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Simulation Tests of Instrument Flight Rule Operations in the Detroit Metropolitan Area

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SIMULATION TESTS OF INSTRUMENT FLIGHT RULE OPERATIONS IN THE DETROIT METROPOLITAN AREA

SUMMARY

This report describes simulation tests of some methods of controlling instrument flight rule operations in the Detroit metropolitan area under conditions of various traffic densities at Willow Run and Detroit Metropolitan Airports.

All tests were conducted through the use of the dynamic air traffic control simulator at the CAA Technical Development Center. Tests indicate that with any appreciable change in the present distribution of traffic at Willow Run and Detroit Metropolitan Airports, feeding fixes other than those presently in use should be adopted. A system using new feeding fixes that can be established from the presently available navigational facilities is recommended. An improved method of routing eastbound flights departing Willow Run and Detroit Metropolitan Airports was developed.

Also tested was a concept of a common instrument flight rule room to serve Willow Run, Detroit Metropolitan, Detroit City, Windsor, Ontario, Pontiac, and Navy Grosse Ile Airports. The common instrument flight rule room concept applied to this area appeared very feasible.

A map study of an improved route structure to handle the heavy traffic that flows between the New York and Chicago terminals and operates through the Detroit area is presented.

INTRODUCTION

In February 1958, the CAA Office of Air Traffic Control requested the Technical Development Center (TDC) to conduct simulation tests of the Detroit, Michigan, air route traffic control area. The test period was scheduled to begin on June 1. Due to modifications of the dynamic air traffic control simulator, during the entire month of June, the tests were rescheduled to commence on July 14, 1958.

On June 3, representatives of the Washington office of CAA, Region 3, and five controllers from TDC met at the Detroit Air Route Traffic Control (ARTC) Center to formulate plans for the simulation program. Discussion was held on the present and some future problems of the area, and of the assumptions to be made in the simulation tests. These general assumptions under which the simulation tests were made are

1. The holding airspace area as defined in TSO N20A would remain unchanged.

2. The New York-Chicago traffic was assumed routed via Victor Airway 218.

3. There were adequate air/ground/air communications between control facilities and all flights.

4. There was adequate radar or secondary radar coverage in the area simulated.

5. Civil jet aircraft were controlled in a conventional manner unless approach delays were excessive. Holding at 20,000 feet and above was practiced only if delays were excessive.

6. Civil jets were operated into Willow Run and Detroit Metropolitan Airports.

7. Airway structure assumed to be based only on VHF navigation aids.

8. Flights entering and departing the Selfridge RAPCON area assumed to do so in level flight. All necessary altitude changes would take place within the RAPCON area and would be controlled by that facility.

The five controllers from TDC spent several days observing traffic operations in the Detroit ARTC Center and the other control facilities in the area. Many of the problems discussed did not appear to lend themselves to solution by dynamic simulation, and some were beyond the scope of the simulation time and equipment available. It therefore was decided after the June 3 meeting to formulate the following objectives for the simulation tests·

1. Determine the effect of the increase in traffic operations at Detroit Metropolitan Airport that will take place in the fall of 1958 when American Airlines move their operation from Willow Run Airport to Detroit Metropolitan Airport. If this increase in traffic at Detroit Metropolitan Airport is found to have a detrimental effect upon present traffic control operations, find a solution that could be accomplished without the addition of new equipment or navigational aids and that could be used this fall.

2. Devise a route structure that would be compatible with southwest instrument operations at Willow Run and Detroit Metropolitan Airports. Currently, the routing of eastbound flights departing Willow Run Airport present a serious problem to the Detroit ARTC Center during periods when southwest operations are in effect at these airports.

Although front-course approaches (landings and takeoffs to the northeast) are at the present time the rule rather than the exception, it is possible that future instrument flight rule (IFR) operations to the southwest may increase. The wind condition present under low-cloud and low-visibility weather is predominantly from a northerly through an easterly direction, but in good weather conditions the wind direction generally is from the southwest. The present trend toward positive control could mean

many more IFR takeoffs to the southwest at Willow Run and Metropolitan Airports. This is especially true of the new civil jets, which will of necessity demand the longest runway, refuse to take off downwind, and probably will not operate on VFR flight plans in this area. Also, from a noise-abatement standpoint, takeoffs to the southwest are more desirable than those to the northeast because of the geographical location of the airports with respect to the city of Detroit.

3. Test procedures to expedite the departure of south- and southwest-bound aircraft from Detroit City and Windsor Airports.

4. Test radar procedures for use in the Detroit City approach control area including approach control service at the Pontiac Airport.

5. Test the concept of a common IFR room to control instrument flight operations in the entire Detroit metropolitan area.

6. Test the effect of rerouting the New York-Chicago traffic via the Peck VOR.

It was requested by the CAA Washington office and Region 3 representatives that a proposed airport site northeast of the city of Detroit be included in the simulation tests. A study of the site location indicated its close proximity to Selfridge Air Force Base (AFB) RAPCON area. The northeast corner of the proposed site is located within that RAPCON area, which would have required the simulation of Selfridge air operations if a realistic appraisal was to be made. Simulation time and equipment capacity did not allow this item to be included in the tests.

Operations at Pontiac Airport, located approximately 28 statute miles west of Selfridge AFB, were simulated at the request of Region 3 personnel. There now are a number of instrument-equipped aircraft based at this airport and a VOR is to be sited on or near this airport in the near future. Approval of an instrument approach with landings to the east is anticipated by Region 3 personnel.

Simulation tests were commenced on July 14 and concluded on August 7, 1958. A total of 36 test runs was made in which approximately 4,000 aircraft flights were simulated. Approximately 20 per cent of these were civil jet types.

EVALUATION METHODS

Measurements.

Traffic delay, airport acceptance rate, and communication data were taken during the simulation tests and used whenever possible as a means of determining the merits of the various systems being tested. However, because of the many variables in this large simulation test, it not always was possible to accomplish sufficient test runs to furnish results that were statistically valid.

The controllers who participated in the en route area tests were personnel from the Detroit ARTC Center who had received no training in radar vectoring or radar control procedures prior to this program. It was evident that the controllers still were learning even in the last few days of the en route tests, and for this reason, the measurements of communications time and aircraft delay were not considered valid.

In the terminal area tests, the controllers were experienced radar controllers and the learning factor was not present to any great extent. However, there were many experimental terminal area systems to test in the limited period of five days, so that it was not possible to make the required number of repeat runs to make the results statistically valid.

Communications and delay data for the present terminal system and terminal area system A are presented in Fig. 1. It is believed that these results are a good indication of the relative communication workload and control efficiency of the two systems. In the terminal area system A, delays averaged about one-third of the delays in the present system.

Controller Opinion.

A large part of the simulation results are based upon the judgments of the controllers participating in the simulation program. Each of the tower controllers completed a questionnaire at the conclusion of every terminal area test, and this was used as a basis for evaluating the tests.

At the conclusion of the en route tests, a critique was held and a tape recording made of all the opinions expressed by the controllers who had participated in the tests. The opinions and recommendations expressed were relied upon to a large extent in the evaluation of the results of the tests.

Traffic Samples.

The Detroit ARTC flight progress strips of two recent, moderately busy days were analyzed and the four busiest hours of each day were used to determine the percentage of traffic utilizing the various airways in the area. The density of the en route traffic simulated was approximately the same as that of the peak hours of the analyzed operations. The arrival and departure traffic of the Detroit metropolitan area was increased in density to show more readily any bottlenecks in the various systems being tested.

Two high-density traffic samples were constructed for use in the terminal area phase of the simulation tests. In one of the samples the distribution of traffic between Willow Run and Detroit Metropolitan Airports was equal. In the other sample, 80 per cent of the flights were operated from Metropolitan and 20 per cent from Willow Run. These samples were approximately 1 hour and 15 minutes in length, and consisted of 75 aircraft of which 20 per cent were civil jets.

The traffic sample used in the en route tests was 2 hours in length and consisted of 235 flights of which 20 per cent were civil jet types. In the tests where arrivals and departures were operated simultaneously, this sample was reduced to meet the capacity of the simulator. The capacity is approximately 75 operations per hour with 24 targets in operation. Table II shows the distribution of the flights in this sample.

TERMINAL AREA TEST PROCEDURES

The first week of simulation was devoted exclusively to the terminal area tests. For further study, they were continued in conjunction with the en route tests during the succeeding three weeks of simulation. One of the primary objectives of the tests was to determine a workable system that should be satisfactory as soon as a portion of the air carrier operations now at Willow Run Airport moves to Metropolitan Airport.

Systems Tested.

Three basic systems were tested· present terminal system, Figs. 2 and 3, terminal system A, Figs. 4 and 5, and terminal system B, Figs. 6 and 7. Location identifiers, applicable to all maps, are listed in Table I. The present terminal system tests were conducted using current rules and restrictions. Terminal system A was altered several times and the rules and restrictions revised to improve the system.

Terminal system B, which is a variation of terminal system A with a parallel runway alignment at both airports, also was tested. This system utilized the same route structure and the same restrictions as terminal system A.

Traffic Samples.

Two traffic samples were compiled using present peak day IFR traffic taken from actual flight progress strips. The arrival traffic was increased by approximately 25 per cent. Twenty per cent of the total traffic was civil jets of DC-8 and Boeing 707 types. Traffic sample 1 was an equal division of traffic between the two airports. Traffic sample 2 was approximately a reversal of present traffic, with 80 per cent of the traffic utilizing Detroit Metropolitan Airport.

Equipment.

Approach control utilized three simulated ASR scopes, as shown in Fig. 8. One was used for Willow Run arrival radar, one for Metropolitan arrival radar, and one for combined departure control position. During the en route tests, a fourth scope was installed in another room to simulate Detroit City approach control, as shown in Fig. 9.

Present System.

The present system, as shown in Figs. 2 and 3, was tested with an east and a west radar arrival controller and one radar departure controller. In the present system, the east controller and a west controller exchanged aircraft that were being vectored through their area to the opposite airport.

For example, an aircraft inbound from the east and terminating at Willow Run Airport was vectored by the east radar arrival controller to a point midway between the airports, then passed to the west controller who completed the vector to the Willow Run localizer course. Inbound aircraft from the west terminating at Metropolitan Airport used the same procedures only in the opposite direction.

Supplemental Controller Duties.

Because of the heavy workload in traffic sample 2, in which 80 per cent terminated at Metropolitan Airport, an extra approach controller was used to assist the east radar arrival controller. His duty was to make all initial radio contacts and descend inbound aircraft to the lowest available altitude. In addition, he metered out the aircraft to the radar vector controller as needed. During the en route portion of the tests, the Center retained control of all arriving aircraft with the exception of the two aircraft next in altitude sequence, which were given to approach control on request.

Clearance Limits.

Inbound aircraft from the east were cleared to the New Boston intersection for a front-course approach. Inbound aircraft from the west and northwest were cleared to Salem, Bridgewater, and Milan intersection for a front-course approach and Stony Creek and Salem for a back-course approach.

Aircraft terminating at Detroit City, Pontiac, and Windsor were cleared to Windsor, Claire, or Pointe from the east and southeast, and Plains, Auburn, and Pontiac from the west and northwest and southwest. Detroit City approach course had, in effect, only one altitude, 3,300 feet. Most departures were tunneled past the inbounds, except eastbound traffic on Victor Airway 221 which crossed the 315° radial of Windsor omnirange at 4,300 feet or higher. One radar departure controller vectored all departures.

Terminal System A.

Terminal system A, as shown in Figs. 4 and 5, utilized a Willow Run radar arrival controller, and a Metropolitan radar arrival controller instead of the east-west division of control used in the present system. One radar departure controller was used in all tests. On traffic sample 2, in which 80 per cent of the traffic terminated at Metropolitan Airport, an extra controller assisted the Metropolitan radar arrival controller.

Clearance Limits.

All inbound aircraft arriving from the east and terminating at Metropolitan Airport were cleared to Flat Rock intersection, which is the intersection of Victor Airways 133 and 98. The same feeder fix, Flat Rock, was used for either front-course or back-course approach. All east arrivals that terminated at Willow Run were cleared via Victor Airway 116 at 6,000 feet to Salem VOR.

All inbounds from the west were cleared to Bridgewater intersection if they terminated at Willow Run Airport, and to Milan intersection if they terminated at Metropolitan Airport.

Back-Course Approaches.

During back-course approaches, arrivals on Victor Airway 90 to Bridgewater intersection were recleared to the Willow Run TVOR by approach control, and arrivals on Victor Airway 10 to Milan intersection were recleared to Metropolitan outer marker. East arrivals were cleared to Flat Rock intersection for Metropolitan Airport and Salem VOR for Willow Run Airport.

Front-Course Approaches.

During front-course approaches, the east arrival clearance limits were the same as back-course approaches with one exception, in which aircraft cleared to Salem were recleared to Stony Creek by approach control. West arrivals were vectored from Bridgewater intersection to Willow Run Airport and from Milan intersection to Metropolitan Airport.

Minimum holding altitude at Salem, Willow Run TVOR, and the Metropolitan outer marker was 5,000 feet. Minimum altitude at Flat Rock was 4,500 feet during back-course approaches.

Detroit City Approach Control Area.

A VOR was established at Pontiac Airport. For the purposes of simulation, an instrument landing system (ILS) and radar arrival control were established at Detroit City approach control. Feeder fixes were realigned at Windsor, Claire, and Pointe with 2,000 feet minimum altitude. Feeder fixes were established at Pontiac VOR and on Detroit City back course at Ferndale. The Detroit City arrival radar controller vectored aircraft to final approach course for Pontiac, Detroit City, and Windsor Airports. A five-mile marker was established on final approach courses at Pontiac and Detroit City Airports. Detroit City approach control was given all altitudes through 5,000 feet within their control jurisdiction. The control boundaries were similar to those used in the present system and the approach control area included the Pontiac Airport control zone.

Departure Routes.

West departures on both front- and back-course approaches utilized the existing tunneled route of the 300° radial from Willow Run TVOR until they intersected Victor Airway 116 or Victor Airway 170 On back-course approaches, departures from Willow Run maintained 2,000 feet and Metropolitan departures did not turn northwest-bound until reaching 3,000 feet. South, southeast, and east departures maintained 2,300 and 3,300 feet until clear of the Flat Rock pattern.

Low-Altitude Control.

During front-course approaches, Toledo departures were routed direct to Flat Rock, Victor Airway 133, ARTC radar vector, or a radial of Waterville VOR to Victor Airway 275. A 3,000-foot minimum altitude pattern was established at Dundee as a clearance limit for low-altitude controlled aircraft from Toledo.

ARTC released all aircraft terminating at Willow Run or Detroit Metropolitan in the Detroit area to approach control at Windsor when approaching Salem, Milan, and Bridgewater.

Terminal System B.

This system, shown in Figs. 6 and 7, was very similar to terminal system A. The main difference was that a jet runway at Willow Run was established parallel to the instrument runway at Metropolitan Airport.

Front-Course Approaches.

On front-course approaches, Willow Run arrivals were cleared to the Willow Run TVOR from the east and to Bridgewater from the west. East arrivals to Metropolitan were cleared to Flat Rock and west arrivals to Azalea, which was the intersection of Victor Airway 10 and the front course of the realigned instrument runway at Willow Run.

Back-Course Approaches.

On back-course approaches, east arrivals were cleared to the Willow Run TVOR. East arrivals to Metropolitan were cleared to Flat Rock. West arrivals were cleared to Azalea and recleared by approach control to Metropolitan VOR via Victor Airway 10 and the front course of the Metropolitan localizer. Departure routes and restrictions were the same as those in terminal system A.

EN ROUTE AREA TEST PROCEDURES

General.

In order to devise a route structure that would permit back- or front-course approaches at Detroit Metropolitan and Willow Run without adverse effect upon en route control, the following changes in traffic flow and airway structure were made:

1. Westbound traffic from the New York area to Chicago was routed via the proposed Victor Airway 218.

2. Westbound traffic from Erie landing in the Detroit area was routed via Victor Airway 116.

3. Northwest-bound traffic from Cleveland landing in the Detroit area was routed via the proposed airway formed by the 358° radial of Cleveland VOR and the 124° radial of Windsor VOR.

4. Eastbound traffic landing at Willow Run and Detroit Metropolitan Airports was segregated west of the terminal area with the Detroit Metropolitan traffic routed via Victor Airway 10 and Willow Run traffic routed via Victor Airway 90

5. When front-course approaches were in progress, departing aircraft destined for the New York area were routed via Victor Airway 26 and Victor Airway 10.

6. When back-course approaches were in progress, departing aircraft destined for the New York area were routed via Carleton VOR and Victor Airway 10.

7. Victor Airway 84 was considered abrogated.

Four controllers and two assistant controllers from the Detroit ARTC Center were detailed to TDC for these tests. After a period of radar training, these controllers assumed the duties of radar controllers. The assistant controllers were used to prepare target markers and perform interphone coordination with the three towers concerned.

Test runs were made simulating back- and front-course approaches at Willow Run and Detroit Metropolitan Airports for both the present airway structure and the modified system. These route structures are shown in Figs. 10 to 13, inclusive.

Operational Layout.

An area within a radius of 50 nautical miles of Detroit Metropolitan Airport was covered by simulated radar This area was divided into departure and arrival radar sectors.

During the period when combined arrival and departure operations were conducted, a total of four sectors was simulated. These were designated as East Arrival, West Arrival, East Departure, and West Departure. During the portion of the test when airway saturation was desired, it was necessary to run either the arrival or departure traffic due to the limited number of targets available. East or west sectors then were designated as shown in Figs. 14 and 15. These sectors were furnished with a SPANRAD display, interphone, and air/ground communication facilities. Willow Run, Detroit Metropolitan, and Detroit City towers were equipped with departure and arrival radar scopes plus interphone and air/ground communications.

Departure Tests.

The traffic sample used in this portion of the simulation tests consisted of 76 departing aircraft per hour. These aircraft were assigned altitudes in accordance with direction of flight in order to simulate realistic traffic conditions. Blocked altitudes were simulated at appropriate fixes. Departure tunneling, when used, was held to a minimum. Target markers for departure traffic carried flight identity, the requested altitude, and one fix identifier to indicate the route of flight. Departures were issued short-range clearances to an altitude and fix that would allow an uninterrupted climb while being handed off from tower to center radar.

Arrival Tests.

The density of this traffic sample was the same as the departure sample. Blocked altitudes were simulated as necessary and traffic was fed into the holding fixes and released to approach control in a realistic manner. SPANRAD target markers, rather than flight progress strips, were used to supply the controller with flight data. These markers carried

flight identity, route, altitude, type, and clearance limit. Center/tower coordination duties were performed by the assistant controller assigned to the sector.

Combined Arrival and Departure Tests.

The traffic sample used for this test consisted of 76 operations per hour. As in the other tests described, all aircraft were afforded positive separation. The control methods and equipment used for this portion of the tests were similar to the other tests.

COMMON IFR ROOM TEST PROCEDURES

Operational Layout.

Four en route radar sectors, consisting of east and west departure sectors and east and west arrival sectors, were used. Due to the limited equipment available, four controllers worked at one SPANRAD and were aided by two assistant controllers. Three terminal arrival controllers utilized another SPANRAD located about ten feet away from the en route sectors. One controller vectored aircraft to final approach at Willow Run Airport, one to Detroit Metropolitan and Navy Grosse Ile Airports, and the other to Detroit City, Windsor, and Pontiac Airports. All sectors were furnished with adequate interphone and air/ground communications.

The tower departure control function was conducted by three controllers in another room. Tower departure controllers were furnished with radar scopes, interphone, and air/ground communications. Coordination between tower and en route departure controllers was accomplished through a "Hand-Off" circuit. Coordination between the en route controllers and the terminal arrival controllers was effected by direct conversation. The en route assistant controllers were used to assist the controllers and to pass traffic information between sectors.

Traffic Sample.

The traffic sample consisting of 76 operations per hour of combined inbound and outbound traffic was used for this portion of the simulation. Table II shows the distribution of this traffic among the various airports in the Detroit metropolitan area.

TERMINAL AREA TEST RESULTS

Present System.

The approach controllers using the present terminal system, shown in Figs. 2 and 3, were involved continuously in the transfer of aircraft to each other. For example, an east arrival terminating at Willow Run Airport was cleared to one of the east feeder fixes by the ARTC Center, the east radar approach controller then vectored the aircraft across the Metropolitan Airport localizer course to the area between the localizer courses, and, after due coordination, either continued the vector to the Willow Run localizer course or transferred control to the west radar arrival controller, who completed the vector. At the same time, the west radar

arrival controller was following the same procedure with aircraft from the west that were destined to land at Metropolitan Airport. The result was that the number of aircraft that could be controlled safely and efficiently was necessarily small. This placed the burden of controlling the reservoir of landing aircraft upon the ARTC Center instead of approach control. The result of this procedure was that the approach controller did not have sufficient aircraft under his control at all times to assure optimum spacing at the runway.

Front-Course ILS Approaches.

Identification of targets at the New Boston intersection was difficult because it was located at the Metropolitan Airport outer marker. Aircraft in the New Boston holding pattern often were on identical courses in the same area as aircraft on final approach to Metropolitan Airport. When the traffic was equally divided between the two airports, the difficulty of proper identification of targets became evident.

In tests using traffic sample 2, with approximately 80 per cent of the traffic terminating at Metropolitan Airport, the targets were so numerous at New Boston intersection that radar identification was impossible. This caused a complete breakdown of the system. This system did not utilize the valuable vector area on the east side of the Metropolitan localizer course. All of the east arrivals were compressed into the relatively small area between the Willow Run and the Metropolitan localizer courses.

Back-Course ILS Approaches.

When back-course approaches were in progress, all east arrivals were cleared to Park intersection instead of New Boston. The vectoring area was so small that fast aircraft, especially jets, overshot the allotted area. Many of the approach paths extended northeast across Victor Airway 42 and in some instances, were over Detroit City Airport. On northeast departures over Midcraft and Warren, jet-type aircraft experienced difficulty in crossing Victor Airway 42 at sufficient altitude to clear Detroit City approach control area. Apparently this occurs at present with some conventional northeast-bound departures on Victor Airway 221, since the 4,300-foot minimum crossing altitude for northeast departures had to be extended from the Detroit City area boundary to the 315° radial of Windsor VOR. This point is approximately three miles inside the Detroit City control boundary.

Effect on the ARTC Center.

During the en route portion of this test, the terminating aircraft at Park intersection had to maintain altitudes as high as 16,000 feet. Long delays were experienced, especially at the Windsor VOR. This system entails a tremendous amount of coordination between both arrival radar approach controllers and air route traffic controllers.

Terminal System A.

Front-Course ILS Approaches.

Moving the feeder fix from New Boston, which is used during front-course approaches in the present terminal system, to Flat Rock in

system A improved the vector pattern and eliminated any overloaded target areas. Also, this left the west side of the Metropolitan localizer course for west arrivals from Milan and Dundee. Toledo departures were routed via either a 180° heading from Flat Rock intersection until intersecting the 205° radial of Waterville and then direct to Waterville VOR, or Flat Rock intersection and Victor Airway 133 to Detroit River and a radar vector to Victor Airway 275.

Back-Course ILS Approaches.

Terminal system A was a vast improvement over the present system. Using Flat Rock intersection instead of Park intersection gave the arrival radar controller much greater latitude for spacing and vectoring. The larger vectoring area made it unnecessary to violate the Detroit City approach control area.

Controller Workload.

The controllers found that the new feeder fixes facilitated vectoring operations. Coordination between radar controllers either was reduced to a minimum or eliminated entirely. The traffic flow from the east was found to be the heaviest. The extra controller who assisted the Metropolitan radar controller, especially when 80 per cent of the traffic was terminating at Metropolitan Airport, reduced the east controller's workload considerably. With an additional approach controller it was possible for the Center to relinquish control of all arriving terminal traffic on entering the terminal area. This reduced the Center controller workload and provided the radar vector controller with sufficient aircraft at all times for optimum spacing of arrivals. The aircraft spacing chart used to obtain optimum separation between successive aircraft on radar vector to the outer marker is shown in Table III.

The Willow Run controllers were concerned about holding at the Willow Run TVOR because of the anticipated area of nonradar coverage. This was estimated to be approximately a 3-mile radius at 5,000 feet over the antenna site. Should this be objectionable, it is suggested that the fix be relocated at the Willow Run outer marker.

Delays in both the front- and back-course tests were less in system A than in the present system. Communication workload also was less, as is shown in Fig. 1.

Terminal System B.

The advantages were similar to those of system A. Having parallel localizers greatly improved the back-course ILS vector areas and controller workload was decreased accordingly. The parallel runway configuration made possible a more completely independent operation at both airports.

The approach controllers all agreed that either terminal system A or B should increase the efficiency of the terminal area radar control. An east and a west radar departure controller should be a distinct advantage over the single departure controller used especially during

peak periods. Terminal systems A and B gave Detroit City approach control unlimited use of their area which they do not have today, having only one usable altitude for both arrivals and departures.

EN ROUTE AREA TEST RESULTS

Landing Traffic From the East.

Present System.

Aircraft inbound from the east via Victor Airway 10 and aircraft from the southeast via Victor Airway 26 converged at Pelee intersection and followed a common route to the single holding fix that served both Willow Run and Detroit Metropolitan Airports. Descent into the holding fix was complicated by over traffic on Victor Airway 116 and by eastbound departures on Victor Airway 224.

Modified System.

In this system, aircraft inbound from the east proceeded via Victor Airway 116 over Windsor, at which point this traffic converged with traffic from the southeast routed via the proposed Victor Airway 42. Windsor also served as a common divergence point for traffic proceeding to the individual holding fixes which served Willow Run and Detroit Metropolitan Airports. This resulted in an orderly flow of traffic to these fixes. In devising this system, consideration was given to increasing the climbing distance of eastbound departures prior to meeting crossing traffic.

Landing Traffic From the West.

Present System.

Aircraft from Chicago Midway Airport proceeded via Victor Airway 90 to either Bridgewater or Stony Creek intersection. Traffic from Chicago O'Hare and Milwaukee Airports was cleared to the Salem VOR via Victor Airway 2.

These routings offered no major problems with the present traffic density at Willow Run and Detroit Metropolitan Airports. Terminal tests indicated that segregation of traffic destined for Willow Run and Detroit Metropolitan Airports was necessary for an optimum flow of traffic into those two airports. This was accomplished by routing traffic landing at Detroit Metropolitan Airport via Victor Airway 10 to the Milan intersection. Although this change in routing increased the workload of the Detroit ARTC Center, it was believed that the over-all efficiency of traffic control in the area was improved due to the favorable acceptance rates of the airports resulting from this arrangement of clearance fixes.

Northeast Takeoffs From Willow Run and Detroit Metropolitan Airports En Route to New York Area.

Present System.

It was found through simulation that civil jet aircraft taking off to the northeast and proceeding to the New York area via Victor Airway 221 were unable to reach an altitude of 4,700 feet before reaching the Detroit City approach control area. Aircraft performance characteristics were determined from the best current information available. Penetration

of Detroit City approach control area at any altitude below 4,700 feet restricted that facility to the use of one altitude level for maneuvering all traffic. Flights on this airway also restricted military flights in the vicinity of Selfridge AFB. Use of this airway also complicated the control of Pontiac arrivals from the southeast modified system.

Aircraft using this system were routed via Victor Airway 26 to Pelee intersection, then via Victor Airway 10 eastward. During heavy traffic conditions, a tunnel restriction of 4,000 feet or below was necessary until past the holding pattern at Flat Rock intersection. Beyond this point, crossing traffic was not encountered until Trout intersection was reached, a distance of 40 nautical miles. Tests showed that crossing altitudes at Trout of 9,000 or 11,000 feet were reasonable.

Southwest Takeoffs From Detroit Metropolitan and Willow Run Airports En Route to New York Area.

Present System.

Under present system procedures, aircraft proceeded over the Carleton VOR, then via Victor Airway 224 to Tilbury intersection, and via Victor Airway 116 over Erie. This route crosses Victor Airway 26, the inbound routing to Park intersection, 20 nautical miles east of Carleton, resulting in a difficult traffic control situation due to interference between climbing and descending aircraft.

Modified System.

Departing aircraft proceeded over the Carleton VOR, then eastward on Victor Airway 10. This improved the traffic control situation because departures encountered no crossing traffic before reaching the proposed Trout intersection, 65 nautical miles from the Willow Run Airport. Controller opinion indicated that a radio fix located on Victor Airway 10 at the Detroit/Cleveland ARTC boundary was desirable for use as a definite point at which the control of aircraft can be transferred from one ARTC Center to the other.

Departures From Detroit Metropolitan and Willow Run Airports En Route to the West or Northwest.

Present procedures utilized the 300° and 315° radials of the Willow Run TVOR as routings to the desired airway for both southwest and northeast takeoffs. These routings proved satisfactory and also were used in the modified system.

Departures From Willow Run and Detroit Metropolitan Airports En Route to the South or Southwest.

Present System.

Northeast Takeoff: These aircraft proceeded directly to the Carleton VOR with tunnel restrictions as necessary until past Carleton. With increased traffic at Detroit Metropolitan Airport, this procedure was unusable due to penetration of the vector area.

Modified System.

Northeast Takeoff These aircraft were cleared southeast via Victor 133 and then vectored by ARTC radar to Victor Airway 275. Tunnel restrictions until past the holding pattern at Flat Rock were found necessary during heavy traffic conditions.

Present System.

Southwest Takeoff. With the present traffic distribution, aircraft proceeded direct to the Carleton VOR with few restrictions. However, with more traffic flowing into Detroit Metropolitan from the west, tunnel restrictions should be necessary.

Modified System.

Southwest Takeoff This system normally required a tunnel of 4,000 feet or below until past the Carleton VOR due to traffic inbound from the west landing at Detroit Metropolitan Airport.

Eastbound Over Traffic.

Present System.

Flights en route from the Chicago area to the Boston area were routed via Victor Airway 10. These aircraft utilized altitudes that offered little interference to arrival or departure traffic.

Modified System.

This traffic flow remained as described in the present system and presented even less problems when controlled by radar.

Westbound Over Traffic.

Present System.

The westbound traffic proceeding over the Detroit metropolitan area was not simulated dynamically in the tests of the present system since it was assumed to be operating on Victor Airway 218.

Flights en route from the New York area to the Chicago area presently are routed via Victor Airway 116 through the Detroit terminal area. This route passes through the vector area of both Willow Run and Detroit Metropolitan Airports when back-course approaches are in progress and conflicts with the airspace of the holding pattern at Park intersection. These aircraft also complicate the control of climbing and descending terminal traffic.

Modified System.

The modified system includes removal of this traffic to Victor Airway 218. This routing alleviates the difficulties mentioned previously and makes additional altitudes available in the terminal area.

Detroit City and Windsor Departures to the South and Southwest.

The location of Detroit City and Windsor Airports, with respect to heavily traveled inbound and outbound routes of the two major airports of this area, did not lend itself to the establishment of independent egress routing to the south or southwest. Simulation tests resulted in no improvement of this situation.

Radar control appears to offer the best means of expediting and separating this traffic. Present procedures utilize the services of Willow Run radar departure control, when workload permits, to furnish radar separation until the aircraft have departed the Detroit terminal area and are established en route. A more efficient operation should result with transfer of this operation to the Detroit ARTC Center. Radar guidance, clear of the Willow Run terminal area to the desired airway, proved feasible during simulation tests. The common IFR room operation appeared to offer more efficient control of these aircraft due to the inherent coordination advantages.

COMMON IFR ROOM TEST RESULTS

Although the limited time available did not allow thorough investigation of this control system, the following facts were readily apparent

1. Time required for coordination between controllers was short due primarily to the close physical proximity of the radar displays.

2. Transfer of target identity from one controller to another was easy to accomplish.

3. Traffic information was relayed between controllers quickly and requests for altitude changes and other pertinent control data were handled in the same manner.

The approach control portion of this operation was very satisfactory. The controllers were pleased with the presentation of the daylight radar display. The 27-inch display was large enough to accommodate the three radar arrival controllers easily and facilitated any coordination necessary. If the results of these brief tests are any criteria, the common IFR room may be particularly adaptable to the Detroit area.

Problems caused by south- or southwest-bound departing traffic from Detroit City Airport still were present, but according to controller opinion, were easier to control. Detroit controllers, both tower and Center, were favorably impressed by this method of operation and expressed the opinion that the Detroit area seem well-suited to this concept.

GRAPHIC SIMULATION STUDIES

Personnel from Willow Run and Detroit Metropolitan towers, the Detroit, Cleveland, and New York ARTC Centers met with TDC personnel at TDC during the week of June 16, 1958. A map study of the major traffic flows through the Detroit area with respect to the surrounding areas was undertaken by this group. Figure 16 shows a possible future route system derived from this study.

The New York-Chicago Routes.

The heavy traffic flow between Chicago and New York terminals was given considerable study. A new high-altitude route, Victor 1600, shown in Fig. 16, appears as a possibility for high-altitude eastbound flights, including jets, from Chicago O'Hare Airport. Approximately three miles of the northern portion of restricted area R-149 is necessary for this route.

The westbound routing via Victor Airway 218 over the Peck VOR and the eastbound route via Victor 1600 offer a possibility of increasing airway capacity to handle the forecast increase in traffic and the future jet operations. It also appears to coincide with the future route structure being planned by Region 1. The westbound route via Victor 218 removes a large amount of traffic from the Detroit Metropolitan area, thus permitting the Detroit ARTC Center to provide better service for aircraft arriving and departing the Detroit terminals.

The new facilities and changes necessary for such a future route structure are as follows

1. A new H - VORTAC at Hillsdale, Mich.
2. A new H - VORTAC at Battle Creek, Mich.
3. Relocate Litchfield VOR.
4. Gain the use of approximately the northernmost three miles of restricted area R-149.

Remote Radar.

This study indicated the possible requirement of a remote radar site to provide radar coverage of the Litchfield, Pullman, and Keeler area. This area has many crossing routes and is a climb-and-letdown area for high-performance aircraft operating between Chicago and terminals to the east. These crossing points are difficult to control under ANC rules. Radar procedures appear to be a solution to the problems associated with the densities likely to be present during peak traffic conditions. With the advent of civil jet operations at Chicago O'Hare Airport, this area will be increasingly difficult to control without radar procedures. Simulation time did not permit the development and testing of these procedures. Close coordination between the Chicago and Detroit ARTC Centers appears necessary to utilize such a remote radar. Direct interphone lines between radar controllers in both ARTC Centers may be necessary.

Cleveland and Detroit Traffic.

The reversal of the present traffic flow between Cleveland and Detroit was studied by the group. From the Detroit-terminal viewpoint, a reversal of traffic during the operations of front-course approaches at Willow Run and Metropolitan Airports appears desirable. Arrivals from over the Bay intersection via Victor 133 are in an excellent position to be radar-vectored to the proper localizer courses. Departures are unaffected by these flights. However, during back-course operations, these inbound flights are not in an optimum location for radar vectoring, and departure flights to the east are required to tunnel under these inbound flights.

The entire effect upon the Cleveland ARTC Center is difficult to determine without the use of a dynamic simulation study. It appears that some problems would be solved and others compounded. The confliction of Detroit southeast-bound departures with Cleveland westbound departures should be solved, however, the routing of Washington-Pittsburgh traffic to the Detroit area may present a difficult problem.

Selfridge Air Force Base.

Flights to and from Selfridge AFB present the Detroit ARTC Center with a problem under peak traffic conditions. The operation of civil jet types, and the possible increase in traffic with the movement of a SAC unit to Selfridge, will increase the severity of this problem. As long as the requirement for ten-mile-wide airways remains, there is no apparent airspace available to allow independent routes of ingress and egress for these flights. It appears that the Detroit ARTC Center will continue to handle these flights on an individual basis. The modified Selfridge RAPCON area, as shown in Fig. 16, provides a reasonable amount of unrestricted airspace to allow for increased activity at that facility in the event the anticipated movement of a SAC unit there takes place.

CONCLUSIONS

1. The locations of the present feeder fixes for Willow Run and Detroit Metropolitan Airports can be improved upon if an appreciable amount of traffic now using Willow Run Airport moves to Detroit Metropolitan Airport.

2. A common IFR room appears as a possible solution to the difficult coordination problems associated with the numerous airports in the Detroit metropolitan area.

3. Routing of the New York-Chicago traffic via Victor Airway 218 will permit flights departing and arriving at the Detroit metropolitan area to operate with much less interference from en route flights.

4. Slow-climbing aircraft taking off northeast at Detroit Metropolitan and Willow Run Airports and proceeding eastbound on Victor Airway 221 enter the Detroit City approach control area at altitudes below 4,300 feet. This, in conjunction with a minimum en route altitude of 2,700 feet, restricts this approach control facility to one usable altitude level. Present traffic at peak periods and future traffic (considering Pontiac Airport) warrants more than one altitude level.

5. Under the present control system, any civil jet or high-speed, conventional-type aircraft being vectored from the Park intersection for a back-course approach at Willow Run or Detroit Metropolitan Airports will enter the Detroit City approach control area.

6. Present procedures of limiting Selfridge AFB traffic to 4,500 feet and below in the area crossed by Victor Airway 221 may be restrictive to Selfridge if flight operations are increased there with the addition of a SAC unit. The north edge of this airway extends approximately to the Selfridge AFB boundary.

7. Reversal of the traffic flow between the Detroit metropolitan area and the Cleveland area does not appear desirable under all wind conditions at Willow Run and Detroit Metropolitan Airports.

8. Simulation tests showed that terminal system A practically eliminated the excessive coordination which exists between the east and west terminal arrival controllers.

RECOMMENDATIONS

1. It is recommended that preferential routings similar to the routings tested in the modified system be employed in the Detroit area.

2. If traffic distribution between Willow Run and Detroit Metropolitan Airports changes as anticipated, it is recommended that feeding fixes similar to those in terminal system A be adopted.

3. It is recommended that Detroit City approach control be provided with arrival and departure radar. If possible, this radar should be sited so as to permit this facility to control Detroit City, Windsor, and Pontiac Airports.

4. If future simulation tests of a common IFR room concept, scheduled to be undertaken in December 1958, confirm the conclusions of these tests, it is recommended that consideration be given to the establishment of a common IFR room as a method of control in the Detroit metropolitan area.

5. It is recommended that consideration be given to the establishment of a route structure similar to the future system, Fig. 16, if the necessary portion of restricted area R-149 can be obtained.

6. The use of an additional arrival controller in the Willow Run approach control facility is recommended. This controller's duties would include controlling descent of aircraft in the terminal area holding fixes, thus insuring a steady supply of aircraft to the arrival controllers. During peak periods, two additional arrival controllers may be justified.

7. If a new instrument runway is proposed for Willow Run Airport to accommodate civil jet aircraft, it is recommended that consideration be given to aligning it parallel with the existing instrument runway at Detroit Metropolitan Airport.

8. It is recommended that a simulation program be undertaken to attempt to develop procedures to utilize radar as a primary means of separating the heavy traffic flows that operate, many on crossing courses, in the Pullman, Keeler, and Litchfield area. Any workable procedures developed would be of assistance to the Detroit and Chicago ARTC Centers and might have application elsewhere.

TABLE I

LOCATION IDENTIFIERS

ADA	Ada
AKM	Alaska (Fan Marker)
ARB	Ann Arbor
APN	Alpena
AZO	Kalamazoo
AUB	Auburn
AZA	Azalea
BEH	Benton Harbor
BEL	Belle
BNR	Bangor
BPI	Blue Pike
BTL	Battle Creek
BUK	Burr Oak
BOW	Bridgewater
CAD	Cadillac
CIA	Clarksville
CLR	Claire
CLK	Clark
CMS	Houghton
CRL	Carleton
COM	Comstock
CHE	Chelsea
CTX	Crest*
CXR	Chardon, Ohio
DDI	Dundee (LF)
DET	Detroit City
DEE	Deerfield
DND	Dundee (VOR Int.)*
DRR	Detroit River
ELM	Elmira*
ELX	Keeler
EHR	Perch
ESC	Escanaba
ERI	Erie VOR
FIW	Flat Rock (LF)
FIR	Flat Rock (VOR Int.)*
FNT	Flint
FRD	Ford
FEN	Fenton
GDW	Gladwin
GMI	Grand Marais
GRR	Grand Rapids
GIL	Gill
GOD	Goodrich
GWO	Galloway Lake*
HIC	White Cloud
HKY	Hickory Intersection
HAS	Hastings
HWL	Howell
HUD	Hudson
HSD	Hillsdale*
IMT	Iron Mountain
INR	Kinross
IWD	Ironwood
JXN	Jackson
JFN	Jefferson VOR
KNT	Kent
KIS	K. I. Sawyer
LYN	Lyons*
LAN	Lansing
LFD	Litchfield
LAW	Lawton Intersection
LEY	Leroy
LES	Leslie
MID	Middle*
MAY	Manchester
MBS	Saginaw
MNM	Menominee
MOS	Moscow
MQT	Marquette
MKG	Muskegon
MTC	Selfridge
MFT	Midcraft
MLN	Milan
NFB	Grosse Ile NAS
NBN	New Boston
NOR	Norvell
NEB	Newburg

TABLE I (cont'd)

LOCATION IDENTIFIERS

OSC	Wurtsmith AFB	SEL	Seymour Lake*
ORL	Orleans	SLE	Saline
OGN	Ogden	SSM	Sault Sainte Marie
		SVM	Salem
PAW	Paw Paw	SBR	South Branch
PLN	Pellston	TRU	Trufant
PTC	Pontiac VOR*	TVC	Traverse City
PTW	Pentwater	TIP	Tipton
PAR	Park		
PNS	Plains	WRN	Warren
PHN	Port Huron	WLK	White Lake
PNT	Point	WYL	Wayland
PUL	Pulaski*	WOO	Wood
PCK	Peck VOR*	WAL	Wallaceburg*
PMN	Pullman	YIP	Willow Run
PTK	Pontiac		
RML	Detroit Metropolitan		
RWD	Rockwood		

Canadian Designators in Detroit Area

C	Charlie	PJ	Pelee
DI	Dolphin	QG	Windsor
DR	Dresden		
		RN	Ridgeton
EL	Carp		
EX	Essex	TB	Tilbury
		TT	Trout*
HS	Colchester		
H	Howard	WG	Wallaceburg
NQ	Canard	ZR	Sarnia
NZ	Angler		

*Indicates unofficial designator.

TABLE II

DISTRIBUTION OF FLIGHTS IN THE EN ROUTE TRAFFIC SAMPLE

Airport	No. Arrivals Per Hour	No. Departures Per Hour	Total Operations Per Hour
Willow Run	12	12	24
Metropolitan	12	12	24
Detroit City	5	5	10
Windsor	2	2	4
Pontiac	5	5	10
Grosse Ile NAS	2	2	4
Total Operations Per Hour	38	38	76

TABLE III

OPTIMUM AIRCRAFT SPACING DETROIT WILLOW RUN - METROPOLITAN ILS

5 Miles From Outer Marker	Aircraft Sequence No. 1	No. 2	Outer Marker Separation (miles)
6.6	S	M	5.1
7.5	S	F	5.5
10.0	S	J	6.6
3.6	M	S	3.1
5.7	M	F	4.5
7.8	M	J	5.8
3.0	F	S	3.0
3.4	F	M	3.5
7.0	F	J	5.2
1.7	J	S	3.0
2.9	J	M	3.0
3.0	J	F	3.0
5.0	Same Type		4.0

Aircraft Category	Approximate Approach Speed (mph)	(knots)
S - Slow	120	104
M - Medium	140	122
F - Fast	150	130
J - Jet	180	156

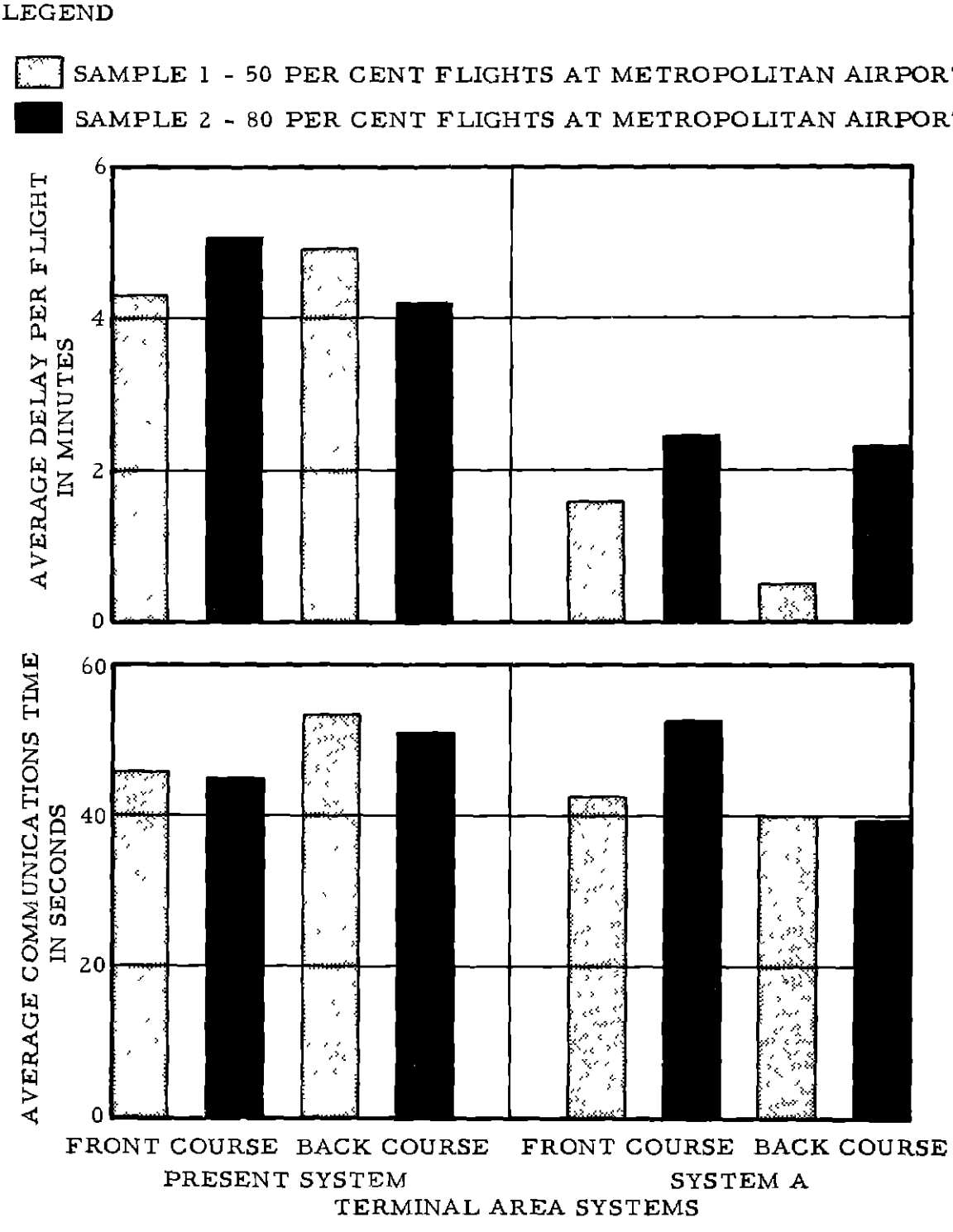

FIG. 1 TERMINAL AREA TESTS DELAY AND COMMUNICATIONS DATA

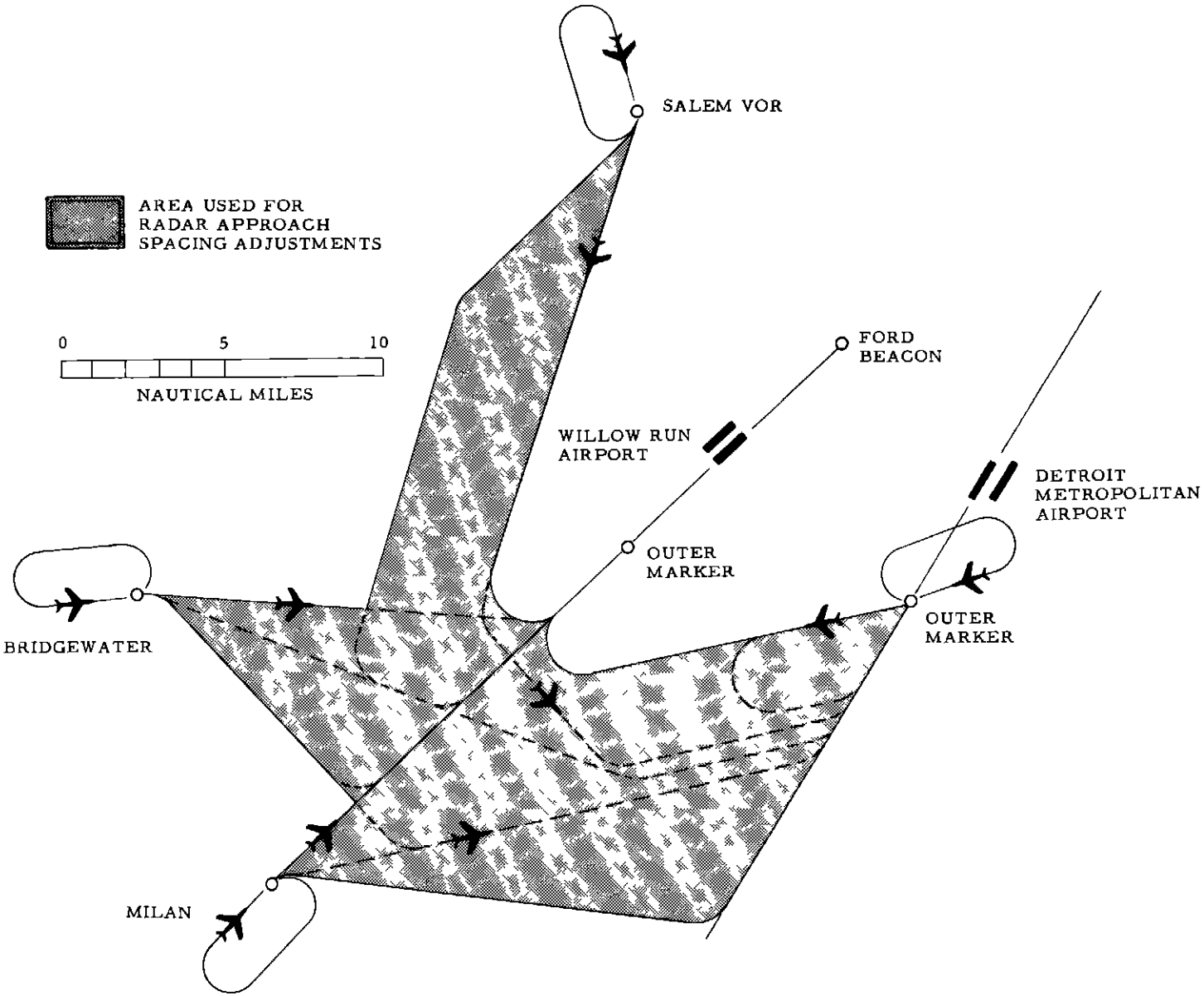

FIG 2 PRESENT SYSTEM FRONT COURSE APPROACHES

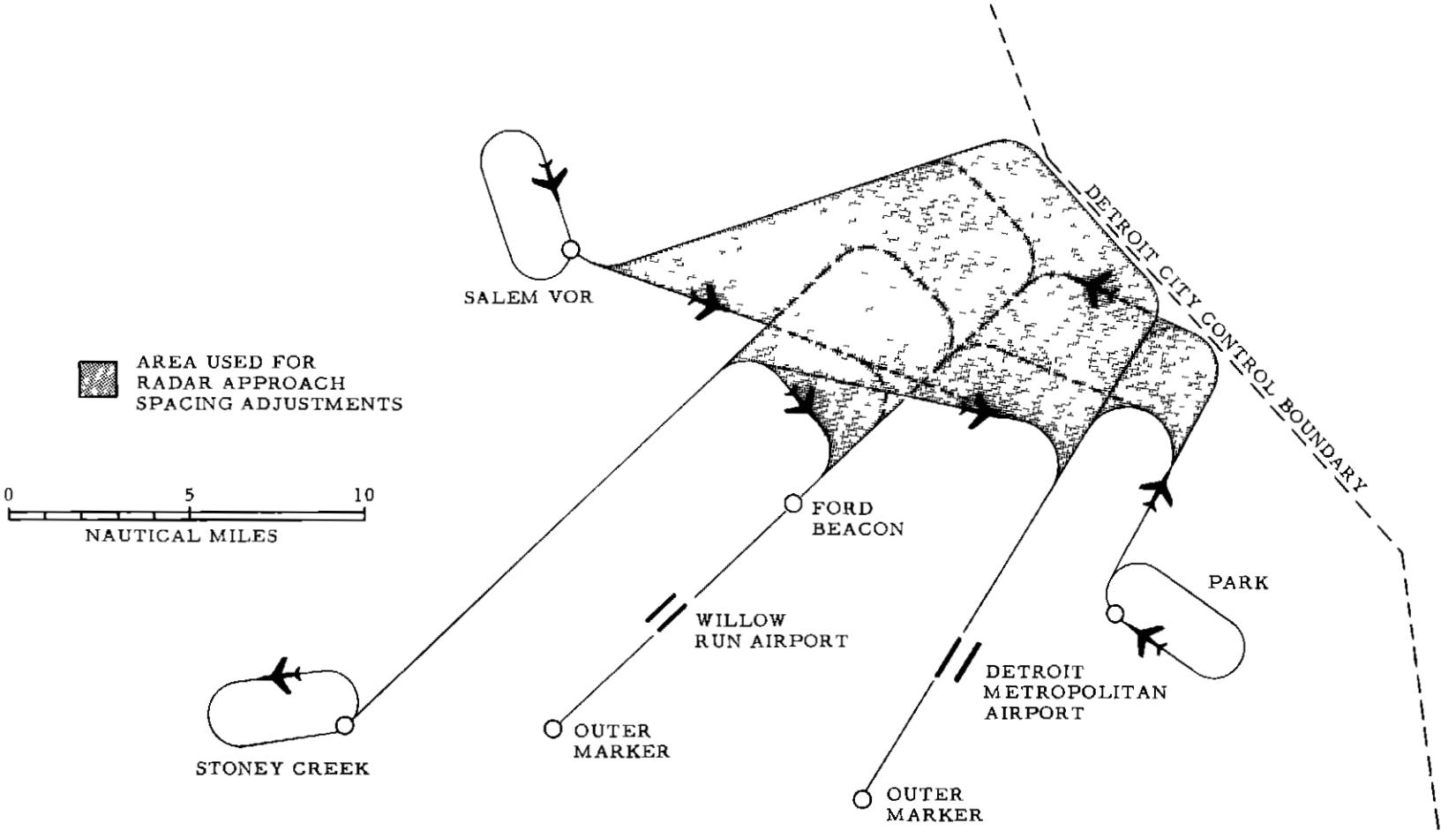

FIG. 3 PRESENT SYSTEM BACK COURSE APPROACHES

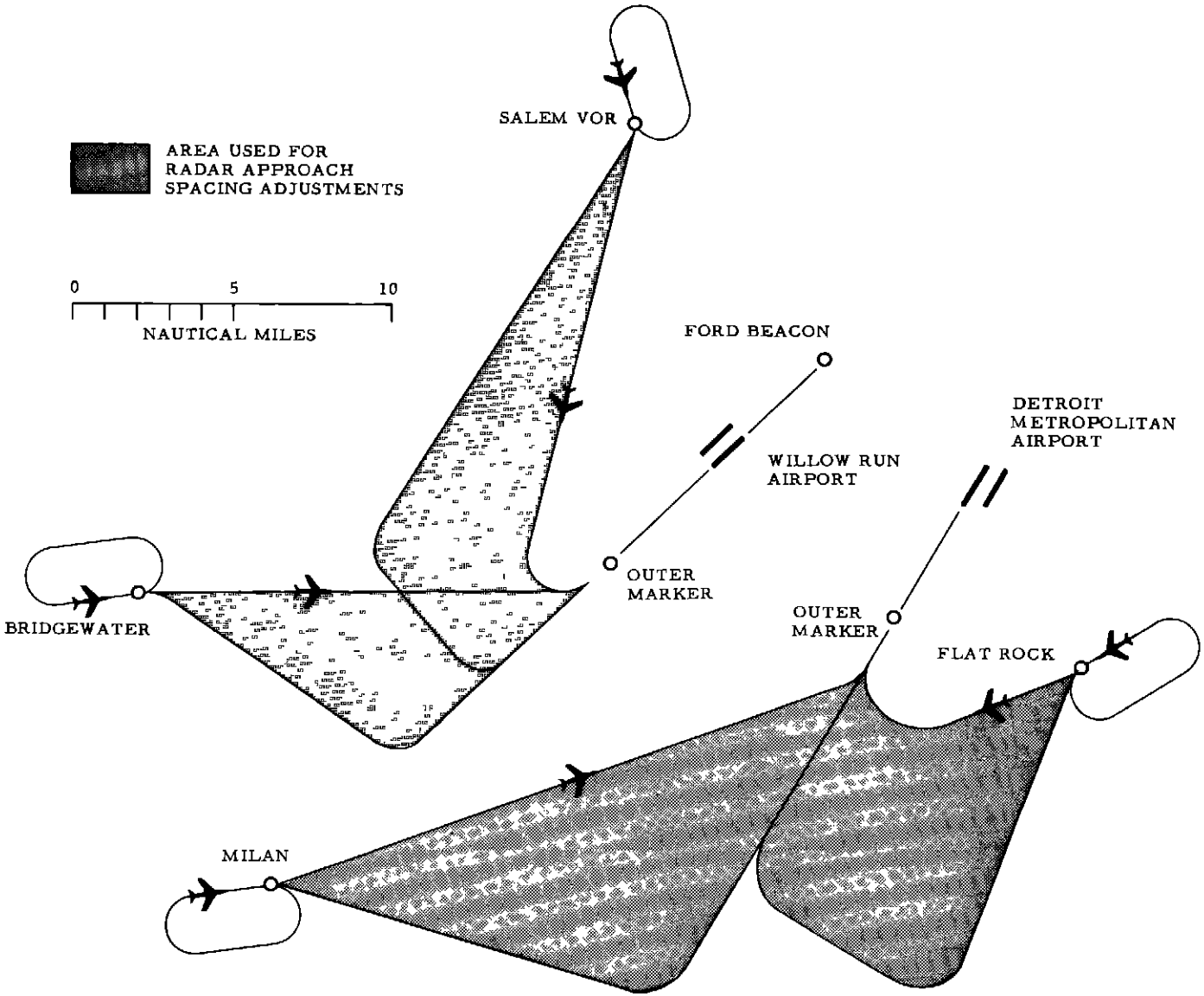

FIG 4 TERMINAL SYSTEM A FRONT COURSE APPROACHES

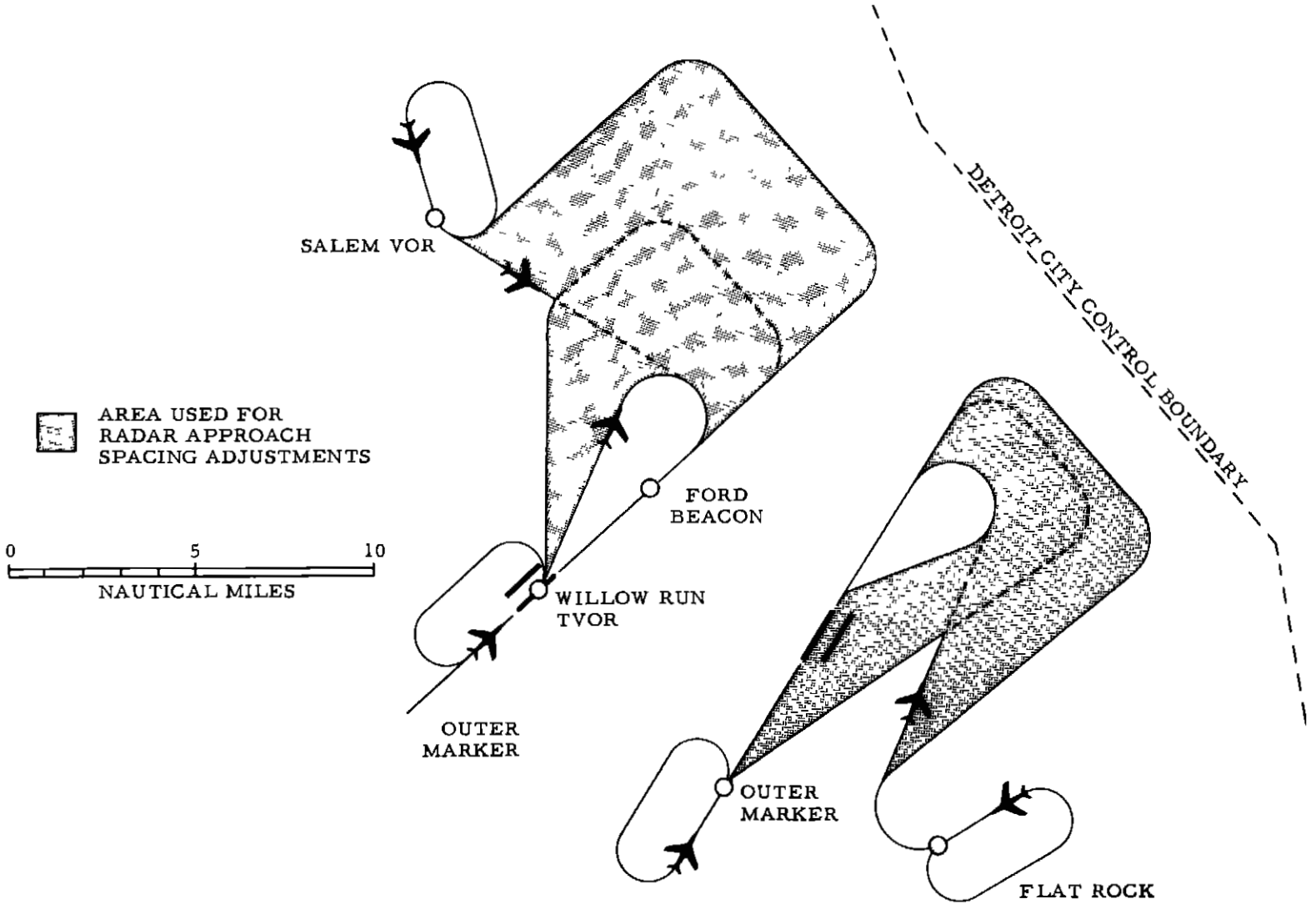

FIG. 5 TERMINAL SYSTEM A BACK-COURSE APPROACHES

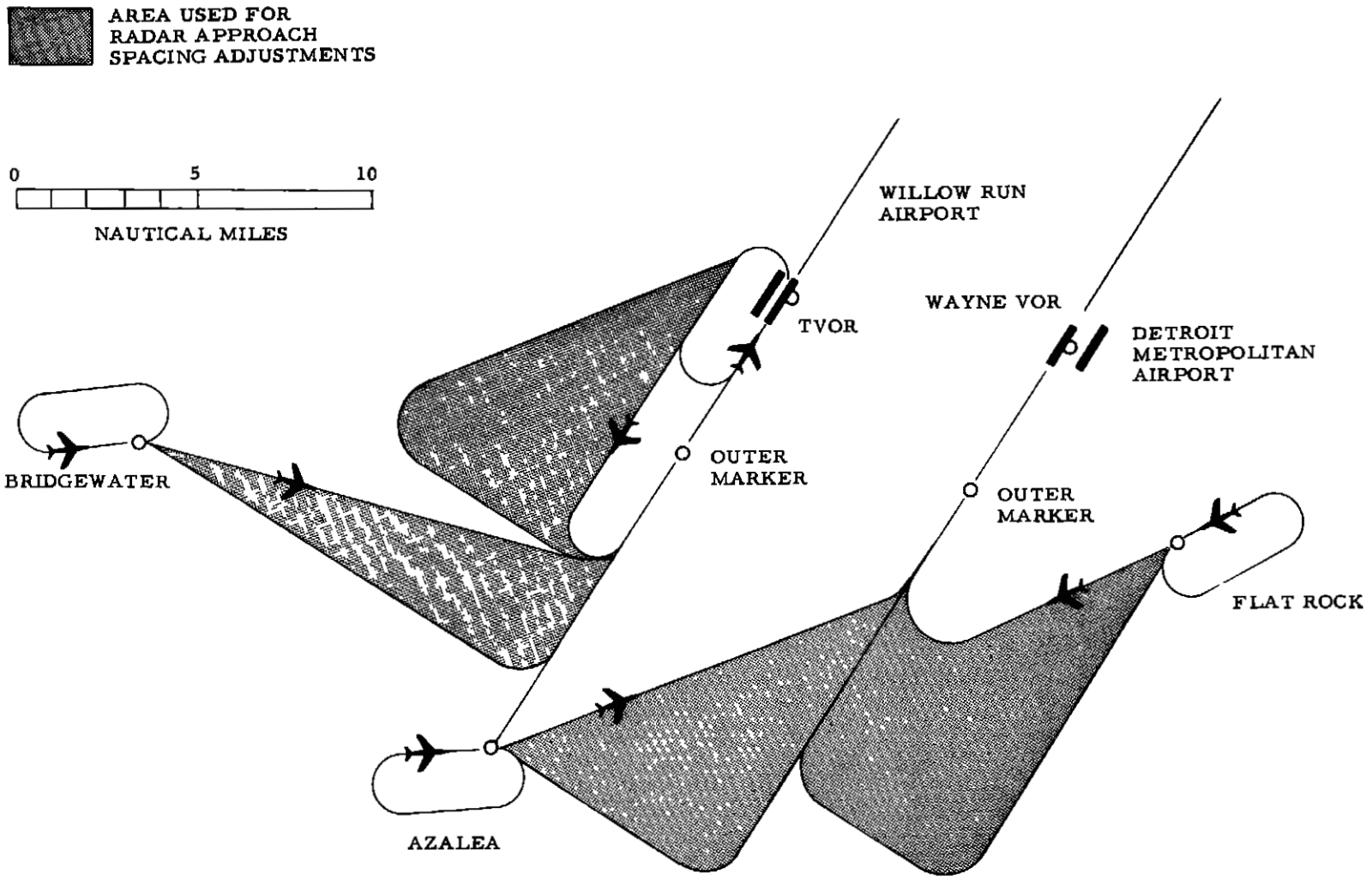

FIG 6 TERMINAL SYSTEM B FRONT-COURSE APPROACHES

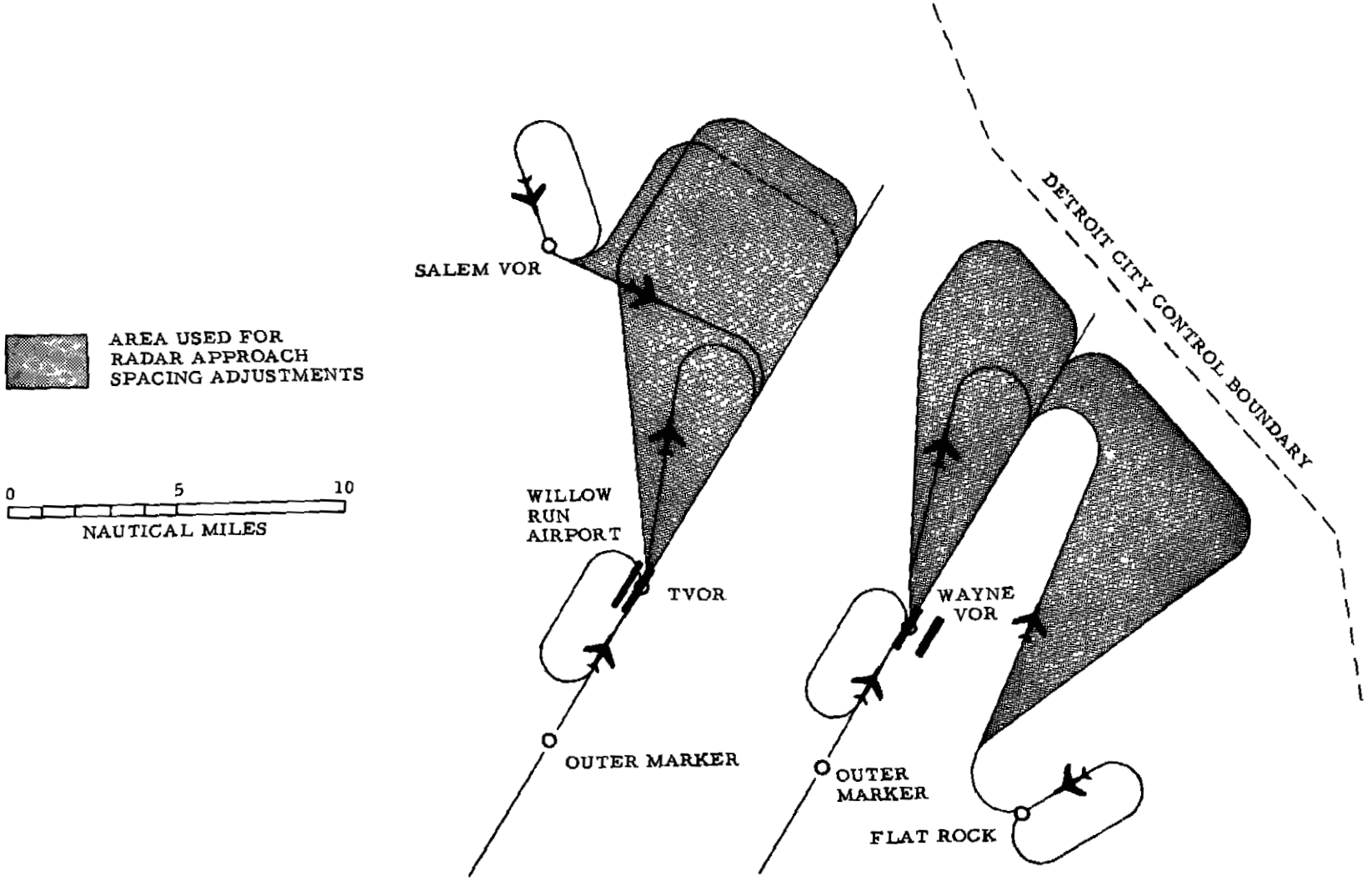

FIG. 7 TERMINAL SYSTEM B BACK-COURSE APPROACHES

FIG. 8 WILLOW RUN APPROACH CONTROL

FIG. 9 DETROIT CITY APPROACH CONTROL

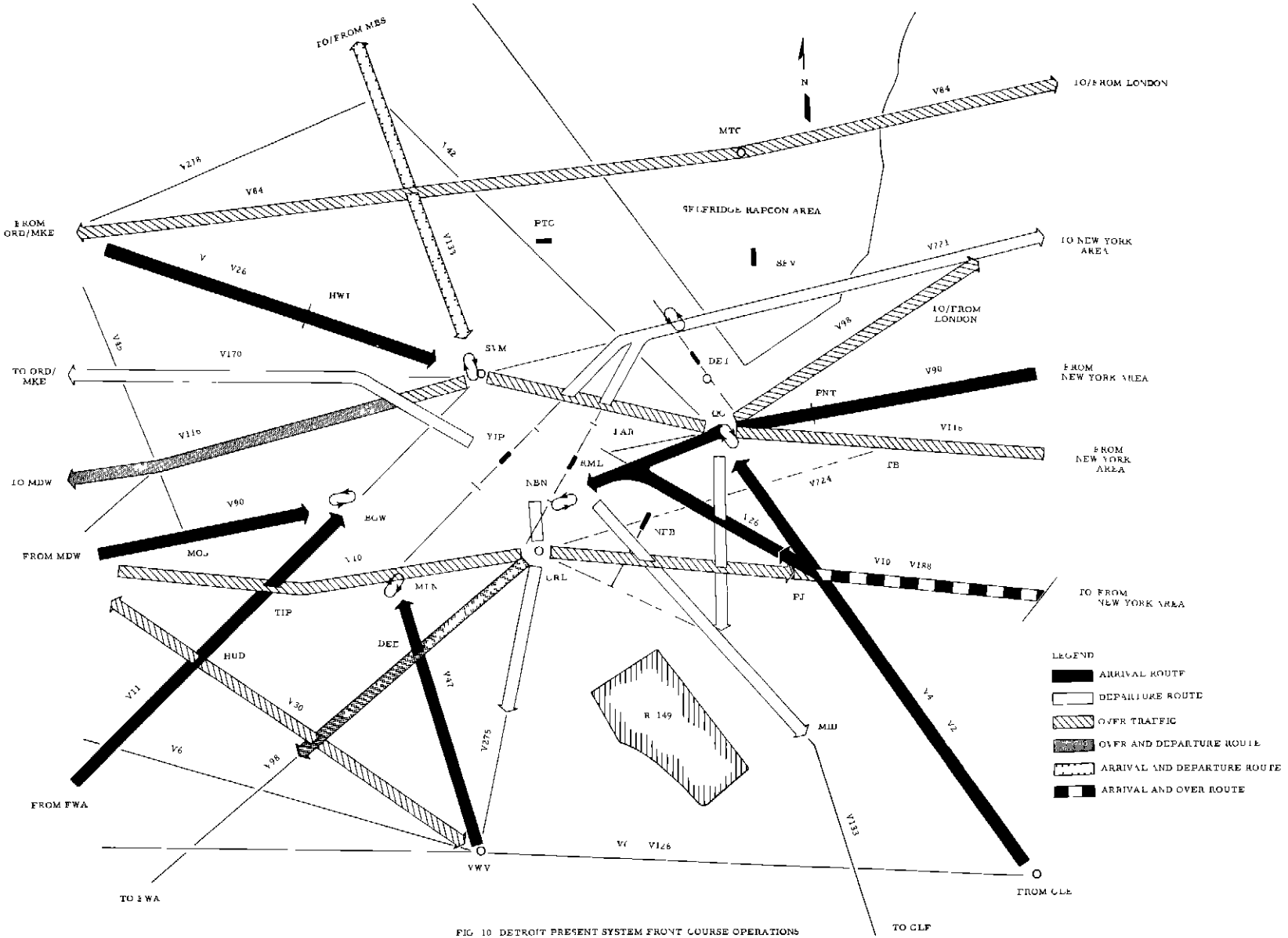

FIG 10 DETROIT PRESENT SYSTEM FRONT COURSE OPERATIONS

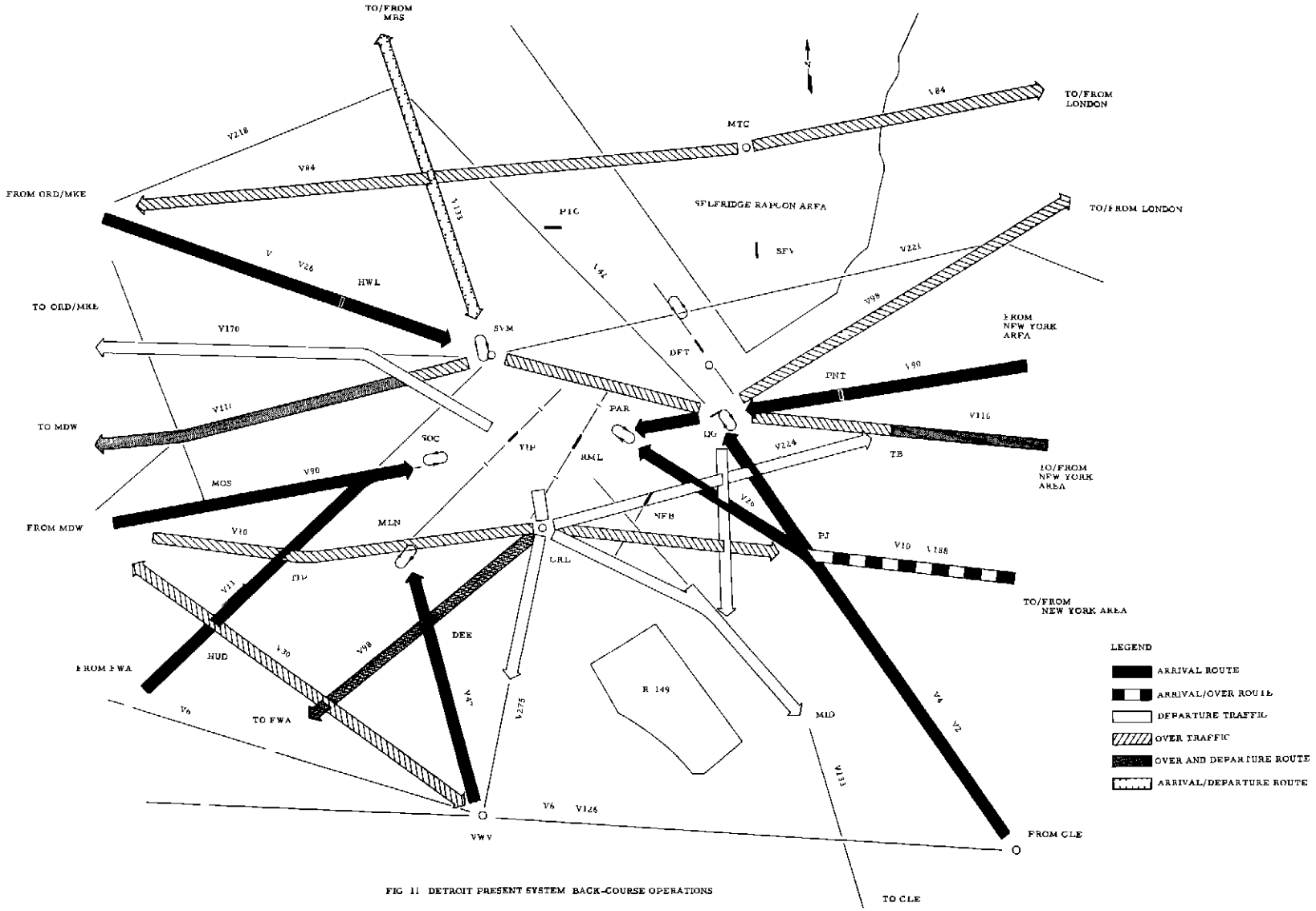

FIG 11 DETROIT PRESENT SYSTEM BACK-COURSE OPERATIONS

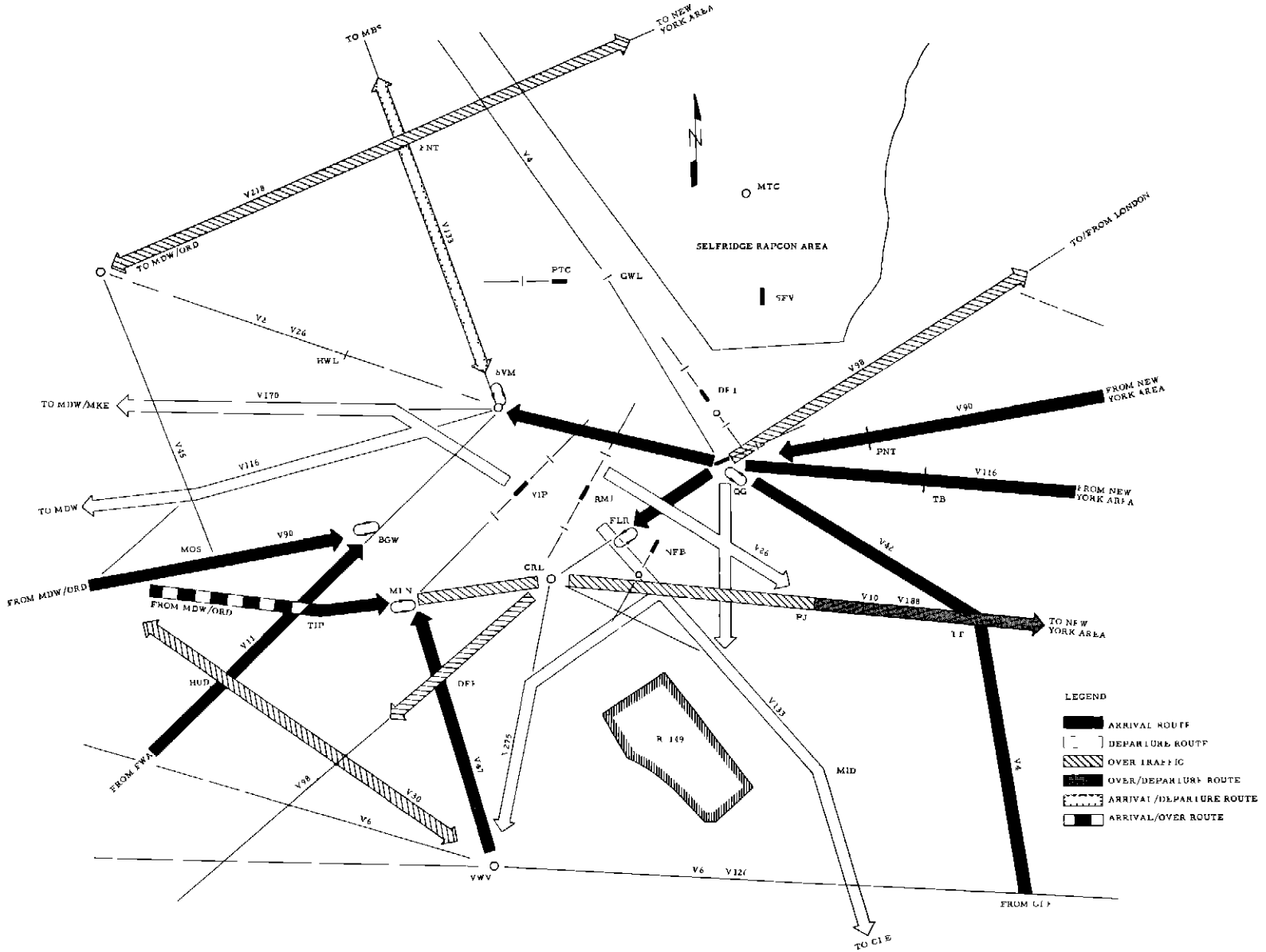

FIG 12 DETROIT AREA MODIFIED SYSTEM FRONT COURSE OPERATIONS

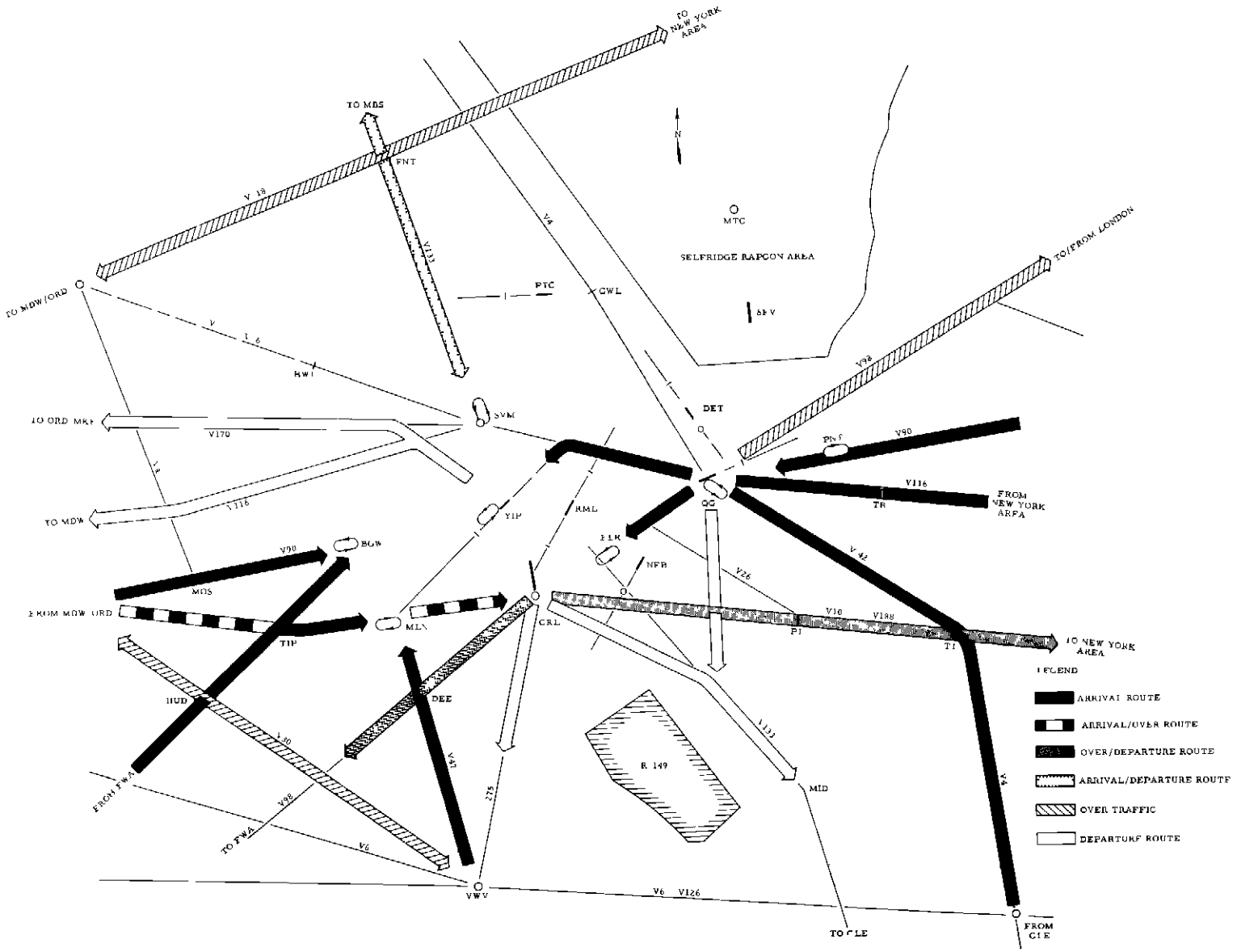

FIG 13 DETROIT AREA MODIFIED SYSTEM BACK COURSE OPERATION

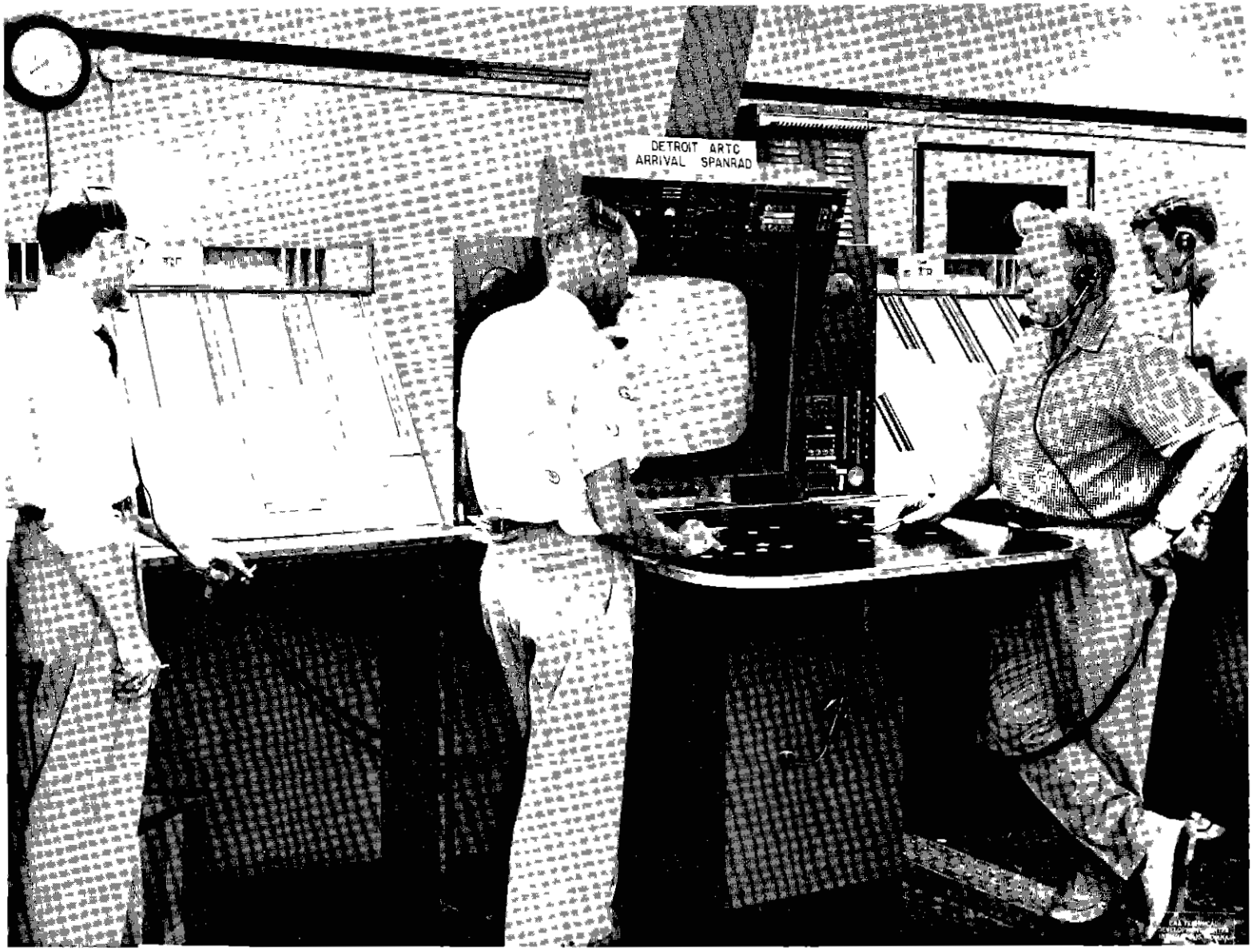

FIG. 14 ARTC CENTER ARRIVAL RADAR SECTOR

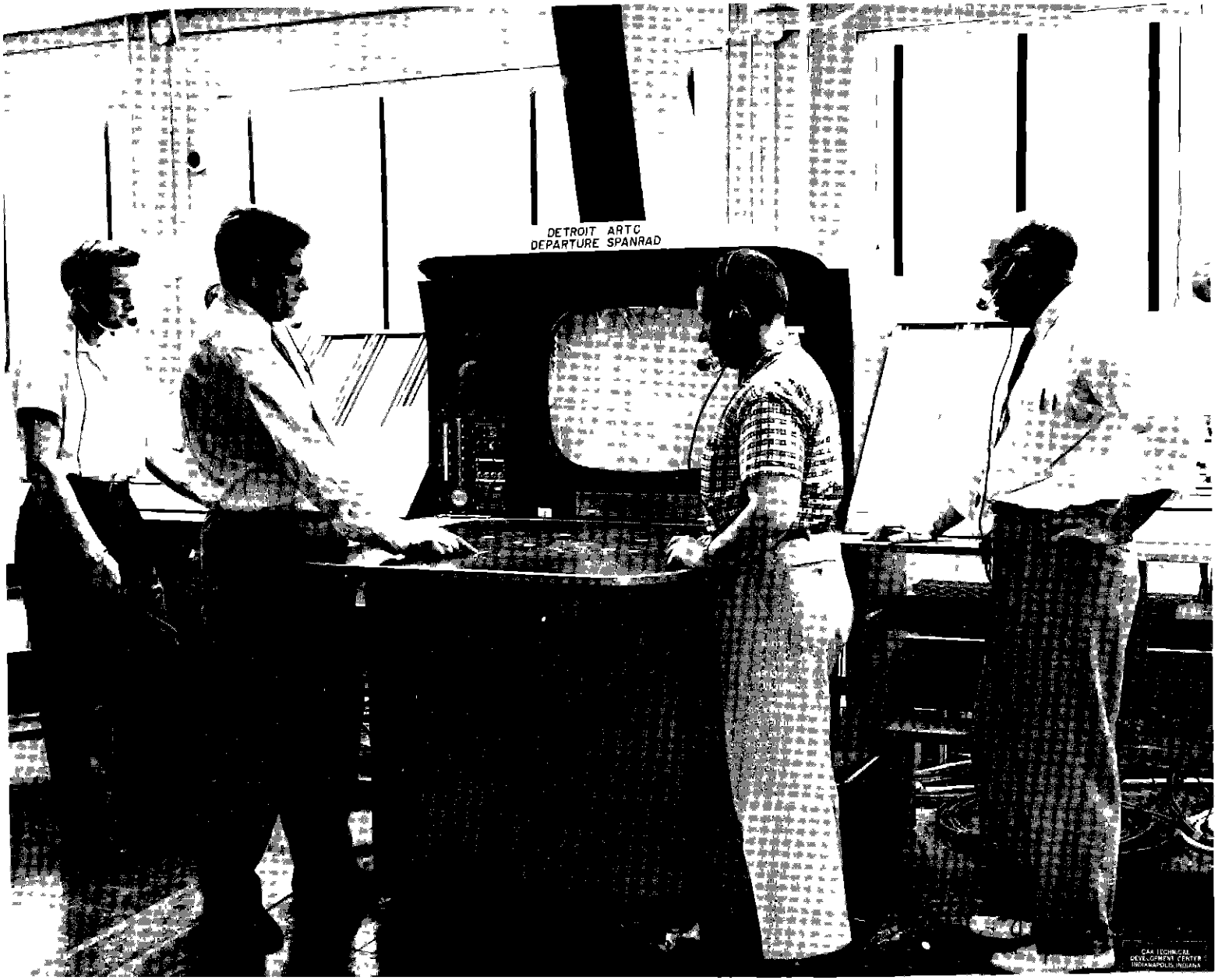

FIG. 15 ARTC CENTER DEPARTURE RADAR SECTOR

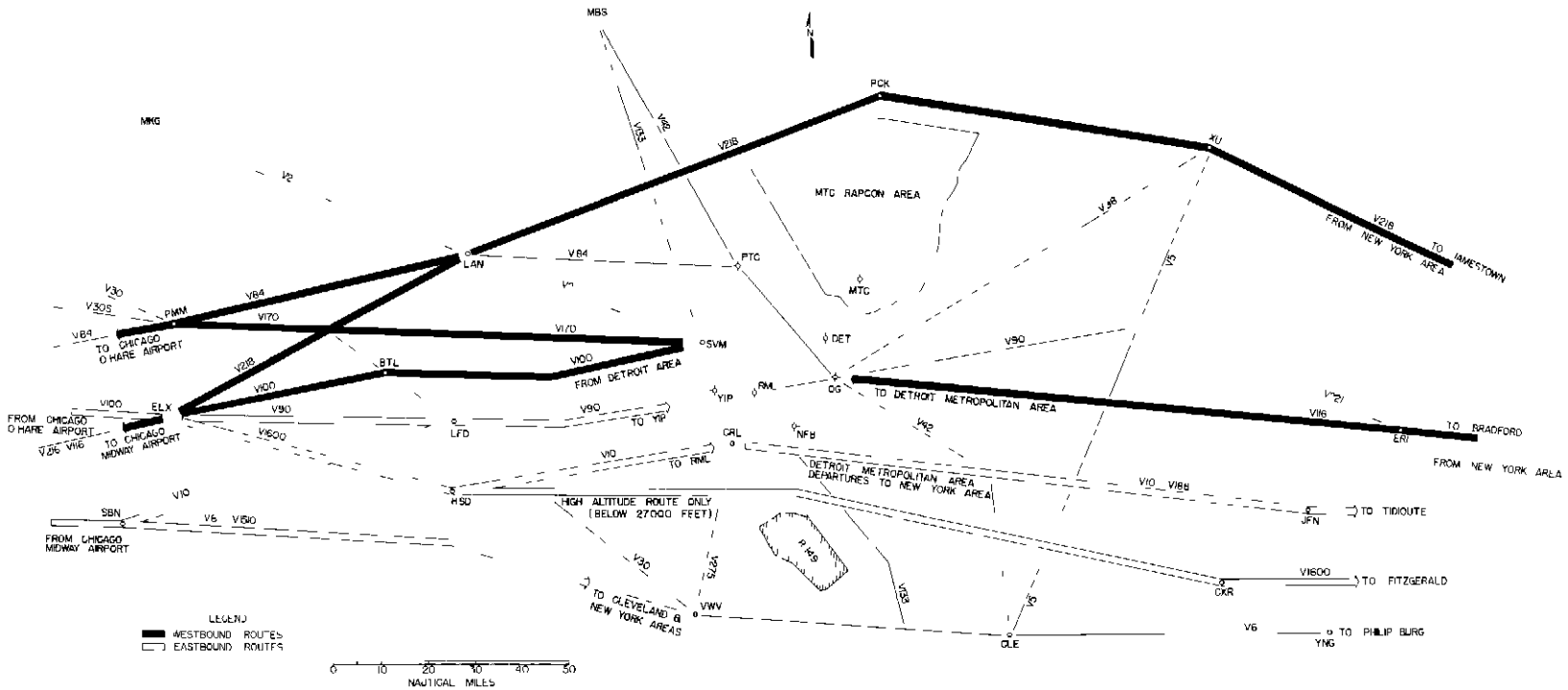

FIG 1C POSSIBLE FUTURE ROUTE SYSTEM