ICAO MID

ATFM Implementation Workshop

MIDANPIRG Air Traffic Flow Management Implementation Workshop

6 – 7 February 2023, Doha, Qatar

ATFM Implementation Workshop

Doha, Qatar; 6 – 7 February 2023

Agenda:

Item 1: Requirements Reference materials, and Regional Plans (MID Doc 014)

Item 2: MID State ATFM survey results

Item 3: Guidance material:

- Regulation establishment
- Capacity Calculation and declaration
- ATFM structure organizational and Job Tasks
- procedure for information sharing

Item 4: Hands on excelsis

Item 5: Experience from MID States

Table of Content:

Part I:

ICAO Provisions And Regional Requirements

Air Traffic Management (ATM) - PANS ATM

The dynamic, integrated management of air traffic and airspace including ATS, ASM and ATFM — safely, economically and efficiently — through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions.

Air Traffic Flow Management (ATFM) – Annex 11

A service established with the objective of contributing to a safe, orderly and expeditious flow of air traffic by ensuring that ATC capacity is utilized to the maximum extent possible, and that the traffic volume is compatible with the capacities declared by the appropriate ATS authority.

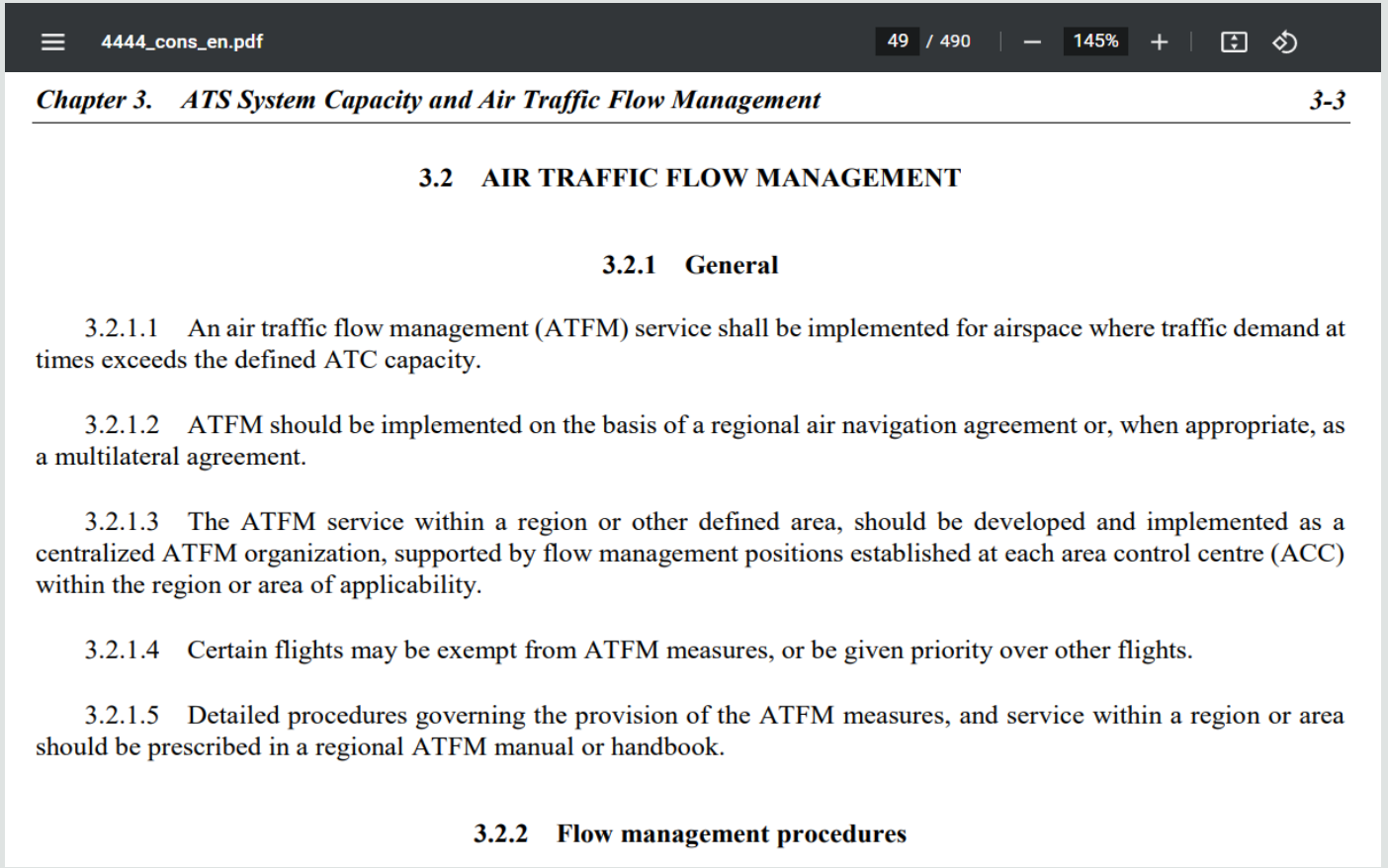
Annex 11, 3.7.5.1

Air traffic flow management (ATFM) **shall** be implemented for airspace where air traffic demand at times exceeds, or is expected to exceed, the declared capacity of the air traffic control services concerned.

Note.— The capacity of the air traffic control services concerned will normally be declared by the appropriate ATS authority.

ATFM Service– PANS ATM

An Air Traffic flow management (ATFM) service **shall** be implemented for airspace where traffic demand at times exceeds the defined ATC Capacity.



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Chapter 3. ATS System Capacity and Air Traffic Flow Management *3-3*

3.2 AIR TRAFFIC FLOW MANAGEMENT

3.2.1 General

3.2.1.1 An air traffic flow management (ATFM) service shall be implemented for airspace where traffic demand at times exceeds the defined ATC capacity.

3.2.1.2 ATFM should be implemented on the basis of a regional air navigation agreement or, when appropriate, as a multilateral agreement.

3.2.1.3 The ATFM service within a region or other defined area, should be developed and implemented as a centralized ATFM organization, supported by flow management positions established at each area control centre (ACC) within the region or area of applicability.

3.2.1.4 Certain flights may be exempt from ATFM measures, or be given priority over other flights.

3.2.1.5 Detailed procedures governing the provision of the ATFM measures, and service within a region or area should be prescribed in a regional ATFM manual or handbook.

3.2.2 Flow management procedures

ATFM PQs USOAP CMA

USOAP CMA 2020 Protocol Questions — ANS Page 28 of 64

PQ No.	Protocol Question	Guidance for Review of Evidence	ICAO References	PPQ	CE
7.081	Does the State ensure that the ATS provider assesses and declares the ATC capacity?	1) Review mechanism to ensure compliance. 2) Review how the State ensures that ATS capacity is reviewed periodically. 3) Sample ATC capacity assessment of control sectors and aerodromes. Note to the auditor: The ATS capacity includes the number of staff required to ensure the adequate provision of an ATS system.	PANS Doc 4444 (ATM) 3.1 GM Doc 9971 Part II, C3 Doc 9426 Part II, Section 1, C1 & App. C		CE-7
7.082	Does the State ensure that air traffic flow management (ATFM) is implemented when air traffic demand at times exceeds, or is expected to exceed, the declared ATC capacity?	1) Review the State mechanism that ensures, when applicable, the establishment and implementation of ATFM service. 2) Review implementation of procedures governing the provision of the ATFM service.	STD A11 3.7.5 PANS Doc 4444 (ATM) 3.2 GM Doc 9971 Part II, C3	Yes	CE-7

Flow control – PANS ATM

Measures designed to adjust the flow of traffic into a given airspace, along a given route, or bound for a given aerodrome, so as to ensure the most effective utilization of the airspace.

Declared capacity - Annex 11

A measure of the ability of the ATC system or any of its subsystems or operating positions to provide service to aircraft during normal activities. It is expressed as the number of aircraft entering a specified portion of airspace in a given period of time, taking due account of weather, ATC unit configuration, staff and equipment available, and any other factors that may affect the workload of the controller responsible for the airspace.

Manual on Collaborative ATFM – ICAO Doc 9971

Doc 9971 was published in 2012 (3rd Edition in 2018)

Part 1 – Collaborative Decision Making (CDM)

Part 2 – Air Traffic Flow Management (ATFM)

Part 3 – Airport CDM (A-CDM)

Part 4 - Operational Handbook (Next edition)

MID ATFM Plan V2.0 - ICAO MID Doc 014

MID DOC 014 - MID ATFM Plan V2.0.pdf (icao.int)

PART I: MID ATFM Framework

PART II: MID ATFM CONOPS

PART III: MID ATFM Common Operating Procedure & Implementation Guidance

MID ATFM - Phase of implementation

Phase IA (1 year)

- ATFM Regulations
- Strategic Capacity-Demand Monitoring & Analysis
- Pre-Tactical Capacity-Demand Monitoring & Analysis
- Pre-Tactical ATFM Execution
- Post-Operations Analysis

Phase IB (1 year)

- ATFM Systems
- Capacity Improvement
- Strategic ATFM Execution
- Pre-Tactical Capacity-Demand Monitoring & Analysis
- Pre-Tactical ATFM Execution
- Tactical Capacity-Demand Monitoring & Analysis
- Tactical ATFM Execution
- Post-Operations Analysis

Phase II (3 years)

- ATFM Systems
- Pre-Tactical Capacity-Demand Monitoring & Analysis
- Tactical Capacity-Demand Monitoring & Analysis
- Tactical ATFM Measures

Part II:

Capacity Management

Capacity Management – PANS ATM 3.1.1.1

The capacity of an ATS system depends on many factors, including but not limited to the followings:

- ATS route structure;
- Navigation accuracy of the aircraft using the airspace;
- Weather-related factors;
- ATCO workload;
- Airspace Sectorization;
- etc.

Capacity Management – PANS ATM 3.1.1.1

Every effort should be made to provide sufficient capacity to cater to both normal & peak traffic levels;

Number of aircraft provided with an ATC service shall not exceed that which can be safely handled.

ATC capacity should be expressed as the maximum aircraft which can be accepted over a given period of time within airspace/aerodrome.

Regulation of ATC capacity & traffic volumes

- Where traffic demand varies significantly, facilities & procedures should be implemented to vary the number of operational sectors or working positions.
- In case of particular events have a negative impact on the declared capacity of an airspace/aerodrome, the operations within the airspace/aerodrome shall be controlled.
- Whenever possible, the capacity related to such events should be predetermined.
- Whenever demand in an airspace/aerodrome is forecast to exceed capacity, measures shall be implemented to regulate traffic volumes

How to optimize Airspace Capacity?

- Airspace Management:
  - ✓ Implementation of FUA
    As elaborated in ICAO Doc 10088 including CDR routes
  - ✓ Implementation of TOS and FLAS
  - ✓ Reduction of airspace complexity and deconfliction by implementation of PBN for:
    - ➢ establishment of parallel & unidirectional airway
    - ➢ split arrival/departure routes as well as entry/exist points

How to optimize Airspace Capacity?

- Reduction of horizontal separation by:
  - ✓ Improvement of COM and NAV infrastructure
  - ✓ Development of Surveillance coverage
  - ✓ Dynamic sectorization
  - ✓ Reinforcement of ATC Competency
  - ✓ Review and update Letter of Agreement

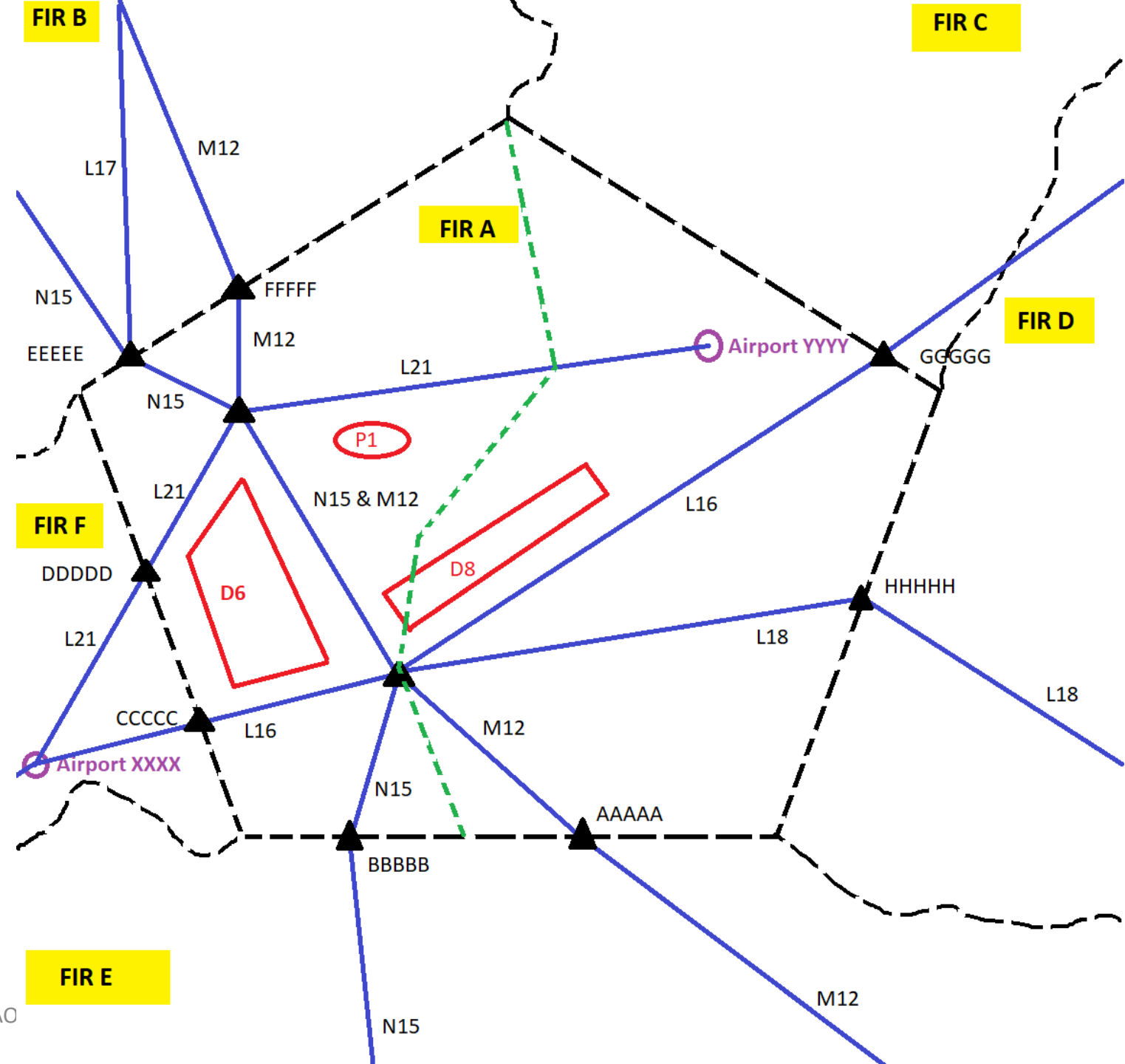
Note: For details, see ICAO Doc 014, Attachment A - Guidelines for Improving Capacity

How to optimize Airspace Capacity?

Case study One

(One hour)

How can we optimize FIR “A” Airspace?



Part III:

Calculation of Capacity

Sector

Primary operational component of the airspace structure that can be considered as an elementary capacity reference of the ATM system. A sector is made up of one or more elementary sectors.

Sector capacity

The maximum number of flights that may enter a sector per hour averaged over a sustainable period of time, to ensure a safe, orderly and efficient traffic flow. Some ANSPs manage sector capacities tactically over a shorter period of time. However, for global assessment purposes, the hourly figure is used as a standard.

Sector group

Group of sectors that strongly interact with each other through close and complex coordination, satisfying the agreed concept of operations.

ACC/sector group capacity:

The theoretical maximum number of flights that may enter an ACC or sector group per hour, over a period of time, without causing excessive workload in any of the sectors. This capacity indicator is used for capacity planning and monitoring purposes and has no operational value. The indicator is calculated mathematically using a validated methodology.

Capacity profile

The evolution of required capacity over the 5-year planning cycle, considering certain assumptions, for a specified volume of airspace (ACC or defined sector group), in terms of absolute demand (flights per hour) and annual percentage increases. These values are published annually and are used as a basis for local capacity planning by ANSPs.

Declared sector capacity or monitoring value

The value the ANSP declares to the FMU as the maximum number of flights per hour that can enter a sector before the application of an ATFM regulation becomes necessary. Several values may exist — depending on the ATC environment at the time (airspace, equipment, traffic pattern, staffing, weather, etc.). The value can change according to the situation at the ACC.

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Airport Acceptance Rate (AAR)

Arrival capacity of an airport normally expressed in movements per hour.

Airport Departure Rate (ADR)

Departure Capacity of an airport normally expressed in movements per hour.

1- Determining Sector Capacity based on FAA Methodology

a) manually monitor each sector, observe and record the average flight time in minutes;

b) after that time is determined:

- multiply that value by 60 seconds in order to compute the average sector flight time in seconds;
- then divide by 36 seconds because each flight takes 36 seconds of a controller's work time; and

Note: *36 seconds is a value established for use in the United States by human factor experts. It represents the average time a controller interacts with a flight while it is in the sector.*

- the result is the sector capacity value (optimum).

$$\frac{(\textbf{average sector flight time in minutes}) * (\textbf{60 } \textit{seconds})}{\textbf{36 seconds}} = \textit{sector capacity value optimum}$$

Example:

a) 20 flights are observed in the sector in 15 minutes;
b) Add the flights individual sector times together 120 minutes;
c) Divide 120 minutes by the 20 flights to obtain the average 120 minutes = 6 minutes / flight;
d) Next, multiply the average sector flight time by 60 seconds (6 minutes / flight) X (60 seconds) = 360 seconds/flight;

e) Next, divide the average sector flight time, in seconds, by 36 seconds;
f) The average sector flight time from above is 360 seconds per flight divide by 36 seconds (the time a controller interacts with a flight) is equal 10 flights
g) 10 flight is the optimum sector capacity value for the 15 minute period.

Adjustments:

The optimum value for a sector is then adjusted for factors such as:

a) airway structure;
b) airspace volume (vertically and laterally);
c) complexity;
d) climbing and descending traffic;
e) terrain, if applicable;
f) number of adjoining sectors that require interaction;
g) military operations; or
h) use Table II-App D-1.

Table II-App D-1. Simplified method	
Average sector flight time (in minutes)	**Optimum sector capacity value (aircraft count)**
3	5
4	7
5	8
6	10
7	12
8	13
9	15
10	17
11	18
12 or more	18

2- ATC Sector Capacity Calculation Model Used in Brazil

This methodology consists in obtaining a value based on a mathematical formula. The basic data for such formula are derived from an investigation carried out by a special working group at the ATC unit, taking into account a busy period in which controller actions and availability to manage control sector traffic are observed and timed; this provides a data sample to be used in the ATC sector capacity calculation methodology.

The number of aircraft that can be controlled simultaneously by a single controller (N) in a given sector is estimated using the following formula:

$$N = \Phi * \delta * (\eta * \tau_m * V_m)^{-1}$$

Φ (availability factor):

The controller availability factor, defined as the percentage of time available for planning aircraft separation procedures; Based on this model, controller workload is the summation of times spent on:

1) communication (transmission/reception);

2) manual activities (filling out flight progress strips) and coordination; and

3) traffic planning and distribution.

Φ (availability factor):

- This availability factor normally falls between a minimum value of 40% of ATCO time for non-radar control, and 60% for radar control.

- It is thus clear that efforts need to focus on increasing the "availability factor" ϕ.

δ (average distance):

Average distance flown by aircraft in the sector, which is a function of the paths and en route or terminal procedures established for each sector;

η (number of communication):

Number of communications for each aircraft in the sector, which must be limited to the least possible number required for an understanding between the pilot and the controller. This number can be minimized by issuing a complete clearance sufficiently in advance for flight planning;

τm (mean communication duration):

mean duration of each message. This factor can be minimized by issuing messages objectively, without long explanations that are detrimental for an understanding between the pilot and the controller;

νm (mean speed of aircraft in the sector)

If δ and νm are replaced with the average flight time of the aircraft in the sector (T), this formula can be replaced with a simpler version:

$$N = \Phi * T * (\eta * \tau_m)^{-1}$$

It is advisable to make at least 30 observations of each parameter (δ, η, τm and νm) for each controller, during peak traffic, respecting the minimum number of controllers specified by the sampling technique used.

Example:

a) Consider T (average flight time in sector) = 12 minutes;
b) τm (mean communication duration) = 9 seconds;
   this time should be expressed in minutes 9/60 = 3/15
c) availability factor = 60%;
d) η (average number of communication for aircraft) = 6;

N = 60%*12* (6*9/60) = 8

In other words, in this sector and under these conditions, a controller would simultaneously control 8 aircraft.

How to calculate Sector Capacity?

Case study Two

(One hour)

Calculate Capacity of the Sector in Surveillance & Procedural environment?

$N = \Phi * \delta * (\eta * \tau m * Vm)^{-1}$	
Φ (availability factor radar ENV)	60%
Φ (availability factor procedural ENV)	40%
δ (average distance)	254 NM
Average number of flight	31.3
η (number of communication)	2.2
τm (mean communication duration)	18.11 S
vm (mean speed of aircraft in the sector)	475 NM/H

Capacity in Surveillance?

Capacity in Procedural?

What is the key factor(s) to increase capacity?

Part IV:

ATFM Measure

ATFM Measure will balance demand vs capacity or assist safe expeditious flow of traffic.

1. Tactical ATFM measures:
   a) Ground Stop (GS)
   b) Miles in Trail (MIT)
   c) Minutes in Trail (MINIT)
   d) calculated time over an arrival fix (AFIX)
   e) calculated time over an en-route fix (RFIX)
2. Pre-tactical ATFM measures:
   Ground Delay Program (GDP) using CTOT
3. Strategic ATFM measures:
   a) Airport slot allocation process
   b) Minimum Departure Intervals (MDIs)

Flow Management Position (FMP)

A position in any ATCC that monitors traffic flows and implements or requests ATFM measures to be implemented".

ATFM Daily Plan

The output of Daily Coordination Conferences is the publication of an ATFM Daily Plan (ADP) and should include subsequent updates. The ADP should be a proposed set of tactical ATFM measures (e.g. activation of routing scenarios, miles-in-trail (MIT)) prepared by the ATFM unit and agreed upon by all partners concerned during the planning phase. The ADP should evolve throughout the day and be periodically updated and published.

Ground Delay Program (GDP)

ATFM process where aircraft are held (Delayed) on the ground in order to manage demand in a specific volume of airspace or at a specific airport. In the process, departure times are assigned and correspond to available entry slots into the constrained airspace or arrival slots into the constrained airport.

Miles in Trail (MIT):

A tactical ATFM measure expressed as the number of miles required between aircraft (in addition to the minimum longitudinal separation requirements) to meet a specific regulation which may be separation, airport, fix, altitude, sector or route specific.

MIT is used to organize traffic into manageable flows as well as to provide space to accommodate additional traffic (merging or departing) in the existing traffic flows. It will never be less than the separation minima.

Minutes in Trail (MINIT):

A tactical ATFM measure expressed as the number of minutes required between successive aircraft. It is normally used in airspace **without air traffic surveillance** or when transitioning **from surveillance to non-surveillance** airspace, or even when the spacing interval is such that it would be difficult for a sector controller to measure it in terms of miles.

Arrival Fix (AFIX):

A waypoint during the arrival phase of a flight. In the context of ATFM it could a waypoint where an ATFM Measure may be applied.

Arriving flights will be measured for compliance at a fix prior to landing. If a flight's actual time over (ATO) the fix is within the compliance window of the flight's CTO for the fix, the flight will be considered compliant. In addition, flights that are late to the fix due to an ATC constraint will not be considered non-compliant.

En-route Fix (RFIX):

A waypoint during the en-route phase of a flight. In the context of ATFM it could a waypoint where an ATFM Measure may be applied.

For ATFM measures relating to airspace demand and capacity balancing, compliance may be measured against the CTO at en-route fix (RFIX).

State experience PPTs:

- Iraq - GCANS
- Oman
- Qatar
- Saudi Arabia - SANS

Sample of Establishment of National regulation content:

- Compliance with National Roles/regulation making process
- Introduction part including approval process, document control and References to national Air law and ICAO SARPs
- Authorization to establish, implementation, change and decommission.
- Scope and area of applicability of the ATFM service: ANSPs, Aircraft operators, Type of operations, geolocation limits and operating hours.
- Date of applicability, pre notification is required.
- Entities involved: ANS, ASM, AIM/AIS, Airport operations and slot coordinators, CMC, MET, ATFM unit.
- Organizational (structure, job task description) and Human resource (training) requirements
- List of ATFM definitions
- Framework: specific ICAO Requirements, agreement on National policy/principle including the main objective of ATFM unit (control traffic beyond the declared capacity in control areas according to the unit declared capacity and supporting in optimizing and enhancing the capacities.
- Definition of obligation and requirements of each entity.
- Requirements for establishing Common operating procedures between the parties involved (manual or document) containing policies, requirements, parameter, procedures, publications requirements, exemptions, and penalties.
- Monitoring and performance assessment requirements
- reporting and record keeping requirements
- Guidance material including regulation compliance matrix
- Implementation support guidance materials

Sample of ENR 1.9 content:

Air traffic flow management (ATFM) and airspace management

Brief description of ATFM system and airspace management, including:

1. ATFM unit details: Structure, Applicability area, operating hours, services provided and contact details.
2. Flight planning requirements,
3. ATFM messages type, format and descriptions,
4. Coordination procedures (including distribution of the ADP, exemptions, penalties).

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Thank you

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