 53' 20.04" W (099° 53.334' W))	Polyline	R-345.00/35.00 NM (19° 53' 59.09" N (19° 53.985' N) / 099° 38' 17.15" W (099° 38.286' W))
4	R-345.00/35.00 NM (19° 53' 59.09" N (19° 53.985' N) / 099° 38' 17.15" W (099° 38.286' W))	Polyline	R-335.00/24.00 NM (19° 42' 06.27" N (19° 42.104' N) / 099° 40' 58.63" W (099° 40.977' W))

SECTOR "N"

ID	Start Point	Via	End Point
1	R-184.00/9.00 NM (19° 10' 19.31" N (19° 10.322' N) / 099° 34'54.30" W (099° 34.905' W))	Radial	R-184.00/27.00 NM (18° 52' 34.47" N (18° 52.574' N) / 099° 38'28.37" W (099° 38.473' W))
2	R-184.00/27.00 NM (18° 52' 34.47" N (18° 52.574' N) / 099° 38'28.37" W (099° 38.473' W))	CW Range	R-260.00/27.00 NM (19° 17' 39.87" N (19° 17.664' N) / 100° 01'36.98" W (100° 01.616' W))
3	R-260.00/27.00 NM (19° 17' 39.87" N (19° 17.664' N) / 100° 01'36.98" W (100° 01.616' W))	Radial	R-260.00/23.00 NM (19° 17' 53.76" N (19° 17.896' N) / 099° 57'23.69" W (099° 57.395' W))
4	R-260.00/23.00 NM (19° 17' 53.76" N (19° 17.896' N) / 099° 57'23.69" W (099° 57.395' W))	CW Range	R-265.00/23.00 NM (19° 19' 54.58" N (19° 19.910' N) / 099° 57'25.45" W (099° 57.424' W))
5	R-265.00/23.00 NM (19° 19' 54.58" N (19° 19.910' N) / 099° 57'25.45" W (099° 57.424' W))	Radial	R-265.00/14.00 NM (19° 19' 38.19" N (19° 19.636' N) / 099° 47'54.74" W (099° 47.912' W))
6	R-265.00/14.00 NM (19° 19' 38.19" N (19° 19.636' N) / 099° 47'54.74" W (099° 47.912' W))	CC Range	R-260.00/14.00 NM (19° 18' 24.64" N (19° 18.411' N) / 099° 47'53.74" W (099° 47.896' W))
7	R-260.00/14.00 NM (19° 18' 24.64" N (19° 18.411' N) / 099° 47'53.74" W (099° 47.896' W))	Radial	R-260.00/9.00 NM (19° 18' 41.58" N (19° 18.693' N) / 099° 42'37.07" W (099° 42.618' W))
8	R-260.00/9.00 NM (19° 18' 41.58" N (19° 18.693' N) / 099° 42'37.07" W (099° 42.618' W))	CC Range	R-184.00/9.00 NM (19° 10' 19.31" N (19° 10.322' N) / 099° 34'54.30" W (099° 34.905' W))

SECTOR "O"

ID	Start Point	Via	End Point
1	R-192.00/27.00 NM (18° 53' 32.45" N (18° 53.541' N) / 099° 42'18.80" W (099° 42.313' W))	Radial	R-192.00/50.00 NM (18° 31' 40.88" N (18° 31.681' N) / 099° 50'06.73" W (099° 50.112' W))
2	R-192.00/50.00 NM (18° 31' 40.88" N (18° 31.681' N) / 099° 50'06.73" W (099° 50.112' W)	CW Range	R-260.00/50.00 NM (19° 16' 18.16" N (19° 16.303' N) / 100° 25'53.04" W (100° 25.884' W))
3	R-260.00/50.00 NM (19° 16' 18.16" N (19° 16.303' N) / 100° 25'53.04" W (100° 25.884' W))	Radial	R-260.00/27.00 NM (19° 17' 39.87" N (19° 17.664' N) / 100° 01'36.98" W (100° 01.616' W))
4	R-260.00/27.00 NM (19° 17' 39.87" N (19° 17.664' N) / 100° 01'36.98" W (100° 01.616' W))	CC Range	R-192.00/27.00 NM (18° 53' 32.45" N (18° 53.541' N) / 099° 42'18.80" W (099° 42.313' W))

SECTOR "P"

ID	Start Point	Via	End Point
1	R-130.00/9.00 NM (19° 12' 35.14" N (19° 12.586' N) / 099° 26'37.85" W (099° 26.631' W))	Polyline	R-150.00/20.00 NM (19° 00' 42.66" N (19° 00.711' N) / 099° 24'52.14" W (099° 24.869' W))
2	R-150.00/20.00 NM (19° 00' 42.66" N (19° 00.711' N) / 099° 24'52.14" W (099° 24.869' W))	Polyline	R-144.00/24.00 NM (18° 58' 06.99" N (18° 58.116' N) / 099° 20'50.37" W (099° 20.840' W))
3	R-144.00/24.00 NM (18° 58' 06.99" N (18° 58.116' N) / 099° 20'50.37" W (099° 20.840' W))	Polyline	R-140.00/50.00 NM (18° 37' 03.77" N (18° 37.063' N) / 099° 04'26.55" W (099° 04.442' W))
4	R-140.00/50.00 NM (18° 37' 03.77" N (18° 37.063' N) / 099° 04'26.55" W (099° 04.442' W))	CC Range	R-192.00/50.00 NM (18° 31' 43.38" N (18° 31.723' N) / 099° 50'14.90" W (099° 50.248' W))
5	R-192.00/50.00 NM (18° 31' 43.38" N (18° 31.723' N) / 099° 50'14.90" W (099° 50.248' W))	Radial	R-192.00/27.00 NM (18° 53' 33.82" N (18° 53.564' N) / 099° 42'23.26" W (099° 42.388' W))
6	R-192.00/27.00 NM (18° 53' 33.82" N (18° 53.564' N) / 099° 42'23.26" W (099° 42.388' W))	CC Range	R-184.00/27.00 NM (18° 52' 35.25" N (18° 52.588' N) / 099° 38'32.98" W (099° 38.550' W))
7	R-184.00/27.00 NM (18° 52' 35.25" N (18° 52.588' N) / 099° 38'32.98" W (099° 38.550' W))	Radial	R-184.00/9.00 NM (19° 10' 19.58" N (19° 10.326' N) / 099° 34'55.85" W (099° 34.931' W))
8	R-184.00/9.00 NM (19° 10' 19.58" N (19° 10.326' N) / 099° 34'55.85" W (099° 34.931' W))	CC Range	R-130.00/9.00 NM (19° 12' 35.14" N (19° 12.586' N) / 099° 26'37.85" W (099° 26.631' W))