Enclosure 2

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MITRE

Center for Advanced Aviation System Development

Nuevo Aeropuerto Internacional de la Ciudad de México and Cancún Airport Terminal Maneuvering Area Redesign

An Overview of Implementation Planning

Prepared for

Aeropuertos y Servicios Auxiliares

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Principal Acronyms and Abbreviations

AICM	Aeropuerto de la Ciudad de México
AIP	Aeronautical Information Publication
AIRAC	Aeronautical Information Regulation and Control
ASA	Aeropuertos y Servicios Auxiliares
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Services
CWP	Controller Working Position
EMS	Environmental Management System
FAA	U.S. Federal Aviation Administration
FIR	Flight Information Region
GA	General Aviation
HITL	Human-in-the-Loop
IAP	Instrument Approach Procedure
ICAO	International Civil Aviation Organization
LOA	Letter of Agreement
MITRE	The MITRE Corporation
MMUN	Cancún International Airport
NAICM	Nuevo Aeropuerto Internacional de la Ciudad de México
NAVAID	Navigational Aid
PMT	Project Management Team
SENEAM	Servicios a la Navegación en el Espacio Aéreo Mexicano
SID	Standard Instrument Departure
SMS	Safety Management System
SOP	Standard Operating Procedure
STAR	Standard Terminal Arrival Route
TMA	Terminal Maneuvering Area
U.S.	United States
VFR	Visual Flight Rules

1. Introduction

The MITRE Corporation (MITRE) is supporting Aeropuertos y Servicios Auxiliares (ASA) in its development and implementation of a new airport, referred to in this document as Nuevo Aeropuerto Internacional de Ciudad de México (NAICM), to replace the current Mexico City International Airport (AICM). NAICM is being designed to conduct triple independent parallel approach and departure procedures, which are complex operations never before conducted in Mexico. Cancún International Airport (MMUN), which has two parallel runways appropriately spaced for dual independent arrival and departure operations (refer to Enclosure 3 of MITRE Technical Letter F500-L14-022, dated 28 March 2014 for additional details) offers a unique opportunity within Mexico for preliminary preparation for the operation of independent approach and departure procedures. At MMUN, Servicios a la Navegación en el Espacio Aéreo Mexicano (SENEAM), with the assistance of MITRE, can set-up a dual independent arrival and departure operation test-bed to allow controllers to understand early-on the far more complicated independent operation that is to be expected at NAICM.

The implementation of independent operations, however, requires numerous issues to be addressed, such as:

- Instrument procedure design
- Airspace design
- Air Traffic Control (ATC) equipment acquisition
- Human-in-the-Loop (HITL) simulation activities
- Controller workforce training
- Standard Operating Procedures (SOPs) development

Therefore, in order to assist the aviation authorities of Mexico, MITRE's support includes guidance regarding the complex ATC transition planning and multiple elements, including general equipment requirements, to be considered in preparing for independent arrival and departure operations. Refer to Enclosure 3 of MITRE Technical Letter F500-L15-007, dated 12 January 2015 for additional details.

Previous work conducted by MITRE has resulted in a conceptual airspace design for NAICM. This conceptual design was presented to the Mexican aviation authorities in July 2012. The airspace design work for dual independent arrival and departure operations at MMUN is in the early stages, but will be developed and implemented ahead of the opening of NAICM. Therefore, this document pertains directly to the implementation steps needed at MMUN, as well as at NAICM.

This document highlights the key tasks and projects that must be conducted to turn a conceptual airspace design into reality. It covers the following:

- The general scope and objectives of an implementation plan
- The establishment of a project management structure and team to oversee implementation
- The many factors, components, and tasks that have to be considered when developing an implementation plan
- The considerations concerning the choosing of an implementation date

- The considerations affecting the successful execution of the implementation date
- The immediate post implementation transition period
- The need for post implementation evaluations

The implementation process involves various organizations and requires inputs from experts with diverse backgrounds, such as instrument procedure design, radar system database configuration, controller training, charting and document publication. All this and much more must be planned and coordinated together to reach the ultimate goal of a start date for the implementation of a new airspace design and procedures. For NAICM, this is made more complex by having to schedule the airspace changes with the opening of the new airport, as both must happen at the same time.

It should be noted that there will be many local factors that will also need addressing, including how the airspace design will be formally approved and tested by the Mexican aviation authorities. This will affect the timeline and the actual achievement of the resulting implementation dates. Such factors include the availability of resources and staffing to complete various tasks, the recruitment and training of additional controllers, and the reconfiguration and expansion of the ATC system, particularly if that includes the procurement of additional equipment or the modification or even construction of a new ATC operations room.

Despite many of these local factors, MITRE feels that this document provides useful guidance to the Mexican aviation authorities in its upcoming MMUN- and NAICM-related procedural and airspace implementation efforts. Specifically, this document highlights key tasks and projects that are recommended to be conducted as part of the implementation of a new airspace design, such as the introduction of a new Terminal Maneuvering Area (TMA) in a large metropolitan area like Mexico City, or major airspace redesign and modification of operations at MMUN. Much of the information is based on MITRE's experience of working with the United States (U.S.) Federal Aviation Administration (FAA), as well as other aviation authorities around the world to help in the implementation of airspace design projects, both large and small. This document also provides information and guidance on essential tasks that should be considered regarding the establishment of a project management structure responsible for the planning and implementation of the new airspace designs.

Of necessity, this document has been written in general terms. It is targeted at senior operational and technical managers who are likely to be overseeing such an airspace implementation, as well as technical and operational personnel who are likely to be in charge of specific tasks as part of the larger implementation project. Therefore, the intended audience are those personnel who are knowledgeable about Air Traffic Management (ATM) and its many technical and operational aspects.

The document does not include information related to local requirements in Mexico. Specific Mexican regulations and associated requirements will still need to be considered and met in addition to those mentioned in this document. It should also be noted that, while this document attempts to cover the most important considerations, the list is not exhaustive. Readers are cautioned against relying solely on this document for guidance. Nevertheless, MITRE considers that this document can provide useful information as a basis to start

implementation planning for both the airspace and procedure designs at the Cancún and new Mexico TMAs.

2. General Scope and Objectives of an Implementation Plan

This section briefly describes the general scope and objective of an implementation plan. An implementation plan should be a high-level document that is used to describe all the necessary parts that will contribute to implementing a particular project. It should also describe how the implementation team will be established, and define the project goals, objectives and priorities as well as set the project's scope. The implementation plan should list all of the key considerations and tasks that must be accomplished to achieve the desired goal, but without going into the detail of how those tasks will be achieved. It should establish the necessary communication links between the different tasks and define the roles and responsibilities of key people, in particular those who will be responsible for making key decisions. Most importantly, an implementation plan should establish a *realistic* time line for each task and show how each task relates to the overall objective as well as its relationship to other tasks. Ideally the implementation plan should establish the benchmarks to measure the success of the project and the implementation.

The objective of an implementation plan is not to describe all the tasks and considerations necessary to achieve the project objectives, but rather to provide an overview that would be used by the managers and decision-makers as guidance for implementing a project. The plan should also be used to help understand the inter-relationships between tasks, provide guidance on the necessary communication links that need to be established and to help monitor progress along the agreed timelines. It should also identify important decision-making milestones along the way.

Implementation plans are *living* documents and they will be revised many times over the course of a major implementation project, such as the introduction of a new TMA airspace design. This is a normal part of the implementation process and should not be considered a weakness of any plan that is developed and then modified, but as a strength that helps to manage and realize an important advancement in modernizing ATM.

3. Project Management Considerations

This section discusses the establishment of a project management structure and the setting up of a project management team with specific task teams created underneath. It also highlights the need to avoid *requirement creep* (defined in section 3.3) and for managing risk, establishing communication links and the need for compliance with the local regulatory process.

3.1 Establishing a Project Management Structure

An important part of an implementation plan is to establish the project team and structure whereby key roles are identified and individual people are appointed to fill those roles. This structure allows for the organization of the multiple tasks that are required to be completed on schedule to ensure the project is successful. It is important to provide leadership and to establish the decision making process and the individual(s) who will be responsible for making the key decisions along the way.

3.2 Establishing a Project Management Team

A Project Management Team (PMT) needs to be established under a single leader who will have final decision-making authority. This single leader will report directly to the highest management level within the organization(s) responsible for the implementation.

Under the PMT leader there will be a number of senior managers, each of them an expert in their own technical or operational field who will be responsible for the implementation and completion of specific tasks identified later in the plan. They should each have sufficient authority to make decisions within their field of expertise and to assign staff to complete specific tasks. These are the managers who will be in communication with each other on a regular and detailed basis concerning the progress being made on various tasks, issues being encountered and will make recommendations for changes or adjustments to the implementation plan.

These senior managers will also be responsible for communicating the project goals, strategies and priorities down to the staff actually completing the tasks. At this point specifics are needed to answer the following questions:

- What tasks need to be done?
- Who is doing them?
- When will they be done by?
- What is the dependency between the tasks, both internal to their area of expertise and external with the other areas of expertise?

Monitoring the progress on each of the tasks and intervening to assure project timelines is also an important role of the PMT.

3.3 Avoiding Requirement Creep

It is important in any large project to resist or avoid completely uncontrolled changes or continuous growth in the scope of a project. This growth in scope is often referred to as "requirement creep". It is easy for large-scale projects to expand far beyond the original scope without good discipline from the managers of the implementation plan. Requirement creep can be the road to failure, and result in severe cost overruns, significant delays to implementation and even total failure of the project.

3.4 Managing Risk

In any large-scale project, such as the implementation of a new TMA design, the management of risk is an important factor in ensuring eventual success. This also involves contemplating the complete failure of the project.

A risk is something that *may* happen. If it does happen then the impact it will have on the project must then be determined.

The second thing to consider is what adverse impact the risk will have on the project. Next is to determine the likelihood of it happening. Some risks may be critical, while others will have a lower chance of occurring and lower impact on the project. Having established these two things it is then possible to respond to the risk and to put in place risk mitigation measures.

Lastly, monitoring and controlling risks as time passes is also an important aspect. Some risks will be avoided and will disappear, others may increase their chances of happening or increase their impact. All these factors need to be managed by the PMT.

3.5 Communication

Communicating to others, within the same organization, as well as with other organizations involved in the implementation, and then externally to other parts of the aviation community as well as the public, is all part of managing the implementation project. It is important to communicate not only the good news, but the bad news too. If communication ceases then people become suspicious and make up their own version of events. Communicating early about a delay in completing a task, or a technical issue that has arisen can help ensure the expectations of others are being kept in line with what is achievable.

3.6 Complying with the Regulatory Process

One of the most important responsibilities of the PMT is to understand, coordinate and comply with the regulatory requirements needed to achieve approval for the airspace design to be implemented. It is one of the key factors and it is important that only one or two individuals be made responsible for this. Achieving regulatory approval is a major milestone towards the successful implementation of a new airspace design.

4. Implementation Planning Considerations

This section of the report highlights the key factors that should be considered when planning the implementation of a major airspace redesign, such as a totally new TMA.

4.1 Change Management and Interrelation with Other Projects

The implementation of a major new airspace design or redesign, such as the one being contemplated by the Mexican authorities in Mexico City and Cancún, respectively, is a major change to the operational ATM environment, and as such has impacts across many different fields in ATM. Managing all the changes required to support such an airspace redesign also requires that it be integrated with other projects that may already be ongoing. These other projects might include changes to the ATC system automation, replacement or updating of components of the radar, communications or navigation infrastructure, annual maintenance of aviation infrastructure e.g., runways, radars, and navigational aids (NAVAIDs) to name just a few. Some of these changes may be a part of regional or international agreements or obligations, perhaps being coordinated under the International Civil Aviation Organization (ICAO), where implementation dates are agreed many months or years in advance and cannot be changed. All of this must be taken into account when planning for a significant change in airspace structure and the associated changes to ATC procedures.

In addition, in building the timeline towards an implementation date, it is necessary to monitor the number of changes that occur in the months and weeks immediately prior to, and after implementation of major airspace changes. Controllers need a stable environment in which to operate while they get used to the new mode of operation that the airspace change has brought and to become familiar with the procedural changes that have been implemented. It also takes

several weeks for all the operational staff to be introduced to the changed environment due to staff that may be on vacation, on sick leave, or assigned to temporary duties elsewhere when the airspace change is implemented. If too many changes are introduced in quick succession, or the operational environment is not stable for a period of several weeks or months, this could result in an increase in controller operational errors. This could then result in increasing the risk of an unsuccessful implementation of the new airspace and the necessity to revert back to the old operational environment. Planning implementation of airspace changes needs to consider this and potentially "freeze" any other changes to the overall system and environment for several weeks or even months prior to and after the airspace implementation date.

4.2 Operational Evaluation of the Airspace Design

Operational evaluations of the airspace design are necessary to assess, prior to actual implementation, the effectiveness of the changes being proposed and to determine if the changes will achieve the desired objectives. In addition, evaluations also help to identify any unforeseen effects of the changes, such as creating new issues or moving problems to new locations. These evaluations usually take two forms; fast-time simulations using computer modeling and real-time simulations (also referred to as HITLs) using active air traffic controllers.

In addition, other simulations may also be useful to evaluate particular aspects of the new design, such as using airline flight simulators to test the flyability of proposed procedures or computer modeling and analysis of simulated flight tracks to determine improved climb or descent profiles.

Revisions to the airspace design can be expected from this stage of the implementation process and may introduce the need for additional evaluations to be conducted if the airspace revisions prove to be significant.

4.2.1 Fast-Time Simulation

Many fast-time simulation tools can be used to evaluate a particular airspace design or redesign proposal of the size of the new Mexico and Cancún TMAs. Fast-time simulations can help controllers visualize how traffic will move through the new airspace design as well as help with identifying unforeseen issues, such as new areas of traffic congestion or new areas of route interaction. Fast-time simulations can also assist in analyzing particular aspects of an airspace redesign, and to re-run an operational analysis using simulated traffic to determine the expected benefits of implementing the new airspace structure compared with the current airspace design.

Changes to traffic levels and traffic distribution in the simulation can also be used to test how robust the new airspace design is in coping with increases in traffic, or changes to traffic flow densities. This helps to ensure that the new airspace design will last several years and cope with higher traffic levels before a further airspace redesign becomes necessary once more.

4.2.2 Real-Time Simulation

Real-time simulations are used to test the new airspace design using active controllers in a real-time environment. Tests are conducted using a simulated ATC environment that is as close as possible to the ATC environment that will be used when the airspace changes are implemented. At this stage of the evaluations only minor changes to the design should be

necessary, such as handoff altitudes or minor lateral changes to a route or airspace/sector boundary.

Real-time simulation is a good method to test the coordination procedures between controllers and to ensure that the planned revisions to Letters of Agreement (LOAs) between ATC facilities or other coordination procedures work effectively in the new airspace environment.

4.3 Instrument Procedure Design

One of the first steps in taking an airspace design from paper to reality is to design specific Standard Instrument Departures (SIDs), Standard Terminal Arrival Routes (STARs) and Instrument Approach Procedures (IAPs). These new instrument procedure designs will form the foundation on which the new airspace design will be implemented.

This is typically an iterative process between procedures designers and airspace designers; where procedures designers may not be able to design an arrival or departure procedure that exactly matches those depicted in the original airspace design concept and vice versa. Revisions to the proposed airspace design may have to be made due to obstacles or terrain that could affect particular routes. Such changes to the design, which can be significant, will have to be retested and reevaluated to ensure new route interactions do not cause multiple adverse ripple effects on the overall design and create additional route interactions elsewhere.

The new instrument procedures will be the basis on which documentation and charts (e.g., SID and STAR charts) will eventually be revised and published. It will also be an essential part of the process for obtaining approval from the necessary regulatory authorities for the airspace design to then be implemented.

4.4 Safety Management System Assessment

ICAO recommends that a safety assessment be conducted prior to the implementation of any major change potentially affecting the safety of aircraft operations in order to demonstrate that the change meets an acceptable level of safety.

Additional information can be found in ICAO Doc. 9859.3, *Safety Management Manual* 2013. Particular attention is drawn to Chapter 5 *Safety Management System (SMS).*

Typically, in any safety assessment, three basic questions are being asked:

- What could go wrong?
- What would be the potential consequences?
- What is the frequency of occurrence?

Consideration of these three questions needs to be applied to all the changes being proposed, including items such as pilots selecting an incorrect procedure, to impacts of partial or total system failures.

Once the severity of a particular failure has been assessed, mitigations can then be put in place to ensure an acceptable level of safety. These mitigations may include back-up or fall-back systems, or something as simple as an adjustment to a procedure to assure safety.

Contingency planning and fall-back procedures also need to be considered for the new airspace design as part of the safety management plan.

Much of what is required in order to meet regulatory approval is contained within local laws and regulation. As a minimum, all local requirements will have to be met, and coordination with the airspace and Air Traffic Service (ATS) regulator will be required prior to implementing any change in airspace design or associated procedures. Time to fulfill these obligations will have to be factored in to any implementation plan of the new Mexico TMA that will serve NAICM and surrounding airports, or the redesigned Cancún TMA. An early assessment of the minimum requirements to address this is recommended.

4.5 Contingency and Fall-back Planning

Changes in the ATC system and procedures brings with it potential changes to contingency and fall-back planning in the event of a partial or complete ATC system failure. The existing contingency and fall-back plan may need to be reconsidered and revised if the fall-back ATC facility is no longer adequate to cope with taking over responsibility of managing the new airspace. Consideration may have to be given to splitting a single existing ATC facility (such as a combined Area and Approach Control Center) into two separate buildings, to avoid or limit the chances that both facilities would fail at the same time. This consideration is particularly important for NAICM, and should also be seen in the light of potential security risks as well as potential system degradation and failure. The opening of NAICM will bring a significant expansion to the size of the ATC operation in Mexico City, and bring a consequent need for much larger ATC facilities. Risks of a single point of failure should be minimized where possible.

Internal documentation and agreements will have to be revised that properly reflect the changes to the contingency and fall-back plan. This could also affect the safety management plan and the mitigations in place to maintain adequate levels of safety.

4.6 Environmental Impact

ICAO has not yet developed any specific guidance document regarding Environmental Management Systems (EMS). However, ICAO does recognize that this is a growing concern, and that the aviation sector, including air traffic control, is coming under increasing pressure to balance growing demand in air transportation with the protection of the environment. In 2013, ICAO published a report[1] that looked at some of the common principles and best practices applied around the world, and recommended that specific EMS guidance be developed for member states.

Any airspace changes or change to routes/procedures will have an environmental impact. Principally these will affect noise distribution around the airports that the new airspace design or redesign will serve, as well as affect emissions and fuel burn for aircraft operators. The impact of these changes should be assessed through studies and analyses using appropriate models to better understand the impact of these changes, and to determine if adjustments to the airspace design can be made that would minimize any adverse impacts that may have been identified.

[1] *ICAO Environmental Report 2013, Aviation and Climate Change* 2013

Assessment of the impact of airspace and ATC procedure changes will have to meet local regulations, and will also form part of the regulatory approval process. As a minimum, all local requirements to assess environmental impacts will have to be met, and coordination with the airspace and ATS regulator will be required prior to implementing any change of airspace design or associated procedures.

The time taken for such assessments and for reaching agreement on what will eventually be implemented should not be under-estimated. In the U.S. and elsewhere, conducting environmental impact studies and reaching agreement on the way forward can take many months or even years. This must be factored in to the implementation plan for the new Mexico TMA and the redesigned Cancún TMA, and an early assessment of the minimum requirements to address this is recommended.

4.7 Radio, Radar, and Navigation Infrastructure

An assessment of the radio, radar and navigation infrastructure will be required to ensure that sufficient coverage is provided along all the proposed routes and radar vector patterns. Where it is determined that coverage is insufficient (e.g., due to terrain or for technical reasons) then additional infrastructure may need to be procured and installed prior to the implementation of the airspace change. The time required for such an assessment and the resulting need for additional infrastructure will need to be factored in to the implementation plan for the new Mexico TMA and redesigned Cancún TMA.

Having installed new infrastructure, approval to use this new equipment will be required. The approval decision is based on the testing and checking (e.g., flight checking of NAVAIDS) of the new routes and procedures and has to be scheduled in advance.

Finally, approval for controllers and/or pilots to use the new equipment may require new procedures and operational standards (e.g., application of new separation standards which may require controller and/or pilot training before approval is given by the appropriate authorities). The type of controller and/or pilot training for the new procedures and operational standards will need to be determined and then developed. This will need to be considered in determining a realistic timeline for such activities.

The length of time for the above-mentioned activities can cause a significant delay in the implementation date of either the new Mexico TMA or redesigned Cancún TMA, and an early assessment of the requirements, procurement and training is recommended.

4.8 Airspace Classification

Along with the many changes being considered in routes, ATC sectors, procedures (both pilot and controller) as part of a major new airspace design or redesign, airspace classification cannot be forgotten. This includes, as a natural progression, the potential expansion or modification to controlled airspace boundaries.

Airspace classification defines the level of ATC services to be provided in a particular sector of airspace, as well as sets the rules on aircraft equipage and pilot qualifications needed to operate within that airspace sector.

The relevant authorities need to consult with users and other interested parties on the potential need to change the airspace classification within airspace structures, such as control zones or TMAs and to raise the classification to another (possibly higher) level (e.g., Class D to Class B). This could result in additional equipage being required for some types of flights (e.g., mandatory carriage of a radio or transponder Mode C) or restrictions on certain types of flights (e.g., Visual Flight Rules [VFR] operations). It could also result in additional controller responsibilities to separate types of traffic or provide traffic information to pilots. This could result in increases in controller workload. This may then affect how the new airspace is sectorized, as well as the number of controllers needed to operate the airspace at peak times.

4.9 Hardware and ATC Equipment Requirements

The implementation of a new airspace design, such as a new TMA, will likely (as mentioned above) also introduce new sectorization and the potential need to add more sectors to manage the traffic at peak times. This potentially will require additional Controller Working Positions (CWPs) that will have to be added to the ATC operations room prior to the new airspace design being implemented.

An assessment of this expansion in CWPs will need to be made early in the project to determine if sufficient numbers of spare CWPs exist today to accommodate this expansion or if additional equipment will be required to be procured and installed. This expansion of CWPs may also impact the expected life-cycle of the existing ATC system, particularly if it is reaching the end of its life. A new, more modern ATC system may have to be considered if additional CWPs from the current ATC system are no longer being manufactured.

At worst this assessment of hardware and ATC equipment may conclude that the existing ATC operations room is insufficient to meet future needs and additional space or a new ATC facility may need to be constructed prior to implementing the new airspace design. This is likely to be the case for NAICM.

The results of this assessment could cause a significant delay in the implementation date of the new Mexico TMA or redesigned Cancún TMA, and early assessment of this aspect is recommended.

4.10 Charting, Publication, and Documentation

Prior to implementing the changes involving a new airspace design, new charting and documentation (internal as well as external) will be needed. A new airspace design or a redesign of an existing airspace involves changes to both published procedures as well as internal changes within the ATC facility. Items such as LOAs between ATC facilities, new charts, revisions to the controller SOPs manual and changes to the Aeronautical Information Publication (AIP) are all required to be ready well in advance of the implementation date of an airspace change. A minimum of two Aeronautical Information Regulation and Control (AIRAC) cycles (56 days) is required to implement changes in the AIP for example.

Sufficient time must be allowed for the required changes to documentation to be determined, negotiated and then published. Where changes to procedures or LOAs affect the handling of flights across international Flight Information Region (FIR) boundaries negotiating changes will require significant lead time and should be started as soon as an airspace design is finalized.

An early assessment of the changes required in charting, publication and documentation is recommended.

4.11 Training

The training of air traffic controllers prior to implementing a new airspace design is essential to a successful implementation. Where changes in the airspace design are major, such as a new TMA, or changes in sectorization and procedures are significant, controllers may require a substantial period of training to learn in detail the new environment. This time for training will also be increased if a new ATC system is to be implemented in a new building. Controllers will first need familiarization training on the system itself and its functionality, prior to training in the new airspace design.

Controller training can range in form from classroom briefings, new documentation to study, computer aided training to learn the new airspace structure and practice new procedures, as well as, eventually, a period of real-time simulation to become familiar with the new way of operating or a combination of any of these forms.

The time taken to prepare the materials for this training, the need to develop a new training simulation environment, develop effective training scenarios and instruct the trainers, as well as the time needed in conducting the actual training program across all the affected controllers, should not be under-estimated. This will have to take into account the fact that you are removing active controllers from the existing operational environment, and that current operations must be maintained. Therefore, such training may have to be conducted only during the season when lower traffic levels are experienced, if possible. In addition, the training may have to be reinforced by refresher training immediately prior to implementing the airspace redesign, depending on how long before the implementation date the main training program was conducted.

Such requirements will also affect new students being trained as well as the existing workforce. Students who will join the ATC facility affected by any of the airspace changes will also have to be incorporated in to the training plan. The need to provide additional instructors to conduct the necessary training and oversee the real-time simulation exercises will also need to be factored into the overall training plan.

Training may extend beyond just controllers. For example, if new hardware is being procured and installed, this may require that technical staff are also trained on maintaining the new equipment. Pilot training may also have to be considered, especially if this includes the mandating by the regulatory authorities of new cockpit equipment requirements in the new airspace (e.g., satellite navigation).

4.12 Go/No-Go Decisions

At various critical stages along the timeline of the implementation plan strategic Go/No-Go decisions points should be included. This is to take into account delays or unforeseen events that could affect the implementation of the new airspace design. If, for example, additional CWPs are required to be installed but procurement is delayed, this will impact implementation of the airspace design, even if everything else is ready to move forward. The impacts of such delays should be factored into a revised time plan for implementation as early as possible and decisions

made that may stop continued progress towards implementation until matters have been resolved or an alternative strategy devised.

Such Go/No-go decisions must be made at a sufficiently high level in the management structure, and responsibility for those decisions must be put in place when developing the overall project management structure.

4.13 Publicity and Awareness

Awareness of the impending changes to the airspace structure and the routes to and from the airports the airspace serves will be required well ahead of the actual implementation. This typically takes two forms: pilot awareness and training and informing the general public.

4.13.1 Pilot Awareness and Training

Pilot awareness of changes to the airspace design, procedures and routes is an important factor to the success of the implementation of a new or redesigned TMA. Efforts by the aviation authorities to brief the local pilot community should start well ahead of an implementation date. This extends beyond just professional pilots and should also include General Aviation (GA) pilots. This is especially important if this includes changes to VFR routes, procedures and airspace classifications. Coordination with the management of local airlines that have pilots based at the main airports and who will fly on a regular basis through the new airspace should be made aware of the planned changes early in the process. In some cases airlines may set up their own internal awareness and/or briefing campaigns to notify their pilots and other affected personnel.

Pilots should also be made aware of the temporary necessity to restrict traffic flows in the new airspace to ensure controllers do not become overloaded during the transition while they become used to the new operating environment. These restrictions may cause a temporary increase in flight delays, but typically are lifted in a phased manner as the controllers get used to the new operation and can handle busier traffic levels.

4.13.2 General Public Awareness Campaign

Closer to the implementation date, efforts should be made to make the general public aware of the changes. This is especially relevant for the local communities that maybe affected by changes in routes and flight paths, some of whom will be positively affected and others who may not be. In addition, during the actual implementation day and for several days or even weeks after, traffic volumes may have to be restricted during the transition to ensure that controllers do not become overloaded and become used to the new operating environment. These restrictions may cause a temporary increase in flight delays and the traveling public should be made aware of this to minimize bad publicity in the media.

5. Planning and Execution of an Implementation Date

This section discusses factors involved with choosing an implementation date as well as factors necessary to consider during the execution of an airspace implementation and transition.

5.1 Choosing the Implementation Date

Choosing the implementation date is an important step and can be critical to the success of the whole implementation. Obviously, the implementation date itself must be after all of the planning steps have been successfully completed, new equipment installed, all of the hardware and software testing is completed, and the workforce and pilots are trained on the new airspace design.

Other considerations might include the season or time of year for implementation. Implementing major airspace changes should be done when traffic demand is lowest so that controllers and pilots can get used to the new changes before peak seasonal traffic periods are experienced. However, the date for implementation should not occur at times when disruptions to traffic flows are common, perhaps due to seasonal thunderstorm activity or other weather-related events (e.g., fog). Airport construction or regular maintenance periods of essential NAVAIDs or other essential aviation components should also be considered prior to deciding an implementation date.

5.2 Planning and Monitoring the First Day of Operations

Planning the first day of the new operation is essential if the implementation of the new airspace design is to be successful. Planning down to the nearest minute may be needed where complex changes are being made. Everything from ensuring new equipment is turned on and working to ensuring new radar video maps are operating on the controller's radar screens must be considered.

In addition, the correct flight planning by airlines and the entry of those flight plans into the ATC system may have to be implemented several hours in advance of the actual change in airspace and routes. Checking that essential flight information (such as flight progress strips) is being provided to the correct ATC sectors needs checking and that the ATC system is correctly managing the progress of flights all need to be in place prior to "going live".

As the implementation day progresses, monitoring and fixing issues that arise throughout the day also leads to a successful implementation of a new airspace design. Early monitoring and identification of issues can prevent small issues from becoming bigger problems later on and make or break the success of the implementation.

5.3 Reduced Capacity

Due to the unfamiliarity of both pilots and controllers to the new airspace operation, and the need to maintain safety and workload levels at a manageable level, traffic flow restrictions are commonly put in place to ensure that controllers do not become overloaded. The first few days may require some significant reductions in the usual capacity of the system, perhaps as much as 25%. However, as controllers become more familiar with the operation, and individual issues that may arise with flights during the first few hours of operation (e.g., incorrect flight plans being issued) occur less often these flow restrictions can be gradually diminished and full capacity can be achieved.

If this reduced capacity is timed with a natural period when traffic demand is lower than capacity the reductions in traffic volumes may be minimal or only cause slight impacts during peak times.

For something as complex as the introduction of a new TMA design, capacity levels should have returned to near normal levels within three to four weeks (assuming no unforeseen issues with the design or its implementation).

5.4 Contingency and Fall-back During Implementation

Contingency and fall-back plans need to be developed and considered during the transition period of moving from one airspace design to another. In the early hours of implementing the new design, careful monitoring is needed to ensure that the new airspace design is operating as expected, and that the new procedures are all working correctly. Specific events or system degradation may require a decision to stop implementation and return to the old design. In the case of the opening of a new airport and the closing of the old airport, reverting back to the old design is not possible. A specific process for contingency and fall-back plans, as well as the criteria to revert to the old design should be established prior to implementation of the new airspace design. Specific individuals should be identified who would be responsible for making that decision should events unfold that make the new design unworkable. These events may be related to system degradation if new systems are not working correctly, operational issues with procedures related to sector and airspace design, problems with pilots correctly filing and flying the new procedures and others.

Intermediate degradations or issues may not require returning to the old operation, but may require modifications to the operation, possibly of a temporary nature, until the full operation can be established. A process and management structure should be established during implementation planning to cover potential scenarios.

5.5 Additional Operational and Management Support During Transition

During the initial transition period, typically for the period where traffic flow restrictions may be necessary to manage controller workload at a lower than usual level, additional technical, operational and managerial support may be needed to troubleshoot issues that may arise with individual flights or groups of flights that may be encountering problems. These problems may stem from implementation difficulties, lack of familiarity with the new operation or even the lack of awareness of the new operation.

As controllers become more familiar with the new operation, the flow restrictions can be gradually lifted and the additional operational and managerial support reduced until no major issues are being encountered.

Management oversight needs to be provided on site, with management personnel and/or personnel familiar with the new airspace design in or close to the operations rooms to answer questions and provide guidance on any procedure issue that may arise. This will also be required, in the first few days, during night shifts and over weekends. Procedures for having senior managers and other essential personnel available, or at least on call, should be considered in the initial critical days of operation.

Typically this additional support will last from just a few days to several weeks depending on the size and complexity of the change. For something like a completely new TMA design this extra support would normally be extended over 3 to 4 weeks from the implementation date.

6. Post Implementation Evaluation and Modification

This section highlights the need for further evaluation and modifications to be considered once the new airspace design has been implemented.

6.1 Post Implementation Evaluation

Implementing a new airspace design is not the end of the story. It is necessary to analyze the new operation and determine if the new airspace design has achieved all the desired goals when the original decision to change the airspace was made. This requires an evaluation of the new operation versus either the last evaluation of the old operation or the anticipated benefits from the modeling of the new operation. The same metrics should also be used to determine and quantify the improvements that have been achieved by implementing the new airspace design.

In addition, the new airspace design should be evaluated and any unexpected outcomes identified. These may take the form of the following:

- New traffic congestion points that are causing delays
- Less than expected reduction in delays
- Operational issues related to the airspace design against actual aircraft performance
- Higher than expected interactions between new routes
- Higher than expected coordination requirements between controllers

Feedback from controllers, pilots and available data sources should be gathered concerning the operational issues that are being encountered in the cockpit or ATC operations room. Any incidents that have occurred should be studied, particularly if there are safety concerns. Trends should be studied to determine if these incidents or issues are merely related to the transition to the new operation and decreasing over time, or if there is consistent or increasing numbers of the same issue. The latter would indicate a design issue that will need to be addressed.

6.2 Post Implementation Airspace Modifications

No airspace design or its implementation is perfect, and issues will arise during the transition phase that will have to be addressed on an individual basis. However, if issues are consistently arising in particular sectors or airspace quadrants or relate to particular procedures, then modifications to those sectors or procedures may have to be considered and rapidly implemented. A similar but slimmed-down process to the airspace design process should be conducted and a solution or mitigation considered for the issue identified. Once more–even after the modifications have been implemented–a further evaluation of the airspace design should be conducted to ensure there are not additional problems.

7. Summary and Next Steps

This document has highlighted the multitude of tasks and projects that must be conducted to turn a paper airspace design into reality. This process involves numerous organizations and

requires inputs from experts with diverse backgrounds. All this and more must be planned and coordinated to reach the ultimate goal of implementing a new airspace design.

This document covered the general scope and objectives of an implementation plan, the establishment of a project management structure and team to oversee implementation and discussed in some detail the many factors that have to be considered when developing an implementation plan. It also highlighted considerations concerning the choosing of an implementation date and the successful execution of the implementation. Finally the need for post implementation evaluations were also discussed.

It is now up to the Mexican aviation authorities to come together and make the strategic decision to plan for a major change to the design, route structure and operations within the new Mexico and Cancún TMAs.

Following such a decision, it is important to set up a PMT similar to that described in Section 3. This team needs to include *Servicios a la Navegación en el Espacio Aéreo Mexicano* (SENEAM) along with other organizations (e.g., airlines) providing expert advice as needed. Identification of specific individuals to be put in charge, and to establish a leadership team as soon as possible is strongly recommended. Decision-making powers should be delegated to the leadership team from the highest level in SENEAM.

Having established the PMT, development of an implementation plan should be considered as the first step in determining how the airspace design concepts can be implemented.

Important decisions now need to be made and steps taken by the relevant Mexican authorities to be ready to implement airspace design changes for both a new Mexico TMA and Cancún TMA. These first steps and decisions begin the process of turning an airspace design that is, at this stage (in the case of NAICM), only a concept design on paper, or in the case of MMUN in the early stages of being designed, into actual flight procedures that pilots will fly, and controllers will use to manage traffic flows into and out of NAICM and MMUN for many years into the future.