Report No. FAA-CT-81-188

DOLC 10734739

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GRAPHIC AIR TRAFFIC CONTROL STUDY OF THE MEXICO CITY TERMINAL AREA

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JUL 27 1981
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PROJECT PLAN

July 1981

Prepared for

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
TECHNICAL CENTER
Atlantic City Airport, N.J. 08405

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1. OBJECTIVE.

The specific objective of this study is to analyze and improve, through the use of graphic study techniques, the capability of the Mexico City terminal area to accommodate existing and projected air traffic demands.

2. BACKGROUND.

The Republic of Mexico Secretaria De Comumicaciones Y Transportes Servicios A La Navegacion En El Espacio Aereo Mexicano (henceforth referred to as SENEAM), requested assistance from the Government of the United States of America, represented by the Federal Aviation Administration (FAA) of the Department of Transportation, in an analysis of the capability of the Mexico City terminal area to accommodate existing and projected air traffic demands.

In response to this request, an agreement was written and signed on February 20, 1981, between the Director General SENEAM and the Director of International Aviation Affairs of the FAA. This agreement (NAT-I-1027) specified that the FAA would assign to this effort experts in the field of air traffic control, flight procedures, graphic simulation, and airport engineering for a period of approximately 6 to 9 months. The agreement also stipulated that the FAA and SENEAM mutually would establish the study design which would include the key objectives of the study, the scope of the project (especially the extent of graphics studies), and the sequence of tasks.

The FAA has responded to this request with the assignment of personnel with the above named specialties, and efforts have commenced in the formulation of the study plan.

3. RELATED DOCUMENTATION/PROJECTS.

The following significant documents relate to this graphic study, involving air traffic control (ATC) procedures and the Mexico City terminal area route structure:

a. FAA Order 7110.65B Air Traffic Control Handbook.

b. International Civil Aviation Organization (ICAO) Document 4444-RAC/501/10, Procedures for Air Navigation Services Rules of the Air and Air Traffic Services.

c. FAA Order 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS).

These documents will govern the new procedures and route structures which will be developed during the study. There are currently no other related efforts in progress. This graphic study will parallel a graphic study which was conducted for the Las Vegas, Nevada, terminal area in 1977. The Las Vegas Graphic Study, Final Report No. FAA-RD-77-182, was published in January 1978, and was conducted by FAA Technical Center personnel between January and February 1977, to assist in comparing newly developed procedural plans in the Las Vegas terminal area.

4. SYSTEMS/EQUIPMENT DESCRIPTION.

No hardware or software systems or equipment are required by this study. Recommendations shall be made during the development of new concepts or procedures for Mexico City terminal area ATC. These recommendations include the placement of additional navigational aids (VOR, VORTAC, ILS, ETC.) and adding or relocating control positions and equipment within the combined Center/RAPCON (CERAP).

5. TESTING AND DATA COLLECTION.

A graphic study, as distinguished from a dynamic study, has, as its basis, all the planning effort that normally precedes a dynamic simulation. It omits only those requirements that are levied by the implementation of the procedural plans in a dynamic facility environment. It includes the development of routes, the definition of control procedures, the assignment of airspace, and the attempted resolution of problem areas. The dynamic simulation is required for the finer adjustments to procedures necessitated by real-time traffic demands and for the collection of data relative to controller workload, system efficiency, and system capacity, which would be used as a measure of comparison between air traffic control systems. The graphic study will use teams of experts to compare and rank the proposed design alternatives.

Personnel required to accomplish this task are to be provided by SENEAM with consultative services from project team personnel of the FAA Technical Center, ATC Applications Branch, ACT-210, with support from other elements of the Technical Center. Consultative service will also be obtained from the FAA Southwest Region's Evaluation Branch, ASW-520; the FAA Southwest Region's Airports Division, ASW-601; and FAA Flight Standards Service, Washington, D.C., Flight Procedures and Airspace Branch, AFS-730. Note: Since this is a Technical Center effort, the Technical Center will assume the complete responsibility and accountability for the technical product it will deliver to the Office of International Aviation Affairs (AIA).

The graphic study of the Mexico City terminal and en route air traffic control areas will be accomplished in three phases. The first phase will delineate the principles to be utilized by the planning groups. These groups of experts will establish and weigh the salient factors in the system design alternatives. The second phase will define the procedures for the movement of air traffic under the system design alternatives. The last phase will compare the system alternatives using the questionnaire data. The results of this study will be presented in a formal briefing to representatives of SENEAM and the FAA Office of International Aviation Affairs. The final report on the graphic study of Mexico City will rank the system designs that were investigated by the teams of experts and delineate possible problem areas. The formal briefing is planned in Mexico City 5 months after the start of Phase II.

5.1 PHASE I.

The teams of air traffic controllers, who will be assigned the task of designing new procedural plans for the control of air traffic in the Mexico City terminal area, will require ground rules under which they will function. These ground

rules will need to stipulate, among other things, the runway configurations and directions of operations which they are to consider while designing their new procedures.

The decisions and approval of the assumptions and ground rules were made by personnel from SENEAM. These ground rules will be adhered to equally by all planning teams during the conduct of the planning or development portion of this study.

During meetings with the SENEAM and FAA Technical Center personnel, it was agreed that the new plans for the control of air traffic in the Mexico City terminal area would be accomplished upon the following configurations:

a. Present airport runway configuration; new operational procedures for two directions of operation (runway 5 and runway 23); present air traffic distribution.

b. Present airport runway configuration; new operational procedures for two directions of operation (runway 5 and runway 23); Mexico City air traffic to be segregated by rerouting all general aviation, air taxi, and charter operations to the Santa Lucia and Toluca airports.

c. New airport runway configuration (new parallel runway); new operational procedures for two directions of operation; Mexico City air traffic to be segregated by rerouting all general aviation, air taxi, and charter operations to the Santa Lucia and Toluca airports.

The ground rules which were agreed upon by SENEAM officials that are to be adhered to by the planning groups are:

a. Navigational Aids. New navigational aids (NAVAID's) may be established or existing NAVAID's relocated in order to obtain maximum utilization. Siting will be coordinated closely with the Flight Standards personnel assigned to the development teams.

b. Separation Standards. Separation standards as outlined in the FAA Order 7110.65B shall be utilized for departure and arrival traffic in the Mexico City terminal area.

c. Approach Aids. New approach aids for the Benito Juarez, Santa Lucia, and Toluca airports may be considered.

d. Noise Abatement Procedures. Existing noise abatement procedures are to be followed.

e. Special Military Operations. Only the military operations existing today are to be considered during the planning.

f. Helicopter Operations. Route structures to accommodate helicopters in the Toluca, Santa Lucia, and Mexico City airport vicinity should be considered in Plans B and C.

g. Radar Coverage. Existing radar coverage patterns throughout the Mexico City study airspace are to be utilized. New terminal radar systems can be

considered for the Mexico City, Santa Lucia, and Toluca airports. Microwaving of existing en route radars to the Mexico City CERAP can be considered, as well as new en route systems.

h. Sectorization. Sectorization of the Mexico City control airspace can be modified to accommodate new traffic flows. This includes the establishment of new control positions, as well as changing control boundaries of existing sectors in both the en route and terminal areas.

i. Meteorological Conditions. Weather conditions at the airports involved in the study will be considered to be such as to accommodate both Instrument Meteorological Conditions (IMC) and Visual Meteorological Conditions (VMC) operations.

j. Traffic Flows. Coordination with adjacent facilities will be required if changes to existing preferential routes are made or new routes are developed which could affect current letters of agreement.

k. Tower En Route. Inclusion of tower en route procedures between the Toluca and Santa Lucia airports may be considered in Plans B and C.

SENEAM was also informed during the initial meetings, held in Mexico City, that the Technical Center personnel would develop a "Project Plan." This document outlines the effort, the step-by-step accomplishment of the work, and a schedule for the accomplishment of the task.

A group of air traffic control specialists was assembled in Mexico City on Friday, April 24, 1981, to perform the task of determining the weighting and ranking of "factors" that significantly affect an air traffic control system. These specialists (representatives of SENEAM) represented a cross section of operational and supervisory experience in the Mexico City terminal area. The factors are elements of air traffic control that take into consideration the users, controllers, and area. Through individual polling and discussion, this team, with the assistance of members of the FAA Technical Center's project team, established the factors that would be used and attached a ranking of importance, from the most to least, and a weight or numeric value. The sum of the numeric weights of all factors equals 100.

Following is the list of the factors and their weights as determined by the weighting and factoring team. These will be applied by the rating team in determining the results of this study:

a.	Airspace	20
b.	Controller Workload	13
c.	Navigational Aids	12
d.	Coordination	11
e.	Traffic Mix	10
f.	Routes	9
g.	Interaction	8
h.	Altitude/Speed Restrictions	7
i.	Communications	5
j.	Radar Vectors	4
k.	Noise Abatement	1
		100

Definitions for the above factors can be seen in appendix A, the sample rating questionnaire which will be utilized by the rating team in their determination of the results.

5.2 PHASE II.

Three groups of seven air traffic controllers were assigned to develop procedural plans for the control of air traffic in the Mexico City terminal area. Each of the three teams was assigned a specific task for development of procedures for certain configurations. Group or team assignments were as follows:

a. Group A.

Development of new procedural plans for the present Mexico City airport configuration, two directions of operation, and present air traffic configuration.

b. Group B.

Development of new procedural plans for the present Mexico City airport configuration, where air traffic is to be segregated by restricting all general aviation, air taxi, and charter operations to Santa Lucia and Toluca airports.

c. Group C.

Development of new procedural plans for the new Mexico City airport configuration (new parallel runway) with air traffic segregated by restricting general aviation, air taxi, and charter operations to Santa Lucia and Toluca airports.

The three groups will work independently. Coordination among the groups will be allowed to ensure some comparability with the concepts and proper preparation. The planning groups will:

a. Provide descriptions of the various controller areas of jurisdiction.

b. Indicate all altitude descriptions.

c. Describe all feeder fixes.

d. Make drawings or sketches for traffic flows for each direction of operation.

e. Describe all Standard Terminal Arrivals (STAR's) and Standard Instrument Departures (SID's) developed.

The planning or design teams will be afforded a period of 3 weeks (15 working days) to accomplish their task. Work of the three planning groups will be conducted concurrently. Each of the planning teams provides a spokesperson who, at the completion of the allotted time, will be responsible for providing a detailed briefing of the procedural design developed by his team. All planning team members should, if possible, be present during the briefings and rating period to answer any questions.

FAA Technical Center personnel will be present during some portion of the time the planning or design teams are developing their procedural designs. The Technical Center personnel will lend assistance and assure that the documentation and preparation of the designs of each team are done in a consistent manner for presentation to the raters and for inclusion into the final report.

Documentation of the procedural designs will consist of:

a. Control Positions and Responsibilities. A brief description of each position area of jurisdiction (figures or illustrations acceptable) and briefing narrative of the position function.

b. Radar Arrival Procedures. A brief description of the arrival flow from each inbound route along with altitude restrictions.

c. Description of STAR's (if applicable).

d. Radar Departure Procedures. A brief description of the departure flow for each departure route along with all pertinent altitude restrictions.

e. Description of SID's (if applicable).

f. Produce briefing charts depicting all traffic flows for each airport and each runway configuration. It will be from these charts that the team spokesperson provides the briefings to the rating team.

At the expiration of the allotted time for the development of plans or designs, a panel of at least 12 air traffic control specialist raters will be activated. The members of the rating panel will have been chosen by SENEAM officials and provided with a reporting date. This group will be comprised of representation from SENEAM, air traffic controllers from the facility of the Benito Juarez airport, Santa Lucia airport, and from the adjacent air route traffic control facilities. None of the personnel assigned will have been actively engaged in the project nor will they have been provided with information relative to the rank or weighting of factors developed by the weighting and factoring team.

The rating team's services will be required for the period of time it takes to complete the rating process. From the scope of this effort, it is estimated a minimum of 3 days will be necessary.

On the first day of the rating process, the FAA Technical Center project manager will brief the rating team on the purpose of the study and the responsibilities and duties of the rating team. In addition the rating team will be given a comprehensive briefing on the operational plans which are developed by the spokesperson for each of the planning/development teams

After completion of the comprehensive briefings, the rating questionnaires will be distributed. The FAA Technical Center representatives (project manager or team representative along with a data analyst) will discuss with the raters the definition of terms and description of highlights along the 10-point scale on the questionnaires.

The rating questionnaire (appendix A) was developed by Technical Center project personnel. Inputs to and approval of this questionnaire were made by an operational analysis expert who was assigned to this effort.

To ensure that each rater has a complete understanding of each plan, a general review of each plan, by factor, will be conducted prior to the rating of each factor. The raters will be provided sufficient time to rate each factor, as well as to make pertinent comments on each of the questions. The FAA Technical Center's project manager or representative will co-chair this meeting along with a co-chairperson from SENEAM. Because this process is time consuming, debates concerning the various plans or procedures will be limited to a time agreeable to SENEAM personnel.

Upon completion of the questionnaires, the FAA Technical Center team will gather the questionnaires, and they will be returned to the Technical Center for analysis.

6. DATA REDUCTION AND ANALYSIS.

6.1 PHASE III.

Ratings will be given to a number of criteria; factors held to be important by a weighting and factoring team. This team will assign a priori weights to the criteria. The ratings will be given on a questionnaire to be completed by the evaluation group of controllers, with a representation balanced according to the proportion of user groups affected by the different airport configurations. The rating group will also weight the criteria following the ratings. Appendix B is the weighting questionnaire, which is to be added as the final item to the rating questionnaire developed for this study and is the proposed means of accomplishing this weighting.

Interrater reliability will be determined for the a priori, for the user, and between the a priori and the user weightings. Given suitably high reliabilities, the weights can be used to combine the individual criterion ratings into a single figure of merit for the entire configuration. Nonparametric statistical tests, such as binomial sign test, rank-order correlation, Friedman two-way analysis of variance, chi square tests, etc., will be applied to the data to determine significance of differences and interrelationships between the weightings and the ratings. Following the appropriate statistical tests, interpretations and graphical depictions of the data will be made.

7. INSTRUMENTATION AND FACILITIES.

None required.

8. COORDINATION AND AREAS OF RESPONSIBILITY.

Personnel from the FAA Technical Center's ATC Applications Branch, ACT-210, will have the responsibility of managing and conducting the graphic study. Team members

from ACT-210 will also assist the SENEAM development teams in developing the procedural plans along with assuring that the documentation of each of the plans is accomplished in a like format.

An analyst from the FAA Technical Center's Systems Integration Branch, ACT-230, will be responsible for statistically analyzing the data collected during the rating process to determine the preferred plan of the rating team. The analyst will write the portion of the final report that pertains to the test design and provide assistance on the interpretation of the analysis of the results.

A representative of the FAA Southwest Regional Office, Evaluation Branch, ASW-520, will be responsible for assisting the three planning/development groups, as necessary, with ATC procedural problems. This representative will also be responsible for assisting in the review of the final report.

A representative of the FAA Southwest Regional Office, Airports Division, ASW-601, will be responsible for assisting the SENEAM airports personnel with new airport runway and taxiway designs as needed.

A representative of the FAA Flight Standards Service, Washington, D.C., Flight Procedures and Airspace Branch, AFS-730, is responsible for assisting each of the planning/development groups with their designs with respect to criteria contained within the FAA Order 8260.3B, (TERPS).

Cartographers from the FAA Technical Center's Printing and Illustration Section, ACT-63C, will have the responsibility for preparing graphical illustrations of the traffic flows which are developed for each of the operational plans in a manner acceptable for publication in a final report. It will also be the responsibility of ACT-63C personnel for the preparation of charts containing the statistical data in a manner for presentation in a final report.

9. SCHEDULE.

Phase II (Development of Three Operational Plans)	June 9 - July 24, 1981
Phase II (Rating Period)	August 3 - August 7, 1981
Phase III (Data Analysis)	August 10 - September 25, 1981
Phase III (Formal briefing to the Office of International Aviation Affairs (AIA))	Week of November 16, 1981*
Phase III (Formal briefing to SENEAM)	Week of November 30, 1981*
Phase III (Final Report to AIA)	December 31, 1981

* No firm date has been established as of the writing of this document.

APPENDIX A

RATING FORM FOR FACTORS OF THE MEXICO CITY TERMINAL AREA
GRAPHIC STUDY

NAME _____ RUNWAY _____
FACILITY OR OFFICE _____ DATE _____

This form will be used to record your evaluation of the three plans (A, B, and C) under one direction of operation. Please use the following letter identification when rating the plans:

A = Present Runway Configuration, New Operational Procedures.

B = Present Runway Configuration, New Operational Procedures, General Aviation and Air Taxi/Charter Operations to Santa Lucia and Toluca.

C = New Runway Configuration, New Operational Procedures, General Aviation, Air Taxi and Charter Operations to Santa Lucia and Toluca.

In rating each factor, choose a point on the scale that most accurately reflects your opinion of the plan under consideration. Place the left edge of the letter identifier at the chosen point. Highlights under each scale (at 1, 4, 7, and 10) are provided to assist you in determining the exact value. Your comments will help in the final evaluation. Please record them in the space provided.

1. ROUTINGS - Structure of the arrival and departure paths as well as overflights.

1	2	3	4	5	6	7	8	9	10
Inadequate structure			Partially inadequate structure			Partially adequate structure			Adequate structure

COMMENTS: _____

2. CONTROLLER WORKLOAD - Number of aircraft that can be handled by a sector, on a given moment, and the complexity of operations.

1	2	3	4	5	6	7	8	9	10
Inadequate distribution and overly complex operation			Inadequate distribution and complex operation			Equitable distribution			Equitable distribution minimum complexity with capacity to increase operation

COMMENTS _____

RATING FORM (Continued)

NAME _____ RUNWAY _____

3. RADAR VECTORS - Need of vectoring in the arrival or departure procedures.

1	2	3	4	5	6	7	8	9	10
Entirely dependent			Heavily dependent			Moderately dependent			Minimally dependent

COMMENTS: _____

4. NAVIGATIONAL AIDS - Distribution of navigational aids in the terminal area, and their correlation in the procedures.

1	2	3	4	5	6	7	8	9	10
Inadequate distribution and correlation			Partially inadequate distribution and correlation			Partially adequate distribution and correlation			Adequate distribution and correlation

COMMENTS _____

5. COMMUNICATIONS - The requirement to change from one frequency to another due to complex sectorization.

1	2	3	4	5	6	7	8	9	10
Excessive changes			Frequent changes			Minimum changes			No changes required

COMMENTS: _____

RATING FORM (Continued)

NAME _____ RUNWAY _____

6. AIRSPACE - Related to the vertical and or horizontal for each sector.

1	2	3	4	5	6	7	8	9	10
Inadequate airspace			Limited airspace			Adequate airspace			Adequate airspace for increase of operations

COMMENTS _____

7. ALTITUDE/SPEED RESTRICTIONS - Number and/or duration of such restrictions.

1	2	3	4	5	6	7	8	9	10
Excessive number and/or duration			Frequent and/or of long duration			Moderate number and/or duration			Minimum number and/or duration

COMMENTS: _____

8. INTERACTION - The effect of one position's or airport's operation on another.

1	2	3	4	5	6	7	8	9	10
Excessive interaction			Heavy interaction			Moderate interaction			Minimum interaction

COMMENTS: _____

RATING FORM (Continued)

NAME _____ RUNWAY _____

9. TRAFFIC MIX - Utilization of common procedures for different types of aircraft or same airport.

1	2	3	4	5	6	7	8	9	10
Inadequate procedures			Partially inadequate procedures			Partially adequate procedures			Adequate procedures

COMMENTS: _____

10. NOISE ABATEMENT - Refers to the existing plan of noise abatement, which affects the procedures.

1	2	3	4	5	6	7	8	9	10
Overly restrictive			Moderately restrictive			Lightly restrictive			Non-restrictive

COMMENTS: _____

11. COORDINATION - Needed interchange of information and its effect on the system.

1	2	3	4	5	6	7	8	9	10
Excessive coordination			Heavy coordination			Moderate coordination			Minimum coordination

COMMENTS: _____

APPENDIX B

WEIGHTING SCALE FOR FACTORS OF MEXICO CITY STUDY

NAME _____ DATE _____

FACILITY _____

On the basis of the forms which you have just completed, we would like to answer the question, "Considering everything, how good is this version of the Mexico City terminal area ATC system?" We could add the 11 ratings together and divide by 10 to get an average, but it is likely that you consider some of the factors more important than others. Simply averaging them would give them all equal importance. This form will be used to record your estimate of the relative importance (the larger the weight, the greater the importance) of each of the 11 factors to the overall goodness of the Mexico City terminal area ATC system.

To aid in the rather difficult task of weighting, the following approach is suggested. First, select the three factors you consider most important and place a 1 in the three selected rows in the RANK BY 3RDS column. Next mark the least important factors by writing three 3's in the same column. Finally, place 2's in the remaining four spaces to indicate the factors of moderate importance. The factors within each of the thirds can now be ranked. Look at those marked with 1's and rank them from "most important = 1" to "least important = 3" by placing the appropriate digit in the RANK WITHIN column. Rank within the second and the third 3rds in the same manner. The COMBINED RANKS should range from 11 (most important) to 13, from 21 to 25, and from 31 to 33 (least important). Now, transform these rankings to a serial ranking such that 11 = 1, 12 = 2, 13 = 3, 21 = 4, 22 = 5 and so on until 33 = 11. Mark these in the SERIAL RANK column. Finally, assign your weights to the aspects. The weights should add up to 100. If all the weights were equal, each factor would be given 100 divided by 11 = 9.09 points. A general guideline is that the more important should be weighted more than 10 points and the less important less than 10 points. If the weights do not reflect your true opinion, make changes until they do. Please write in pencil.

	COMBINED RANKS					
FACTOR TO BE RANKED AND WEIGHTED	RANK BY 3RDS	RANK WITH-IN	SERIAL RANK	WEIGHT 1ST TRY	WEIGHT 2ND TRY	WEIGHT 3RD TRY
1. ROUTINGS						
2. CONTROLLER WORKLOAD						
3. RADAR VECTORS						
4. NAVIGATIONAL AIDS						
5. COMMUNICATIONS						
6. AIRSPACE						
7. ALTITUDE/SPEED RESTRICTIONS						
8. INTERACTION						
9. TRAFFIC MIX						
10. NOISE ABATEMENT						
11. COORDINATION						
			TOTALS			