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SIMULATION TESTS OF AIR TRAFFIC CONTROL OPERATIONS IN THE TAMPA TERMINAL AREA

FOR LIMITED DISTRIBUTION

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SUMMARY

This report describes the study of various control procedures and route configurations for the handling of air traffic in the Tampa, Fla , terminal area under instrument flight rule conditions. This study was conducted through the use of the dynamic air traffic control simulator at the FAA Technical Development Center, Indianapolis, Ind

The area under study included MacDill Air Force Base and Tampa International and St Petersburg Municipal Airports Tests showed that the configuration of the instrument runways at the three airports precluded any substantial increase in instrument flight rule traffic capacity, regardless of the routes or procedures used Although the time available for this study did not permit an investigation of possible changes in runway alignment to alleviate this condition, the simulation tests indicated that a broad field for improvement exists in this direction

A noticeable reduction in controller workload and coordination was made by a relocation of feeder fixes and the establishment of a new jet penetration procedure Provision of two supplemental positions in the RAPCON met the need for a substantial reduction in the workload of the RAPCON coordinator, who is key man in the terminal area control system.

INTRODUCTION

Background

In May 1958, the CAA Office of Air Traffic Control (OATC), now the Bureau of Air Traffic Management, requested the Technical Development Center (TDC) to conduct air traffic simulation studies of the entire Florida peninsula On August 21, 1958, representatives of OATC, TDC, and Region 2 met at the Miami Air Route Traffic Control (ARTC) Center to formulate plans for this program. It was decided to divide the program into separate studies of the Miami, Tampa, Orlando, and Jacksonville areas. The time allotted for the Tampa area study was 3 weeks for preliminary study and programming, followed by 2 weeks of simulation testing

One ATC specialist from the Tampa radar approach control facility (RAPCON) assisted in the preliminary planning Nine controller personnel from the Florida area operated the various control positions during the simulation tests The testing began on September 22, and was completed on October 3, 1958

Objectives.

It was requested that the simulation study include the evaluation of present routes, facilities, and procedures, the exploration of possible changes, and recommendations for specific improvements.

Ground Rules.

It was agreed that the following assumptions would govern the scope and conduct of the simulation tests

1 The airway structure would be based entirely on VHF navigation aids, utilizing only existing facilities plus those programmed for installation by June 1959.

2. Anticipating a probable change in TSO-N20A, the dimensions of the standard holding reservation would be increased as shown in Fig. 1

3. Adequate radar and air/ground communications coverage would exist throughout an area within 70 nautical miles' radius of the St Petersburg VOR facility

4. Aircraft entering or leaving the terminal area would be separated in accordance with ANC standards Landing traffic entering the area normally would occupy altitude levels below those of overflights.

5. Civil jet aircraft would comprise 20 per cent of the total traffic simulated. These aircraft would be handled in a conventional manner unless approach delays became excessive, in which case the aircraft would be permitted to absorb the bulk of their delays at high altitudes, and then be recleared for en route descent to close-in feeder fixes.

SIMULATION METHODS

Equipment.

The terminal area and en route area tests were conducted simultaneously The terminal area RAPCON operation was simulated using the equipment layout shown in Fig 2. The ARTC operation was simulated using two flight progress boards for ANC control For the radar portion of the en route tests, a superimposed panoramic radar display (SPANRAD) unit was utilized as shown in Fig 3. SPANRAD is a bright-tube manual tracking system which utilizes television techniques to superimpose the picture of radar target markers on their associated radar targets

Traffic Samples.

From information furnished by the Miami ARTC Center and Tampa RAPCON facilities, two 1-hour traffic samples were constructed In Sample 1, the distribution of aircraft was as follows

	Number of Operations	
	Departures	Arrivals
MacDill Air Force Base	9	9
Tampa Airport	8	9
St. Petersburg Airport	3	3
Overflights	10	
Total Operations - 51		

An additional sample, known as Sample 2, was prepared in order to test the system under heavier loading In this sample, each of the categories listed above was increased by approximately 25 per cent

Civil jets of Douglas DC-8 and Boeing 707 types comprised approximately 20 per cent of the total traffic Military jets were of the B-47 type.

Evaluation Criteria

Although data on traffic delays and communications were recorded during the test runs, the large number of uncontrolled variables in the test program made these quantitative data of doubtful value The human factor was the largest single variable This was due to the fact that the simulation program served also as a radar training program for the Miami ARTC Center personnel who participated in the tests These controllers had received no previous training in the use of radar control procedures. Although this training was an excellent by-product of the simulation program, the presence of the learning factor had an unpredictable effect on the results Because the time available for the entire program was too short to get all personnel stabilized at a high level of skill in the use of radar procedures, the statistical data are not included in this report Therefore, another source of evaluation data had to be used. This was the subjective opinions of the controllers and observers who participated in the tests.

A day-by-day oral evaluation was made by the controllers during the test program. At the conclusion of the study, a formal critique was held, at which time each controller was given an opportunity to express his opinions and recommendations To a great extent, the results included in this report refer to the opinions thus recorded.

RAPCON OPERATIONS

Workload Factors.

Tampa RAPCON operations are characterized by an extremely high workload per flight. Basically, this is due to the configuration of airport runways, which is shown in Fig. 4. Because of mutual interference between the approach and departure paths of the three airports, a large percentage of instrument flight rule (IFR) operations to or from either airport conflicts potentially with operations at the other airports This is true particularly for south operations, as tabulated in Fig 4 For this reason, a large amount of preplanning and coordination is required to make sure that the proposed flight paths are clear of possible conflictions The additional coordination workload slows down operations and adds to airport delay in a system that already is limited by a low capacity due to the fact that few IFR operations can be carried on simultaneously at the three airports As a result, the total traffic flow in the three-airport complex is limited to little more than would be possible with a single, well-designed airport

Most of the coordination workload revolves around a single position in the RAPCON This key man is the coordinator (position 2 in Fig 2). He is responsible for devising the separation used between the many combinations of arrival and departure operations for all three airports. He also is responsible for the control of IFR traffic at Bartow and Sarasota Airports, control of the Tampa-St Petersburg shuttle operation, and low-altitude en route control between Tampa and Orlando In present operations, the coordinator also serves as an important communications link in copying and relaying flight data to and from the ARTC Center and the three major control towers.

Supplemental Positions

Because of the obvious overloading of the coordinator, considerable study was given to methods of simplifying or reducing his workload Basically, the configuration of the terminal area precluded any radical simplification of the control function However, relief was found for much of his routine communications by providing a man in a data position (position 5 in Fig. 2) to copy flight data from the ARTC Center and to keep the Center advised regarding vacant altitudes, departure times, expected approach clearance times, and other pertinent information.

In present operations, inbound aircraft are transferred from ARTC to Tampa RAPCON control at only one altitude, namely, 5,000 feet Aircraft above that altitude are retained under Center control, a procedure which, at times, tends to reduce the capacity of the terminal area even more through starvation To alleviate this situation, two additional altitudes, 6,000 and 7,000 feet, were tested It was found immediately that the coordinator could not handle this additional workload, and a second supplementary position, the radio feeder-controller (position 6 in Fig. 2), was added This man had the responsibility for laddering-down aircraft at the secondary clearance limits and reclearing them to the appropriate primary clearance limits to maintain a smooth, regulated supply of inbound traffic to the arrival radar controller.

With these new positions, the coordinator was freed of many time-consuming communications details, and had more time in which to perform his basic control function Although no great increase in terminal area IFR capacity was possible because of the limitations of the runway configuration, the addition of the supplementary positions tended to reduce delays and to produce a smoother, safer operation.

Radar Performance.

Although the simulation tests were based on the assumption that adequate radar coverage would exist throughout the terminal area, such is not the case in actual practice. As shown in Fig. 5, the present CPN-18 RAPCON radar does not provide adequate low-altitude coverage of either the Tampa or St. Petersburg approach and departure paths It is extremely unlikely that an aircraft on south approach to Tampa or St. Petersburg will be visible on the radar scope at flight altitudes below 3,000 feet. It was reported that slow-climbing aircraft often depart St Petersburg northbound and leave the terminal area without ever being seen on the RAPCON radar This condition permits the RAPCON personnel little choice but to base their control procedures almost entirely on ANC separation, with the situation monitored by radar in those portions of the airspace where the targets can be seen This complex terminal area layout is particularly difficult to control under ANC rules. Therefore, the provision of adequate radar coverage would be one of the most important contributions which could be made toward reducing controller workload and speeding up the flow of traffic in the Tampa terminal area.

TERMINAL AREA TESTS

Present System.

The route layout for the present system is shown in Fig. 6. Approach patterns for south operations are shown in Fig. 7, and for north operations in Fig. 8.

In tests of the present system, the Tampa and MacDill arrival radar controllers were involved continuously in the transfer of aircraft proceeding across the area. For example, a north arrival terminating at MacDill Air Force Base (AFB) was cleared to one of the north feeder fixes by the Miami ARTC Center, the Tampa radar arrival controller then identified and vectored the aircraft across the Tampa Airport localizer course to an area east of the final inbound course to Tampa, and after coordination, transferred control to the MacDill radar approach controller, who completed the vector. The reverse was true when an arrival departed Gibson en route to Tampa Airport and whose flight path had to traverse the MacDill approach control area.

Simulation tests showed that the holding fixes at Dover, Brooksville, and Bluegill are poorly located for efficient feeding of the various approach paths The use of Gibson as a feeder fix for Tampa or St Petersburg is not only inefficient from the radar control standpoint, but leads to the complicated coordination problem mentioned above.

Tests pointed out the inadequacy of Lakeland jet penetration to MacDill. Unless positive radar separation can be obtained from other traffic on Victor 7/157, such traffic must be rerouted or held short of the area while the penetration is in progress. Such a procedure not only increases the ARTC Center workload, but greatly reduces the capacity of this main north-south airway.

The Lakeland penetration path is barely long enough for a straight-in uninterrupted descent to MacDill. During the tests whenever descents were delayed or interrupted, to secure altitude separation from aircraft on Victor 7/157 or the Dover holding pattern, jets had difficulty in getting down to the final approach altitude at the MacDill outer marker, increasing the approach interval and the radar controller's workload further.

The jet penetration for northerly operations, shown in Fig. 8, was easier to handle than the Lakeland penetration, as it interfered less with other traffic paths. In general, northerly operations at the three airports, as shown in Fig. 8, were less difficult to coordinate than the southerly operations shown in Fig 7. This mainly was because a greater percentage of the flight paths for northerly operations diverged from, rather than converged toward, each other In actual practice, however, the prevailing wind in the Tampa area is such that the great majority of airport operations are southerly.

Simulation tests indicated that the traffic volume from the north did not warrant the use of separate feeder fixes at Brooksville and Hudson.

Revised System

The route layout for this system is shown in Fig 9 Approach patterns for south operations are shown in Fig. 10, and for north operations in Fig. 11

The basic idea behind the revised system was to reduce coordination and provide better segregation of military and civil operations by opening up an area south of MacDill for exclusive use by MacDill traffic. This was done by eliminating the Victor 97/193 route up to the Gibson pattern, rerouting this traffic over Lakeland to a new feeder fix at Ren. To make use of the open area south of MacDill, the Lakeland and the St. Petersburg jet penetrations were changed to a 115° penetration off the St Petersburg VOR. Depending on the direction of operation, the downwind leg of the approach pattern was made either to the right or left, as shown in Fig. 9.

The Dover holding fix in the present system was poorly located for radar approaches into MacDill, and too far out for efficient operations into Tampa and St. Petersburg. It was replaced by the Ren feeder fix in the revised system A relocation of Victor 35E permitted the establishment of a feeder fix at Tarpon, which handled the arrivals formerly cleared into Hudson and Brooksville.

Moving the feeder fixes to Ren and Tarpon improved the vector pattern and eliminated much of the coordination which was mandatory in the operation of the present system. All Tampa and St. Petersburg arrivals were shuttled to the Tarpon Intersection, whereas all MacDill AFB "prop" traffic was shuttled to the Ren Intersection This configuration minimized crossfeeding operations, thereby reducing controller coordination.

The consolidation of the inbound traffic routings from the north into Tarpon enabled Victor 35 to be used as a departure route with a long, unrestricted climb. This reduced the control workload greatly in handling these operations which, in previous tests of the present system, sometimes required close radar control for as long as 20 minutes after takeoff

The 115° MacDill radar penetrations functioned satisfactorily on the assumption that complete radar and/or radar beacon coverage of the area existed. The Tampa controllers pointed out, however, that their present CPN-18 radar probably would not be able to pick up the penetrating jet aircraft in this pattern until the aircraft was starting its turn on the downwind leg.

Although the simulation schedule did not permit further exploration, it appeared that various procedures involving en route TACAN approaches from the south would be feasible.

The Tampa area still lacked a good departure route toward the east coast. However, the routing of departures to Jacksonville via Victor 35 allowed unrestricted climbs in most cases. Because of the large Navy restricted area R161 southwest of Jacksonville, the mileage from Tampa to Jacksonville via Victor 35 was very little more than the present routing over Orlando, as shown in Fig. 12.

ARTC OPERATIONS

Procedural (ANC) Control

The simulated area, which encompassed the airspace within a radius of 70 nautical miles from the Tampa VOR, was divided into two sectors. In tests of the present system, the south sector controllers were given jurisdiction over the area south of Victor 152S, with north sector controllers assuming jurisdiction over the remaining area. In the revised system, the jurisdiction was modified by increasing the south sector to include the area from the west edge of Victor 157 commencing at Gene Intersection clockwise to the south edge of NL Route 2 Each sector had one controller and one assistant controller. The communications workload was divided further by a radio controller who handled most of the air/ground communications for both sectors.

Radar Control

A single geographical sector was used, with the control responsibility divided by function. One radar controller, aided by an assistant, handled all departure operations Another controller and an assistant handled all arrival and over-traffic, using the same SPANRAD. Radar target markers used on this display were of two colors, one to indicate departures and the other to indicate landing or overflights

EN ROUTE TESTS

Present System.

Departures climbing to altitudes above 7,000 feet, and proceeding either over Orlando or northbound on Victor 157, presented a difficult ARTC problem due to other traffic on Victor 7/157. This traffic usually precluded a climb on course, necessitating a long "tunnel" or a climb in a holding pattern clear of the airways.

On the whole, however, the present air route system functioned satisfactorily during the simulation tests. With or without the use of ARTC radar, the Center had the ability to flood the Tampa RAPCON with more aircraft than the terminal area could process, even at the comparatively low rates used in Sample 1. Thus, the changes which were made in the route layout to form the revised system were made primarily to improve terminal-area, rather than en route, operations.

Revised System.

As may be noted by a comparison of Figs. 6 and 9, the major modifications to the present air route structure consisted of the relocation of Victor 35E and the deletion of Victor 97 from Arcadia to St. Petersburg, as well as Victor 7 from Homo to Lakeland.

The Victor 97 segment serves presently as an arrival route from Miami, permitting unrestricted descent from Arcadia to Gibson. In order to open up the area south of MacDill, this traffic was rerouted over Lakeland to Ren. Although this increased the ARTC Center workload, it appeared that the over-all benefits to the terminal area justified this change. The elimination of the troublesome Lakeland jet penetration served as a compensation to the Center in this layout.

The use of Victor 35 as a departure route to the north offered an unrestricted climb of approximately 80 miles before encountering the inbound traffic northwest of Homo Intersection on Victor Airway 7. The deletion of Victor 7 between Homo and Lakeland permitted unrestricted descents of landing traffic proceeding from Cross City or Gainesville prior to clearing Homo, as is required in the present procedure. Studies indicated that en route flow now proceeding via Victor 7 between Albany and Lakeland could be rerouted via Albany, Tallahassee, and a redesignated Victor 97, which would be contingent upon the location of a VOR facility at Egmont, as shown in Fig. 12.

Traffic flow between Orlando and Tampa was reversed in the revised system, with eastbound aircraft proceeding via Victor 152 or Victor 152S and westbound via Victor 152N. This was done to ease the departure problem of eastbound aircraft toward Orlando. Departure via Victor 152N entailed a vector or tunnel through the Ren holding pattern, with a consequent increase in terminal controller workload The reversal of traffic flow had no appreciable effect on ARTC Center workload. The effect of this reversal of traffic at Orlando was not tested, and no conclusions were reached regarding this factor

CONCLUSIONS

It is concluded that:

1. The traffic capacity of the Tampa terminal area is limited severely due to interference between the traffic patterns of the three airports Although St. Petersburg and MacDill do not interfere with each other appreciably, Tampa interferes with both. The technique of pre-planning or grouping IFR operations so as to alternate the use of Tampa alone, with the use of MacDill and St. Petersburg together, will tend to

increase the terminal area IFR traffic capacity, since the key to any substantial increase in capacity lies in the use of procedures which will permit more than one arrival and/or departure path to be used simultaneously. Ultimately, a change in airport runway alignments may be necessary to handle an increased traffic demand Meanwhile, the implementation of dependable, adequate, radar coverage of the terminal area would enable controllers to make better use of the available airspace, and thereby reduce the restrictive effects of the present configuration.

2. Use of a flight data position, as shown in Fig. 2, will provide a much needed reduction in the workload of the RAPCON coordinator, and give him more time to concentrate on his primary control function.

3 Use of a radio feeder controller, as shown in Fig. 2, will enable the RAPCON to accept arrivals at additional altitude levels, thus reducing the Center workload and providing a smoother, regulated flow of traffic to the radar arrival controllers.

RECOMMENDATIONS

1. The need for more adequate, dependable, radar coverage of the terminal area cannot be overemphasized as a necessity for more efficient air traffic control.

2. Replacement of the Egmont MH facility with a VOR is recommended in order to establish Victor 97 as a southbound airway, bypassing over-traffic west of the Tampa area, as shown in Fig. 12. This would permit Victor 157 to be used primarily as a northbound airway for over-traffic from Miami.

3. Relocation of the feeder fixes and establishment of the 115° jet penetration to MacDill, as described in this report, is recommended as a means of reducing the coordination workload and making more efficient use of arrival radar facilities.

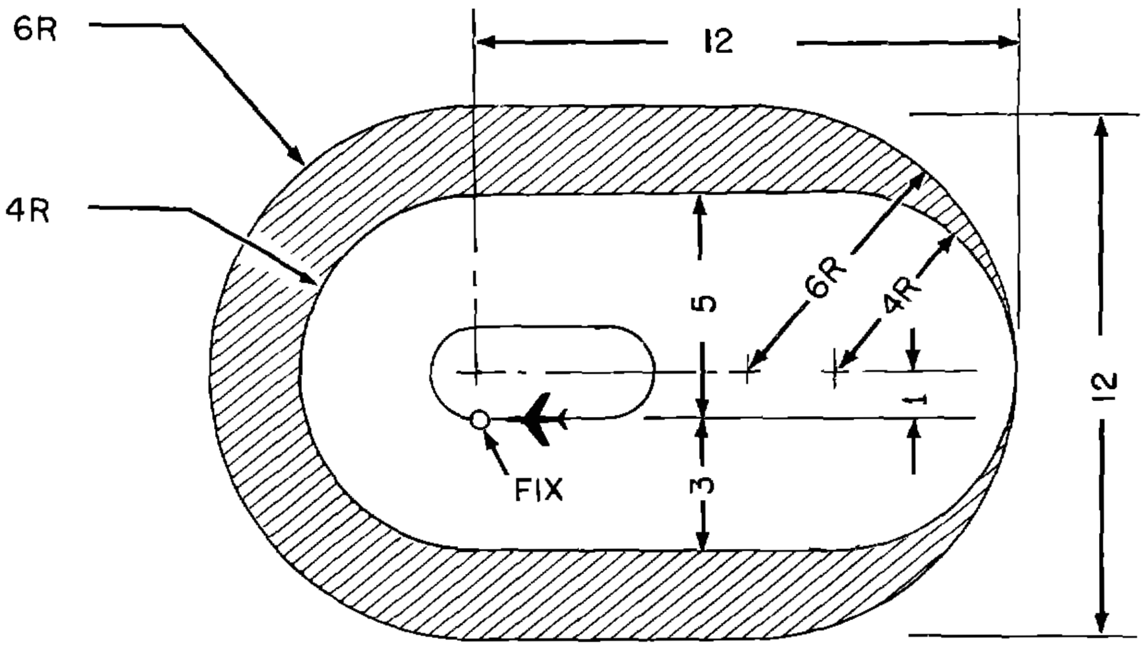
4. Establishment of the two supplemental RAPCON positions, as described in this report, is recommended as a means of reducing the workload of the coordinator and thus providing a smoother, more efficient traffic flow.

5. The short time allotted for the Tampa simulation program did not permit a thorough study of all possible methods of increasing the IFR traffic capacity of the Tampa terminal area. Within the next two years it would be desirable to supplement this program with a study of the following factors.

a. Possible use of a VORTAC or TACAN jet penetration from the south into MacDill.

b. Possible improvement in the runway alignment at one or more of the three major airports.

c. Further refinement in the layout of approach and departure routes to reduce interference and thus permit more IFR traffic lanes to be operated simultaneously.

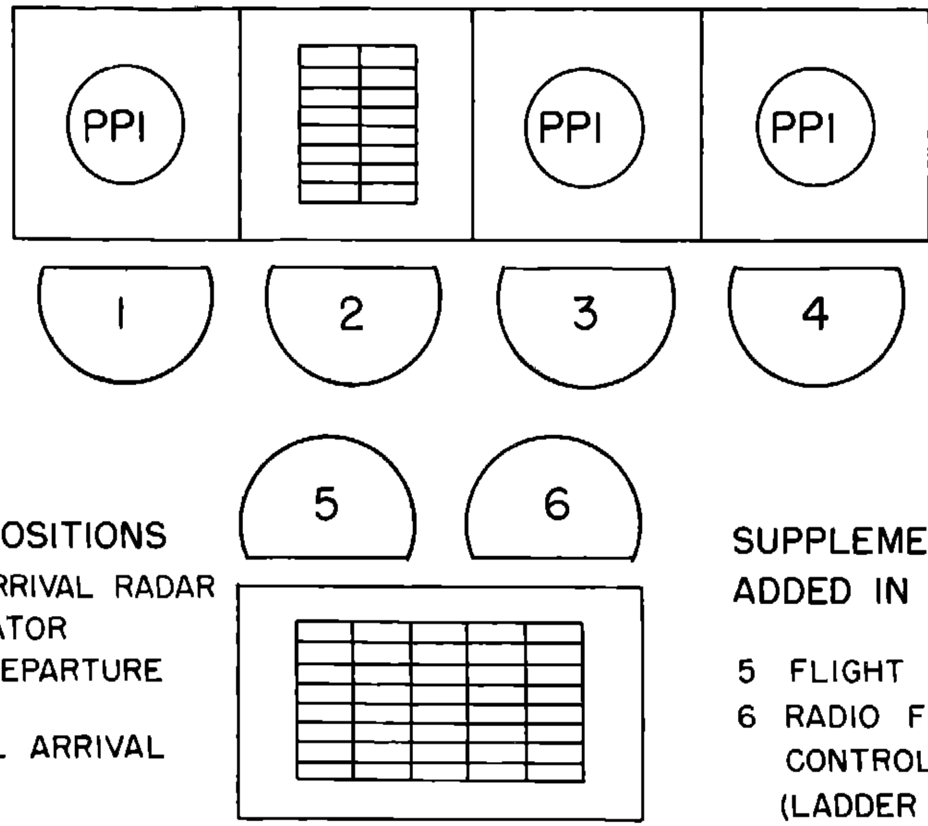


INNER PATTERN= PRESENT TSO-N20A HOLDING AREA FOR ONE-MINUTE PATTERN

SHADED AREA SHOWS INCREASED AREA ASSUMED FOR SIMULATION TESTS

ALL DIMENSIONS ARE IN STATUTE MILES

FIG 1 HOLDING AIRSPACE AREA



BASIC POSITIONS

1 TAMPA ARRIVAL RADAR
2 COORDINATOR
3 TAMPA DEPARTURE RADAR
4 MAC DILL ARRIVAL RADAR

SUPPLEMENTAL POSITIONS ADDED IN LATER TESTS

5 FLIGHT DATA
6 RADIO FEEDER CONTROLLER (LADDER MAN)

FIG 2 LAYOUT OF CONTROL POSITIONS USED IN SIMULATION TESTS OF TAMPA RAPCON.

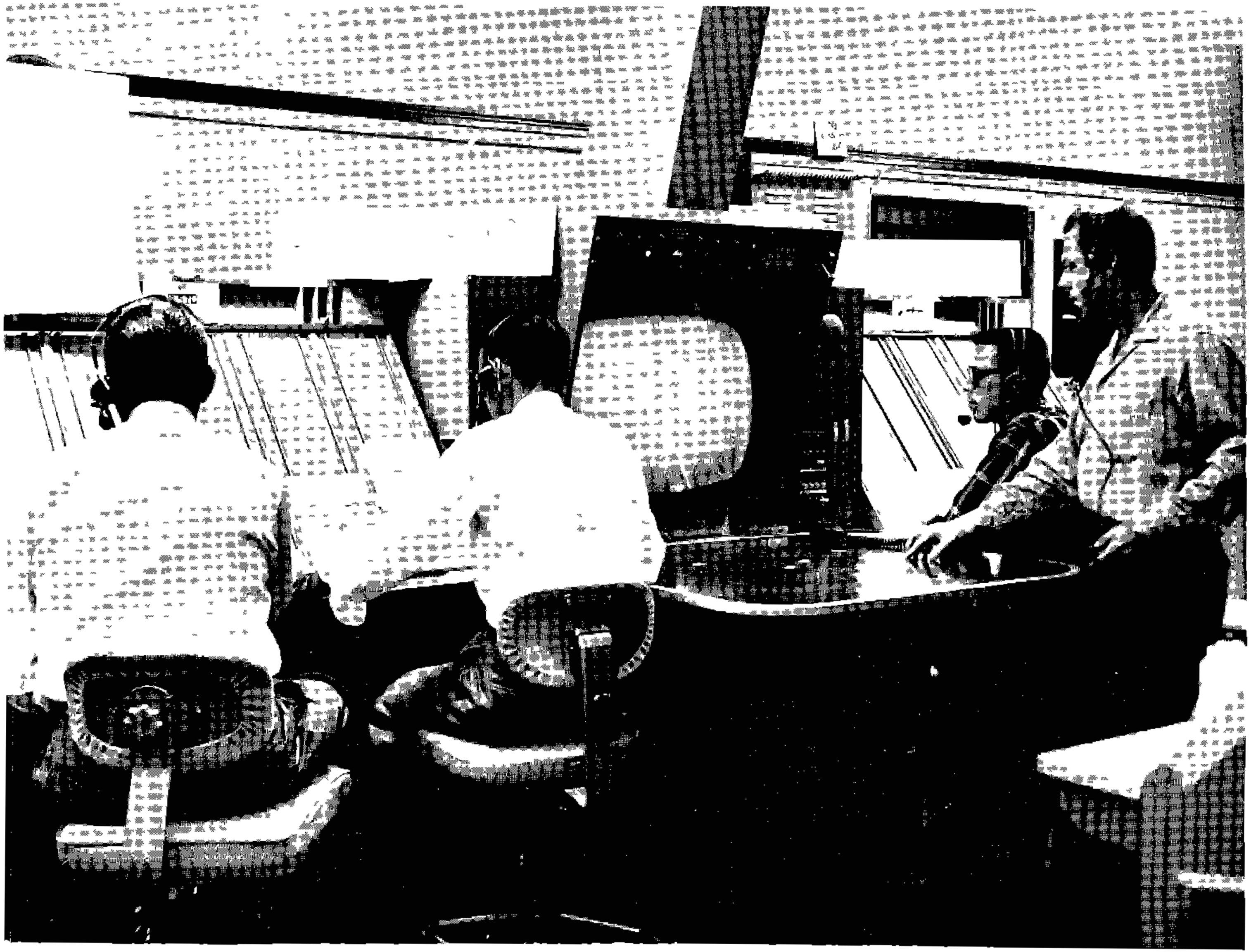
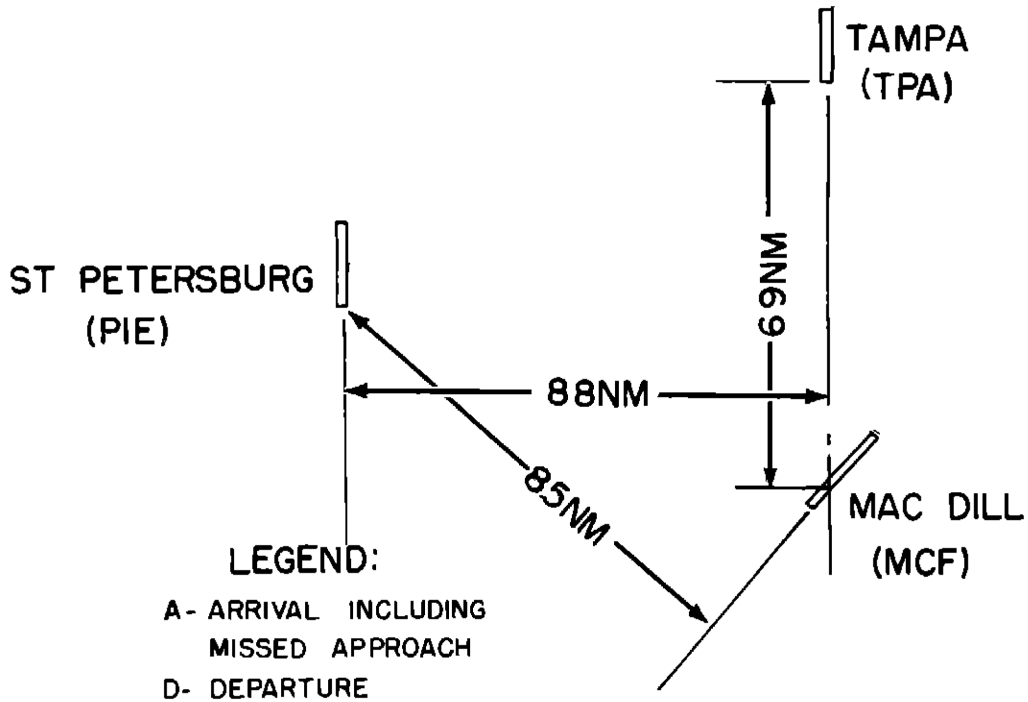


FIG 3 SPANRAD DISPLAY USED FOR EN ROUTE CONTROL OPERATIONS



LEGEND:

A- ARRIVAL INCLUDING MISSED APPROACH

D- DEPARTURE

X- POSSIBLE CONFLICTION

SUMMARY

			PIE		MCF	
			A	D	A	D
SOUTH OPERATIONS	TPA	A	X	X	X	
		D	X	X	X	X
NORTH OPERATIONS	TPA	A			X	
		D				

FIG 4 INTER-AIRPORT INTERFERENCE

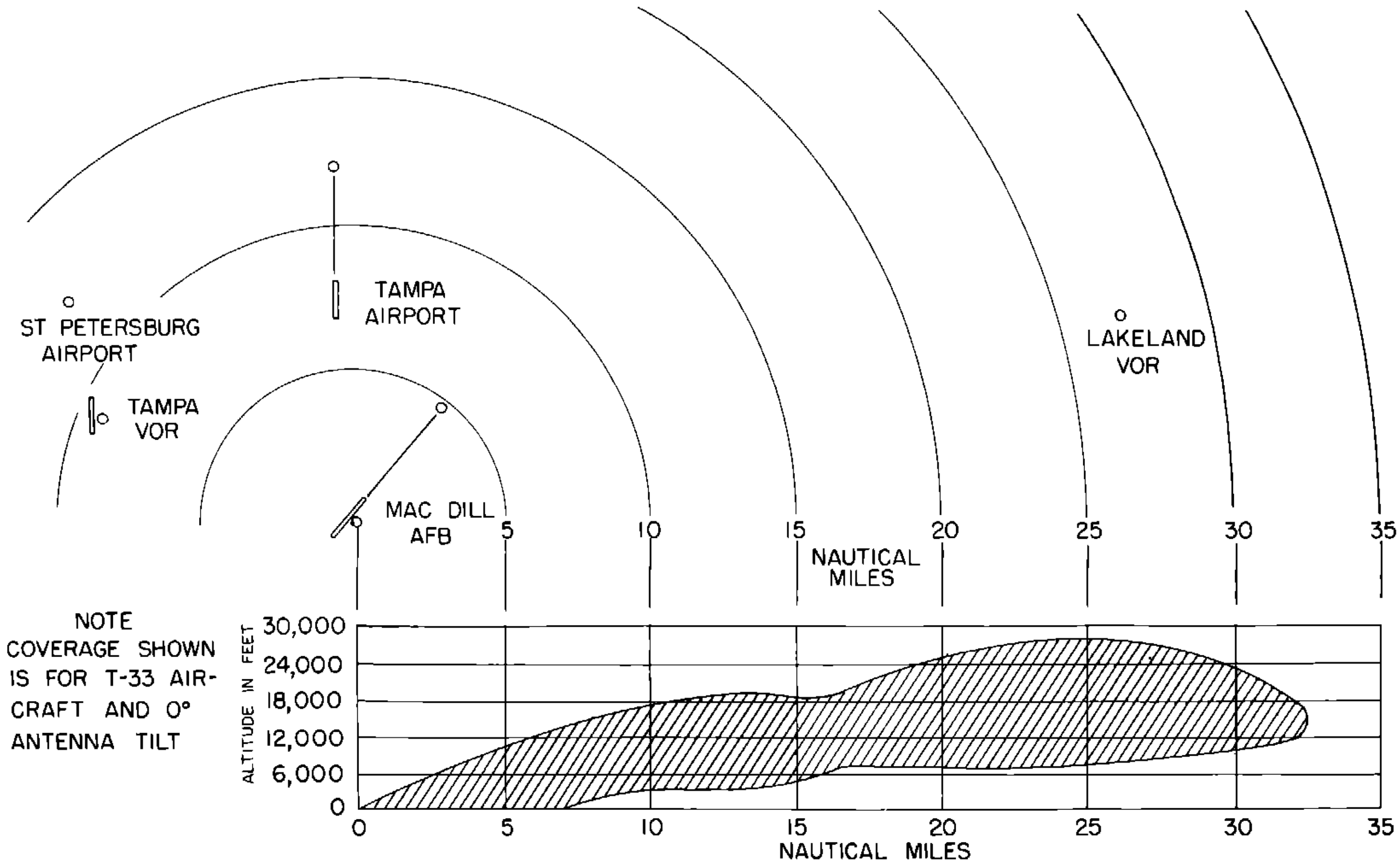


FIG 5 VERTICAL PATTERN OF MAC DILL CPN-18 RADAR CORRELATED WITH LOCAL LANDMARKS

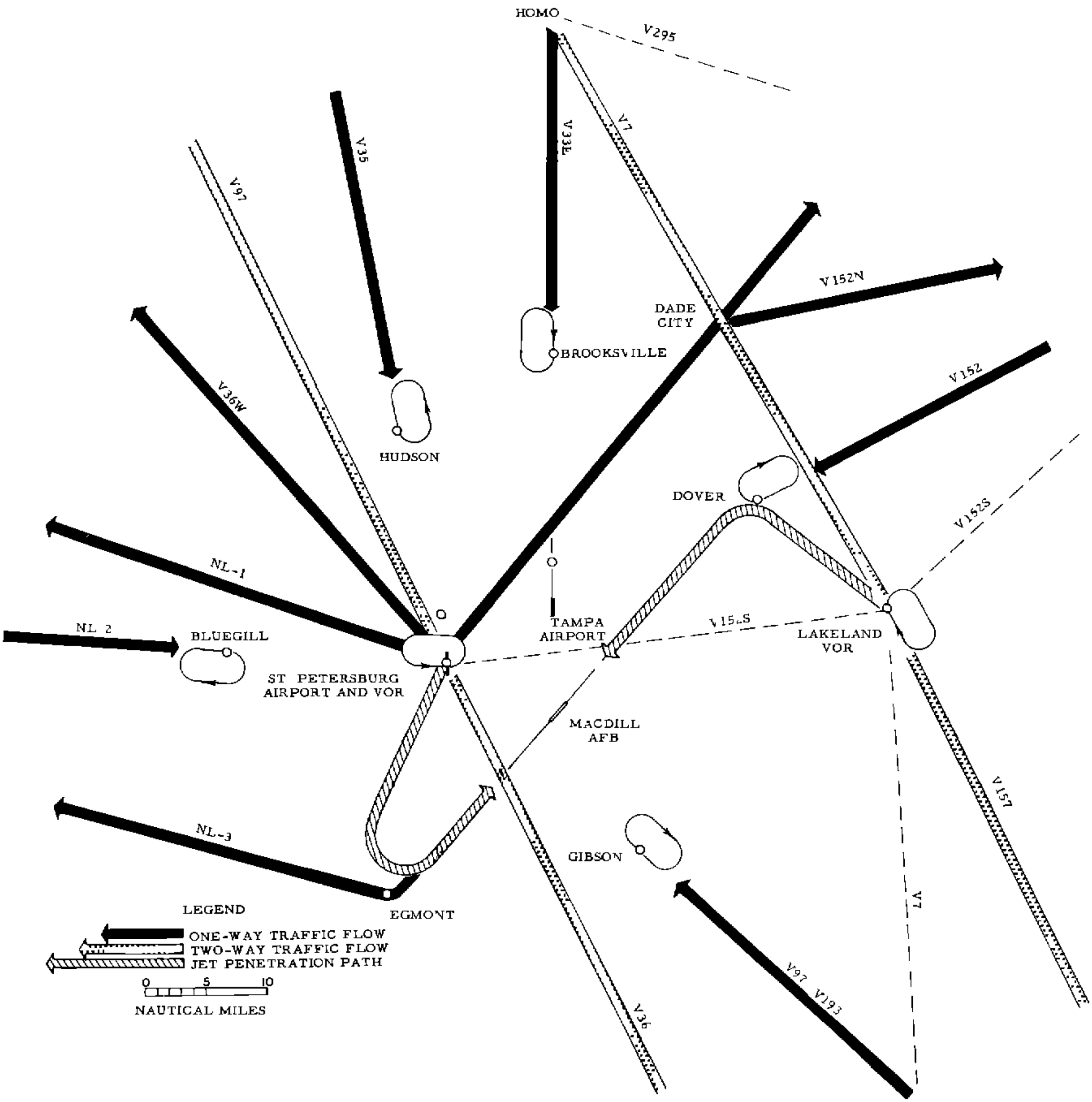


FIG 6 MAIN ROUTES AND HOLDING PATTERNS OF PRESENT SYSTEM

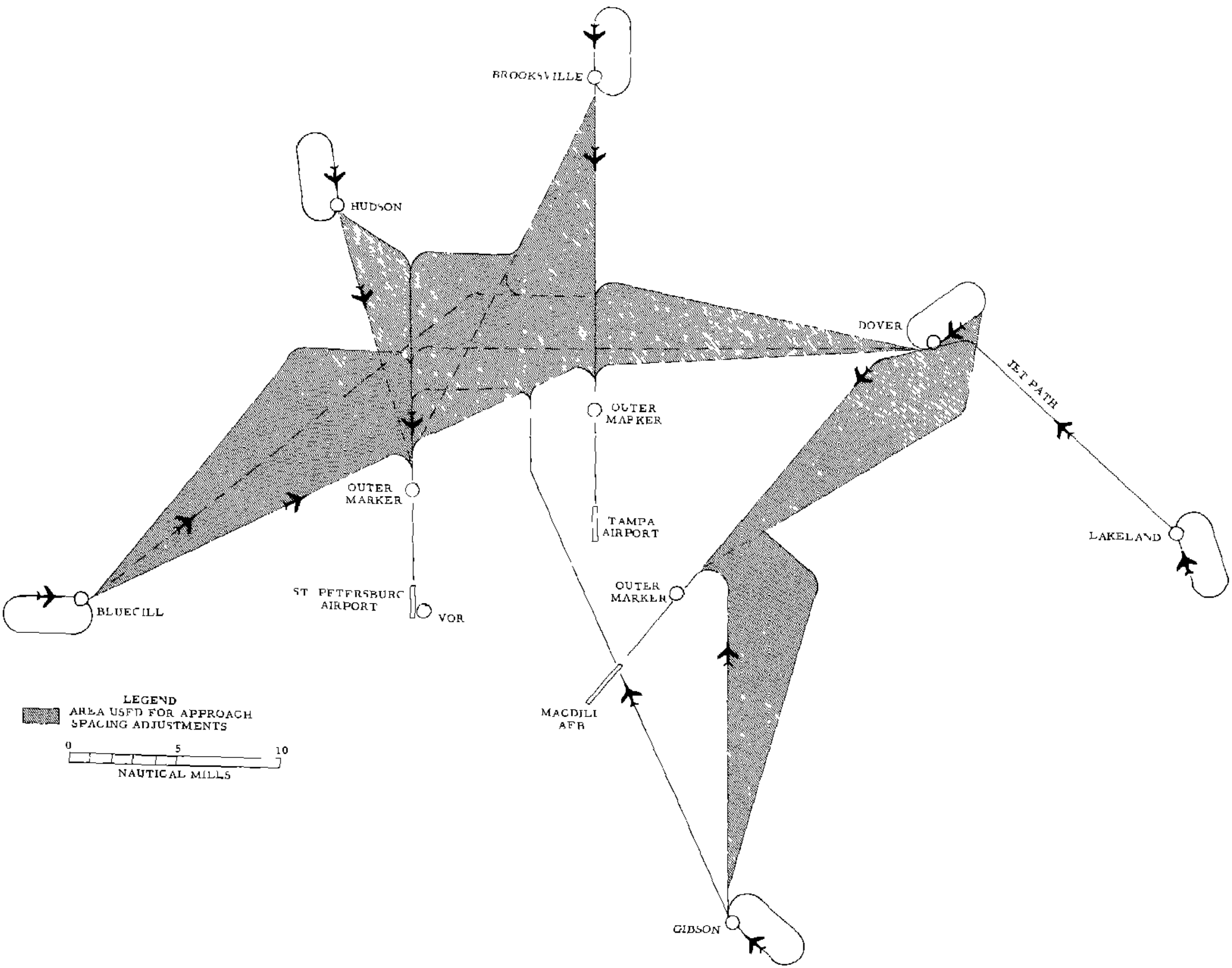


FIG 7 APPROACH PATTERNS - PRESENT SYSTEM - SOUTH OPERATION

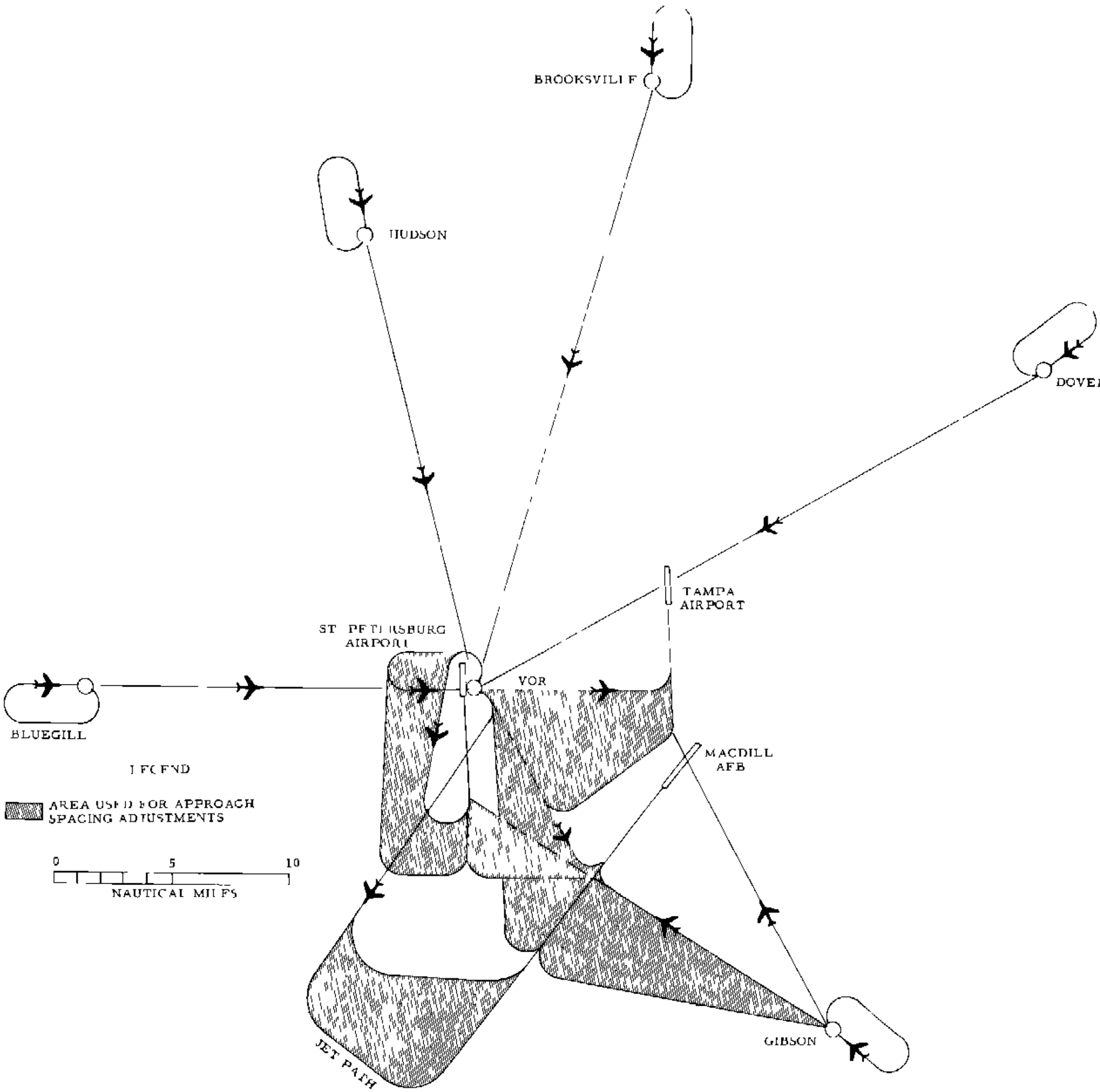


FIG 8 APPROACH PATTERNS - PRESENT SYSTEM - NORTH OPERATIONS

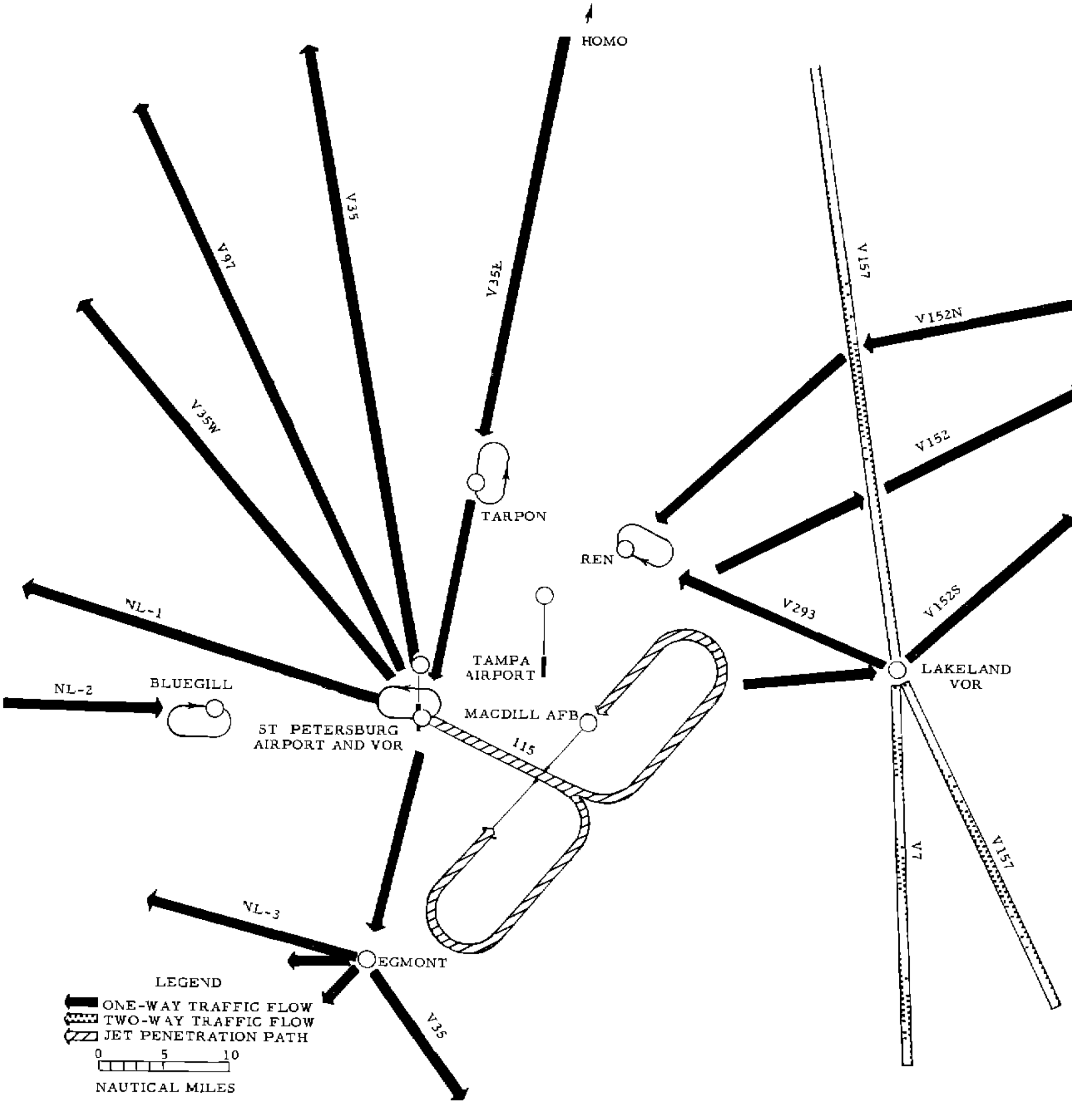


FIG 9 MAIN ROUTES AND HOLDING PATTERNS OF REVISED SYSTEM

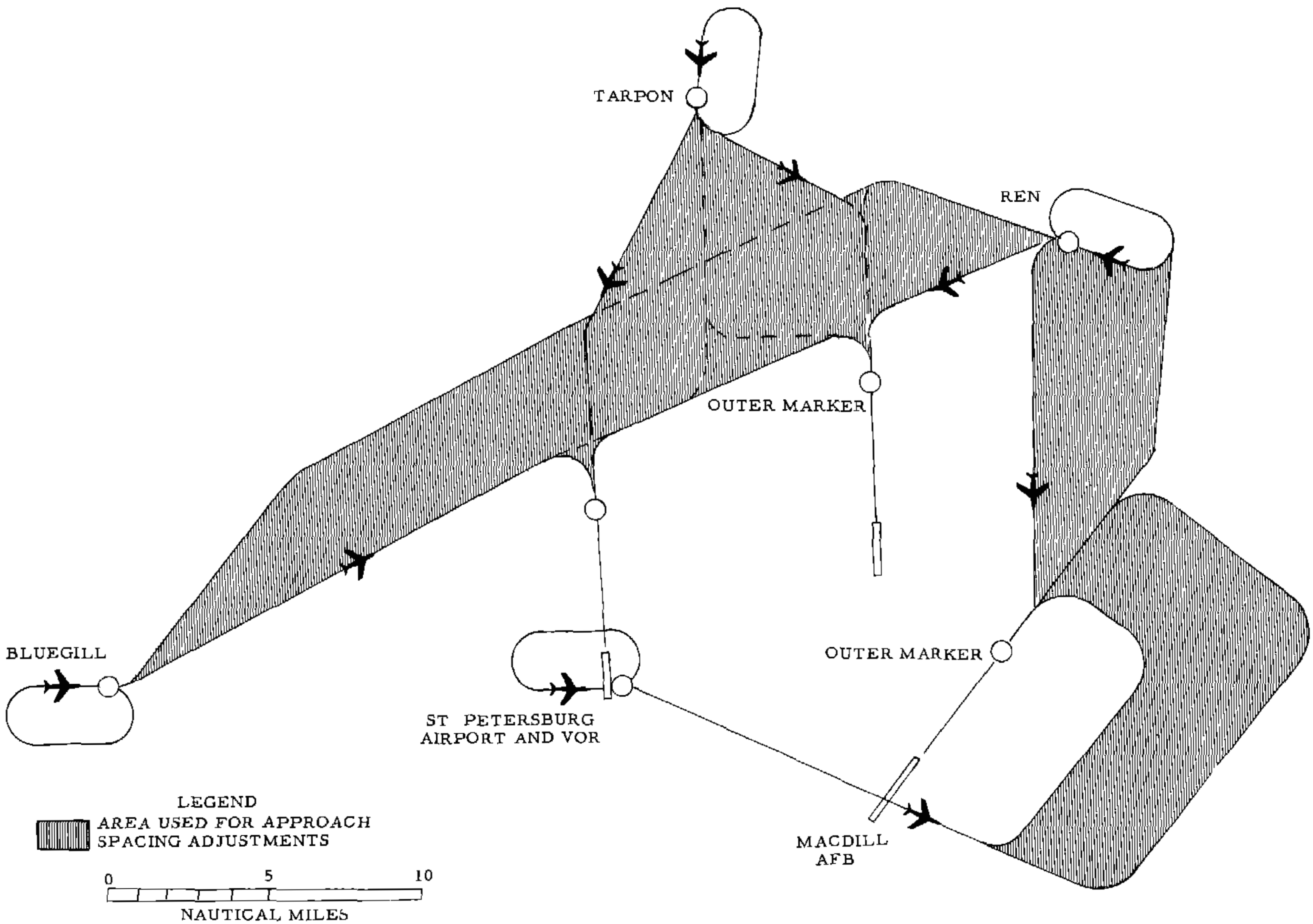


FIG 10 APPROACH PATTERNS - REVISED SYSTEM - SOUTH OPERATIONS

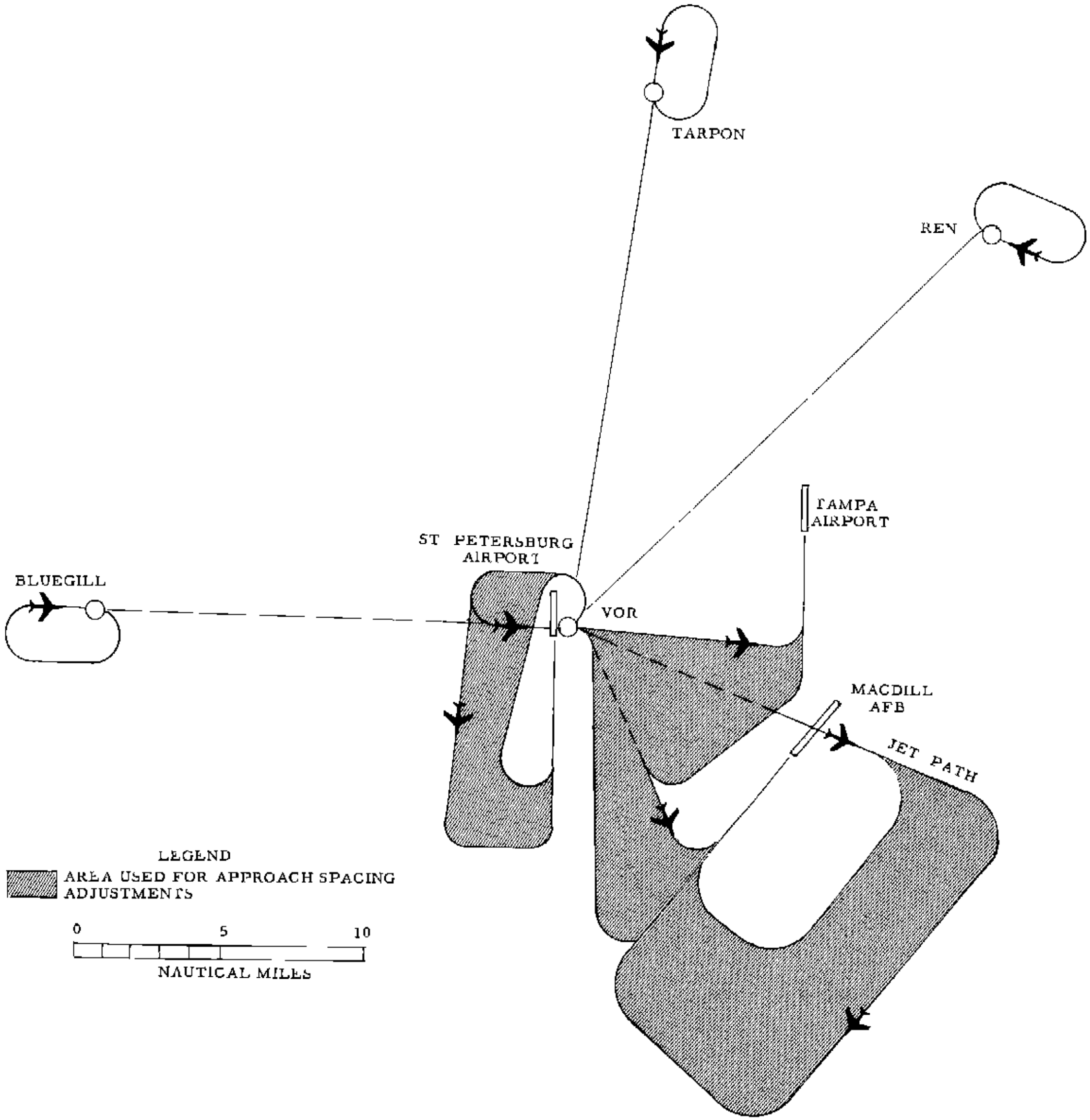


FIG 11 APPROACH PATTERNS - REVISED SYSTEM - NORTH OPERATIONS

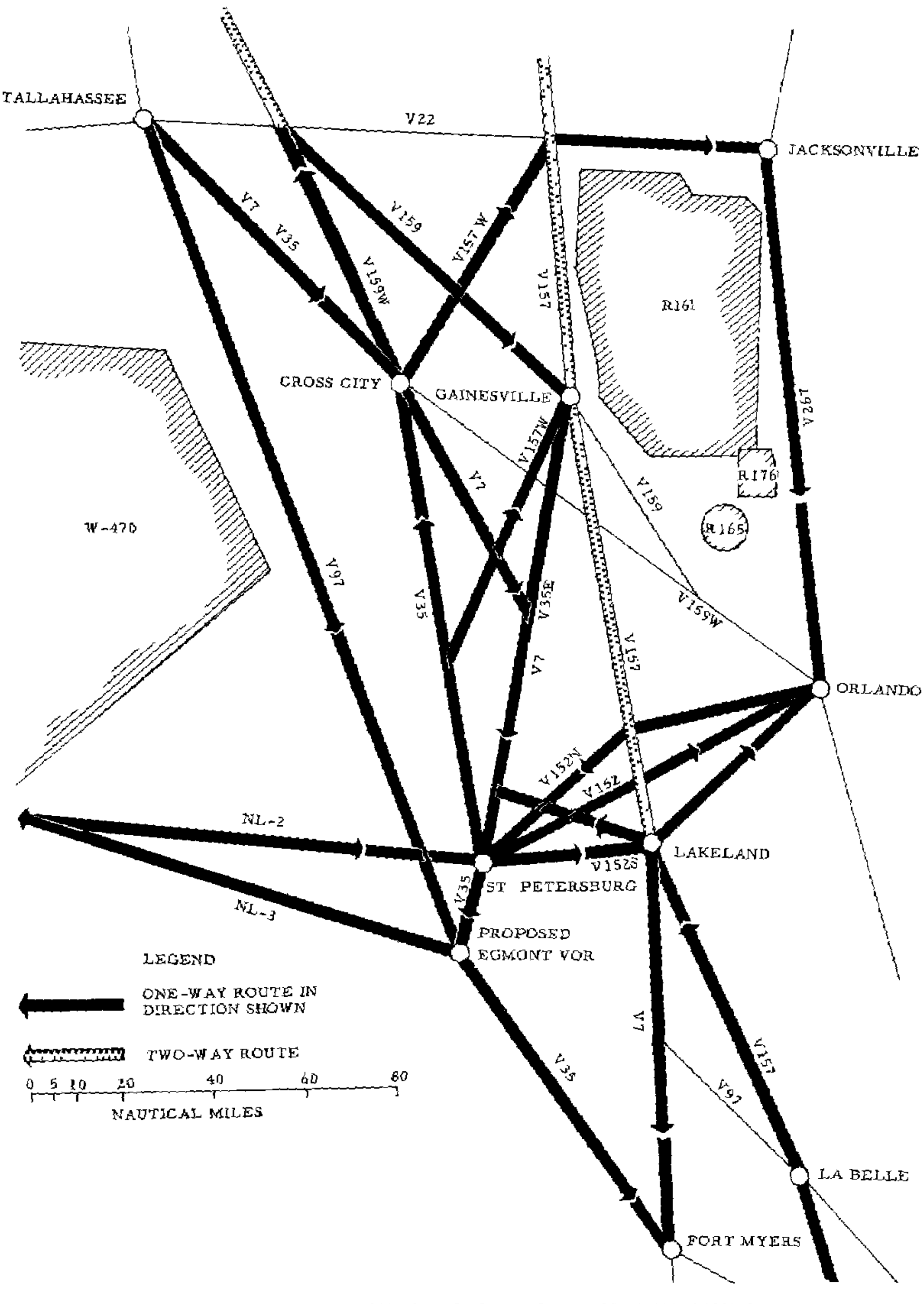


FIG 12 RECOMMENDED ROUTE STRUCTURE