Airport Layout Plan Update

AIRSIDE SIMULATION ANALYSIS

O'Hare Modernization Program

DRAFT

Prepared for:

City of Chicago, Department of Aviation

Prepared by:

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List of Abbreviations

AAR	Arrival Acceptance Rate
ACARS	Aircraft Communication Addressing and Reporting System
ADG	Airplane Design Group
ALP	Airport Layout Plan
ARTCC	Air Route Traffic Control Center
ANMS	Airport Noise Monitoring System
ARTS	Automated RADAR Terminal System
ATC	Air Traffic Control
ATCS	Air Traffic Control Specialists
ATCT	Airport Traffic Control Tower
ATM	Air Traffic Management
BTS	Bureau of Transportation Statistics
CAT	Category
CY	Calendar Year
DOA	Department of Aviation
DOT	Department of Transportation
EA	Environmental Assessment
ETMS	Enhanced Traffic Management System
FAA	Federal Aviation Administration
FY	Fiscal Year
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
LAHSO	Land and Hold Short Operations
LOA	Letters of Agreement
MKE	Milwaukee International Airport
MSL	Mean Sea Level
NAR	National Airspace Redesign
NAS	National Airspace System
NATCA	National Air Traffic Controller Association
NLA	New Large Aircraft
NM	Nautical Miles
OAG	Official Airline Guide
OMP	O'Hare Modernization Program
ORD	O'Hare International Airport
PAL	Planning Activity Level
PMAD	Peak Month Average Day
RPZ	Runway Protection Zone

SOP	Standard Operating Procedures
TAAM	Total Airspace and Airport Modeller
TAF	Terminal Area Forecast
TRACON	Terminal RADAR Approach Control Facility
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VOR	Very High Frequency Omnidirectional Range
VORTAC	Very High Frequency Omnidirectional Range Collocated with Tactical Air Navigation
WGP	World Gateway Program
ZAU	Chicago Air Route Traffic Control Center

I. Introduction

The operational and simulation analysis for the O'Hare Modernization Plan (OMP) for Chicago O'Hare International Airport (the Airport) was conducted to evaluate the operational impacts of the proposed airfield and airspace reconfiguration alternatives compared with the existing operating procedures at the Airport. In addition, the simulation analysis was used to assist in evaluating and refining future airfield geometries and to formulate Air Traffic Control (ATC) operating procedures for each of the alternatives. The effects of changed runway crossing points or routings, alternative runway use plans, operational effects of alternative runway lengths or taxiway configuration were also evaluated. The results of the analysis were used to estimate the changes in aircraft delays and travel times, and the resulting operating costs that would be associated with the implementation of any of the alternatives.

The Total Airspace and Airport Modeller (TAAM) Plus model was used for the simulation analysis. Produced by Preston Aviation Solutions, a Boeing Aircraft Corporation subsidiary, TAAM is capable of, but not limited to, considering and analyzing the following procedural issues:

- Separation standards such as wake turbulence, runway separation criteria and in-trail separations
- Aircraft performance criteria such as climb rates and approach speeds
- Airline operations criteria such as aircraft/airline specific gate assignments, pushback procedures, arrival/departure schedule linking
- Airfield operation standards such as runway crossing patterns, hold pads, restricted use taxiways, runway queue balancing.

TAAM is currently being used for airfield and airspace assessments by the Federal Aviation Administration (FAA) National Airspace Redesign (NAR) team, American, Continental and Delta Airlines and Boeing Air Traffic Management (ATM). The Chicago Department of Aviation (DOA) also used TAAM in support of the Environmental Assessment (EA) of the World Gateway project.

The simulation effort was initiated by setting up models for the six existing runway use operating configurations at the Airport. Initial TAAM databases developed for the World Gateway EA were used as the basis for the analysis and were updated where required, including the addition of the Chicago Terminal RADAR Approach Control (TRACON) airspace parameters.

As explained in detail in Section III, *Model Calibration and Validation*, the simulation of existing conditions at the Airport included two calibration analyses. These configurations, Plan X in VMC and Parallel 27s in IMC were calibrated with actual statistics for runway use, hourly arrival and departure flow rates and taxi times to match airport operating characteristics specific to O'Hare International Airport and to ensure that TAAM was replicating a close approximation of actual airfield/airspace operations at the Airport. The simulation results compared favorably with the actual operating statistics of the calibration days. Additionally, during the development of the baseline/existing conditions and alternatives simulation analyses and calibration cases, the simulation results and animations were presented to Airport Traffic Control Tower (ATCT), TRACON, airline representatives and other operations and simulation experts for review and approval. Based on feedback received from these sources, adjustments to simulation parameters and airfield/airspace operational procedures were made to reflect existing and planned operating conditions at the Airport.

Following model calibration, simulation model experiments with the various airfield and airspace options were established in accordance with the future operating assumptions developed in cooperation with the ATCT and TRACON. Results were then obtained by modeling existing and future demand levels and estimating delay and travel time statistics for both existing and future airfield configurations.

O'Hare International Airport's existing operating configurations that were modeled included Plan X, Plan W, Plan B, and Plan B modified (currently being implemented). These configurations were simulated under VMC conditions that would allow triple visual approaches during periods of peak arrival demand. IMC configurations that were modeled included one configuration operating in Category I (CAT I) ILS weather conditions utilizing simultaneous Instrument Landing System (ILS) approaches to Runways 27L and 27R. A single CAT III ILS weather condition analysis was conducted that modeled simultaneous ILS approaches to Runways 14L and 14R. An existing operational demand level and several additional increased Planning Activity Levels (PALs) were simulated. At the higher PALs, the airfield geometry that was simulated included elements of the proposed World Gateway program, so that demand on the airfield could be maximized without gate limitations.

Three future airfield layout plans, Options 1, 2 and 5, were initially selected for evaluation with TAAM simulation model. Out of these three, Options 1 and 5 were simulated and analyzed at future demand levels of PAL 1 and PAL 2, which correspond to 1.1 and 1.3 million annual aircraft operations at the Airport respectively. Option 2 was eliminated from the modeling process after the initial stage due to certain operational deficiencies. These deficiencies are explained in detail in Sections V, *Airfield and Airspace Procedures* and Section VI, *Simulation Results*. Input from ATCT and TRACON was used to develop ground movement and airspace assumptions for these future airfield layout plans under various weather criteria, including VMC and IMC in both east and west flow. The selection of these options was a result of planning discussions held between FAA, ATCT, TRACON, airline representatives and City of Chicago, DOA during various advisory sessions.

Options 3 and 4 were not selected for simulation purposes, although the primary features of each are contained in Option 2. Option 3 was a variation of Option 2 that included a southwest extension to Runway 4L-22R and relocated existing Runway 9L-27R to the north while preserving the perimeter taxiways around the west end of the runways. The relocation of the runway was considered to provide a dual taxiway system in the inner core of the Airport. Option 4 was also a variation of Option 2 that included a southwest extension to Runway 4L-22R and an extension to existing Runway 9L-27R. However, Option 4 did not include the relocation of existing Runway 9L-27R.

All three selected options include the addition of new runways that are parallel to existing Runways 9L-27R and 9R-27L that transition the Airport to an essentially east/west traffic flow configuration. Since the total number of parallel runways would exceed three, all new runways associated with the north airfield would be designated as 9-27 and all south runways would be designated 10-28. All new runway ends would be located to satisfy clearance requirements for CAT II/III operations. The structure of the airspace supporting the future airfield was developed from direct input received from the appropriate branches of the FAA.

Option 1 proposes adding one new parallel runway to the north airfield and one new parallel runway to the south airfield. All other existing runways would remain in their current configuration. Runway 10R-28L would be designed to FAA Airplane Design Group (ADG) VI standards, while all other runways would be designed to ADG V standards. Perimeter taxiways would be added to the west end of Runways 9R-27L, 10L-28R and 10R-28L to permit controlled aircraft taxi movements around the runway ends in lieu of runway crossings.

Option 2 would add two new runways to the north airfield and two new runways to the south airfield. The existing Runways 4L-22R and 4R-22L would be maintained for wind coverage purposes and would additionally be used under several airfield operating configurations to facilitate departure and arrival operations. Additionally, perimeter taxiways would be added around the west end of Runways 9R-27L, 9C-27C, 10L-28R and 10C-28C to accommodate controlled aircraft taxi movements around the runway ends in lieu of runway crossings. The two center runways, i.e., Runways 9C-27C and 10C-28C, would be designed to ADG VI standards, while all other runways would be designed to ADG V standards. It should be noted that the City of Chicago requested a criteria clarification from the FAA on how the perimeter taxiways in Option 2 should be operated. The FAA Flight Technologies and Procedures Division provided a memorandum dated 22 August 2002. However, there have been discussions within the FAA on the accuracy of this memo. A copy of this memo is attached in Appendix A.

Similar to Option 2, Option 5 would add two new runways to the north airfield and two new runways to the south airfield. Existing Runways 4L-22R and 4R-22L would be maintained for wind coverage purposes and to facilitate departure and arrival operations under several airfield operating configurations. Unlike Option 2, runway extensions of existing Runways 9L-27R and 9R-27L are included in Option 5. The two center runways, i.e., Runways 9C-27C and 10C-28C, are designed to ADG VI standards, while all other runways are designed to ADG V standards.

As explained in Section II, *Data Collection and Model Inputs*, data used in the TAAM simulations was gathered from various sources. Wind and weather data used in the OMP modeling effort represents ten years of hourly observations at the Airport collected by the National Climatic Data Center between January 1991 and December 2000. The schedule of aircraft activity was developed from Official Airline Guide (OAG) data supplemented by actual operating statistics from the U.S. Department of Transportation (DOT) Bureau of Transportation Statistics (BTS) Airline On Time Data, Enhanced Traffic Management System (ETMS) data, Aircraft Communication Addressing and Reporting System (ACARS) and Automated RADAR Terminal Systems (ARTS) data supplied by the DOA Noise Office. The FAA's 2001 Terminal Area Forecast (TAF) was used as the basis for determining future aircraft activity levels.

The FAA's Great Lakes Air Traffic Division formed a team comprised of National Air Traffic Controller Association (NATCA) members and management personnel from O'Hare ATCT and Chicago TRACON to support the proof of concept phase of the OMP. The team, Messrs. Kevin Markwell (ATCT), Bill Spencer (ATCT NATCA), Mark Ray (TRACON NATCA), and Jeffrey McCoy (TRACON), provided essential input into the formulation of airfield alternatives, Airport operating plans, airspace assumptions, taxi flows, operating strategies, and the validation of modeled assumptions.

This report documents the following key elements of the operational and simulation analysis for the O'Hare Modernization Program:

- Data collection sources and efforts
- Model inputs and assumptions
- Model calibration and validation
- Description of the existing operating procedures and alternatives evaluated
- Summary of simulation results

II. Data Collection and Model Inputs

This section provides the description and sources of various inputs that were used to develop the TAAM simulation analyses. These inputs include scheduled aircraft activity for various analysis years, routing information including city pairs, typical arrival and departure fixes associated with these city pairs, and weather data required for the airspace configurations modeled. Chicago TRACON and O'Hare ATCT staff provided verification of inputs and assumptions required in modeling the existing and future airspace and ground movements at the Airport. The simulation model was also calibrated for specific Airport characteristics such as arrival and departure flow rates, runway exit usage, taxiway speeds and aircraft climb and descent rates.

2.1 Assumed Traffic Levels and Aircraft Schedule Development

Demand schedules used for TAAM simulation purposes were developed from aviation demand analysis performed as part of the Airport Layout Plan (ALP) Update Study for the OMP. This aviation demand analysis utilized previously developed forecasts to define aviation activity profiles and demand thresholds for the Airport. Additional documentation on the aviation demand forecasts is attached as Appendix A to this report.

The 2001 FAA Terminal Area Forecast (TAF) was used as the primary forecast source for quantifying future aviation activity for the Airport. Other industry forecasts such as the FAA's Long Range Forecasts, the Airbus Global Market Forecasts (2000-2019), and the Boeing Market Outlook Forecasts (2001) were also used as reference documents to confirm the demand profiles established for the Airport.

Additional information on the sources of historical activity and the methodologies used to derive future demand projections are presented in the following sections.

2.1.1 Historical Activity

Annual aviation activity patterns from 1990 through 2001 for the Airport were obtained from the City of Chicago DOA Management Records. The following adjustments in the categorization of the Airport's historical activity were made to the data presented in the Airports Annual Traffic Summary Reports:

- Canadian activity, including passenger volumes and aircraft operations, served by scheduled domestic and foreign flag carriers are represented as domestic activity, since these flights typically receive Customs and Immigration screening at their originating Canadian market.
- Aviation activity represented under the headings of "General Aviation", "Miscellaneous", and "Helicopter" in the Management Reports have been combined into one category titled General Aviation/Miscellaneous.
- In most cases, domestic commuter and domestic air carrier activity have been combined into one Domestic category.

In addition, several other minor adjustments were made to the categorization of domestic and international airline activity. Summaries of the adjustments made to the airline activity and adopted for this demand analysis are presented in **Table II-1** and **II-2**.

Table II-1

Historical Domestic and International Passenger Enplanements

Year	Domestic Enplanements[1]	Adjusted Domestic Enplanements[2,3]	International Enplanements[1]	Adjusted International Enplanements[4]
1990	27,101,329	27,866,330	2,317,673	1,552,672
1991	27,098,675	27,826,320	2,277,674	1,550,029
1992	29,121,304	29,754,331	2,533,770	1,900,743
1993	29,101,964	29,909,993	2,882,034	2,074,005
1994	29,715,188	30,541,648	3,003,537	2,177,077
1995	29,563,080	30,496,053	3,298,380	2,365,407
1996	30,538,684	31,479,170	3,529,201	2,588,715
1997	30,887,134	31,858,776	3,886,980	2,915,338
1998	31,460,468	32,455,965	4,298,576	3,302,845
1999	31,190,082	32,213,452	4,757,001	3,733,512
2000	30,651,529	31,652,950	5,048,996	4,047,575
2001	28,693,866	29,488,760	4,616,337	3,821,443

1. As reported in the Airport Management Records. Domestic activity includes commuters.
2. Domestic enplanements were adjusted by adding domestic activity reported as international activity and deducting international activity reported as domestic activity in the Airport Management Records.
3. Express-One enplanements were deducted from Domestic enplanements.
4. International enplanements were adjusted by adding international activity reported as domestic activity and deducting domestic activity reported as international activity in the Airport Management Records.

Sources: City of Chicago DOA Management Records; Official Airline Guide; Ricondo & Associates, Inc.
Prepared By: Ricondo & Associates, Inc.

Table II-2

Historical Domestic and International Air Carrier Operations

Year	Domestic Departures[1]	Adjusted Domestic Departures[2,3,4]	International Departures[1]	Adjusted International Departures[4,5]
1990	363,585	371,286	19,734	12,033
1991	359,979	368,169	20,661	12,471
1992	370,557	379,350	23,114	14,321
1993	373,404	383,044	25,912	16,272
1994	367,965	378,195	26,786	16,556
1995	375,499	388,289	29,464	16,674
1996	376,534	389,124	30,816	18,216
1997	373,719	387,143	33,307	19,877
1998	377,070	390,615	36,223	22,675
1999	376,804	390,731	39,184	25,219
2000	381,819	396,472	42,589	27,788
2001	386,015	400,748	40,966	26,086

1. As reported in the Airport Management Records. Domestic activity includes commuters.
2. Domestic enplanements were adjusted by adding domestic activity reported as international activity and deducting international activity reported as domestic activity in the Airport Management Records.
3. Express-One departures were deducted from Domestic Departures.
4. Canadian departures obtained from 2001 FAA TAF database were added to domestic departures and deducted from international departures.
5. International enplanements were adjusted by adding international activity reported as domestic activity and deducting domestic activity reported as international activity in the Airport Management Records.

Sources: City of Chicago DOA Management Records; Official Airline Guide; 2001 FAA Terminal Area Forecasts database; Ricondo & Associates, Inc.
Prepared By: Ricondo & Associates, Inc.

2.1.2 Future Annual Demand Projections

Annual projections of future aviation activity were developed using the 2001 FAA TAF published for the Airport. These FAA forecasts, which provide annual projections of passenger enplanements and total aircraft operations through fiscal year 2015, were converted to calendar year (CY) projections and extrapolated through the year 2030 using a trend analysis of the forecast activity from CY2002 through CY2014 (the forecast horizon included in the published 2001 TAF). **Table II-3** and **II-4** summarize the TAF projections utilized in the OMP ALP Update Study. As shown, the 2001 TAF projects passenger enplanement growth at the Airport to reach approximately 48.6 million in calendar year 2014. The extrapolation of the 2001 TAF, as described above, resulted in nearly 66.1 million annual passenger enplanements in the year 2030. Similarly, the 2001 TAF projected growth in total annual aircraft operations to 1.1 million operations in calendar year 2014. The extrapolation of the TAF projections resulted in nearly 1.3 million operations in calendar year 2030.

2.1.3 Identification of Planning Activity Levels (PALs) 1 and 2

To facilitate the analytical process associated with the various ALP planning tasks, two future demand levels, PAL 1 and PAL 2, were developed. These correspond to the activity levels projected by the FAA in the 2001 TAF for calendar year 2014 (i.e., 48.6 million annual enplanements and 1.1 million total annual aircraft operations) and calendar year 2030 (i.e., 66.1 million annual enplanements and 1.3 million total annual aircraft operations, as extrapolated by Ricondo & Associates, Inc.). **Exhibits II-1** and **II-2** depict the 2001 TAF and the two PALs selected for the simulation analyses associated with the OMP.

PAL 1 and PAL 2 have been defined in terms of annual, peak month, and Peak Month Average Day (PMAD) activity. August is typically the peak month for aircraft operations at the Airport. In terms of total aircraft operations, PAL 1 (1.1 million annual operations) and PAL 2 (1.3 million annual operations) translate to 3,243 PMAD operations at PAL 1 and 3,864 PMAD operations at PAL 2. These total volumes of PMAD aircraft operations are further broken down by category in **Table II-5** below.

2.1.4 General Trends Assumed in Projected Aviation Activity

The annual passenger enplanement and operations projections for PAL 1 and PAL 2 were segregated into domestic and international activity. Air Carrier and Commuter (Commercial) aircraft operations were derived using the projections for passenger enplanements and estimates of future growth in boarding load factors and seats per operation based on historic trends. Domestic load factors were held constant at 72.5 percent through PAL 2. International load factors were assumed to grow gradually from 2001 through PAL 1, reaching 72 percent, then held constant at that level through PAL 2. Average domestic seats per operation were assumed to increase at a rate of 1.5 seats per year, on average, from 2001 through PAL 1 (reaching 131 average seats per departure). From PAL 1 through PAL 2, domestic seats per departure were assumed to grow at a slower rate, ranging between 0.75 and 1.0 seats per year, reaching 144 average seats per departure at PAL 2. Average international seats per departure were assumed to grow by 1.0 seats per year, on average, from 2001 through PAL 1 (reaching 270 average seats per departure).

Table II-3

2001 FAA Terminal Area Forecasts for O'Hare International Airport - Passenger Enplanements

Year	2001 TAF Enplanements (in FY)		2001 TAF Enplanements (in CY)	
	Historical[1]	Projected	Historical	Projected
1990	29,419,002		29,419,002	
1991	29,376,349		29,376,349	
1992	31,655,074		31,655,074	
1993	31,983,998		31,983,998	
1994	32,718,725		32,718,725	
1995	32,861,460		32,861,460	
1996	34,067,885		34,067,885	
1997	34,774,114		34,774,114	
1998	35,758,810		35,758,810	
1999	35,946,964		35,946,964	
2000	35,700,525		35,700,525	
2001	33,310,203	34,153,190	33,310,203	33,310,203
2002		35,284,393		35,556,730
2003		36,373,739		36,646,076
2004		37,463,086		37,735,423
2005		38,552,434		38,824,771
2006		39,641,781		39,914,118
2007		40,731,129		41,003,466
2008		41,820,477		42,092,814
2009		42,909,825		43,182,162
2010		43,999,173		44,271,510
2011		45,088,521		45,360,858
2012		46,177,868		46,450,205
2013		47,267,216		47,539,553
2014		48,356,563		48,628,901
2015		49,445,913		*49,719,645*
2016		*50,540,840*		*50,813,438*
2017		*51,631,234*		*51,903,832*
2018		*52,721,628*		*52,994,226*
2019		*53,812,022*		*54,084,620*
2020		*54,902,416*		*55,175,014*
2021		*55,992,810*		*56,265,408*
2022		*57,083,204*		*57,355,802*
2023		*58,173,598*		*58,446,197*
2024		*59,263,992*		*59,536,591*
2025		*60,354,386*		*60,626,985*
2026		*61,444,780*		*61,717,379*
2027		*62,535,174*		*62,807,773*
2028		*63,625,568*		*63,898,167*
2029		*64,715,962*		*64,988,561*
2030		*65,806,356*		*66,078,955*

1. Historic Activity shown in Calendar Years and obtained from the City of Chicago DOA Management Records.
2. Represents FAA TAF projections for Fiscal Year (FY) 2001.
   Italic text represents extrapolated TAF projections by Ricondo & Associates, Inc.

Sources: City of Chicago DOA Management Records; FAA Terminal Area Forecasts; Ricondo & Associates, Inc.
Prepared By: Ricondo & Associates, Inc.

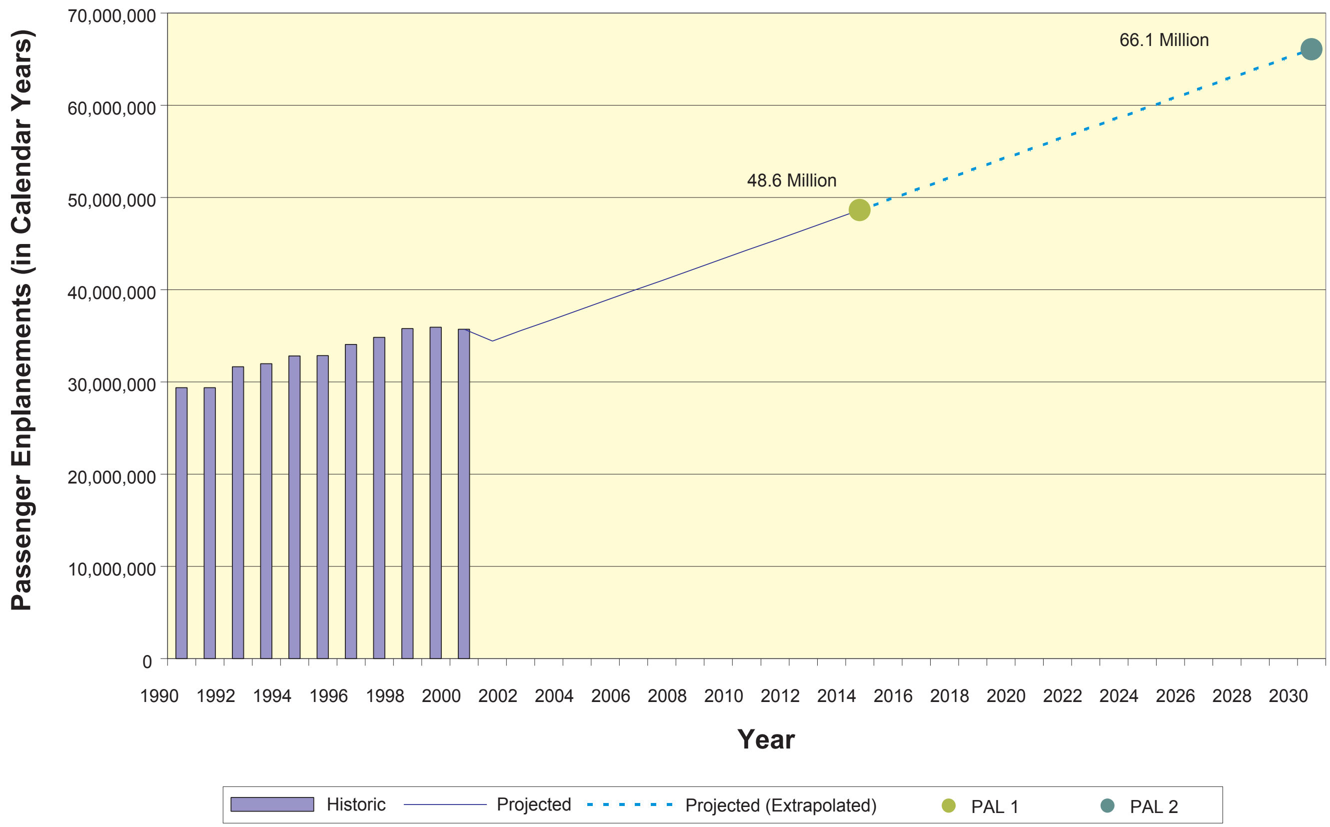
Table II-4

2001 FAA Terminal Area Forecasts for O'Hare International Airport – Total Aircraft Operations

	2001 TAF Aircraft Operations (in FY)		2001 TAF Aircraft Operations (in CY)	
Year	Historical[1]	Projected	Historical	Projected
1990	810,865		810,865	
1991	813,896		813,896	
1992	841,193		841,193	
1993	859,208		859,208	
1994	883,062		883,062	
1995	900,279		900,279	
1996	909,593		909,593	
1997	883,761		883,761	
1998	896,104		896,104	
1999	884,783		884,783	
2000	908,989		908,989	
2001	911,917	923,435[2]	911,917	911,917
2002		929,097		932,542
2003		942,878		946,324
2004		956,661		960,107
2005		970,444		973,890
2006		984,227		987,673
2007		998,010		1,001,456
2008		1,011,793		1,015,238
2009		1,025,574		1,029,020
2010		1,039,357		1,042,803
2011		1,053,140		1,056,586
2012		1,066,923		1,070,369
2013		1,080,706		1,084,152
2014		1,094,489		1,097,935
2015		1,108,272		*1,111,447*
2016		*1,120,971*		*1,124,366*
2017		*1,134,551*		*1,137,946*
2018		*1,148,131*		*1,151,525*
2019		*1,161,710*		*1,165,105*
2020		*1,175,290*		*1,178,685*
2021		*1,188,870*		*1,192,265*
2022		*1,202,449*		*1,205,844*
2023		*1,216,029*		*1,219,424*
2024		*1,229,609*		*1,233,004*
2025		*1,243,188*		*1,246,583*
2026		*1,256,768*		*1,260,163*
2027		*1,270,348*		*1,273,743*
2028		*1,283,927*		*1,287,322*
2029		*1,297,507*		*1,300,902*
2030		*1,311,087*		*1,314,482*

1. Historic Activity shown in Calendar Years and obtained from the City of Chicago DOA Management Records.
2. Represents FAA TAF projections for Fiscal Year (FY) 2001.
   Italic text represents extrapolated TAF projections by Ricondo & Associates, Inc.

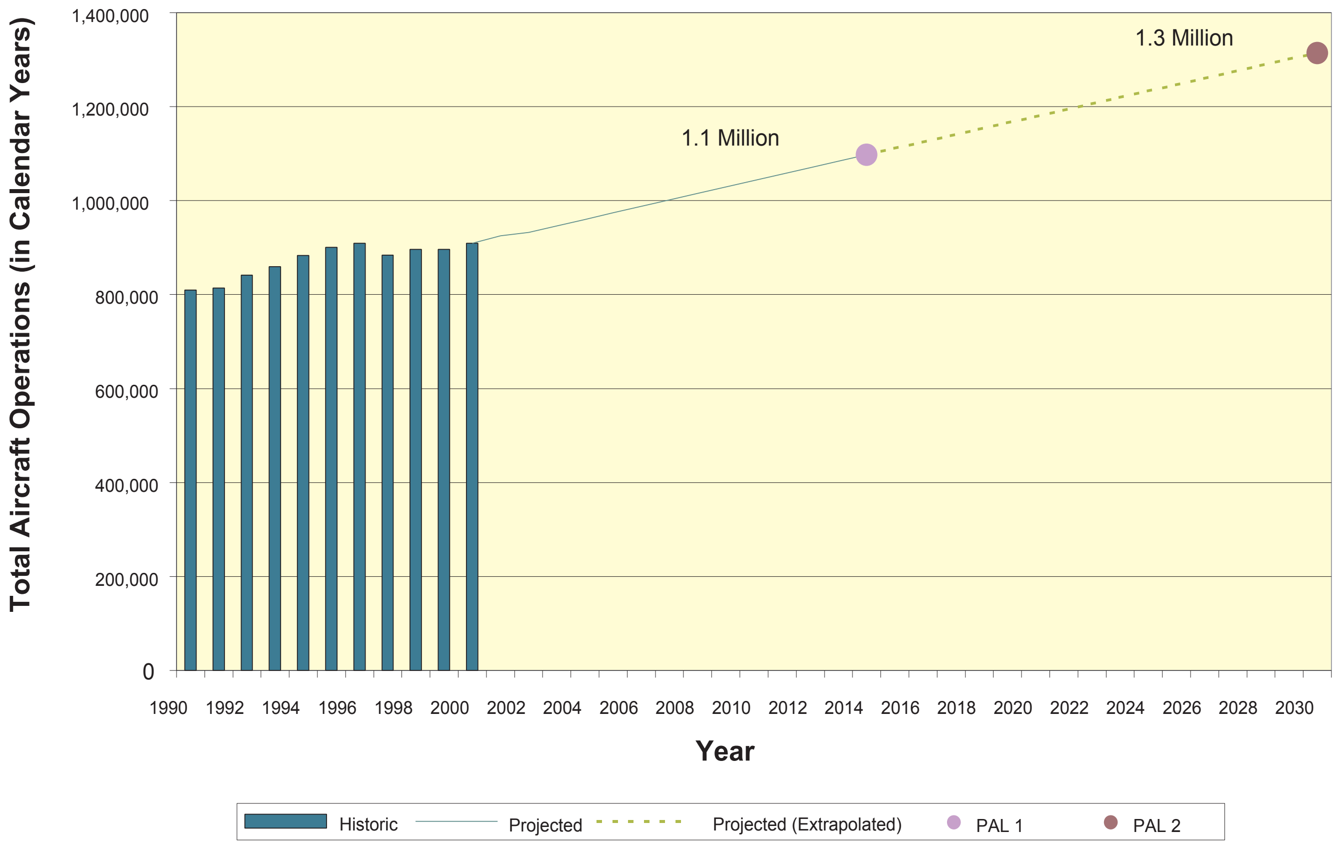
Sources: City of Chicago DOA Management Records; FAA Terminal Area Forecasts; Ricondo & Associates, Inc.
Prepared By: Ricondo & Associates, Inc.



Sources: Actual - City of Chicago DOA Management Records,
FAA Terminal Area Forecasts: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-1

2001 FAA Terminal Area Forecasts
Passenger Enplanements in Calendar Years



Sources: Actual - City of Chicago DOA Management Records,
FAA Terminal Area Forecasts: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-2

2001 FAA Terminal Area Forecasts
Total Aircraft Operations in Calendar Years

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Table II-5

PMAD Aircraft Operations

Category	Peak Month Average Day Operations		
	2001	PAL 1	PAL 2
Domestic Air Carrier and Commuter	2,333	2,825	3,306
International Air Carrier	246	299	443
Non-scheduled Activity (includes All-cargo, General Aviation/Miscellaneous, and Military operations)	154	119	115
Total PMAD Aircraft Operations	**2,733**	**3,243**	**3,864**

Sources: City of Chicago DOA Management Records; 2001 FAA Terminal Area Forecasts; Ricondo & Associates, Inc.
Prepared By: Ricondo & Associates, Inc.

From PAL 1 through PAL 2, domestic seats per departure were assumed to increase by between 1.5 and 1.75 seats per year, reaching 286 average seats per departure at PAL 2. These load factor and seats per departure assumptions resulted in 2,825 domestic and 299 international PMAD operations in PAL 1 and 3,306 domestic and 443 international PMAD operations in PAL 2.

Non-scheduled activity, which includes all-cargo, miscellaneous/general aviation, and military operations, is forecast to be 119 and 115 PMAD operations in PAL 1 and PAL 2 respectively. All-cargo operations are also expected to grow at the Airport. The growth trend projected for all-cargo operations at the Airport represents a trend analysis from 1996-2001. This near-term trend analysis reflected less aggressive growth patterns in all-cargo aircraft operations in comparison to the 10-year and 20-year trends that were also considered. All-cargo operations are projected to grow from 21,105 operations in 2001 to 29,900 operations in PAL 1 and 37,900 operations in PAL 2.

General aviation activity is projected to decrease over time at the Airport, a trend projected by other previously developed forecasts based on the assumption that general aviation activity will naturally relocate to less congested, non-commercial airports in the region. Based on this projected pattern of activity, general aviation operations are projected to decrease steadily throughout the planning horizon, reaching 32,940 annual operations in PAL 1 (compared to 36,492 in 2001) and 20,300 annual operations in PAL 2.

2.1.5 Design Day Schedule Development

The PMAD activity estimates derived from the 2001 TAF were used to develop the design day schedules, representative of PAL 1 and PAL 2, that were utilized in the TAAM simulation modeling. As previously shown in Table II-5, the total PMAD operations for PAL 1 and PAL 2 are 3,243 and 3,864 respectively.

Using the projected PMAD activity levels summarized above, and an Airport flight schedule of commercial service activity for August 20, 2001 obtained from the Official Airline Guide, the PAL 1 and PAL 2 design day schedules were developed. This day (August 20, 2001) was selected because August is typically a peak month for aircraft operations at the Airport, and research determined that August 20 was a relatively calm day without many weather delays throughout the national airspace system. The August 20, 2001 schedule reflected a total of 2,802 scheduled and non-scheduled flight operations. However, actual activity for August 20, 2001 as reflected by Automated RADAR Terminal Systems (ARTS) data indicates that only 2,745 total operations (including scheduled and non-scheduled) actually occurred, due to flight cancellations and other factors that led to reduced flights for that day.

A pre-September 11, 2001 flight schedule was selected to derive the future design day schedules following group discussions during Airport Advisory Sessions held early in the planning process and attended by members of the DOA, FAA, and the planning team. Although several airlines have altered their daily schedules to reflect a more even distribution of traffic throughout the day, it is anticipated that the pre-September 2001 daily activity profiles still represent valid traffic distributions and peaking patterns for long-term (10+ years) planning purposes.

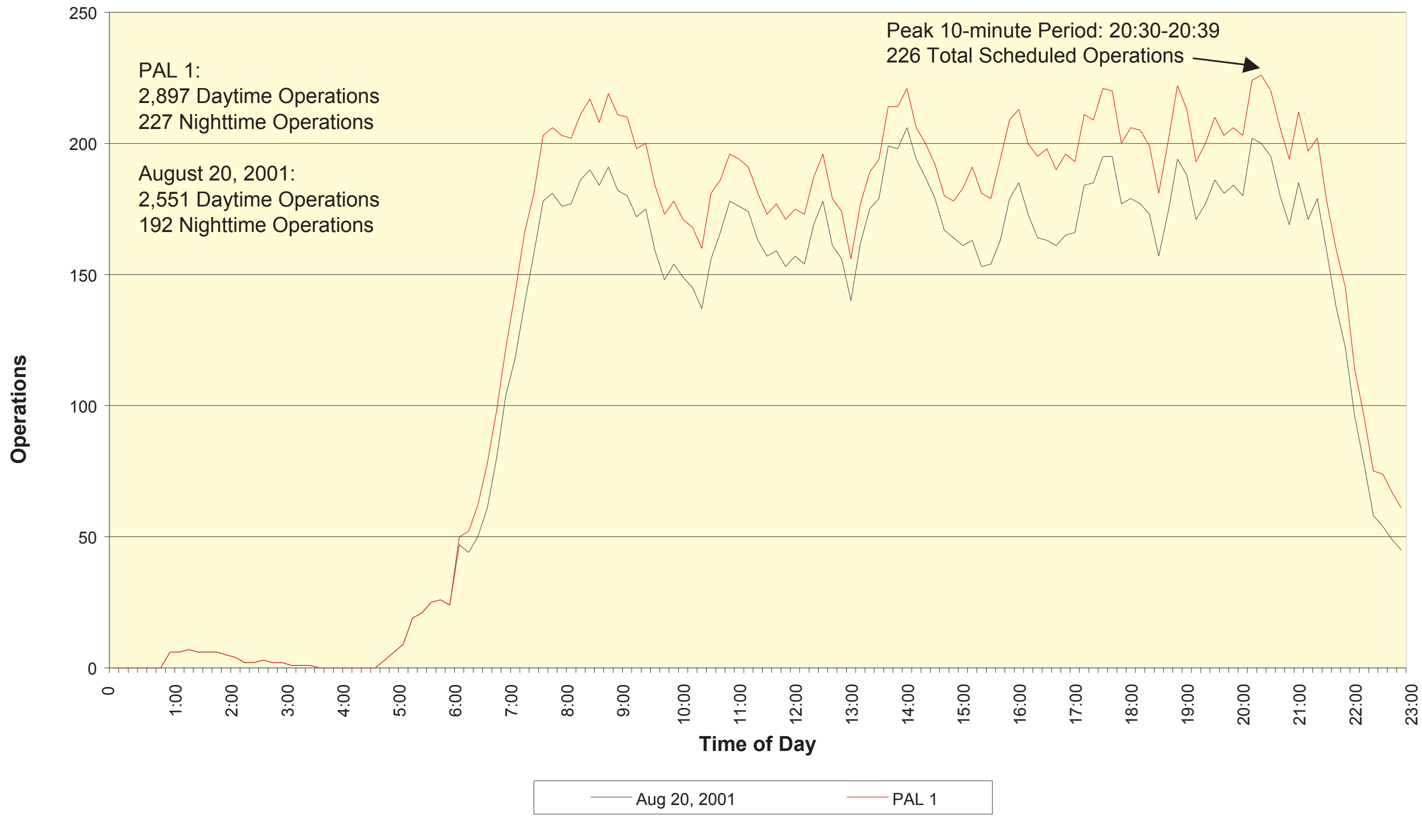
Additional flights added to the August 2001 schedule in order to derive the PAL 1 and PAL 2 design day schedules were distributed among the existing carriers using the commercial activity market shares for fiscal year (FY) 2000/2001. This period represents the most current one-year period prior to the September 2001 terrorist attacks. Once future flight increments were identified for each carrier, additional flights were added based on each carrier's distinct hub network and historical service patterns adopted by each airline at O'Hare International Airport and other large hub airports. Increased flight frequencies to existing markets served by each carrier were also included as part of the PAL 1 and PAL 2 schedule development. **Exhibit II-3** and **II-4** depict the daily flight distribution patterns for commercial scheduled operations associated with the PAL 1 and 2 schedules. For reference purposes, the daily traffic patterns associated with the August 2001 schedule are also presented. As shown, the future design day schedules are assumed to preserve the same daily distribution patterns as the August 2001 schedule.

2.1.6 Fleet Mix

Table II-6 presents a summary of the August 2001 fleet mix and the projected fleet composition for PALs 1 and 2. The fleet mix shown in this table reflects scheduled airline activity only. As shown, growth in the large narrow body and regional jet fleets are anticipated, influenced predominantly by the domestic air service activity. It is assumed that all commuter turbo props will be replaced with regional jets by PAL 1, with continued growth in the number of 70-seat and 90-seat regional jets operating at O'Hare International Airport occurring between PAL 1 and PAL 2.

In addition, aircraft equipment changes and aircraft equipment selection for the new flights added were based on each carrier's current and projected fleet composition, as reported in JP Airline-Fleets International (2001/02 Edition) and aircraft orders reviewed from the Boeing and Airbus Industries web sites. In a few instances in which there were no documented orders for new aircraft that could serve as replacement fleets to older aircraft like the MD-80 and the B727, assumptions were made for future replacement aircraft based on compatible seat size and/or aircraft range characteristics. For example, it is assumed that the Boeing 757-200 aircraft would be replaced by the newer generation Boeing 757-300 as well as the Boeing 737-900 and the Airbus 321.

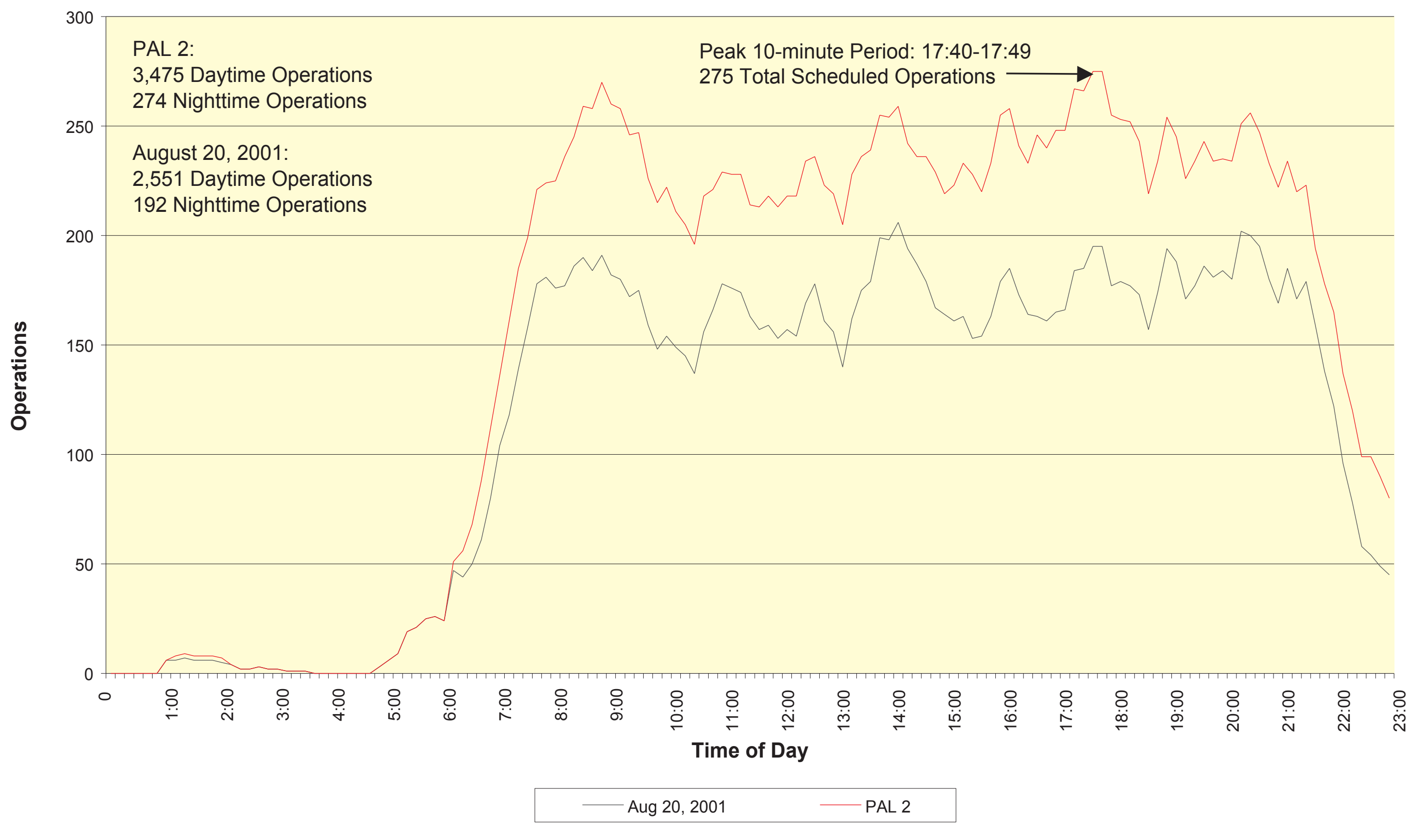
It is anticipated that the regional jets will continue to serve the regional markets; however, it is also assumed that these aircraft will expand the traditional commuter service area to include some markets that have historically been served by the small narrow body fleets.



Sources: Actual - Arts-III data for August 20, 2001 as compiled by the City of Chicago Department of Aviation Noise Office
Simulation - Design Day Schedules developed by Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-3

PAL 1 Commercial Scheduled Operations



Sources: Actual - Arts-III data for August 20, 2001 as compiled by the City of Chicago Department of Aviation Noise Office
Simulation - Design Day Schedules developed by Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit II-4

PAL 2 Commercial Scheduled Operations

Table II-6

Commercial Scheduled Operations-Fleet Mix Composition

Aircraft Type	Seating Capacity	Representative Aircraft	August 2001		PAL 1		PAL 2	
			Aircraft Count	% of Total	Aircraft Count	% of Total	Aircraft Count	% of Total
Jumbo	350 +	B-744, B74M, A380	31	1.1%	94	3.0%	148	3.9%
Widebody	250-349	MD-11, A340, B777, A310, A330	70	2.6%	282	9.0%	423	11.3%
Large Widebody	150-249	B738, B72S, MD-90, 762, B767, A321 B739, B757, B764, B763	567	20.7%	1,133	36.3%	1,482	39.5%
Narrow Body	100-149	DC-9, B735, B73S, A319, MD-80, B733 B737, B73G, A320, B734	1,125	41.0%	633	20.3%	592	15.8%
Regional Jet	50-99	CRJ, E145, ERJ, CRJ700, E146, F100 CRJ900	772	28.1%	982	31.4%	1,104	29.4%
Commuter	Up to 49	BE1900, D328, E135, E140	178	6.5%	0	0.0%	0	0.0%
	Total[2]		**2,743**[3]	**100%**	**3,124**	**100%**	**3,749**	**100%**
* B757 Composition[1]			195	7.1%	263	8.4%	467	12.5%

Notes:
1. B757 has a special wake turbulence category that falls within Heavy and Large Aircraft categories.
2. The total aircraft operations do not include non-scheduled operations for PAL 1 and PAL 2.
3. The total aircraft operations for August 2001 were obtained from OAG data and don't include non-scheduled flight operations.
4. Non-scheduled flights were added to these total aircraft operations for design day schedules used for simulations. For August 2001 schedule, actual number of flights flown on that day (2,745) was obtained from ARTS data.

Sources: Official Airline Guide, Ricondo & Associates, Inc.
Prepared By: Ricondo & Associates, Inc.

Some transcontinental markets (such as west coast cities like San Francisco, Los Angeles, and Seattle and east coast cities like Boston, Washington D.C. and Miami) would continue to be served by the large narrow body and some wide body fleets. The jumbo body fleets are assumed to be utilized primarily for connecting hub cities and international markets. As such, given the increased international growth projected for the Airport, the future fleet mix reflects an increase in the share of jumbo body aircraft operating at the Airport. In addition, growth in the number of New Large Aircraft (NLA), including the A380, is assumed to occur gradually through PAL 2. Deliveries of these aircraft to carriers such as Signapore Airlines, Air France, and Virgin Atlantic, all of which are assumed to represent some of the international service growth at the Airport, are anticipated.

All-cargo operations are also assumed to occur using more modern fleets. Specifically, it is assumed that the Boeing 727 and McDonnell Douglas DC-8 aircraft will completely eliminated by PAL 1. As such, it is assumed that aircraft such as the Airbus A300, Boeing 757, and Boeing 767 will become more prevalent among all-cargo carriers for domestic flights. For international all-cargo operations, it is assumed that the Boeing 747 and 777 will comprise the aircraft fleets transporting cargo to and from transpacific and transatlantic markets.

General aviation operations remaining at O'Hare International Airport are anticipated to be associated with corporate activity that prefer to utilize the Airport due to its geographic location relative to Chicago's downtown business district and metropolitan areas surrounding the Airport. As such, it is assumed that the newer corporate fleets, such as the Learjet, Gulfstream V, Citation and Global Express will comprise most of the general aviation activity operating at the Airport in PAL 1 and PAL 2.

2.2 Air Traffic Control Procedures

Three facilities provide Air Traffic Control (ATC) services to aircraft arriving or departing O'Hare International Airport. The FAA Chicago (ZAU) Air Route Traffic Control Center (ARTCC), located in Aurora, Illinois, provides ATC services to aircraft operating on Instrument Flight Rules (IFR) flight plans within controlled airspace during the enroute phase of flight. The enroute phase of flight is generally when aircraft are operating between departure and destination terminal areas. The Chicago TRACON is an FAA facility located in Elgin, Illinois. This facility provides radar ATC services to aircraft arriving and departing the Airport and other civil airports in the Chicago terminal area. The O'Hare ATCT located on the airfield provides ATC services to aircraft operating in the vicinity of the Airport. The ATCT authorizes aircraft to land or takeoff at the Airport or to transit the airspace delegated to the facility.

Initial operating data was collected in a series of meetings with both ATCT and TRACON staff. Data was obtained from these facilities for six distinct runway operating configurations. These configurations are:

- Plan X: Arriving Runways 4R, 9R and 9L. Departing Runways 4L, 9L, 32L and 32R.
- Plan W: Arriving Runways 22R, 27L and 27R. Departing Runways 22L, 32L and 32R.
- Plan B: Arriving Runways 14R, 22L and 22R. Departing Runways 27L and 22L.
- Plan B Modified: Arriving Runways 14R, 14L and 9R. Departing Runways 9L, 14L and 22L.
- Parallel 27s: Arriving Runways 27L and 27R. Departing Runways 22L, 32R and 32L.
- Parallel 14s: Arriving Runways 14L and 14R. Departing Runways 9L, 22L and 27L.

For each runway operating configuration, ATCT staff provided detailed information on ground movement flows, ground movement procedures, departure runway assignments, departure runway assignment strategies and initial departure headings. TRACON provided detailed information on arrival/departure vector flows, arrival runway assignments, arrival runway assignment strategies and in-trail separation requirements. Both facilities provided Standard Operating Procedures (SOP) manuals along with pertinent Inter and Intra Facility Letters of Agreement (LOA).

ATC assumptions, for the future build scenarios, were developed during numerous working sessions with ATCT and TRACON representatives. Procedural assumptions were developed by representatives from ATCT and TRACON and were input into the simulations, observed and refined as necessary. Members of the simulation team also observed real time simulations of high and wide procedures conducted by the TRACON. The TRACON's Dynamic Simulator was configured to test the use of simultaneous triple approaches to the Airport. The simulation team observed scenario pre-briefings, real time simulation of the scenarios and scenario debriefings. Both arrival and departure problems were observed over a 3-day period. The procedures refined during these real time simulations were input into the fast time simulations by the TAAM simulation team.

Representatives from the National Airspace Redesign (NAR) team from ZAU provided the detailed data on future departure and arrival routes and procedures. These departure and arrival airspace assumptions were input into the models analyzing Options 1 and 5.

In TAAM simulation models for the Airport, arrivals and departures were modeled for their full flight plan (i.e. every flight was flown from its originating city to the destination city) according to the schedules developed. Data used in the model was obtained from the following sources and agencies:

1. ETMS data was obtained from the FAA website and was used to develop airspace routes between Chicago and other cities. Flight plans filed with ATC for specific O'Hare International Airport city pairs were analyzed for completeness and accuracy. Navigational points and final requested cruising altitudes were identified from the ETMS flight plans and then input into the model. In cases where more than one route per city pair existed, these multiple routes were input and used proportionally, based on actual use, in the simulation timetable.
2. ACARS and U.S. DOT Bureau of Transportation Statistics (BTS) Airline On Time Data were used to find taxi times at O'Hare International Airport and other airports. This data proved useful in calibrating modeled taxi times for accuracy.
3. Flight track information from ARTS data supplied by the DOA Noise Office was reviewed to ensure the accuracy of TRACON flight track locations and procedures. This data was also used to determine climb rates for departures from the Airport.
4. Information from the ATCT and TRACON representatives was supplemented with Jeppesen charts to develop standard arrival and departure procedures.
5. Direct field observations were made at the Airport during various times of the day to ensure the accuracy of the simulations.
6. Input was obtained from ATCT and TRACON staff regarding the air traffic procedures assumptions in relation to the OMP alternatives. These procedures for existing facilities and working assumptions for Options 1,2, and 5 are discussed in detail in Section 5, *Airfield and Airspace Procedures*.
7. Members of the simulation team attended a two-week Ground Control Training Course held at the Chicago ATCT. These classes were comprised of members of the simulation team and Air Traffic Control Specialists (ATCS) recently assigned to the facility. The class was taught by members of the ATCT Training Department.

Additional sources of information included but were not limited to Chicago-O'Hare International Airport Air Traffic Control Order 7110.65C, O'Hare International Ops Order C90 7110.65A, and Chicago ARTCC/Chicago TRACON Letter of Agreement dated March 22, 2001. Additionally, ATCT and TRACON staff comments on the simulation work-in-progress were incorporated into the simulation experiments.

2.3 Wind and Weather Conditions

Airfield capacity can vary significantly due to the weather conditions experienced at the Airport. Prevailing winds (direction and speed) dictate which runways can be used for aircraft arrival and departure operations. Aircraft typically land and takeoff into the wind, and can accommodate a limited amount of crosswind and tailwind. If the maximum crosswind or tailwind is exceeded, the aircraft may not operate on that particular runway. Therefore, wind conditions may prevent use of a higher-capacity runway operating configuration, thus increasing aircraft delays.

Other meteorological conditions affecting airfield capacity include cloud ceiling height and visibility. Low cloud ceiling heights and visibility conditions result in increased spacing between aircraft in the airspace surrounding the Airport. These conditions may also cause restrictions on which runways can be used. Two operating conditions have been established based on cloud ceiling height and visibility:

- Visual Flight Rules (VFR) operations
- Instrument Flight Rules (IFR) operations

VFR govern the procedures used to conduct flight operations under VMC. Similarly, IFR govern the procedures used to conduct flight operations under IMC. The criteria for establishing the two operating conditions are summarized in **Table II-7**.

Table II-7

Operating Conditions for Airfield Capacity and Aircraft Delay Analysis

Classification	Weather Conditions		
	Visibility		Cloud Ceilings
VMC	Greater than or equal to 3 statute miles	and/or	Greater than or equal to 1,000 feet AGL
IMC	Less than 3 statute miles	and/or	Less than 1,000'

Source: FAA Advisory Circular 150/5060-5, Aircraft Capacity and Delay
Prepared By: Ricondo & Associates, Inc.

During IMC, in-trail separations for arrivals and departures are increased, thus reducing the hourly capacity of the airfield. The restriction of aircraft arrivals to runways with an established instrument approach procedure also contributes to a diminished airfield capacity during IMC. During IMC, procedures for aircraft arrivals and departures on parallel runway operations are also limited. Aircraft operational demand levels are also reduced during IMC, as private pilots are prohibited from flying during these conditions unless they possess an instrument rating.

Wind and weather data used in the modeling effort represents ten years of hourly observations collected by the National Climatic Data Center between January 1991 and December 2000. This data was reviewed to determine the nature, frequency and duration of weather conditions that influence aircraft operations. The analysis focused on the direction and velocity of the wind, ceiling and visibility conditions, as well as precipitation trends.

For the purpose of this simulation, six operating configurations were used to assess existing airfield performance. As described in Section 2.2, *Air Traffic Control Procedures*, these configurations include Plan X, Plan W, Plan B, Plan B Modified under VFR, and Parallel 27s, and 14s under Instrument Flight Rules.

Option 1 was modeled for two configurations, VFR East and IFR 27. These two configurations represent the high capacity VFR and IFR runway uses for Option 1. The VFR East configuration was used as a representative for all VFR runway use configurations while the IFR 27 configuration was used as a representative for all IFR runway use configurations. Four operating configurations were assessed for the future airfield alternative Option 5. These configurations included VFR East, VFR West, IFR 27 and IFR 9. These operating configurations were defined on the basis of average annual weather conditions at the Airport.

Throughout the year, different patterns of runway use and routing through the TRACON airspace are encountered as weather and traffic conditions change. In order to quantify these effects, each flow must be weighted to reflect the percentage of time each configuration is used throughout the year. This process is termed annualization. Annual average airfield delay and travel times were computed by averaging simulation results from each operating configuration. The performance results of each configuration were averaged based on their level of annual utilization as determined from weather statistics.

VMC and IMC as defined in Table II-7 occur 90.75% and 9.2% of the time at the Airport respectively. For the purpose of this analysis, the utilization of each runway use configuration was based on the ten-year weather data set. A maximum tailwind of 5 knots and a crosswind component of 20 knots were assumed for VMC. The IMC assumption assumed a maximum crosswind component of 15 knots with no tailwind component allowed.

Existing operating configurations at the Airport, the expected annualized weighting obtained from the wind and weather data, and, as a sensitively check, historic data for the Airport obtained from the 2001 Chicago Delay Task Force are shown in **Table II-8**. The raw numbers were calculated by determining the potential use of each runway configuration based on the weather data and assumptions obtained from ATCT on their preferred usage of these configurations. Normalization was obtained by adding the percent of time the remaining configurations would be used to the similar (same direction) runway use configurations that were modeled. **Table II-9** and **II-10** include the annual weighting for operating configurations for Options 1 and 5 respectively.

Table II-8

Annualized Weighting for O'Hare International Airport Existing Operating Configurations

Airfield Scenarios	Operating Configurations	Annualized Weighting		Historic[1]
		Raw	Normalized	
Existing Airfield	Plan X	42.6%	42.8%	39.7%
	Plan W	28.1%	30.8%	32.6%
	Plan B	2.4%	4.4%	15.5%
	Plan B modified	12.3%	12.7%	n/a[2]
	IFR 27	1.7%	4.1%	4.9%
	IFR 14	2.7%	5.2%	4.6%
		89.8%	100.0%	

1. Historic data collected from the Airport Noise Monitoring System (ANMS) collection of January 2000 to September 2001 for VMC configurations and January 2000 to December 2000 for IMC scenarios.
2. Plan B modified has only recently been implemented at O'Hare International Airport.

Sources: National Climatic Data Center between January 1991 and December 2000, City of Chicago DOA Airport Noise Monitoring System data between January 2000 and December 2000.
Prepared By: Ricondo & Associates, Inc.

Table II-9

Annualized Weighting for Option 1 Operating Configurations

Airfield Scenarios	Operating Configurations	Annualized Weighting Raw	Annualized Weighting Normalized[1]
Option 1	VFR East[1]	90.1%	90.8%
	IFR 27[2]	8.6%	9.2%
		98.7%	100.0%

1. The VFR East configuration was used as a representative for all VFR runway use configurations.
2. The IFR 27 configuration was used as a representative for all IFR runway use configurations.

Sources: National Climatic Data Center between January 1991 and December 2000, Ricondo & Associates, Inc.
Prepared By: Ricondo & Associates, Inc.

Table II-10

Annualized Weighting for Option 5 Operating Configurations

Airfield Scenarios	Operating Configurations	Annualized Weighting Raw	Annualized Weighting Normalized
Option 5	VFR West	31.9%	32.2%
	VFR East	58.2%	58.6%
	IFR 27	5.2%	5.3%
	IFR 9	3.4%	3.9%
		98.7%	100.0%

Sources: National Climatic Data Center between January 1991 and December 2000, Ricondo & Associates, Inc.
Prepared By: Ricondo & Associates, Inc.

2.4 Aircraft Operating Characteristics

The TAAM model includes a default aircraft characteristics file. This file contains aircraft performance data such as standard climb and descent rates, typical acceleration and deceleration rates during takeoff and landing, and other aircraft specific data such as weight and wake turbulence categories.

The standard climb rates of aircraft in the aircraft performance file were refined to provide a more realistic representation of the climb rates observed at the Airport. ARTS data specific to O'Hare International Airport forms the basis of the refined climb rates. Observations of departure operations were obtained from ARTS data for the Airport over the period of October 1, 2000 to October 7, 2000, representing a period of average temperatures near the standard temperature of 15 degrees Celsius used in the simulation modeling. This data sample included almost 8,900 departure operations. For each operation, the following information was available:

- Time of operation
- Aircraft ID number
- Aircraft type
- Runway use

- A series of times, altitudes, and coordinates along the departure track at which the aircraft registered on radar

In the TAAM aircraft performance file, climb rates are specified up to 10,000 feet Mean Sea Level (MSL) in the following altitude ranges: ground to 1,500 feet, 1,500 to 3,000 feet, 3,000 to 5,000 feet, and 5,000 to 10,000 feet. In order to confirm the standard climb rates contained in the TAAM aircraft performance file, the ARTS data was analyzed. Based on this information, the climb rate in each altitude grouping was calculated as the change in altitude between the first points in each subsequent altitude grouping divided by the time between these points.

> For example, if in the 1,500 to 3,000 feet altitude range the first point was observed at 21 seconds after the start of the radar track (i.e., the point at which radar acquires the aircraft) at an altitude of 1,600 feet and the first point in the 3,000 to 5,000 feet altitude range was observed at 58 seconds at an altitude of 3,100 feet, then the climb rate in the 1,500 to 3,000 feet altitude range for this point would be ((3,100-1,600 feet)/(58 - 21 seconds))*(60 seconds per minute) = 2,432 feet per minute.

The climb rates for each departure operation and altitude range were calculated as described above. For each aircraft type present in the TAAM aircraft characteristics file, the average climb rate in each altitude grouping up to 10,000 feet MSL was then calculated. These refined climb rates were updated in the TAAM aircraft performance file as the O'Hare International Airport specific climb rates and were used in all simulations.

2.5 Aircraft Separation Requirements

The aircraft fleet mix is an important factor in determining an airport's airfield capacity. As the diversity of approach speeds and aircraft weights increase, airfield capacity decreases. This is due to a safety issue referred to as wake vortices or wake turbulence. This is a phenomenon that creates air turbulence behind an airplane as a result of its movement through the air. Heavier aircraft result in more severe wake vortices than smaller aircraft. Although more prevalent during departure operations than arrivals, wake vortices are considered a significant safety hazard during any operation.

In order to alleviate the hazards of wake vortices, aircraft are spaced according to the differences in their airspeeds and weight. Lighter aircraft are more susceptible to damage from wake vortices than heavy aircraft. Therefore, light aircraft are typically required to wait up to two minutes before operating on a runway after a heavy aircraft. This delay results in a loss in airfield capacity. The greater the size and weight differential of the aircraft fleet, the greater the separation required between successive aircraft operations.

In the TAAM model, the wake turbulence separation requirements file is one component used to determine the minimum in trail separation between successive aircraft approaching the same runway. During VMC, the minimum separation requirements are based on criteria contained in the FAA publication *Air Traffic Control* 7110.65 Section 5-5. This document provides the minimum radar separation requirements for aircraft following aircraft in the large, 757, and heavy wake turbulence weight categories. Final approach sectors were put in the model with a separation of 2.5 miles. This provided an approximation of the Airport operating characteristics as it was observed that aircraft separation tends to be reduced on final approach under VMC. During IMC controllers often provide additional separation between successive aircraft on final approach to ensure that minimum separation requirements are met. To account for this additional separation, the distances in the wake turbulence separation requirements file were increased beyond those used for VMC.

The increased distances in the wake turbulence separation requirements file during IMC were derived from an analysis of ARTS data collected during periods of IFR weather in 2001 including January 12-16, February 13-14, and August 16-23. This data sample included over 5,200 arrival operations during IMC at different times of the day to various runways at the Airport. The following information was available for each operation in the data sample:

- Aircraft ID number
- Aircraft type
- Runway use
- The time when the arriving aircraft is 4,000 feet from end of the runway
- The average speed of the aircraft between the outer marker and 4,000 feet from the end of the runway

Based on the aircraft type, the wake turbulence category of each arriving aircraft was determined. The time between subsequent arrivals during periods of peak arrival demand was then estimated as the time between when the leading aircraft passed the point 4,000 feet from the runway end and the time when the following aircraft passed the same point. The distance between the leading and following aircraft was calculated as the average speed of the following aircraft between the outer marker and the point 4,000 feet from the runway end multiplied by the time between subsequent arrivals.

> For example, if the lead aircraft passed the point 4,000 feet from the runway end at 1:00:45 seconds and the following aircraft passed the same point at 1:02:15 seconds, the time between subsequent arrivals would be 105 seconds. Then, if the average speed of the following aircraft between the outer marker and the point 4,000 feet from the runway end were 138 nautical miles (NM) per hour, the distance between these subsequent arrivals would be calculated as (105 seconds * 138 NM/hour) *(1 hour/3600 seconds) = 4.02 NM.

The separation distances for subsequent arrivals were calculated for each set of arrivals during periods of peak arrival demand. For each wake turbulence separation category (e.g., small following heavy, small following 757, etc.) the average arrival separation distances were calculated. These average separation distances were then reviewed by ATCT staff and either accepted or modified based on operator experience.

Table II-11 lists the in-trail separation values used in the VMC calibration runs and all subsequent VMC simulation experiments. These values are consistent with Standard FAA separation minima as found in FAA Order 7110.65M. The shaded area of Table II-11 indicates those aircraft pairings that are eligible for Reduced Separation on Final criteria of 2.5 NM. The TAAM model allows special areas called sectors to be built which correctly define the area on the final approach where reduced separation of 2.5 NM is allowed.

Table II-11

Intrail Separation Values Used for VMC Calibration Runs

TRAIL AIRCRAFT	INTRAIL SEPARATIONS (NM) LEAD AIRCRAFT HEAVY	B757	LARGE	SMALL +	SMALL
HEAVY	4.0	4.0	3.0	3.0	3.0
B757	5.0	4.0	3.0	3.0	3.0
LARGE	5.0	4.0	3.0	3.0	3.0
SMALL+	6.0	5.0	4.0	3.0	3.0
SMALL	6.0	5.0	4.0	3.0	3.0

Notes: HEAVY (> 255,000 pounds); B757; LARGE (> 41,000 pounds and <225,000 pounds); SMALL+ (>12,500 pounds and <41,000 pounds); SMALL (< 12,500 pounds). The shaded areas indicate those aircraft pairings that are eligible for Reduced Separation on Final criteria of 2.5 NM on final approach.

Sources: ARTS Data and Discussions with ATCT staff, FAA Order 7110.65M, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Table II-12 contains the minimum wake turbulence separation requirements file for use during IMC in the simulation experiments.

Table II-12

Intrail Separation Values Used for IMC Calibration Runs

TRAIL AIRCRAFT	INTRAIL SEPARATIONS (NM) LEAD AIRCRAFT HEAVY	B757	LARGE	SMALL +	SMALL
HEAVY	4.3	4.1	3.3	3.5	3.5
B757	5.1	4.1	3.2	3.4	3.4
LARGE	5.2	4.2	3.2	3.3	3.3
SMALL+	6.2	5.2	4.1	3.3	3.3
SMALL	6.7	5.2	4.1	3.4	3.4

Note: HEAVY (> 255,000 pounds); B757; LARGE (> 41,000 pounds and <225,000 pounds); SMALL+ (>12,500 pounds and <41,000 pounds); SMALL (< 12,500 pounds).

Sources: ARTS Data and Discussions with ATCT staff, FAA Order 7110.65M, Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

III. Model Calibration and Validation

The simulation of existing conditions at the Airport included two calibration analyses to ensure that the TAAM model is replicating a close approximation of actual airfield/airspace operations. One calibration analysis involved a design day in which the airfield predominantly operated on a single runway use configuration under VMC, that would allow triple approaches during periods of peak arrival demand. The second calibration analysis involved a design day in which the airfield predominantly operated on a single runway use configuration under IMC.

The schedule of activity used in the model for these calibration days was developed using data for those dates from the OAG, supplemented by actual operating statistics from the DOT BTS Airline On Time Data, ETMS data, ACARS data and ARTS data supplied by the DOA Noise Office as discussed in Section II, *Data Collection and Model Inputs.*

The simulation results were compared with the actual operating statistics recorded for those days. This included a comparison of actual and simulated hourly flow rates for arrivals and departures at the Airport, as well as a rolling 60-minute flow rate comparison. The rolling 60-minute flow rate provides, on a ten-minute basis, the sum of the operations over the previous hour, thereby providing greater detail about peak 60-minute flow rates. Taxiing time and taxiing delay estimates produced by the model were compared with actual taxi-in and taxi-out times to determine how closely the ground handling assumptions approximate actual ground handling procedures at the Airport.

During the development of the calibration cases, animations of the simulation results were presented to representatives from ATCT, TRACON, and airline representatives, as well as other operations and simulation experts for review. Based on feedback received from these sources, adjustments to simulation parameters were made.

3.1 VMC Design Day Activity

For the purposes of calibrating the model, VMC must be prevalent throughout the National Airspace System (NAS) as much as possible during the day that is selected for calibration. August 20, 2001 was selected as the VMC calibration day. This day also represents a close approximation of the average day, peak month level of operation. Plan X, one of the primary VFR configurations at the Airport, was used for the majority of the day.

Actual runway departure times (off times) from origin airports were used for traffic arriving at the Airport, as ground networks for these origin airports were not developed in the model. Taxi-in times for arrivals were obtained from the simulations and calibrated against actual taxi-in times. Actual gate departure times (out times) were used in the model for traffic departing from the Airport. Taxi-out times were then calculated by the model and calibrated with actual taxi-out times. Where such precise off time data for the Airport's arrivals was unavailable, either an average off time for a particular origin city was used or an average taxi-out time was used to supplement the OAG data. Aircraft departure times were based on actual out-times or OAG schedules and ARTS data. Initial gate assignments for arrivals and departures for most airlines were identified through an airline ramp chart analysis.

3.2 VMC Plan X Airfield and Airspace Assumptions

The airfield operating configuration Plan X, simulated for VMC calibration purposes, is depicted on **Exhibit III-1**. Under Plan X, arriving aircraft can use either Runway 9R or Runway 4R. Runway 9L is also available for landing during periods of peak arrival demand. Departing aircraft use Runways 4L, 9L, 32R or 32L. Section 5.1.1, *Plan X* includes a detailed description of airspace and airfield assumptions used for modeling Plan X.

3.3 VMC Calibration Results

In this analysis, (1) actual hourly aircraft flow rates and (2) actual taxi-in and taxi-out times were used to characterize the aircraft operations in the Airport's airspace and airfield. This data is used in conjunction with visual assessments from ATCT staff.

Exhibits III-2 and **III-3** show the comparison of hourly flow rates obtained from the model and the actual ARTS data for the VMC calibration day of August 20, 2001 from the Noise Office for arrival and departure operations respectively. **Exhibits III-4** and **III-5** show the comparison of rolling 60-minute flow rates obtained from the model and the actual ARTS data for arrival and departure operations respectively.

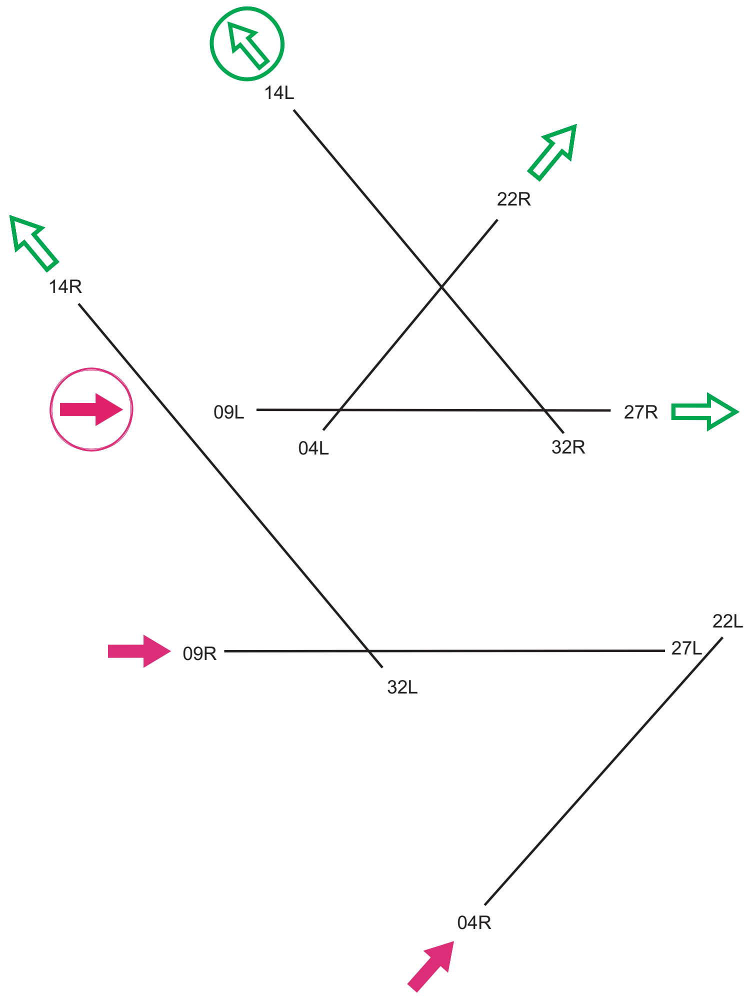
Table III-1 shows the comparison of median taxi-in and taxi-out times by runway. The slight discrepancy in the actual and simulated taxi-out time for Runway 4L, was due to air traffic conditions in the New York and Boston areas on that date. Longer taxi-out times occurred due to a ground hold program that was instituted on the calibration day for departures to that region. The primary runway for departures to that region is Runway 4L and the longer taxi-out times are from aircraft departing to that region. The impacts of the ground hold to the New York and Boston areas were not modeled explicitly as the purpose of the analysis was the evaluation of operations at O'Hare International Airport.

Table III-1

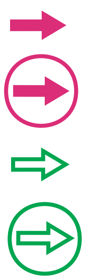
Comparison of Median Actual and Simulated Taxi Times

Operation	Runway	Actual (minutes per operation)	Simulated (minutes per operation)
Arrival – Taxi-In Times	4R	8.0	7.0
	9L	7.0	6.0
	9R	7.0	5.0
Departures – Taxi-Out Times	4L	16.0	13.0
	9L	14.0	17.0
	32L (full)	14.0	12.0
	32L (T10)	N/A	10.0
	32R	14.0	13.0

Sources: Actual: U.S. Department of Transportation, Bureau of Transportation Statistics, Airline On-Time Statistics, Detailed Statistics for August 20, 2001. Simulation: Ricondo & Associates, Inc.
Prepared By: Ricondo & Associates, Inc.



Legend



Primary Arrivals

Overflow Arrivals

Primary Departures

Overflow Departures

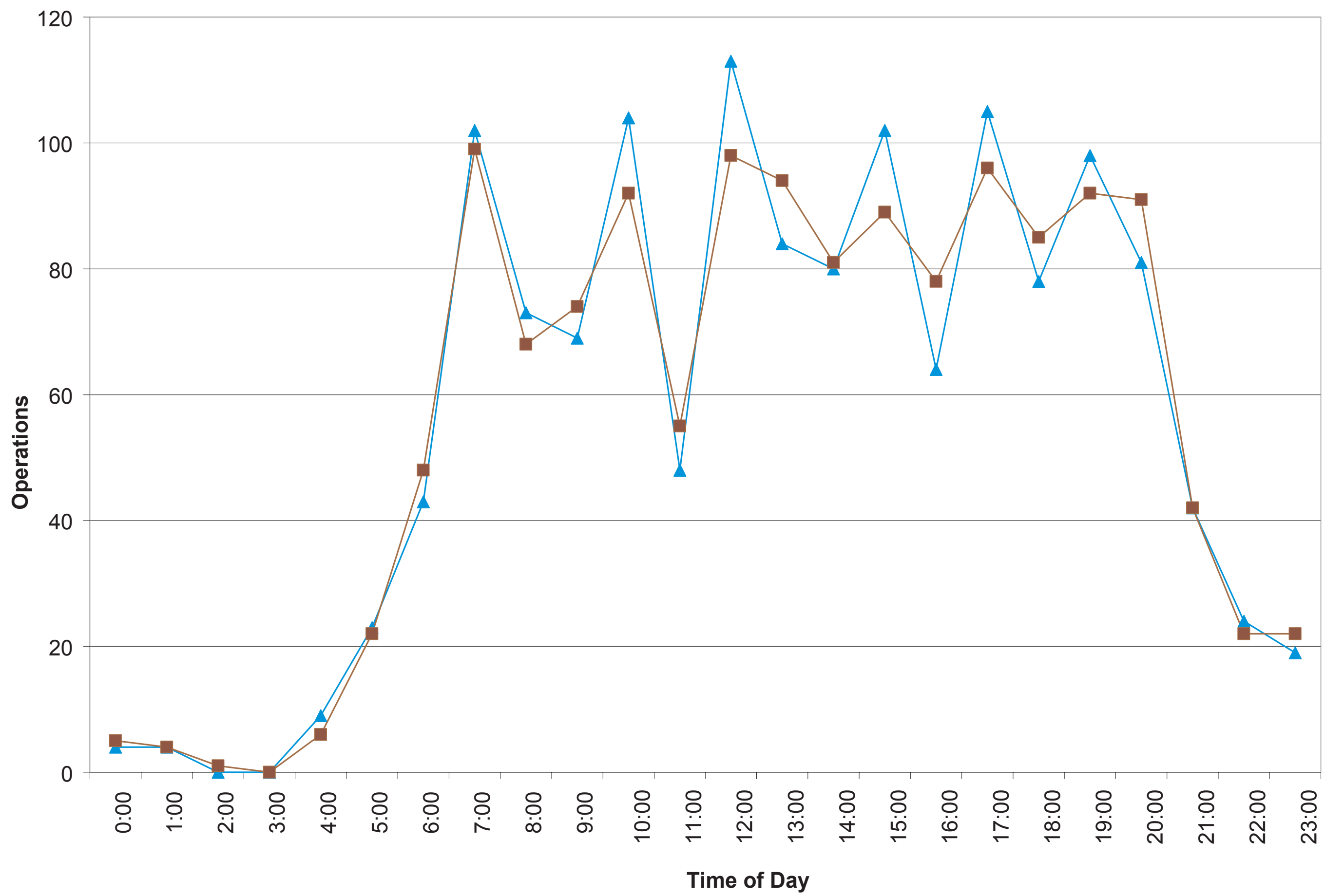
Sources: Ricondo & Associates, Inc., ORD ATCT.
Prepared by: Ricondo & Associates, Inc.

Exhibit III-1

Not to Scale

North

Runway Operating Configuration
Existing Airfield Plan X, VFR East Flow

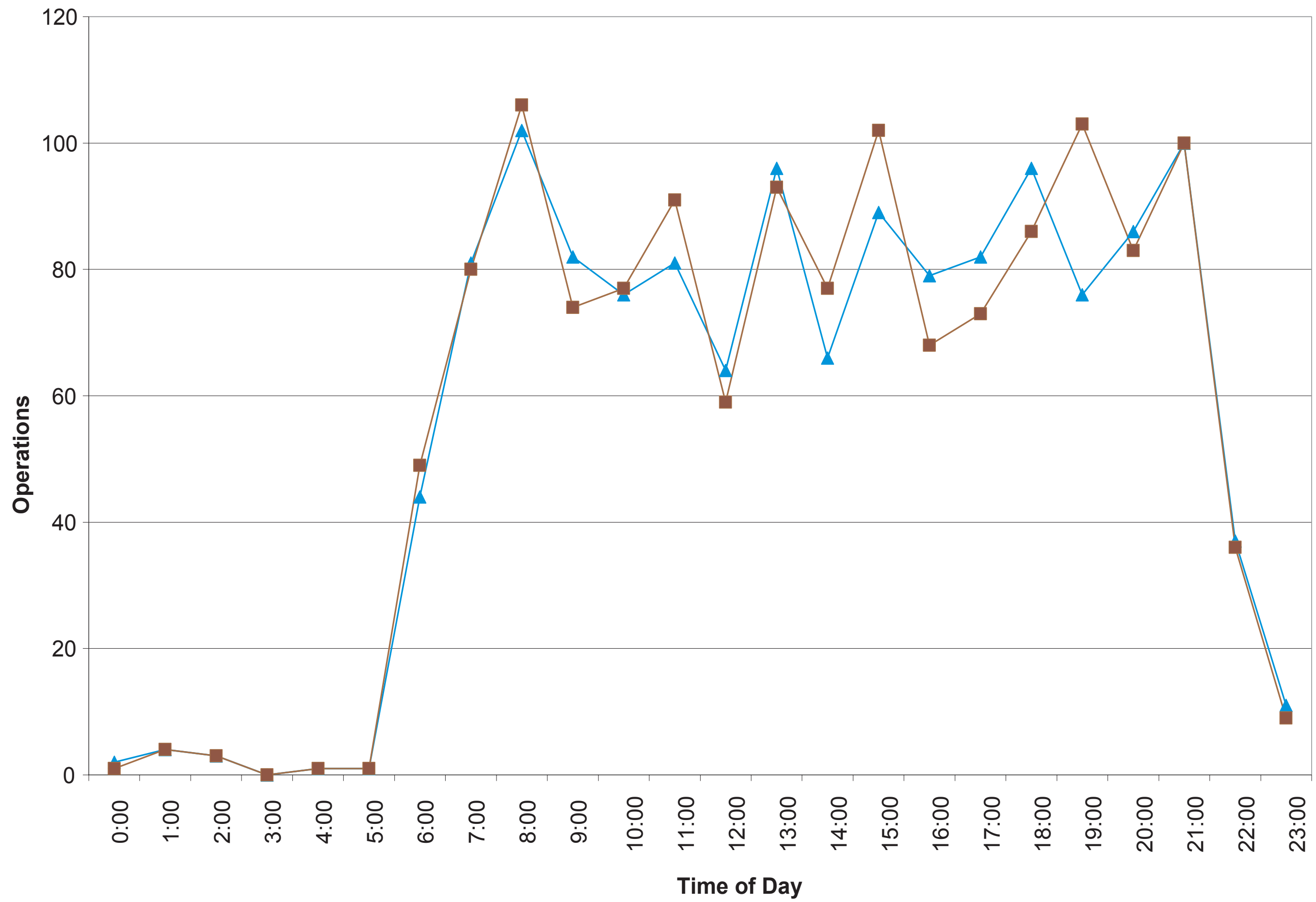


Sources: Actual - ARTS data for August 20, 2001 as compiled by the City of Chicago Department of Aviation Noise Office
Simulation - Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit III-2

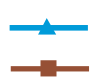
Actual
Simulated

Hourly Aircraft Arrival Flow Rates VMC, Plan X, Calibration

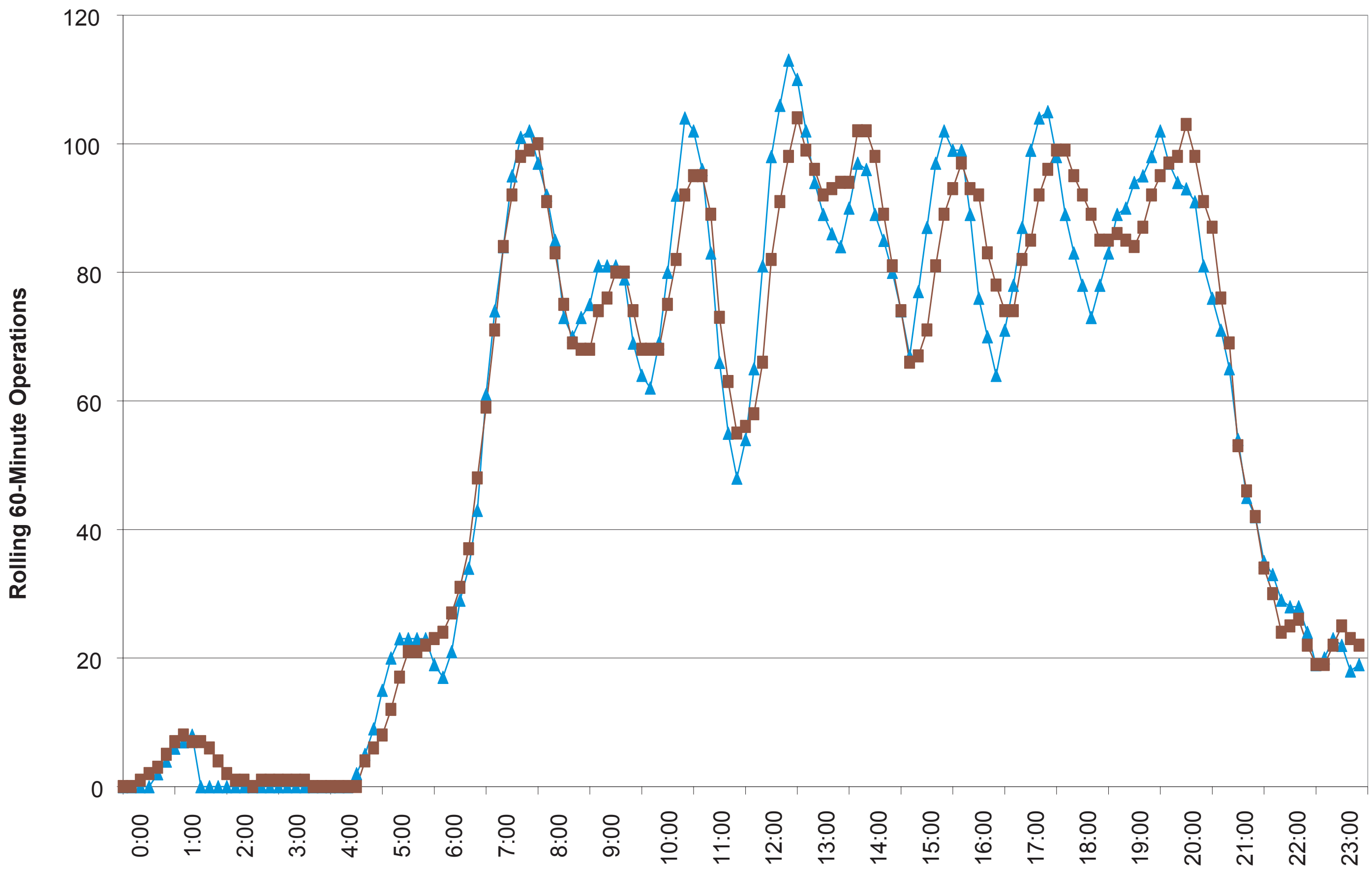


Sources: Actual - ARTS data for August 20, 2001 as compiled by the City of Chicago Department of Aviation Noise Office
Simulation - Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit III-3

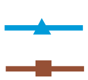


Hourly Aircraft Departure Flow Rates
VMC, Plan X, Calibration



Sources: Actual - ARTS data for August 20, 2001 as compiled by the City of Chicago Department of Aviation Noise Office
Simulation - Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit III-4



Rolling 60-Minute Aircraft Arrival Flow Rates
VMC, Plan X, Calibration

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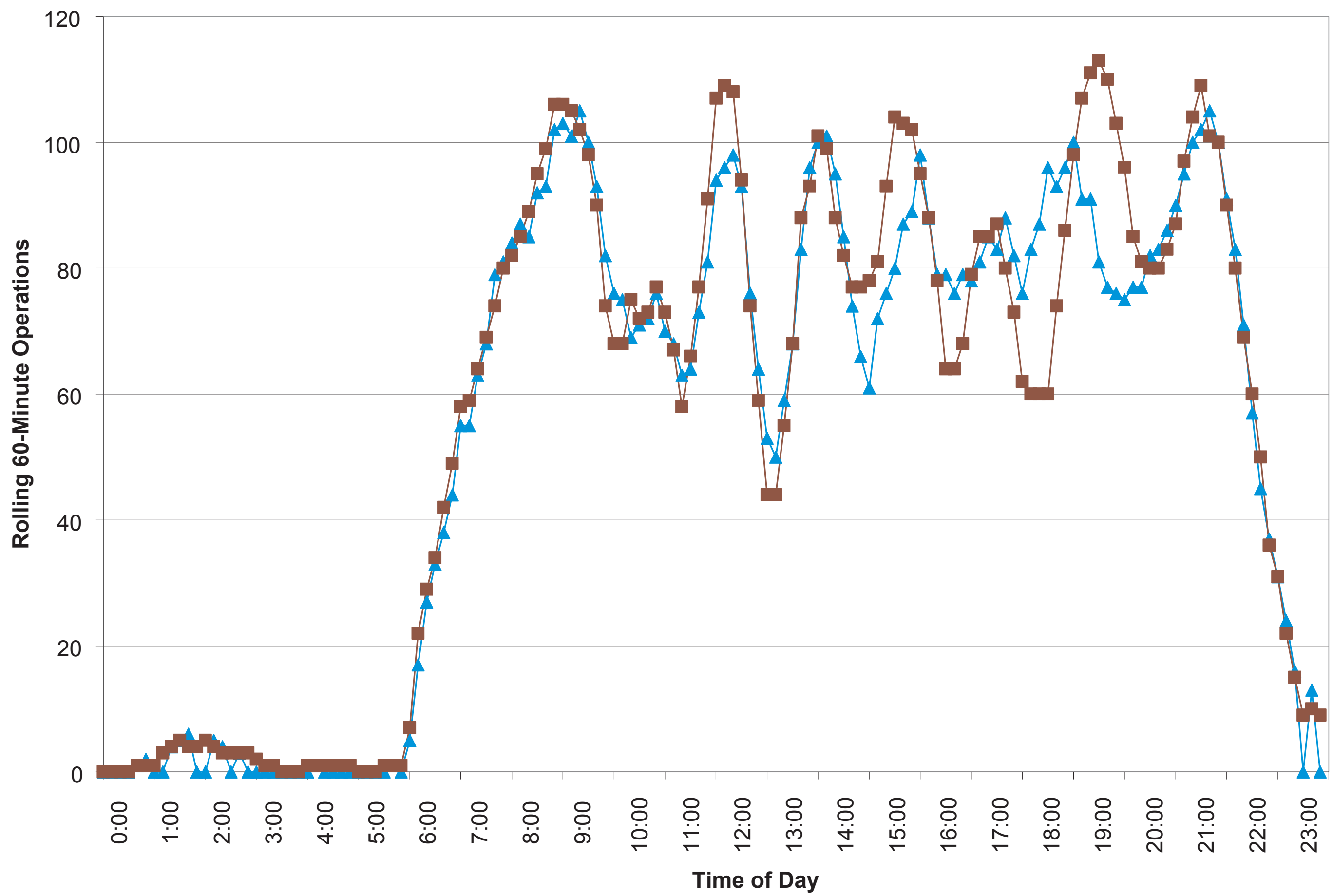


Sources: Actual - ARTS data for August 20, 2001 as compiled by the City of Chicago Department of Aviation Noise Office
Simulation - Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit III-5

Rolling 60-Minute Aircraft Departure Flow Rates
VMC, Plan X, Calibration

3.4 IMC Design Day Activity

For IMC calibration, it was necessary to find a day in which the Airport predominantly operated on a single IFR runway use configuration, IMC weather conditions were prevalent for the majority of the day, and operations at other airports did not significantly affect operations at the Airport. January 15, 2001 met these criteria and was selected as the IMC calibration day with Runways 27L and 27R used as the approach runways. Parallel 27s, the primary IFR runway use configuration for the Airport, was in use for most of the day. The activity schedule used in the model was developed using ARTS data for that date supplemented by DOT BTS data. DOT BTS on-time data for traffic arriving at the Airport was used while DOT BTS out-time data was used for departing traffic. For flights that were not listed in the DOT BTS data, arrival and departure times were derived from ARTS data. The ARTS runway time was used for the arrival touchdown time and ARTS data with runway time minus a 17-minute taxi out time was used for the departure out-time.

3.5 IMC Parallel Runway 27L and 27R Airfield and Airspace Assumptions

The airfield operating configuration simulated for IMC calibration purposes includes parallel approaches to Runways 27L and 27R (Parallel 27s) and is depicted in **Exhibit III-6**. Departing aircraft use Runway 22L, 32R and 32L. Section 5.1.5, *Parallel 27s* includes a detailed description of airspace and airfield assumptions used for modeling Parallel 27s.

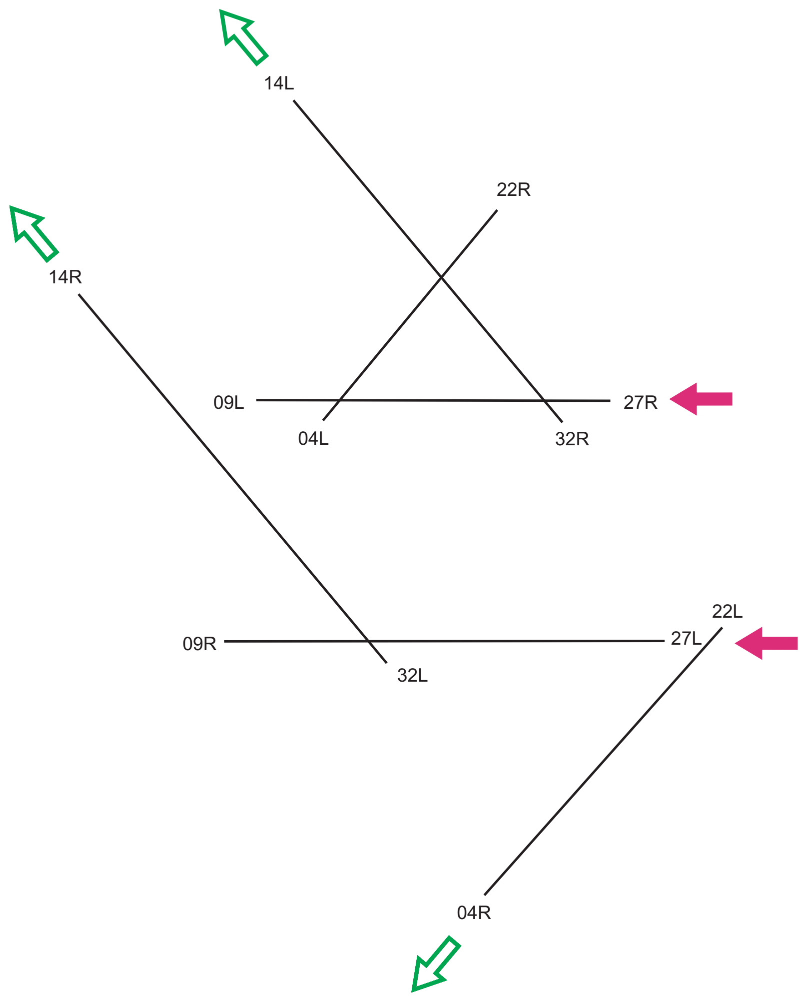
3.6 IMC Calibration Results

Hourly aircraft flow rates were used to characterize aircraft operations in the O'Hare International Airport airspace and on the airfield during IMC. These data were used in conjunction with validations from ATCT staff.

Exhibits III-7 and **III-8** show the comparison of hourly flow rates obtained from the model and the actual ARTS data from the Noise Office for January 15, 2001 for arrival and departure operations respectively. It should be noted that on January 15, 2001, there were periods of VMC from approximately 3:00 p.m. to 4:00 p.m. and marginal VMC from 4:00 p.m. to 5:00 p.m. and 6:00 p.m. to 7:00 p.m. However, for simulation calibration purposes, it was assumed that IMC would occur throughout the entire day. Therefore, the simulation flow rates during the VMC periods are lower than the actual flow rates for the calibration day.

Exhibits III-9 and **III-10** show the comparison of rolling 60-minute flow rates obtained from the model and the actual ARTS data for arrival and departure operations respectively.

As a sensitivity test, in addition to modeling the flights that operated on January 15, 2001, the flights that were cancelled on that day, as recorded on the DOT BTS Airline On-Time Statistics, were incorporated into the schedule of operations to ensure that the IMC operating procedures would maintain an appropriate IMC flow rate condition, even with higher demand levels. As shown on **Exhibit III-11**, the comparison of rolling 60-minute flow rates maintains an arrival flow rate of approximately 70 to 80 arrival operations per hour during the IMC even with the higher demand level.



Legend

Primary Arrivals

Primary Departures

Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc..

Exhibit III-6

Not to Scale

Runway Operating Configuration
Existing Airfield Parallel 27, West Flow

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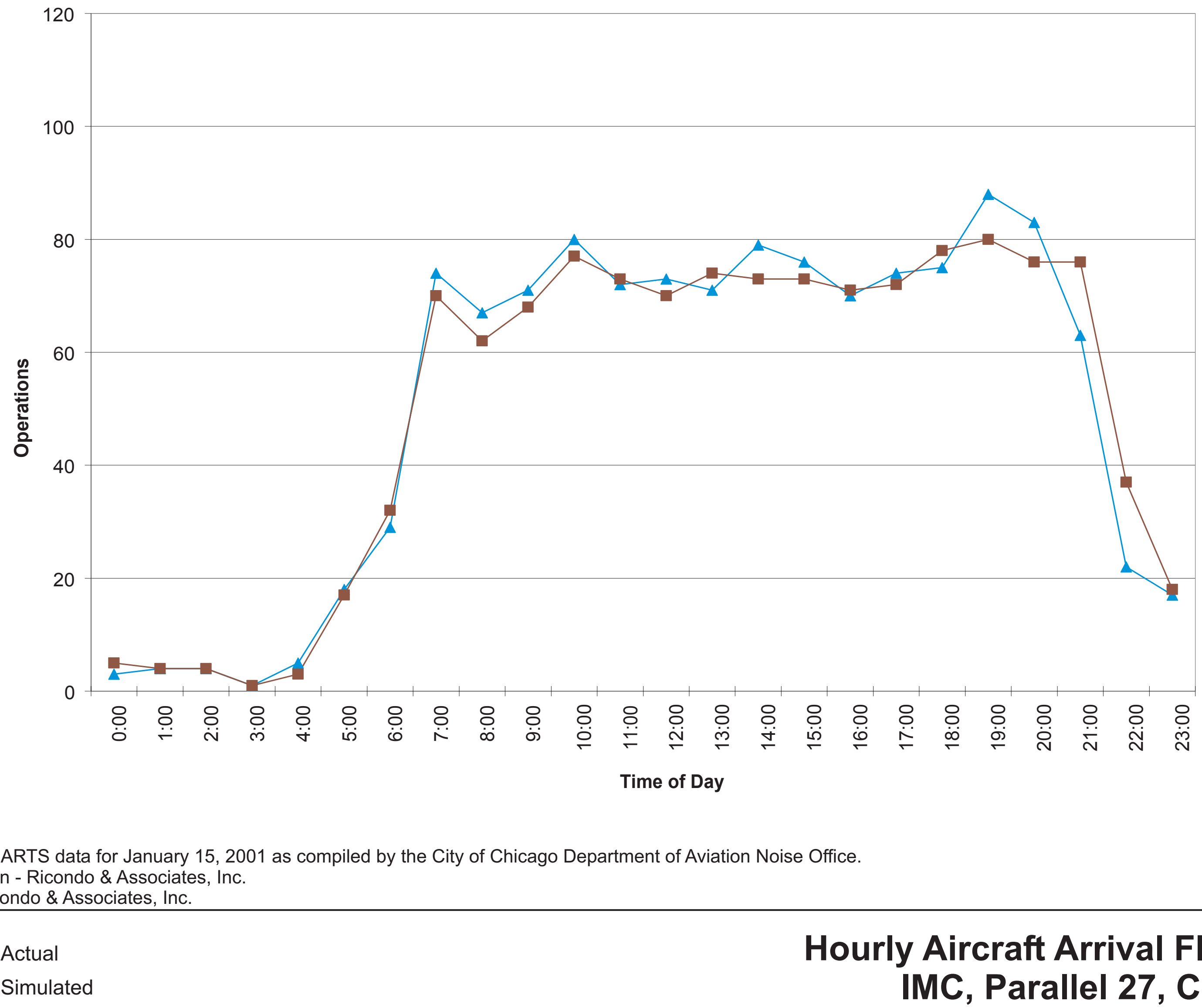
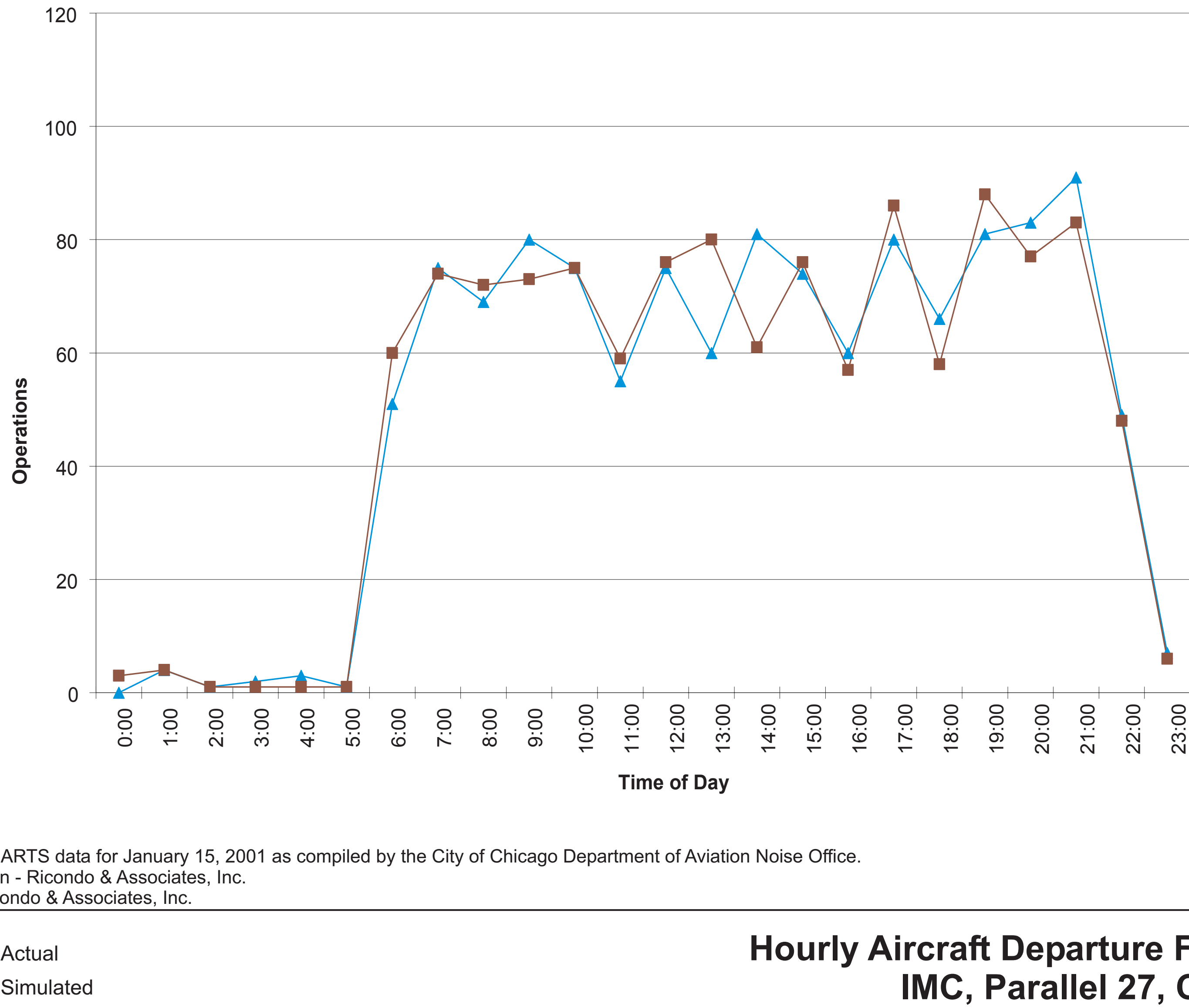
January 2003
DRAFT



Sources: Actual - ARTS data for January 15, 2001 as compiled by the City of Chicago Department of Aviation Noise Office.
Simulation - Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit III-7

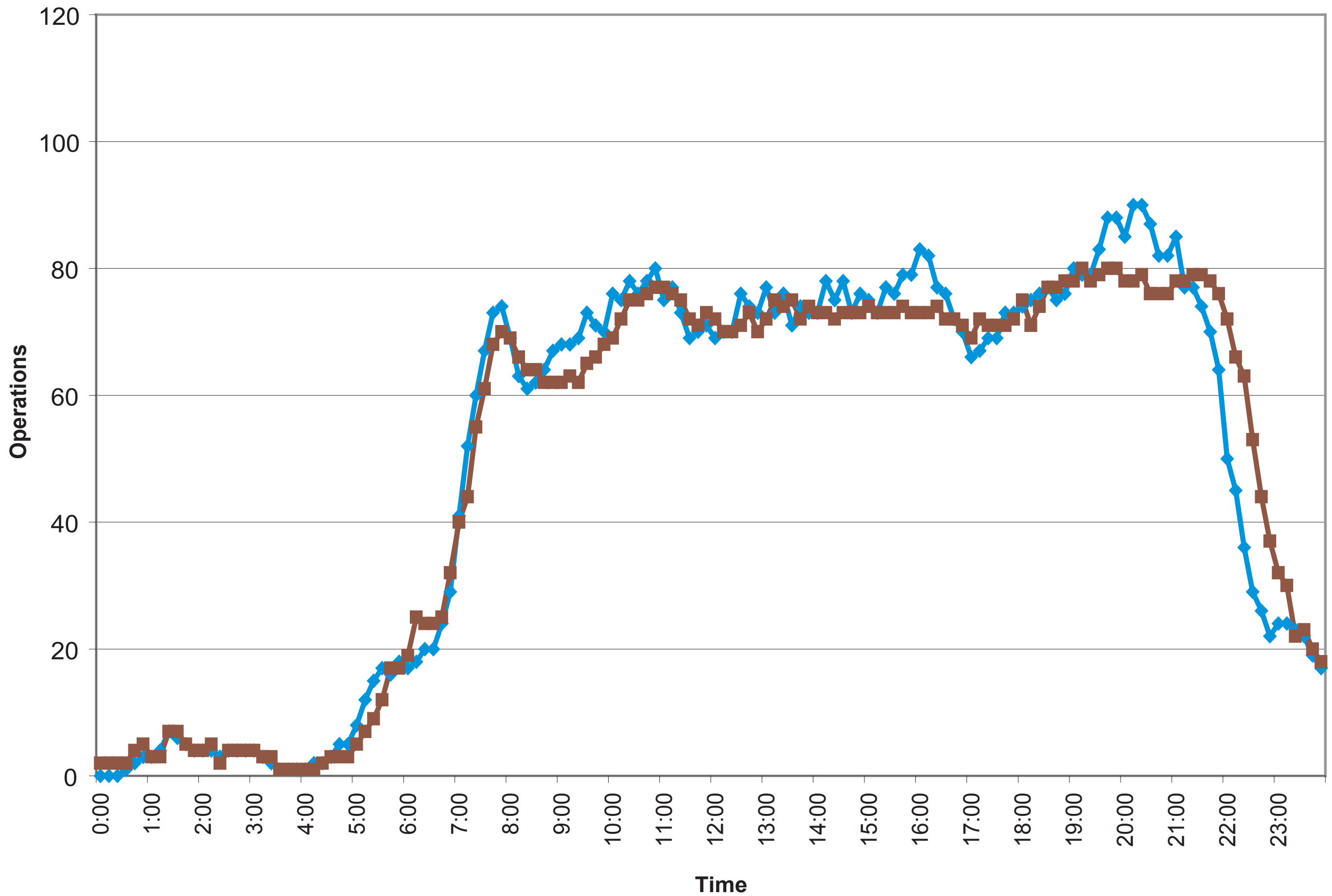
Hourly Aircraft Arrival Flow Rates IMC, Parallel 27, Calibration



Sources: Actual - ARTS data for January 15, 2001 as compiled by the City of Chicago Department of Aviation Noise Office.
Simulation - Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit III-8

Hourly Aircraft Departure Flow Rates
IMC, Parallel 27, Calibration



Sources: Actual - ARTS data for January 15, 2001 as compiled by the City of Chicago Department of Aviation Noise Office.
Simulation - Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit III-9

Actual
Simulated

Rolling 60-Minute Aircraft Arrival Flow Rates
IMC, Parallel 27, Calibration

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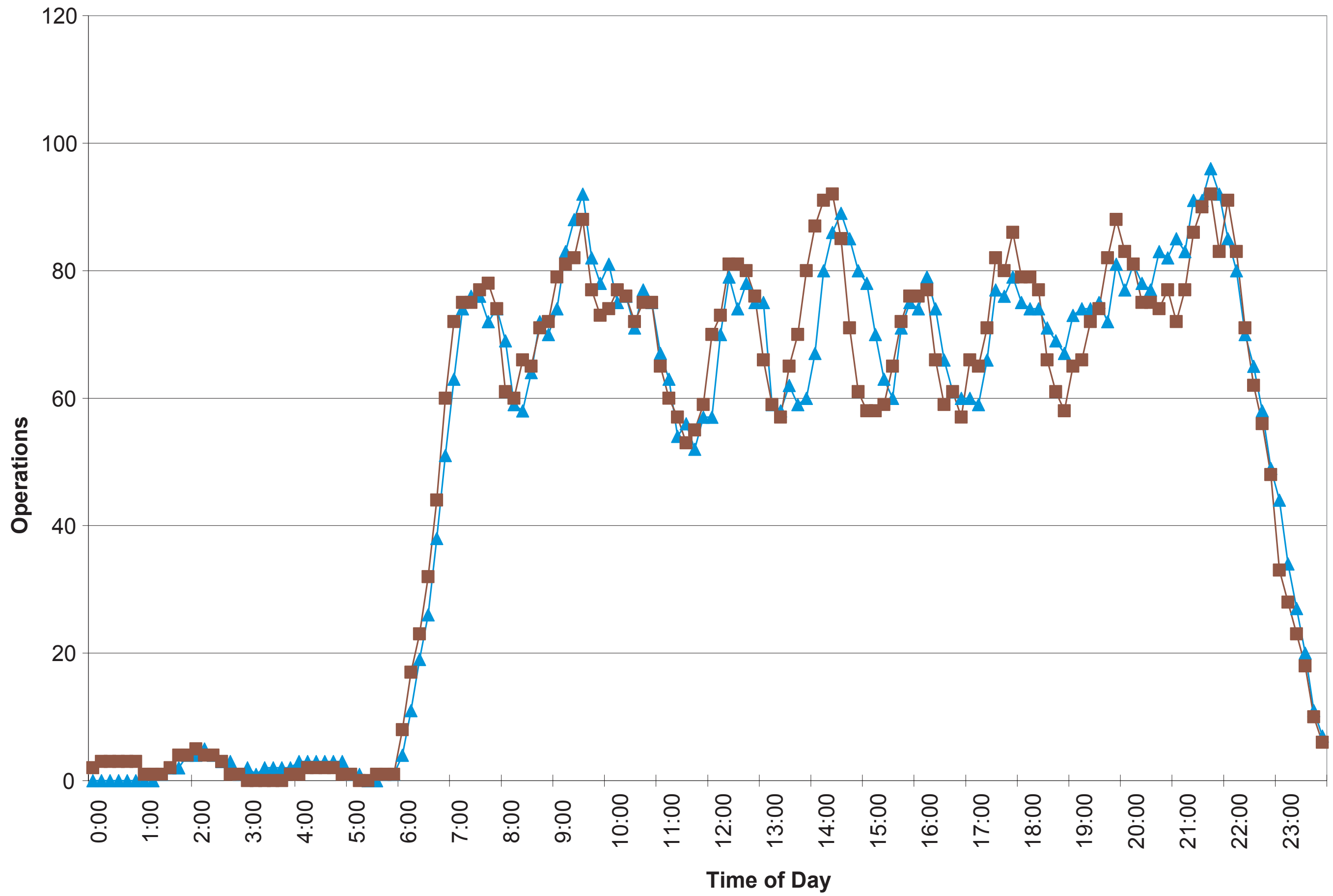
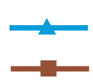
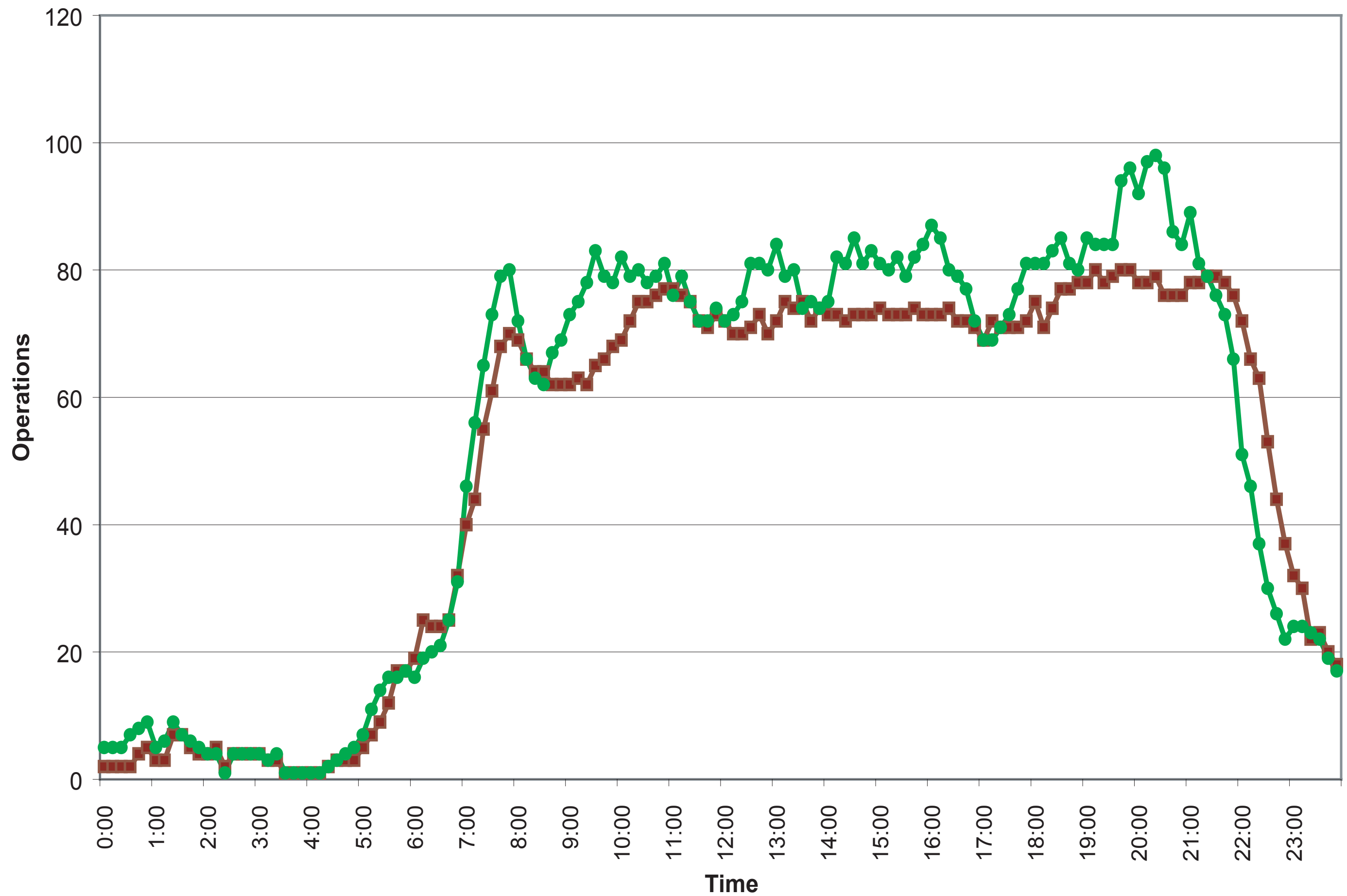


Sources: Actual - ARTS data for January 15, 2001 as compiled by the City of Chicago Department of Aviation Noise Office.
Simulation - Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit III-10

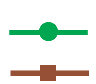


Rolling 60-Minute Aircraft Departure Flow Rates IMC, Parallel 27, Calibration



Sources: Actual - ARTS data for January 15, 2001 as compiled by the City of Chicago Department of Aviation Noise Office.
Simulation - Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit III-11



Rolling 60-Minute Aircraft Arrival Flow Rates IMC, Parallel 27, Calibration

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IV. Alternatives Evaluated

Three alternative future airfield configurations, Options 1, 2 and 5 were analyzed for the OMP; however, only Options 1 and 5 were completely simulated. As discussed in Sections I, *Introduction* and V, *Airfield and Airspace Procedures* of this report, Options 2, 3, and 4 were eliminated from further consideration through the operational evaluation process. These options either did not meet operational goals, produced operational difficulties that could not be easily overcome, or were functionally similar when compared with the other options. The selection of Options 1 and 5 for simulation was a result of planning discussions held between the FAA, ATCT staff, TRACON staff, airline representatives, and City of Chicago DOA during various Airport Advisory Sessions. The airfield configurations utilized for these simulations were adopted as of August 2002. Airfield configurations shown in **Exhibits IV-1, IV-2, and IV-3** do not include refinements to each of the alternatives that were made after August 2002 based on comments from the Airfield Advisory Sessions. As a result of these refinements, that include a revised concept for a new terminal on the west side, shift of the closely spaced north runway (Runway 9C) 400 feet further north, and minor runway length and taxiway differences, the airfield configurations differ slightly from the simulated airfield layouts. These revisions subsequent to the modeling effort specific for each option are also described below. Revisions are not expected to materially change the airfield/airspace, operational characteristics, performance, or capacity/delay results.

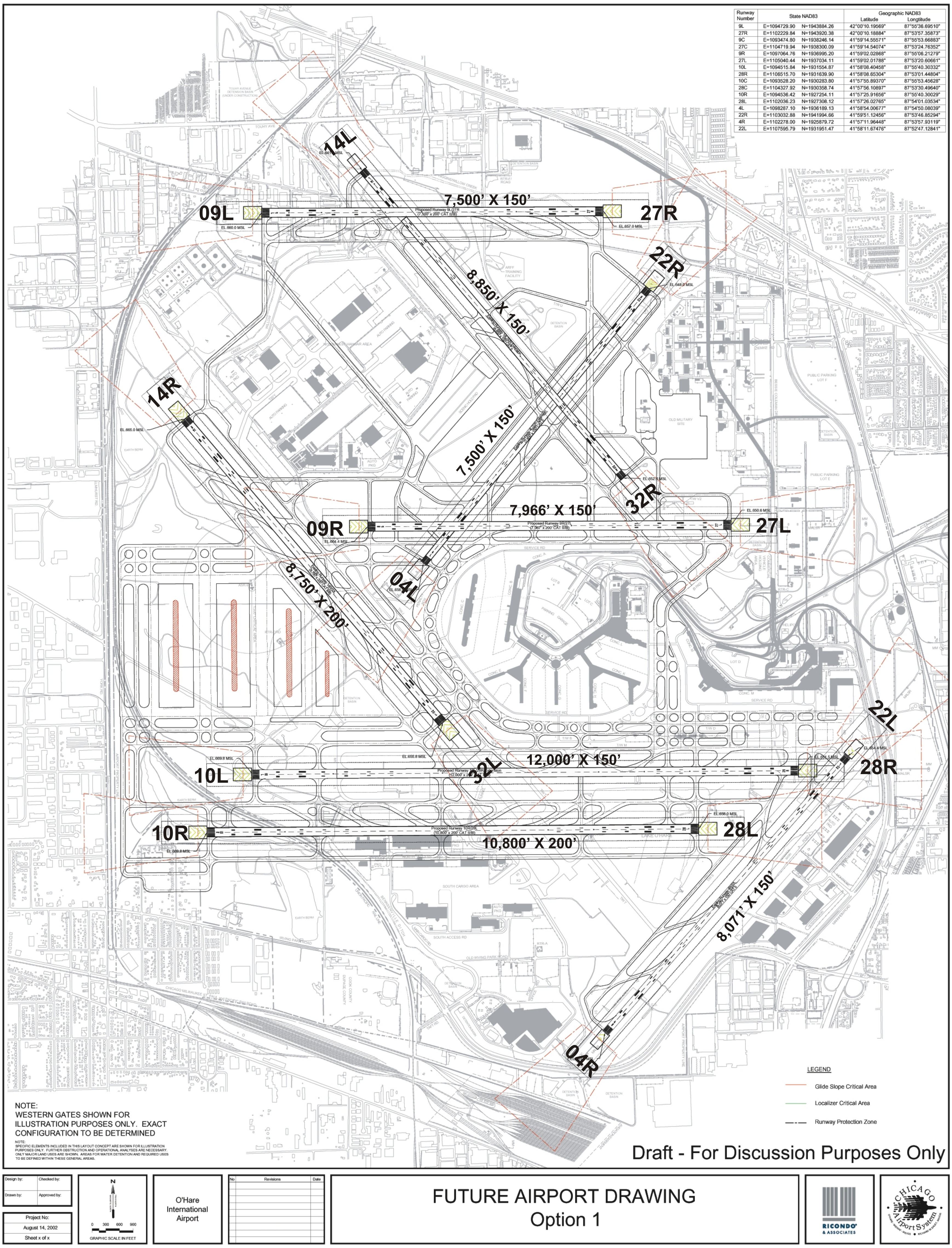
The existing airfield configuration was also simulated to serve as a benchmark for evaluating Options 1 and 5.

4.1 Option 1

The Option 1 airfield layout, shown in **Exhibit IV-1,** would construct one new runway on the North Airfield and one new runway on the South Airfield. All other existing runways would remain in their current configuration. While Runway 14R-32L and 14L-32R are shortened to eliminate runway intersections, existing Runway 9R-27L would be extended to better satisfy long-haul aircraft departure requirements. Runway 10R-28L would be designed to FAA Airplane Design Group (ADG) VI standards, while all other runways would be designed to ADG V standards. Perimeter taxiways would be added to the west end of Runways 10L-28R and 10R-28L to permit controlled aircraft taxi movements around the runway ends in lieu of runway crossings. All east-west parallel runway ends would be located to satisfy clearance requirements for CAT II/III operations.

Option 1 would also include additional terminal gate facilities to support operations at the higher demand levels. Additional gate facilities would be provided so as to provide for sufficient gate capacity to allow for a full analysis of the airfield capacity without gate constraints. Therefore, Option 1 would include the World Gateway Program (WGP) facilities, as well as additional airside concourses provided in the west terminal complex in a manner that would maximize the use of available space within the Airport's boundaries.

The following further describes the changes to the airside facilities of the Airport associated with Option 1.



Runway Number	State NAD83		Geographic NAD83 Latitude	Longtitude
9L	E=1094729.90	N=1943884.26	42°00'10.19569"	87°55'36.69510"
27R	E=1102229.84	N=1943920.38	42°00'10.18884"	87°53'57.35873"
9C	E=1093474.80	N=1938246.14	41°59'14.55571"	87°55'53.66883"
27C	E=1104719.94	N=1938300.09	41°59'14.54074"	87°53'24.76352"
9R	E=1097064.76	N=1936995.20	41°59'02.02868"	87°55'06.21279"
27L	E=1105040.44	N=1937034.11	41°59'02.01788"	87°53'20.60661"
10L	E=1094515.84	N=1931554.87	41°58'08.40458"	87°55'40.30332"
28R	E=1106515.70	N=1931639.90	41°58'08.65304"	87°53'01.44804"
10C	E=1093528.20	N=1930283.80	41°57'55.89370"	87°55'53.45628"
28C	E=1104327.92	N=1930358.74	41°57'56.10897"	87°53'30.49640"
10R	E=1094536.42	N=1927254.11	41°57'25.91656"	87°55'40.30029"
28L	E=1102036.23	N=1927308.12	41°57'26.02765"	87°54'01.03534"
4L	E=1098287.10	N=1936189.13	41°58'54.00677"	87°54'50.08039"
22R	E=1103032.88	N=1941994.66	41°59'51.12456"	87°53'46.85294"
4R	E=1102278.00	N=1925879.72	41°57'11.96448"	87°53'57.93119"
22L	E=1107595.79	N=1931951.47	41°58'11.67476"	87°52'47.12841"

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit IV-1

Future Airport Drawing
Option 1 (As Simulated)

Z://Chicago/ORD/OMP/graphics/Project Definition Notebook/Future Airport Layouts.cdr

4.1.1 North Airfield Facilities

4.1.1.1 New Runway 9L-27R (7,500 feet x 150 feet)

The runway would be 150 feet wide and 7,500 feet long and located 6,901 feet north of Runway 9R-27L (existing Runway 9L-27R). Although the majority of aircraft would be capable of departing from the runway, it is envisioned that this runway would operate primarily as an arrival runway both in west and east traffic flows. The length of this runway would satisfy landing runway length requirements for the vast majority of aircraft types. Runway-to-parallel taxiway separation would be 500 feet for the portion of the parallel taxiway west of Taxiway P. East of Taxiway P, the runway-to-taxiway separation distance would be 400 feet as a result of land-use requirements for the North Airfield detention basin.

For ADG V aircraft, the standard runway centerline to parallel taxiway centerline separation is 400 feet. However, TERPS[1] criteria for CAT II/III approaches for ADG V aircraft requires a runway to parallel taxiway centerline separation of 500 feet with 400-foot spacing reserved for aircraft with wingspans less than 171 feet and tail heights less than 55 feet. On this basis, CAT II approaches by ADG V aircraft landing Runway 27R would exit the runway and either taxi south on the north-south taxiway at the west end, or back-taxi on the parallel taxiway to Taxiway P before proceeding south. Conversely, ADG V aircraft landing runway 9L during CAT II/III operations would exit the runway and proceed south on the north-south taxiway at the east end of the runway.

4.1.1.2 Runway 14L-32R (8,850 feet x 150 feet)

A 1,400-foot extension would be constructed at the northwest end of Runway 14L-32R, with a reduction of 2,553 feet to the southeast end of the runway resulting in an overall runway length of 8,850 feet. This extension would permit Land and Hold Short Operations (LAHSO) when landing on Runway 14L to hold short of Runway 4L-22R. The reduction in runway length would eliminate the intersection with Runway 9R-27L.

4.1.1.3 Runway 14R-32L (8,750 feet x 200 feet)

The southeast end of the runway would be reduced by 4,250 feet for an overall runway length of 8,750 feet. The reduction in length would eliminate the intersection with Runways 10L-28R and 10R-28L.

4.1.1.4 Runway 9R-27L (Existing Runway 9L-27R) – (7,966 feet x 150 feet)

The length of the runway would not change and perimeter taxiways would be added to the west end of the runway to accommodate controlled aircraft movements to and from Runway 9L-27R in lieu of runway crossings.

4.1.2 South Airfield Facilities

4.1.2.1 Runway 10L-28R (Existing Runway 9R-27L) – (12,000 feet x 150 feet)

A 1,859-foot extension would be constructed at the west end of existing Runway 9R-27L for an overall runway length of 12,000 feet. Similarly, an extension would be constructed for the existing parallel Taxiway M westward, spaced 500 feet from the runway centerline, to the new west end of

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[1] Contained in TERPS Instruction Letter TIL00-005A, *Interim Category II/III Obstruction Clearance Criteria*, September 18, 2000

the runway. As also indicated in the World Gateway Program, runway-to-taxiway centerline separation of 400 feet from Taxiway M to the runway centerline would be provided for the east 2,700-foot portion of Taxiway M (east of exit Taxiway M5). This would accommodate a taxilane, a snow service road and three taxiways located south of Terminal 5 to benefit the queuing of departures and the movement of aircraft around the terminal areas. The runway and angled exit taxiways would be built to ADG V standards. However, perpendicular taxiways at the ends of Runway 10L-28R in addition to perimeter taxiways are planned at 100-foot widths to satisfy ADG VI operations to and from Runway's 10R-28L.

Dual perimeter taxiways are located 2,500 feet west of the runway end to provide controlled aircraft access to and from Runway 10R-28L in lieu of runway crossings.

4.1.2.2 New Runway 10R-28L (Relocated Runway 14R-32L) – (10,800 feet x 200 feet)

Runway 10R-28L would be located 1,265 feet south of existing Runway 9R-27L (future Runway 10L-28R). This new runway would be 10,800 feet long by 200 feet wide to satisfy ADG VI criteria. North of the runway, a full-length ADG Group VI parallel taxiway would be constructed between Runway 10L-28R and Runway 10R-28L with taxiway-to-runway separation of 600 feet from Runway 10R-28L. A hold pad would be constructed south of the runway at the west end of the runway to provide aircraft queuing capability.

A perimeter taxiway would be provided 1,850 feet west of the Runway 10R-28L end to accommodate controlled aircraft taxiing around the runway in lieu of runway crossings.

4.2 Option 2

The Option 2 airfield layout, shown in **Exhibit IV-2,** would add two new runways to the North Airfield and two new runways to the South Airfield to effect a transition to an essentially east/west traffic flow configuration. The existing Runways 4L-22R and 4R-22L would be maintained for wind coverage purposes. The Runways 4L-22R and 4R-22L would also be used under certain airfield operating conditions to facilitate departures and arrival operations. Existing Runway 9R-27L would be extended to better satisfy long-haul aircraft departure requirements. New runway ends would be located to satisfy clearance requirements for CAT II/III operations. The center runways on the north and south airfields are designed to meet ADG VI standards, while other runways are designed to ADG V standards.

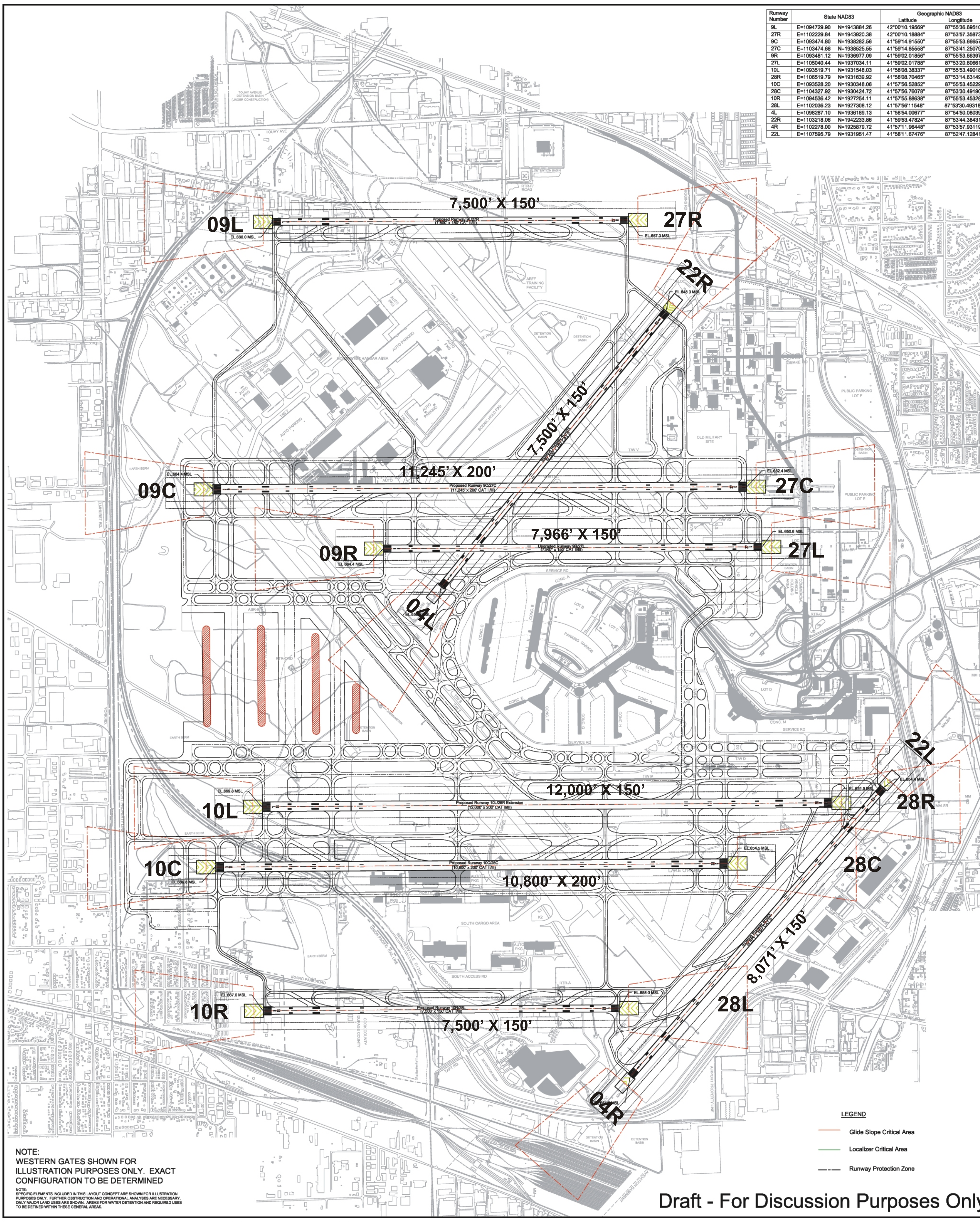
Option 2 would also include additional terminal gate facilities to support operations at the higher demand levels. Additional gate facilities would be provided so as to provide for sufficient gate capacity to allow for a full analysis of the airfield capacity without gate constraints. Therefore, Option 2 would include the WGP facilities, as well as additional airside concourses provided in the west terminal complex in a manner that would maximize the use of available space within the Airport's boundaries.

The following further describes the changes to the airside facilities of the Airport associated with Option 2.

4.2.1 North Airfield Facilities

4.2.1.1 New Runway 9L-27R (7,500 feet x 150 feet)

This runway would be the same as described in Section 4.1.1.1.



Runway Number	State NAD83		Geographic NAD83 Latitude	Longtitude
9L	E=1094729.90	N=1943884.26	42°00'10.19569"	87°55'36.69510"
27R	E=1102229.84	N=1943920.38	42°00'10.18884"	87°53'57.35873"
9C	E=1093474.80	N=1938282.56	41°59'14.91550"	87°55'53.66657"
27C	E=1103474.68	N=1938525.55	41°59'14.85558"	87°53'41.25079"
9R	E=1093481.12	N=1936977.09	41°59'02.01856"	87°55'53.66397"
27L	E=1105040.44	N=1937034.11	41°59'02.01788"	87°53'20.60661"
10L	E=1093519.71	N=1931548.03	41°58'08.38337"	87°55'53.49018"
28R	E=1106519.79	N=1931639.92	41°58'08.70465"	87°53'14.63149"
10C	E=1093528.20	N=1930348.06	41°57'56.52852"	87°55'53.45229"
28C	E=1104327.92	N=1930424.72	41°57'56.76078"	87°53'30.49190"
10R	E=1094536.42	N=1927254.11	41°57'55.88638"	87°55'53.45328"
28L	E=1102036.23	N=1927308.12	41°57'56'11548"	87°53'30.49318"
4L	E=1098287.10	N=1936189.13	41°58'54.00677"	87°54'50.08039"
22R	E=1103218.06	N=1942233.86	41°59'53.47824"	87°53'44.38431"
4R	E=1102278.00	N=1925879.72	41°57'11.96448"	87°53'57.93119"
22L	E=1107595.79	N=1931951.47	41°58'11.67476"	87°52'47.12841"

Design by: Checked by:
Drawn by: Approved by:
Project No:
August 14, 2002
Sheet x of x

GRAPHIC SCALE IN FEET: 0 300 600 900

O'Hare International Airport

No | Revisions | Date

FUTURE AIRPORT DRAWING
Option 2

RICONDO & ASSOCIATES

CHICAGO Airport System

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit IV-2

Future Airport Drawing
Option 2 (As Simulated)

Z://Chicago/ORD/OMP/graphics/Project Definition Notebook/Future Airport Layouts.cdr

4.2.1.2 New Runway 9C-27C (Relocated Runway 14L-32R) – (11,245 feet x 200 feet)

A new runway would be built 1,265 feet north of Runway 9R-27L (existing Runway 9L-27R). This new runway would be 11,245 feet long with a width of 200 feet to satisfy ADG VI requirements.

The runway would be served by 100-foot wide full-length parallel taxiways to the north and south spaced 600 feet from the Runway 9C-27C centerline to satisfy ADG VI criteria. Additionally, there would be eight 90-degree exit taxiways to the north and seven to the south to facilitate runway entry/exit and to better provide staging areas for departing aircraft. There would also be seven 100-foot wide north/south taxiways connecting the south parallel taxiway to Runway 9R-27L to provide crossing points to the terminal area located to the south.

4.2.1.3 Runway 9R-27L (Existing Runway 9L-27R) – (7,966 feet x 150 feet)

This runway would be the same as described in Section 4.1.1.4.

4.2.2 South Airfield Facilities

4.2.2.1 Runway 10L-28R (Existing Runway 9R-27L) – (12,000 feet x 150 feet)

This runway would be the same as described in Section 4.1.2.1.

4.2.2.2 New Runway 10C-28C (Relocated Runway 18-36) – (10,800 feet x 200 feet)

This runway would be the same as described in Section 4.1.2.2.

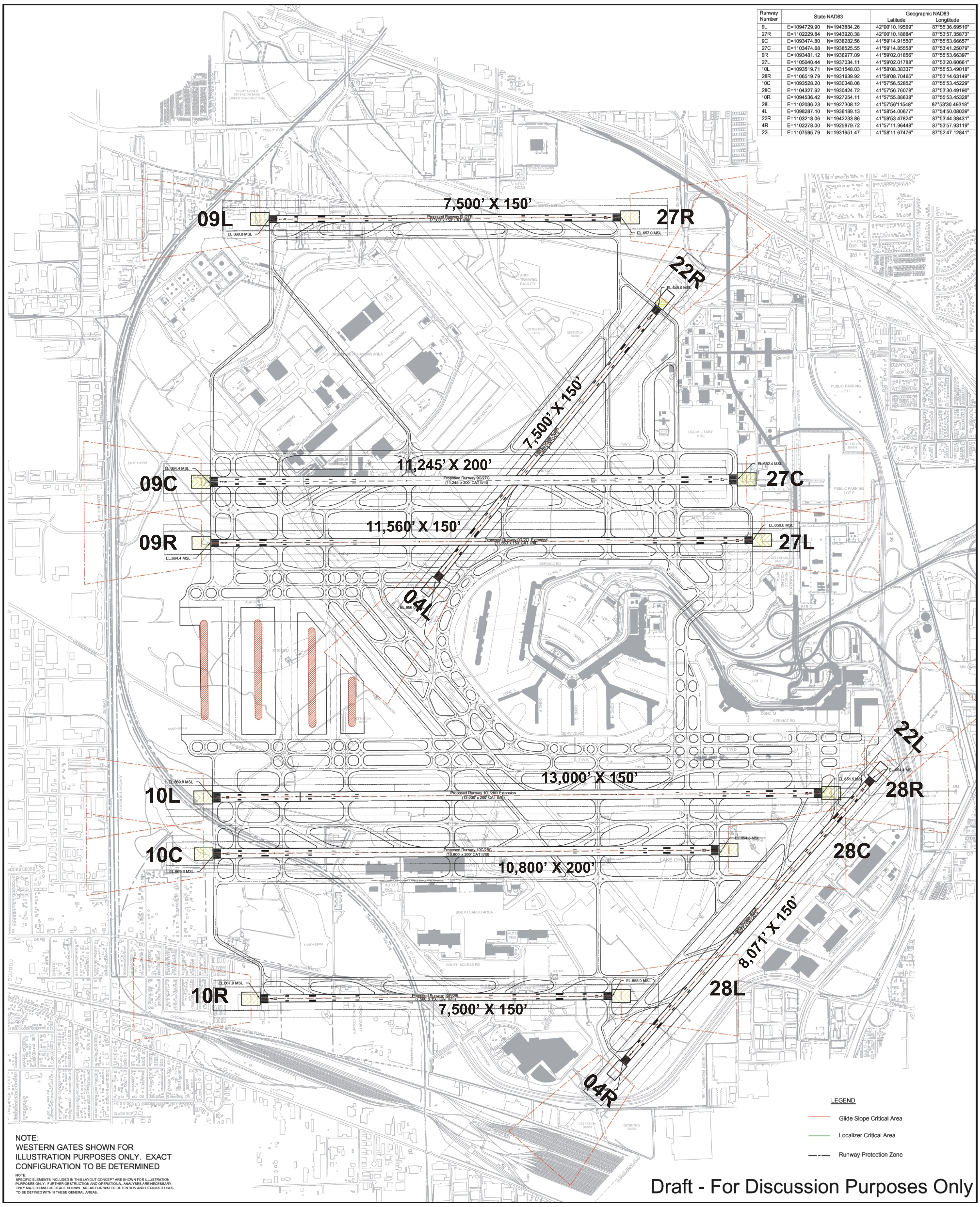
4.2.2.3 New Runway 10R-28L (Relocated Runway 14R-32L) – (7,500 feet x 150 feet)

Runway 10R-28L would be located 4,300 feet south of future Runway 10L-28R (existing Runway 9R-27L). The new runway would be 7,500 feet in length and 150 feet wide to satisfy ADG V requirements. A full-length parallel taxiway would be constructed north of the runway, spaced 400 feet from the runway centerline, at a width of 75 feet. In addition to end crossover taxiways, two angled exit taxiways would be constructed near each runway end to facilitate aircraft exits from the runway.

The new runway would operate as an arrival or departure runway depending on the runway configuration. The length of this runway would satisfy landing and departure length requirements for a majority of aircraft types. The runway-to-parallel taxiway centerline spacing of 400 feet conforms to ADG V criteria; however, 400-foot separation would result in the parallel taxiway to be restricted to ADG IV or smaller during CAT II/III operations. ADG V aircraft landing Runway 10R-28L would exit the runway then taxi north, thus remain outside of CAT II/III critical areas.

4.3 Option 5

The Option 5 airfield layout, as shown in **Exhibit IV-3,** would add two new runways to the North Airfield and two new runways to the South Airfield to effect a transition to an essentially east/west traffic flow configuration. The existing Runways 4L-22R and 4R-22L would be maintained for wind coverage purposes. These runways would also be used under certain airfield operating conditions to facilitate departures and arrival operations. Existing Runways 9L-27R and 9R-27L would be extended to the west to better satisfy long-haul aircraft departure requirements and LAHSO and intersection departures would be implemented to facilitate uncoordinated runway crossings. New runway ends would be located to satisfy clearance requirements for CAT II/III operations.



Runway Number	State NAD83		Geographic NAD83 Latitude	Geographic NAD83 Longtitude
9L	E=1094729.90	N=1943884.26	42°00'10.19569"	87°55'36.69510"
27R	E=1102229.84	N=1943920.38	42°00'10.18884"	87°53'57.35873"
9C	E=1093474.80	N=1938282.56	41°59'14.91550"	87°55'53.66657"
27C	E=1103474.68	N=1938525.55	41°59'14.85558"	87°53'41.25079"
9R	E=1093481.12	N=1936977.09	41°59'02.01856"	87°55'53.66397"
27L	E=1105040.44	N=1937034.11	41°59'02.01788"	87°53'20.60661"
10L	E=1093519.71	N=1931548.03	41°58'08.38337"	87°55'53.49018"
28R	E=1106519.79	N=1931639.92	41°58'08.70465"	87°53'14.63149"
10C	E=1093528.20	N=1930348.06	41°57'56.52852"	87°55'53.45229"
28C	E=1104327.92	N=1930424.72	41°57'56.76078"	87°53'30.49190"
10R	E=1094536.42	N=1927254.11	41°57'55.88638"	87°55'53.45328"
28L	E=1102036.23	N=1927308.12	41°57'56'11548"	87°53'30.49318"
4L	E=1098287.10	N=1936189.13	41°58'54.00677"	87°54'50.08039"
22R	E=1103218.06	N=1942233.86	41°59'53.47824"	87°53'44.38431"
4R	E=1102278.00	N=1925879.72	41°57'11.96448"	87°53'57.93119"
22L	E=1107595.79	N=1931951.47	41°58'11.67476"	87°52'47.12841"

Design by: Checked by:
Drawn by: Approved by:
Project No:
August 14, 2002
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O'Hare International Airport

No | Revisions | Date

FUTURE AIRPORT DRAWING
Option 5

RICONDO & ASSOCIATES

CHICAGO Airport System

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit IV-3

Future Airport Drawing
Option 5 (As Simulated)

Z://Chicago/ORD/OMP/graphics/Project Definition Notebook/Future Airport Layouts.cdr

The center runways on the north and south airfields would be designed to meet ADG VI standards, while other runways would be designed to ADG V standards. The following further describes the components of the airside facilities both physically and operationally.

Option 5 would also include additional terminal gate facilities to support operations at the higher demand levels. Additional gate facilities would be provided so as to provide for sufficient gate capacity to allow for a full analysis of the airfield capacity without gate constraints. Therefore, Option 5 would include the WGP facilities, as well as additional airside concourses provided in the west terminal complex in a manner that would maximize the use of available space within the Airport's boundaries.

The following further describes the changes to the airside facilities of the Airport associated with Option 5.

4.3.1 North Airfield Facilities

4.3.1.1 New Runway 9L-27R (7,500 feet x 150 feet)

This runway would be the same as described in Section 4.1.1.1

4.3.1.2 New Runway 9C-27C (Relocated Runway 14L-32R) – (11,245 feet x 200 feet)

This runway would be the same as described in Section 4.2.1.2., with a runway separation of 1,200 feet from Runway 9R-27L. It is envisioned by O'Hare ATCT, that Runway 9C-27C would primarily be an arrival runway under both IMC and VMC.

Subsequent to the simulation analysis used to determine the preferred option, although not predicated by the OMP, a refinement was made to Option 5 that would relocate Runway 9C-27C 400 feet further north to facilitate potential opportunity to provide a dual taxiway system in the inner core of the terminal. Additionally, hold pads were added to the north side of the runway at each runway end to provide aircraft queuing capability.

4.3.1.3 Runway 9R-27L (Existing Runway 9L-27R) (11,560 feet x 150 feet)

A 3,594-foot west extension would be constructed for existing Runway 9L-27R and designated as Runway 9R-27L to provide an overall length of 11,560 feet and width of 150 feet.

Subsequent to the simulation analysis used to evaluate the various alternatives, a refinement was made to Option 5 that would revise the runway length to 12,260 feet. The east runway threshold would be relocated 300 feet west of its existing location to provide a full 1,000 feet Runway Safety Area.

The existing parallel taxiway to the south of the runway (Taxiway H) would be maintained at a centerline separation of 365 feet; however, for the extension of the taxiway to the west, to correspond with the new west end, the separation would be increased to 400 feet to satisfy ADG V requirements.

TERPS criteria allows for CAT II/III approaches for taxiway centerline separations of 400 feet provided taxi operations are restricted to aircraft with wingspans less than 171 feet and tail heights less than 55 feet. During Category II/III approaches to Runway 9R-27L, aircraft using Taxiway H would be restricted to ADG IV aircraft, or smaller. It is envisioned by O'Hare ATCT, that Runway 9R-27L will be a primary departure runway under both VMC and IMC.

4.3.2 South Airfield Facilities

4.3.2.1 Runway 10L-28R (Existing Runway 9R-27L) (13,000 feet x 150 feet)

Existing Runway 9R-27L would be extended 2,859 feet to the west and designated as Runway 10L-28R for an overall runway length of 13,000 feet and width of 150 feet. Similarly, the existing parallel taxiway, spaced 500 feet from the runway centerline to the north, would be extended to the new west end of the runway. As also included in the World Gateway Program, the runway-to-taxiway centerline separation for the east 3,500-foot portion of the northern parallel taxiway would be narrowed to 400 feet to accommodate three taxiways and a taxilane south of Terminal 5. These taxiways would benefit the queuing of departures and the movement of aircraft around the terminal areas. Two new high-speed exit taxiways and four new crossover taxiways would be constructed to facilitate landings to the west. The runway and high-speed exit taxiways would be designed to ADG V standards; however, perpendicular taxiways located at the ends of the runway will be 100 ft. wide to provide runway crossing locations for ADG V aircraft transitioning from or to Runway 10C-28C. It has been envisioned by FAA ATCT, that Runway 10L-28R would be a primary landing runway under VMC and a primary departure runway under IMC.

4.3.2.2 New Runway 10C-28C (Relocated Runway 18-36) – (10,800 feet x 200 feet)

Runway 10C-28C would be located 1,200 feet south of future Runway 10L-28R (existing Runway 9R-27L). This new runway would be 10,800 feet long by 200 feet wide to meet ADG VI criteria. The runway would have a full-length parallel taxiway to the north spaced 600 feet from the runway centerline. The runway would primarily be used for departures during VMC and landings during IMC.

Subsequent to the simulation analysis used to determine the preferred option, a refinement was made to Option 5 that revised the runway length to 10,600 ft. (The Runway 10C localizer would be located east of Runway 4R-22L and subsequently, the Runway 28C threshold was located 200 feet further west from an earlier concept to provide additional clearances.) Additionally, hold pads located south of Runway 10C-28C at each end of the runway were added to provide aircraft queuing capabilities.

4.3.2.3 New Runway 10R-28L (Relocated Runway 14R-32L) – (7,500 feet x 150 feet)

This runway would be the same as described in Section 4.2.2.3.

V. Airfield and Airspace Procedures

This section describes the existing airfield and airspace procedures for various operating configurations at O'Hare International Airport. It also details the assumptions used in developing the simulation model inputs for the development alternatives (Option 1, 2, and 5) and ground movements associated with them. The assumptions used in the simulation modeling were developed in cooperation with or were reviewed by ATCT and Chicago TRACON staff.

5.1 Existing Facilities and Procedures

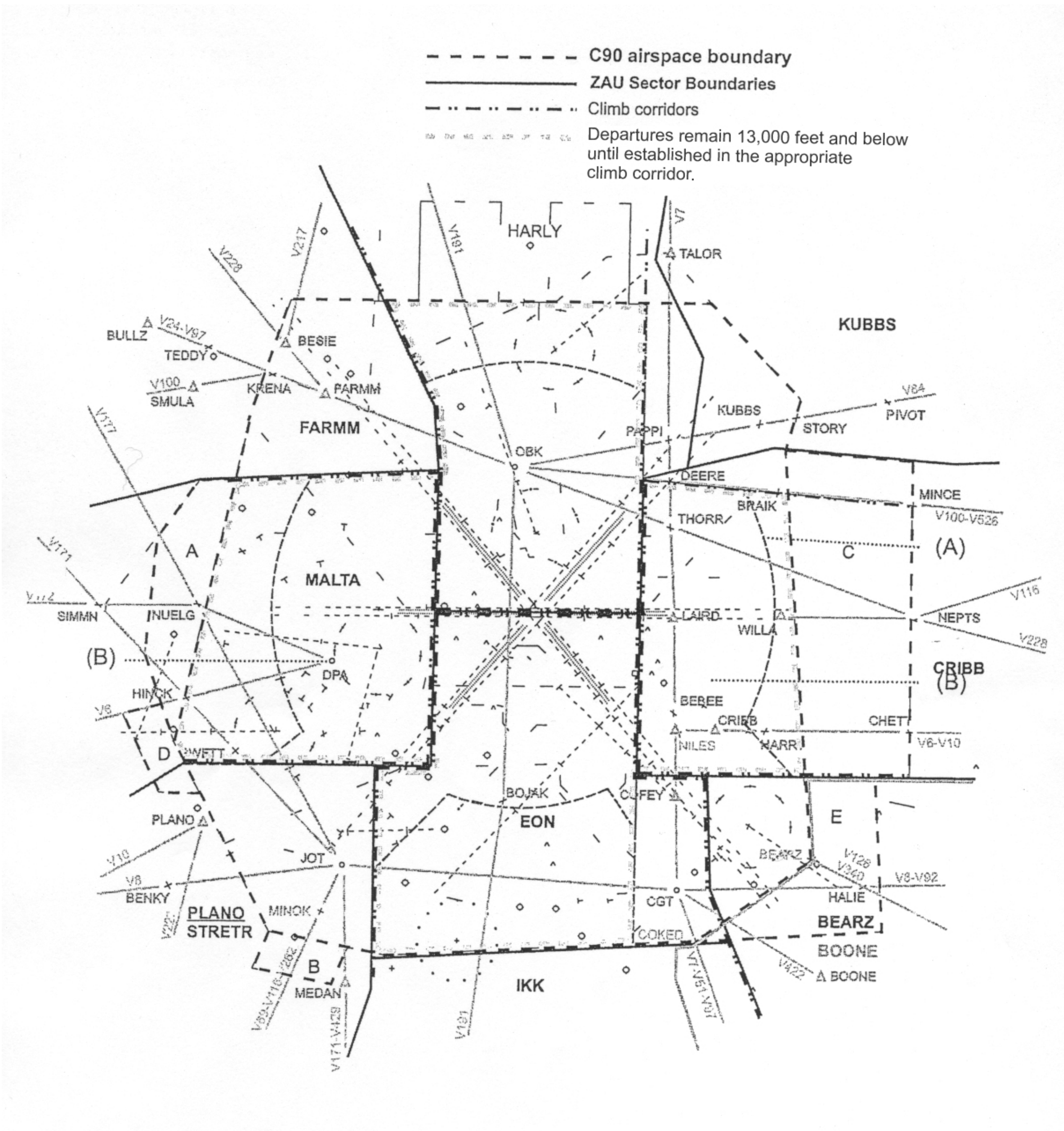
The Chicago TRACON provides air traffic control services for aircraft arriving and departing the Airport. The TRACON airspace encompasses an area approximately 80 miles north to south by 80 miles east to west, at altitudes of 13,000 feet and below excluding airspace shelves and corridors. The boundaries of the airspace, defined in the Letter of Agreement (LOA) between Chicago Air Route Traffic Control Center (ZAU ARTCC) and Chicago TRACON dated March 22, 2001, are depicted on **Exhibit V-1**.

For aircraft arriving at O'Hare International Airport, the current operating environment is based on a four corner-post airspace structure as depicted on **Exhibit V-2**. These primary corner posts are STORY, BEARZ, PLANO and KRENA intersections. MATRU intersection is used for traffic arriving from Milwaukee (MKE) while MINCE intersection is used for traffic arriving from South Bend (SBN) in the tower en-route structure. The Airport corner posts, or arrival gates, are located approximately 40 nautical miles from the Airport, and are named in relation to a fix or navigational aide over which the arriving aircraft will fly. Aircraft enter the TRACON airspace with five miles in-trail separation at speeds of approximately 250 knots. Higher performance turbojet aircraft are typically separated from lower performance propeller driven aircraft by altitude. The location of the origin city of the arrival traffic normally determines the corner post to which the aircraft is assigned. For simulation purposes, arrival routings to the corner posts were obtained from ETMS flight plan data for August 20, 2001, which provided actual airspace routing information for aircraft.

In the northeast quadrant, aircraft arrive over the STORY intersection. This fix serves as a waypoint for much of the traffic arriving from cities in the northeastern United States, eastern Canada, and Europe. Turbojet aircraft descending into the Airport generally cross the STORY intersection at 10,000 feet MSL, with propeller driven aircraft below them at 8,000 feet MSL. When the Airport runway configuration requires landings on Runways 22R and/or 27R all aircraft arriving over the STORY intersection descend to 8,000 feet MSL.

The southeast arrival gate is BEARZ. The BEARZ gate is an Airport arrival corridor bounded by the 130 degree radial from the Airport's Very High Frequency Omnidirectional Range (VOR) and the extended Runway 32L localizer course. The BEARZ arrival gate serves as an entryway for cities from the mid-Atlantic and southeastern United States, the Caribbean, and eastern South America. Turbojet aircraft are routed through the BEARZ arrival gate at 11,000 feet MSL, with propeller driven aircraft crossing the BEARZ intersection at or below 10,000 feet MSL with a clearance to 8,000 feet MSL.

From the southwest, aircraft arrive through the PLANO gate. The PLANO Gate is an arrival corridor bounded by the 233 degree radial from the ORD VOR and the extended Runway 4R



Sources: Letter of Agreement (LOA) between Chicago Air Route Traffic Control Center (ZAU ARTCC) and Chicago TRACON (C90) dated March 22, 2001.
Prepared by: Ricondo & Associates, Inc.

Exhibit V-1

north

TRACON Airspace

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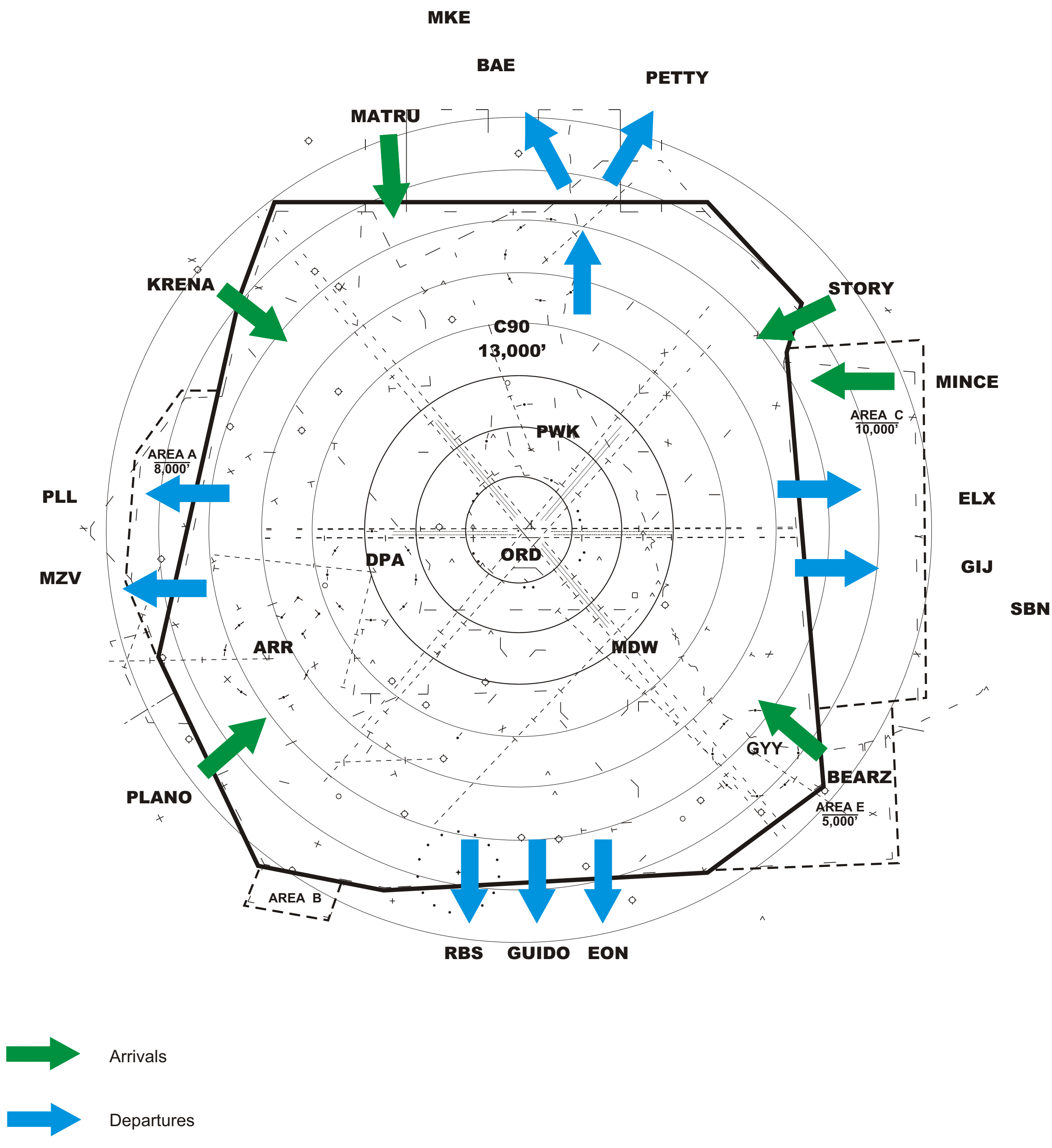

Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-2

Existing Airspace

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localizer course. This gate serves as an entryway for cities from New Orleans to Mexico City to the Los Angeles basin. Turbojet aircraft arriving through the PLANO Gate cross 45 miles southwest of ORD at 11,000 feet MSL. Propeller driven aircraft arrive at 8,000 feet MSL.

KRENA intersection is the northwest arrival fix into the Airport. Most aircraft arriving from the northwestern United States, western Canada, and the Pacific Rim are routed to the Airport from over the KRENA intersection. Generally, turbojet aircraft cross KRENA at 10,000 feet MSL, with propeller driven aircraft assigned 9,000 feet MSL. Aircraft originating in or transitioning through Rockford (RFD) airspace are assigned 7,000 feet MSL when landing at the Airport. When the landing configuration at the Airport requires the use of Runways 9L, 9R, 14L or 14R, both turbojet and propeller driven aircraft routed over KRENA are assigned 9,000 feet MSL.

Aircraft departing the Airport exit the TRACON airspace along broad departure corridors aligned with the four cardinal directions (i.e., north, east, south, and west), as shown on Exhibit V-2. Aircraft departing the Airport eastbound are routed over the Keeler VOR (ELX) or Gipper (GIJ) Very High Frequency Omnidrectional Range Collocated Tactical Air Navigation (VORTAC). New York, Boston, Toronto, and some European cities are examples of destinations associated with the ELX departure route. Aircraft bound for Pittsburgh, Cleveland, and Washington D.C. area airports, and New York's LaGuardia Airport are examples of city pairs routed over GIJ. By LOA between ZAU ARTCC and TRACON, TRACON will establish these aircraft in the east climb corridor with ELX traffic positioned north of aircraft routed over GIJ. Turbojet aircraft are cleared to an assigned altitude of 13,000 feet MSL. Propeller driven aircraft are assigned 11,000 feet MSL or their requested altitude, if lower.

Southbound departures utilize the Roberts VOR (RBS), the Peotone VORTAC (EON), and the GUIDO intersection. Aircraft bound for New Orleans, Dallas and Mexico City are representative of the traffic routed over RBS. Aircraft bound for destinations in the southeastern portion of the United States and the Caribbean are routed over EON and GUIDO. By agreement, south departures are routed so that aircraft bound for RBS remain west of traffic bound for GUIDO and EON; GUIDO departures remain east of traffic bound for RBS and west of traffic routed over EON; and EON departures remain east of other southbound routes. Turbojet aircraft are instructed to climb to 23,000 feet MSL, with propeller driven aircraft cleared to 11,000 feet MSL.

Westbound departures are generally routed by way of the Dubuque (DBQ)/Polo (PLL), Moline (MZV), and Iowa City (IOW) VORTACs. These three departure routes are funneled into two west departure tracks, the DBQ/IOW track and the IOW/MZV track. Departures routed to DBQ are positioned north of aircraft routed to IOW or MZV. Departures routed over IOW are positioned south of DBQ/PLL traffic or north of MZV traffic. Departures routed over MZV remain south of IOW and DBQ/PLL traffic. Turbojet aircraft are instructed to climb to 13,000 feet MSL. Propeller driven aircraft are assigned 11,000 feet MSL or their requested altitude, if lower. Aircraft en-route to cities in Mexico and the southwestern U.S. will generally use the IOW/MZV departure track, while aircraft heading to the San Francisco area, the Pacific Northwest, and Hawaii are examples of flights that use the DBQ/IOW departure track.

Northbound departures are routed toward the PETTY intersection or the Badger (BAE) VORTAC. The location of the north departure track varies and is dependent on the runways in use at the Airport. When the Airport arrival runway configuration requires use of Runways 14L, 14R, 9L, 9R, 4L, 4R, or any combination of Runways 14L/14R and 22L/22R, north departures are routed east of a north-south line bisecting the north climb corridor. On all other runway configurations northbound departures will be positioned west of the aforementioned line. Turbojet aircraft routed over either BAE or PETTY are required to climb to 13,000 feet MSL, while propeller driven aircraft are typically required to climbed to 11,000 feet MSL. Aircraft destined for Anchorage and the Pacific Rim are routed over BAE, while aircraft en-route to Europe and Detroit are routed over the PETTY intersection.

The existing airfield layout is depicted on **Exhibit V-3**. With three sets of parallel runways, which include a set of two northeast-southwest parallel runways (4L-22R and 4R-22L), a set of two east-west parallel runways (9L-27R and 9R-27L), and a set of two southeast-northwest parallel runways (14L-32R and 14R-32L), the existing airfield provides an opportunity for aircraft to arrive and depart simultaneously on a number of parallel, converging and diverging runway configurations. Runway 18-36 is typically not frequently used. The runway use for six operating configurations, Plan X, Plan W, Plan B, Plan B modified, Parallel 27s and Parallel 14s, that include the majority of Airport operations both in VMC and IMC, are illustrated on **Exhibit V-4**.

The following rules apply to all aircraft arriving at or departing from O'Hare International Airport:

- Regardless of the runway assignment, arriving aircraft will maintain an altitude of 7,000 feet MSL or above until entering the appropriate descent area. Upon entering the descent area, arriving aircraft will normally descend to 4,000 feet MSL and will remain at that altitude until within 15 miles of the Airport and within three miles of the final approach course.
- Departing aircraft will initially be assigned an altitude of 5,000 feet MSL, and a departure course that will avoid conflicting aircraft in the arrival descent area. Once clear of the arriving aircraft, departures will be climbed to an altitude consistent with the ZAU/C90 LOA described earlier.

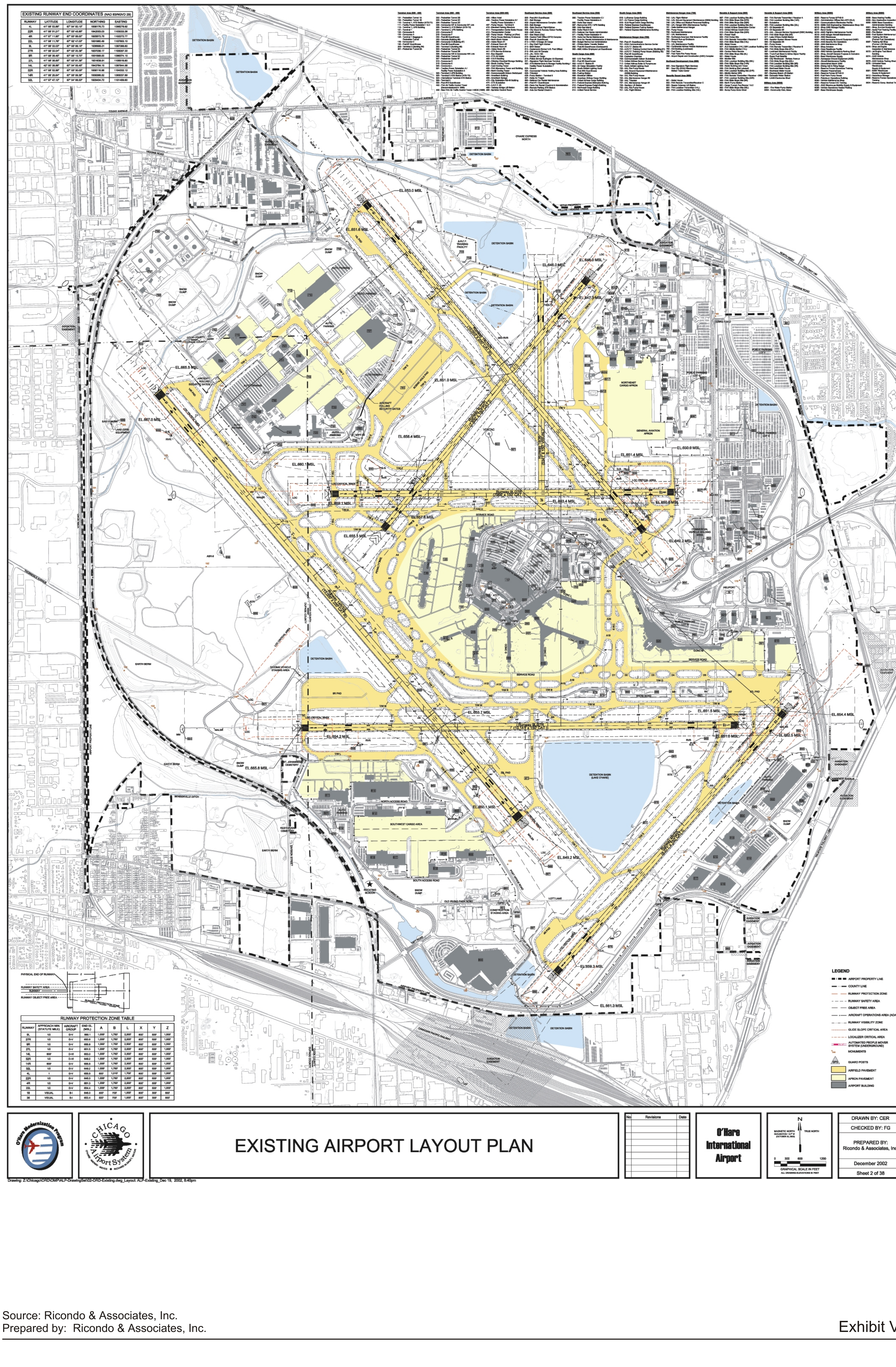
Runway utilization, arrival/departure flight tracks and taxi flow associated with each of these configurations are discussed below.

5.1.1 Plan X

Plan X is the most frequently utilized operating configurations as it supports the highest Arrival Acceptance rate (AAR) during VMC. **Exhibit V-5** illustrates the primary arrival and departure flight paths associated with this configuration. O'Hare ATCT will generally select this operating configuration under VMC with winds ranging from the northwest (330^o) to southeast (130^o). Analysis indicates that wind and weather conditions are favorable for a 42.8% annual use of this operating configuration. Historic data collected from the Airport Noise Monitoring System (ANMS) supports this finding with data collected from January 2000 through September 2001 demonstrating its use for approximately 40% of annual operations.

5.1.1.1 Arrivals

Aircraft entering the TRACON airspace from STORY and KRENA intersections and in the tower en-route structure from MKE and South Bend (SBN) will normally be assigned Runway 9R. Aircraft arriving through the BEARZ and PLANO arrival gates will normally be assigned Runway 4R.



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit V-3

Existing Airport Layout

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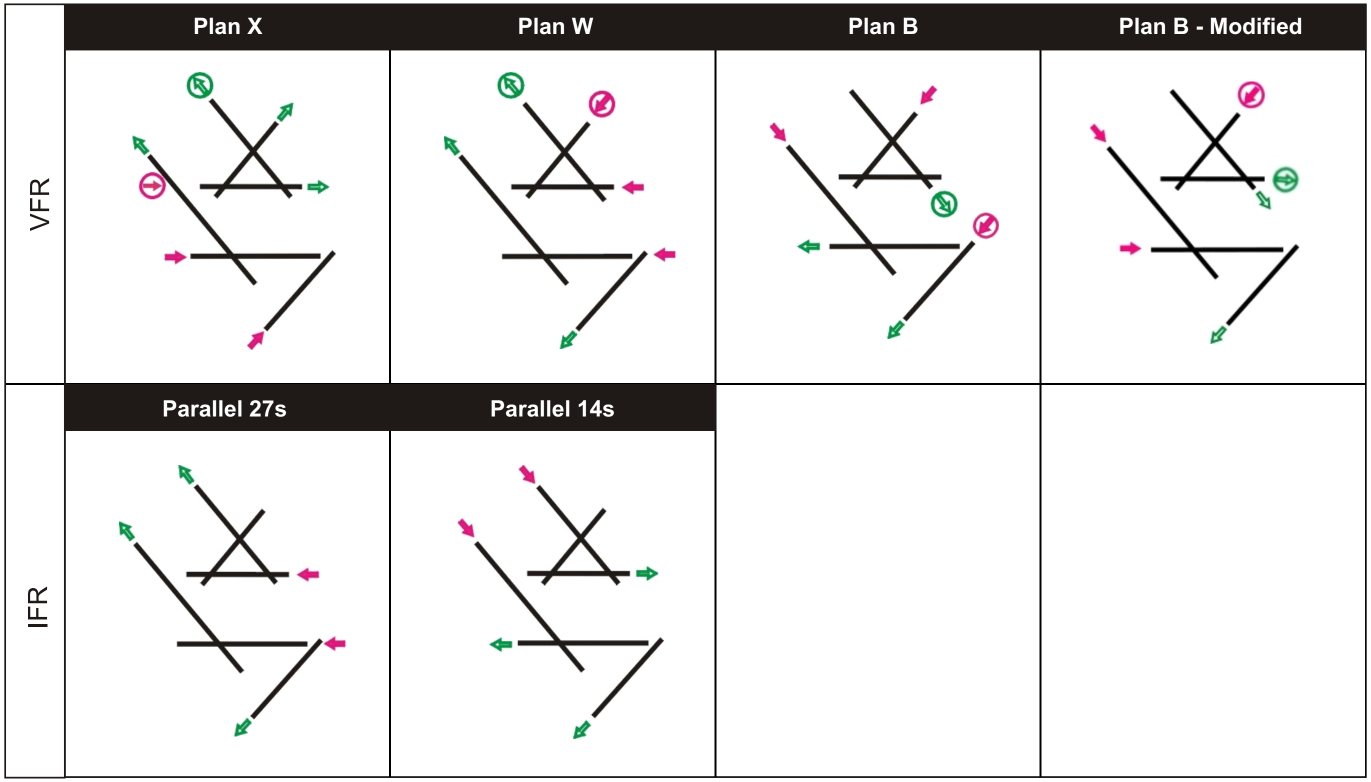

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit V-4

north

Primary Departures
Overflow Departures
Primary Arrivals
Overflow Arrivals

Existing Airfield
Runway Operating Configurations

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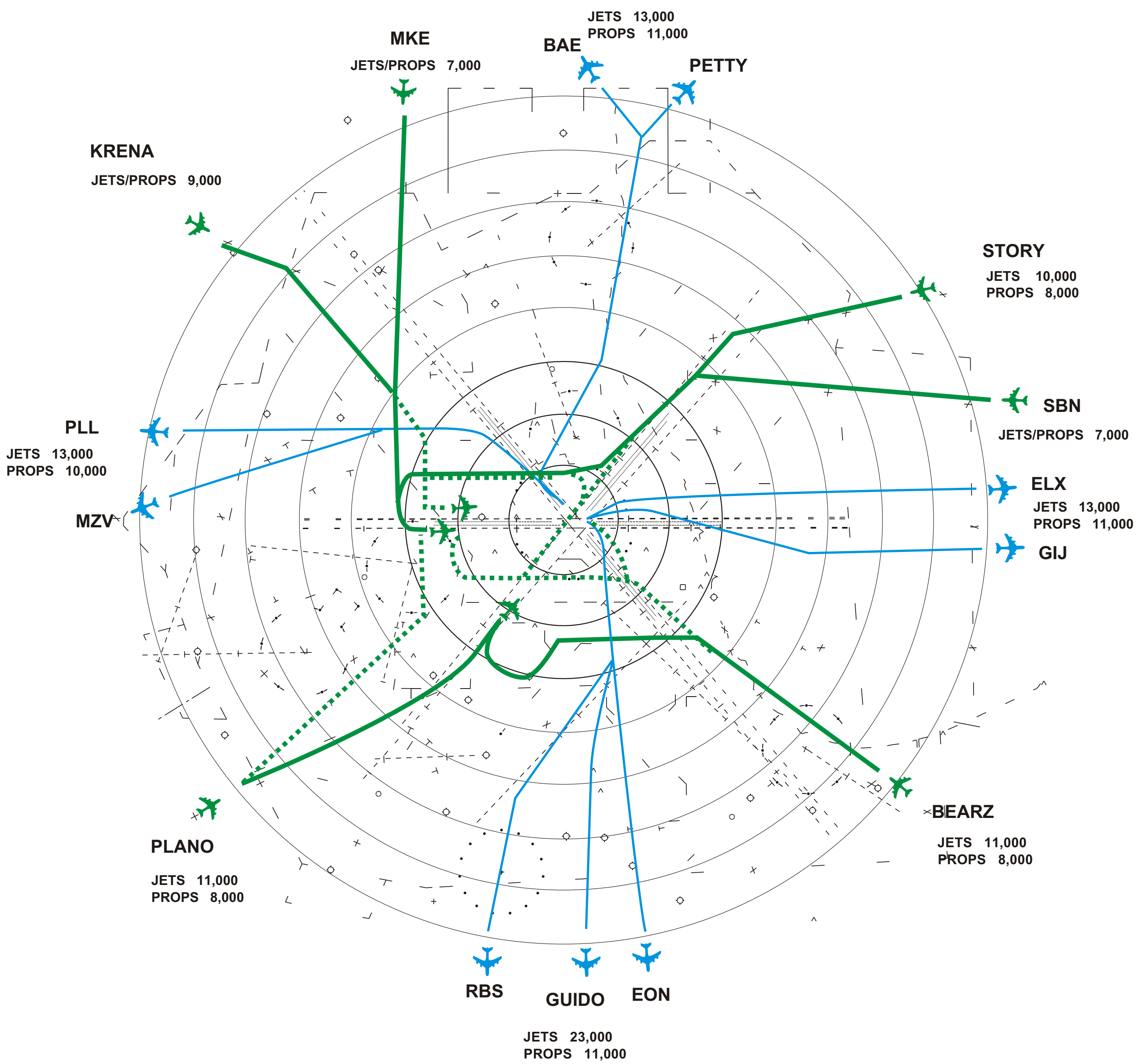

Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-5

Airspace Routes
Existing Airfield - Plan X

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The base configuration of Plan X consists of aircraft arriving on Runways 4R and 9R, and aircraft departing on Runways 32L (typically from the intersection of Taxiway T10), 4L, and 9L. During periods of peak arrival demand, Runway 9L is used as the third arrival runway. Arriving aircraft assigned Runway 9L are generally spaced at an interval of 6 miles to accommodate aircraft departing on Runways 32L and 9L.

During periods of peak arrival demand a number of off-load strategies are employed to balance traffic on a given route or runway, these are shown as secondary arrival routes on Exhibit V-5. Traffic from STORY and SBN may be vectored to a left downwind to Runway 9L, if in use. Arriving traffic using the BEARZ intersection is normally assigned to Runway 4R. Traffic from BEARZ may also be vectored to a right downwind to Runway 9R or a left downwind to Runway 9L. PLANO traffic may be vectored for a right base entry to Runway 9R. KRENA and MKE traffic may be vectored to a left base entry to Runway 9L.

5.1.1.2 Departures

Aircraft depart the TRACON airspace as illustrated on Exhibit V-5. Departure runways are generally assigned to be consistent with the intended route of flight. On Plan X, aircraft departing to North American destinations and Asia via BAE or PETTY are normally assigned Runway 32L. European departures using BAE or PETTY as initial departure fixes will typically use Runway 32R. Domestic traffic departing to the east over ELX or GIJ will typically be assigned to Runway 4L. International traffic departing via eastbound fixes will use Runway 32R. Runway 9L serves traffic departing to the south over EON, GUIDO, or RBS. Westbound traffic departing via DBQ, IOW, PLL or MZV will use Runway 32L.

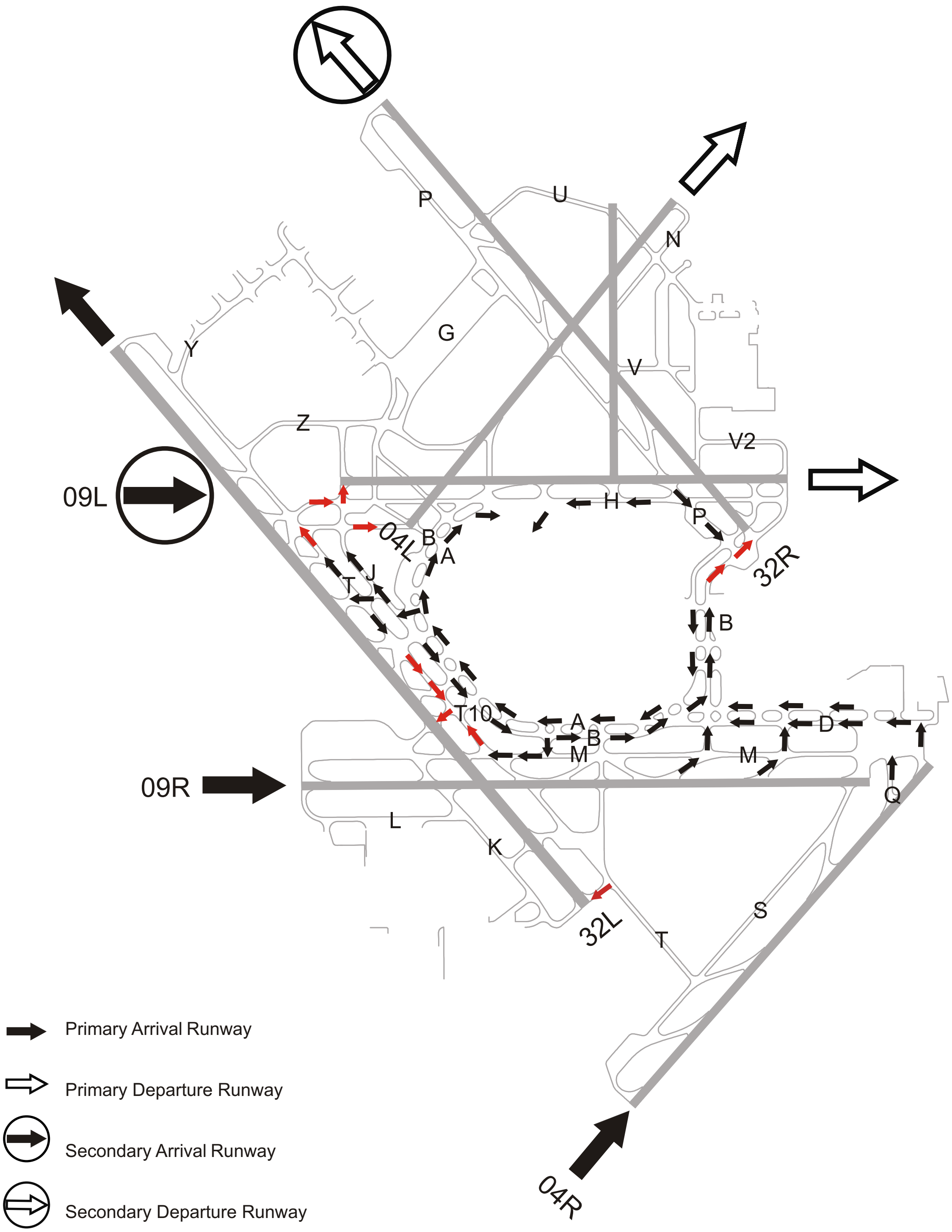
As with the arrivals, there are a number of off-load strategies that are used to balance the number of departures at the runways. These are shown as secondary departure routes on Exhibit V-5. During periods of peak eastbound traffic, aircraft routed over ELX are assigned Runway 32L rather than Runway 4L. In addition, aircraft routed over GIJ may depart from Runway 9L in lieu of Runway 4L. Conversely, during high west departure demand, north departures and possibly some low performance westbound aircraft are assigned to Runway 4L.

5.1.1.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-6**. The black arrows indicate directional flow on the associated taxiway. Red arrows denote departure queuing areas. For reference purposes, the primary and secondary arrival and departure runways are also shown.

As shown, taxiing aircraft are not separated by arrivals and departures but are separated by directional flow on parallel taxiways. Traffic on Taxiway A moves in a clockwise direction while traffic on Taxiway B moves in a counter-clockwise direction. Inbound taxi routings are also depicted on Exhibit V-6. It is important to note that some aircraft destined to Concourses E (east side), F, G, H or K may be assigned Taxiways H and B should there be opposite direction traffic on the Taxiway B Bridge (Bravo Bridge). This allows traffic to expeditiously clear Runway 9L after landing. In addition, most aircraft departing on Runway 32L will depart from the Taxiway T10 intersection.

Aircraft taxiing speeds were based on data previously used in simulation analyses in support of the WGP and confirmed with field observations taken by the TAAM simulation team**.**



Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-6

Taxiway Routes
Existing Airfield - Plan X

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January 2003
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5.1.2 Plan W

Plan W is another higher capacity operating configuration at the Airport, during VMC. **Exhibit V-7** illustrates the primary arrival and departure flight paths associated with this operating configuration. This configuration will generally be used during VMC with winds ranging from the southwest (230°) to northwest (310°). No tail wind component can exist for Runway 22R operations, as land and hold short operation (LAHSO) procedures are used. Analysis indicates that wind and weather conditions are conducive for a 30.8% annual use of this operating configuration. Historic data collected from the ANMS supports this finding with data collected from January 2000 through September 2001 demonstrating its use for approximately 33% of annual operations.

5.1.2.1 Arrivals

Aircraft entering the TRACON airspace from STORY and KRENA intersections and in the tower en-route structure from MKE will normally be assigned Runway 22R. Aircraft arriving through the BEARZ and PLANO arrival gates and in the tower en-route structure from SBN will normally be assigned Runway 27L.

The primary operating configuration of Plan W consists of arrivals on Runways 22R and 27L and simultaneous departures on Runways 32L (from the intersection of Taxiway T10) and 22L. During periods of peak arrival demand, Runway 27R is used as a third arrival runway. LAHSO procedures are required for this operation, as Runways 22R and 27R intersect, with 6,050 feet of runway available on Runway 22R prior to the intersection of Runway 27R. Aircraft types such as the B737 or smaller are capable of conducting this operation. However, some aircraft operators require a minimum of 8,000 feet for the use LAHSO procedures. This precludes many pilots from using Runway 22R, and requires the TRACON to segregate traffic not only by aircraft type but also by company.

Off-load strategies are used during periods of peak arrival demand.. Traffic from STORY may be vectored to a right base leg entry to Runways 27R or 27L. Aircraft from KRENA may be vectored to a right downwind to Runways 27R or 27L. PLANO traffic may be vectored to a right downwind to Runways 27R or 22R.

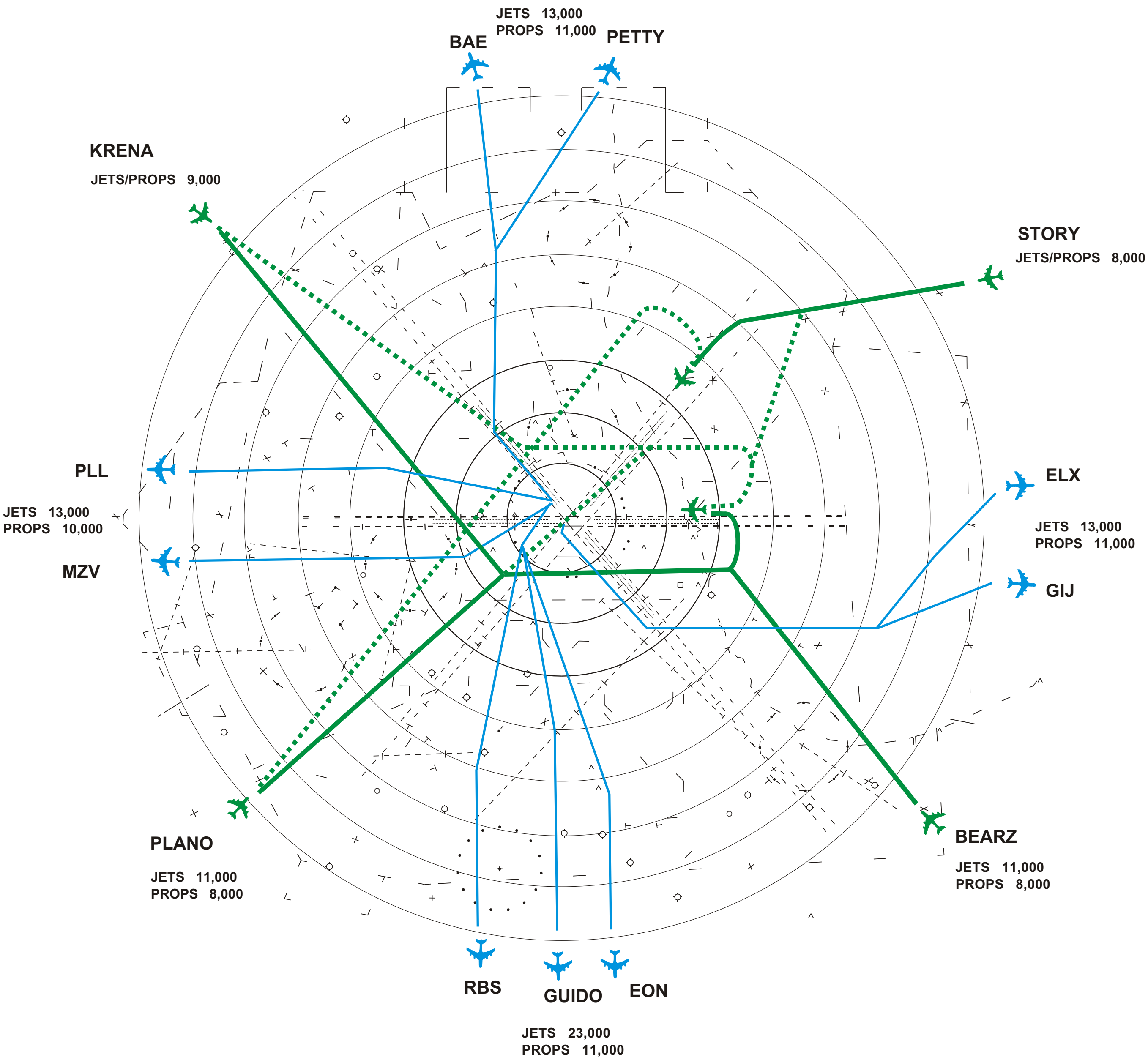
5.1.2.2 Departures

Aircraft depart the TRACON airspace as indicated on Exhibit V-7. In this configuration, eastbound (ELX or GIJ) and southbound (EON, RBS, or GUIDO) departures are generally assigned Runway 22L. Northbound (BAE or PETTY) and westbound (DBQ, IOW, or MZV) departures will be assigned Runway 32L. Runway 32R is also used during some periods to accommodate international departures routed over west and north departure fixes.

Departure runway balancing strategies are associated with this operating configuration. During periods of heavy eastbound traffic, aircraft routed over southern fixes are assigned to Runway 32L rather than Runway 22L, and during high west departure rush aircraft departing via MZV or IOW are assigned Runway 22L.

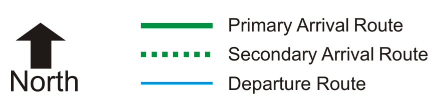
5.1.2.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-8**. The black arrows indicate directional flow on the associated taxiway. Red arrows depict departure



Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-7



Airspace Routes
Existing Airfield - Plan W

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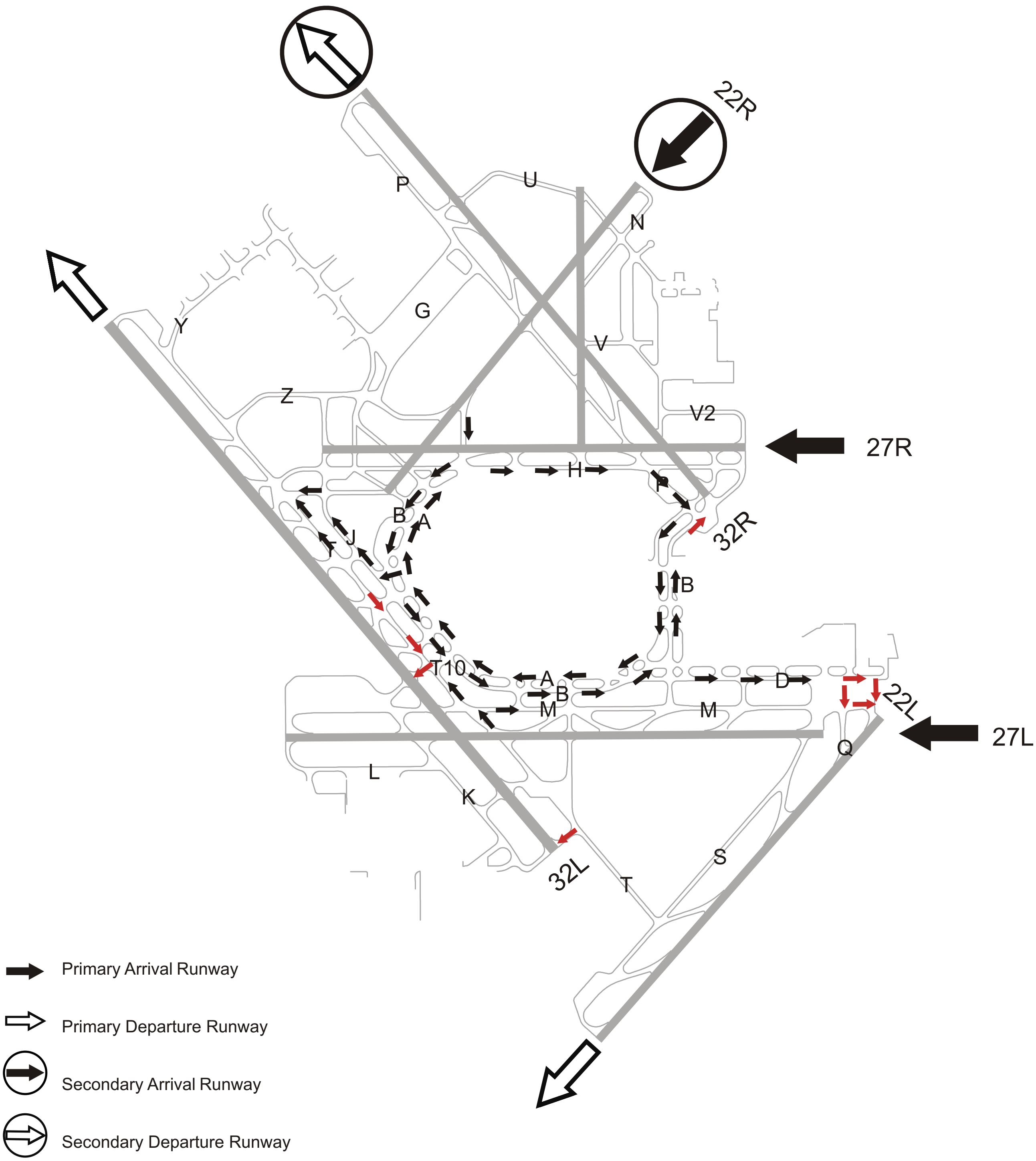

Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-8

north

Arrivals and Departures
Departure Queue

Taxiway Routes
Existing Airfield - Plan W

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queuing areas. Traffic on Taxiway A moves in a clockwise direction while traffic on Taxiway B moves in a counter-clockwise direction. Most aircraft departing from Runway 32L will queue on Taxiway T north of Taxiway T10 and depart from the Taxiway T10 intersection. Aircraft landing on Runway 22R are required to land and hold short of Runway 27R.

5.1.3 Plan B

Plan B at one time was the most frequently used operating configuration at the Airport. Because LAHSO procedures between aircraft arriving Runway 14R and departing Runway 27L can not be used due to a change in LAHSO requirements, this configuration is no longer preferred. Plan B will generally be used during VMC with winds ranging from the southeast (130^o) to south (180^o), and from southeast to southwest (220^o) under wet conditions that would preclude the use of Plan W. Analysis indicates that wind and weather conditions are consistent with a 4.4% annual use of this operating configuration. Historic data collected from the ANMS differ greatly from this finding. Data collected from January 2000 through September 2001 demonstrates an annual use of about 16%. However, when considering the cumulative results for Plan B and Plan B Modified, which has been recently implemented (17.1% annual use**)** the finding becomes more consistent.

The primary operating configuration of Plan B consists of aircraft arriving on Runways 14R and 22R, and aircraft departing on Runways 27L, 22L, and 14L. Runway 14R arrivals are routinely spaced at intervals of 3.5 to four miles to provide sufficient spacing to permit aircraft to depart Runway 27L.

Exhibit V-9 illustrates the primary arrival and departure flight paths associated with this configuration.

5.1.3.1 Arrivals

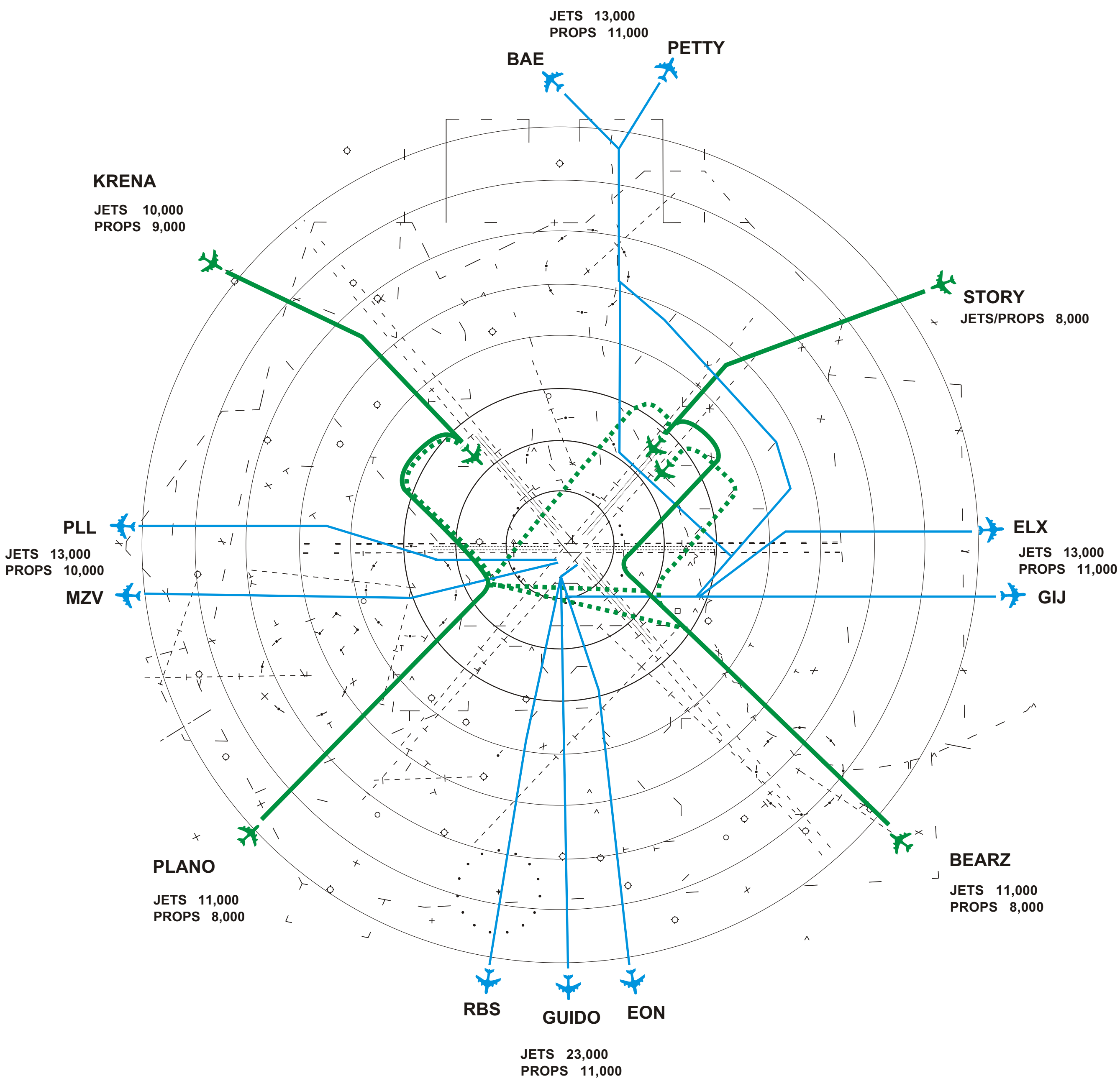
Aircraft entering the TRACON airspace from the STORY intersection, through the BEARZ arrival gate and in the tower en-route structure from SBN, will normally be assigned Runway 22R. Aircraft arriving through the PLANO arrival gate, from the KRENA intersection and in the tower en-route structure from MKE, will normally be assigned Runway 14R.

During periods of peak arrival demand, Runway 22L is used as the third arrival runway, which has a significant impact on the departure capacity of the Airport. With Runway 22L used for arrivals, Runway 14L cannot be used for departures. Further exacerbating the situation is the loss of Runway 22L as the only independent departure runway.. To address this constraint, the use of Runway 22L for both arrivals and departures is held to a minimum and, when used, aircraft are spaced at five-mile intervals to provide sufficient separation to permit departure operations on the same runway.

Off-load strategies are used during periods of peak arrival demand. . Traffic from BEARZ may be vectored to a right downwind leg to Runway 14R or a left downwind to Runway 22L. Aircraft arriving from PLANO may be vectored to a right downwind to Runway 22R or a left downwind to Runway 22L.

5.1.3.2 Departures

Aircraft depart the TRACON airspace as indicated on Exhibit V-9. On this configuration, eastbound (ELX or GIJ) and southbound (EON, RBS, or GUIDO) aircraft are generally assigned Runway 22L.



Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-9

Airspace Routes
Existing Airfield - Plan B

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Northbound (BAE or PETTY) traffic will be assigned Runway 14L, and westbound (DBQ, IOW, or MZV) aircraft will depart on Runway 27L. Runway 14L is also used during some periods to accommodate international departures routed over east and north departure fixes. Runway 14R is typically used for aircraft bound for Pacific Rim destinations.

Departure runway balancing strategies are associated with this operating configuration. During periods of peak eastbound traffic, aircraft routed over southern fixes will be assigned Runway 27L rather than Runway 22L;, conversely, during a west departure rush, MZV traffic can be assigned Runway 22L and ELX traffic can be accommodated by Runway 14L.

5.1.3.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-10**. The black arrows denote directional flow on the associated taxiway. Red arrows indicate departure queuing areas.

5.1.4 Plan B Modified

Plan B Modified is becoming the third most frequently used operating configuration at the Airport on an annual basis. It will generally be used during VMC conditions with winds ranging from the southeast (130^{o}) to south (180^{o}). No tail wind component can exist for Runway 14R, as LAHSO procedures are used. Analysis indicates that wind and weather conditions are favorable for a 12.7% annual use of this operating configuration**.** No historic data was collected for this configuration, as it has only recently been developed.

The base configuration of Plan B Modified consists of aircraft arriving on Runways 9R and 14R, employing LAHSO procedures to hold aircraft landing on Runway 14R short of Runway 9R. There is 9,800 feet of runway on Runway 14R prior to the intersection of Runway 9R. This distance is adequate for use by all but a few aircraft types, general aviation, and foreign flag carriers. The primary departure runways include Runways 22L and 14L. During periods of peak arrival demand, Runway 22R can be used as the third arrival runway.

Exhibit V-11 illustrates the primary arrival and departure flight paths associated with this configuration.

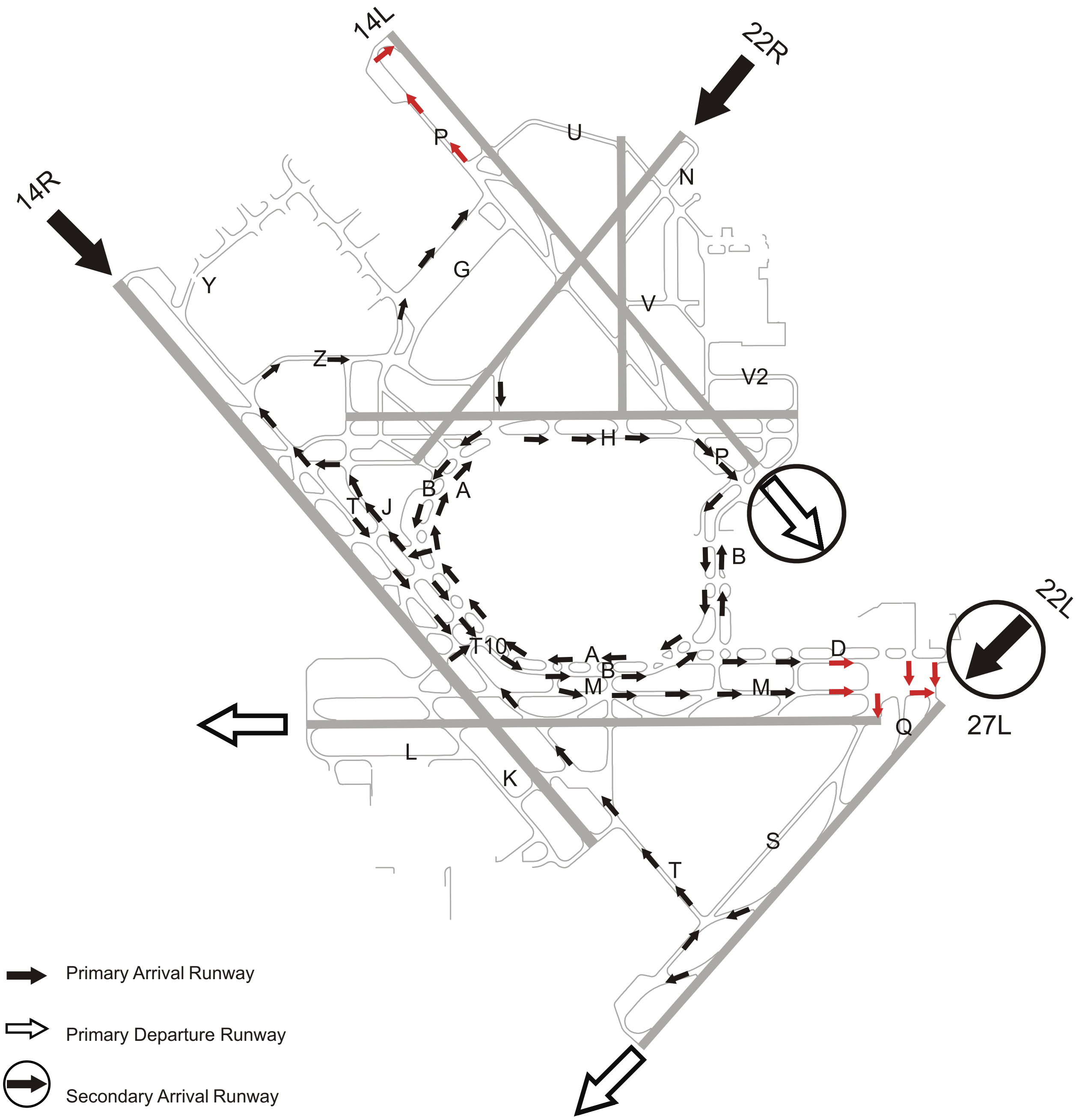
5.1.4.1 Arrivals

Aircraft entering the TRACON airspace from over the STORY and KRENA intersections, and in the tower en-route structure from MKE and SBN, will normally be assigned Runway 14R. Aircraft arriving through the PLANO and BEARZ arrival gates will normally be assigned Runway 9R. Aircraft not capable of conducting a LAHSO operation will be assigned Runway 9R or Runway 22R, if in use.

Off-load strategies are used during periods of peak arrival demand.. Traffic from BEARZ may be vectored to a right downwind leg to Runway 14R or a left downwind to Runway 22R. Aircraft arriving from over the STORY intersection and tower en-route from SBN airspace may be vectored straight in to Runway 22R.

5.1.4.2 Departures

Aircraft depart the TRACON airspace as indicated on Exhibit V-11. On this operating configuration, north (BAE or PETTY) and eastbound (ELX or GIJ) aircraft are generally assigned Runway 14L.



Primary Arrival Runway

Primary Departure Runway

Secondary Arrival Runway

Secondary Departure Runway

Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-10

north

Arrivals and Departures

Departure Queue

Taxiway Routes
Existing Airfield - Plan B

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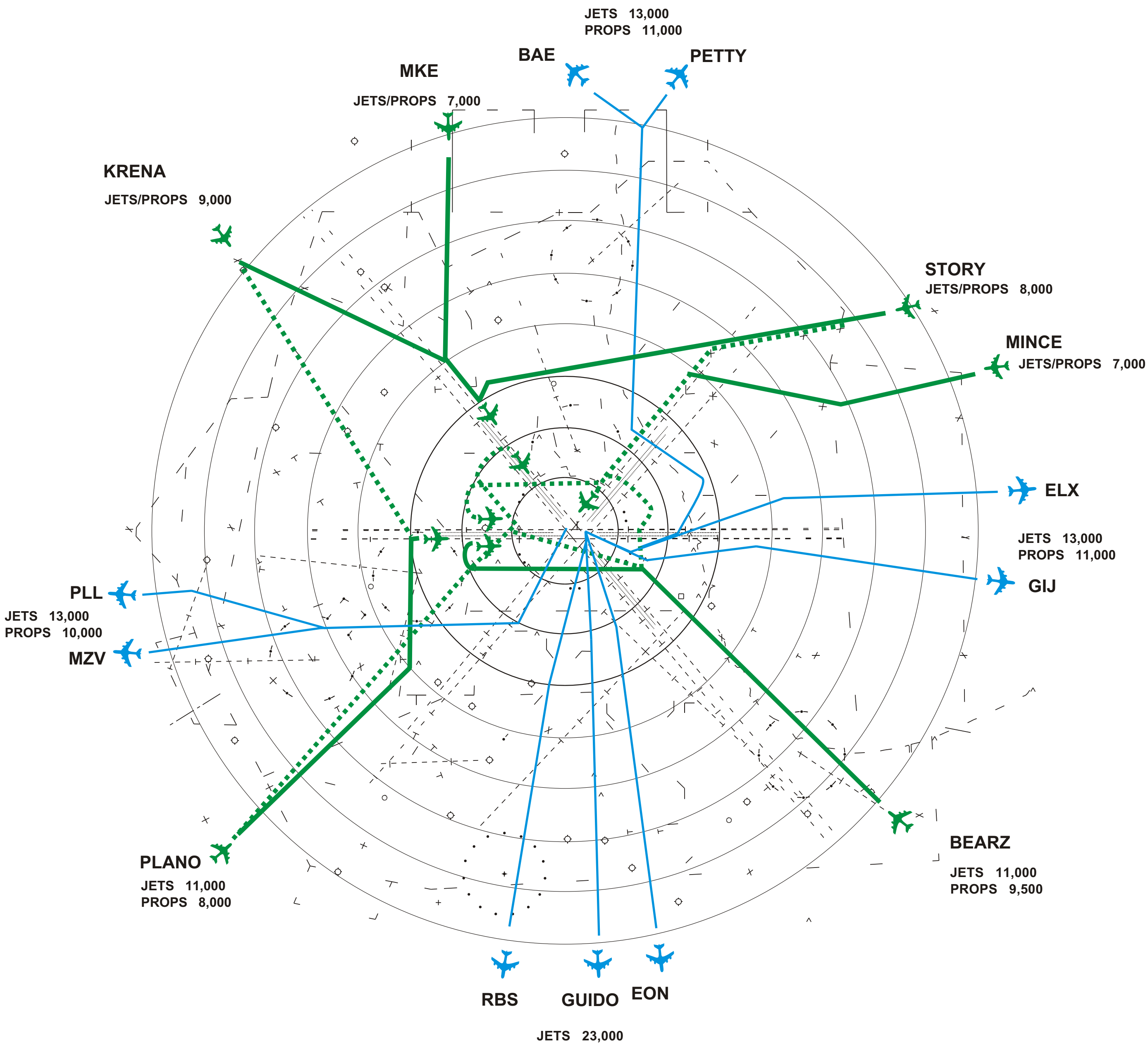

Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-11

Airspace Routes
Existing Airfield - Plan B Modified

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Southbound (EON, RBS, or GUIDO) and westbound (DBQ, IOW, or MZV) aircraft will depart on Runway 22L. Runway 14R is generally used by aircraft bound for Pacific Rim destinations.

The following departure runway balancing strategies are associated with this operating configuration. During periods of peak eastbound traffic, aircraft routed over GIJ may be assigned Runway 22L rather than Runway 14L. During a west departure rush all or some of the southbound traffic can be assigned to Runway 14L.

5.1.4.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-12**. The black arrows indicate directional flow on the associated taxiway. Red arrows denote departure queuing areas.

5.1.5 Parallel 27s

Parallel 27s is the preferred operating configuration at the Airport during IMC. It is used in IMC conditions with a runway visual range (RVR) of 1,800 feet or better. Analysis indicates that wind and weather conditions are consistent with the annual use of this operating configuration 4.1% of the time**.** Historic data collected from the ANMS supports this finding. Data collected from January 2000 through December 2000 demonstrate a 5% annual use. For the purposes of the simulation analysis, the Parallel 27 configuration was used as the representative configuration for all Category I IMC (CAT I) conditions. Therefore an annual percentage use of 4.1% was used to represent the percentage of time for CAT I configurations.

The base operating configuration of Parallel 27s consists of aircraft arriving on Runways 27R and 27L, and aircraft departing Runways 32L, 32R and 22L. There is no third arrival runway alternative.

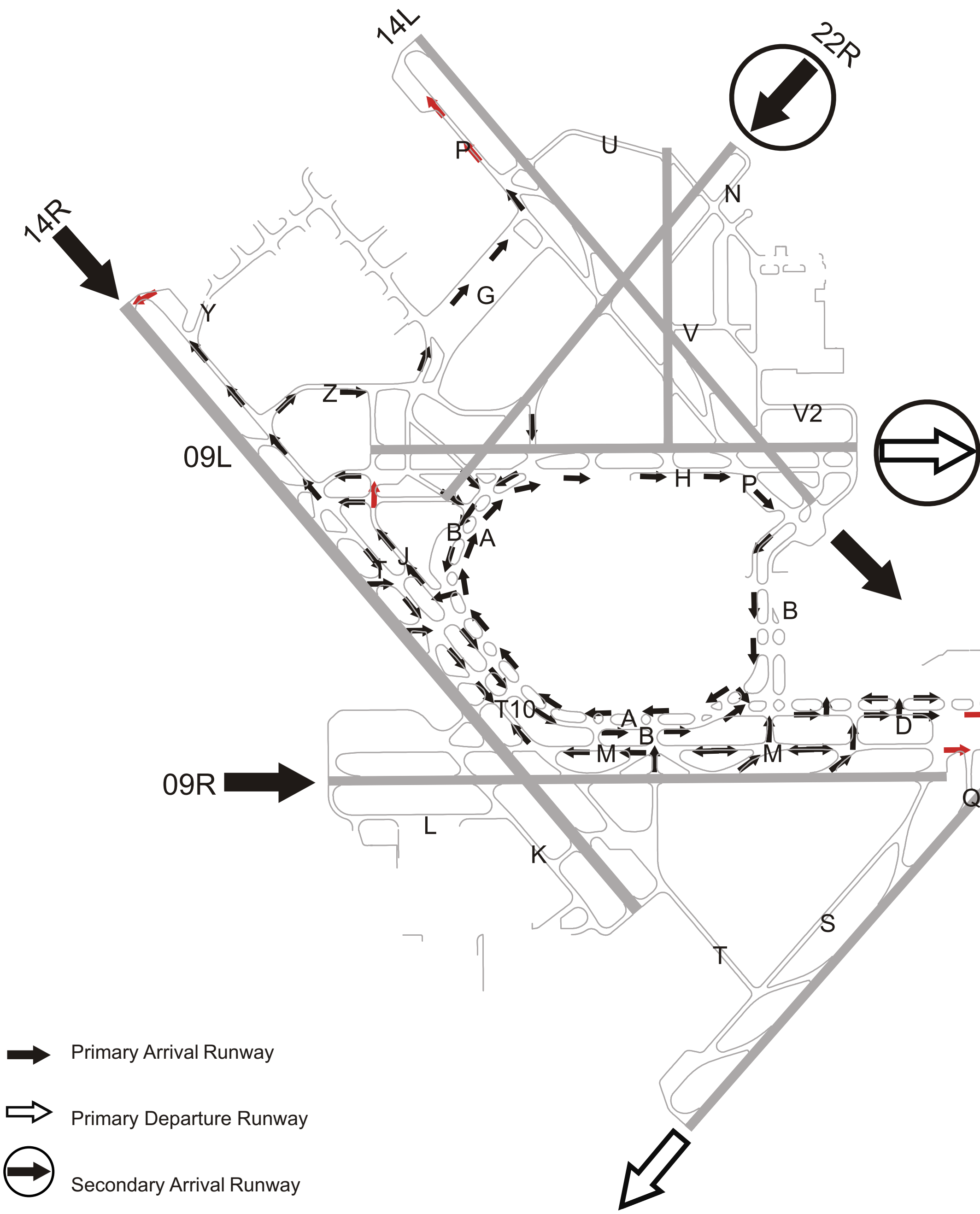
Exhibit V-13 illustrates the primary arrival and departure flight paths associated with this configuration.

5.1.5.1 Arrivals

Aircraft entering the TRACON airspace from over STORY and KRENA intersections, and in the tower en-route structure from MKE, will normally be assigned Runway 27R. Aircraft arriving through the PLANO and BEARZ arrival gates, and in the tower en-route structure from SBN, will normally be assigned Runway 27L.

During periods of peak arrival demand, two off-load strategies are employed to balance traffic on a given route or runway. Traffic from KRENA is vectored to a left downwind leg for Runway 27L, and, at other times, traffic from PLANO is vectored to a right downwind to Runway 27R. There are generally no off-load strategies associated with the STORY or BEARZ arrival routes.

Regardless of runway use, under Parallel 27s operations, aircraft will maintain an altitude of 7,000 feet MSL or above until entering the appropriate descent area. Once in the descent area aircraft routed to Runway 27R will descend to 4,000 feet MSL, while aircraft vectored to Runway 27L will descend to 5,000 feet MSL. Aircraft will maintain these altitudes until established on the final course at least 16 miles from the Airport. These procedures allow for simultaneous approaches to Runways 27L and 27R.



Primary Arrival Runway

Primary Departure Runway

Secondary Arrival Runway

Secondary Departure Runway

Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-12

north

Arrivals and Departures

Departure Queue

Taxiway Routes
Existing Airfield - Plan B Modified

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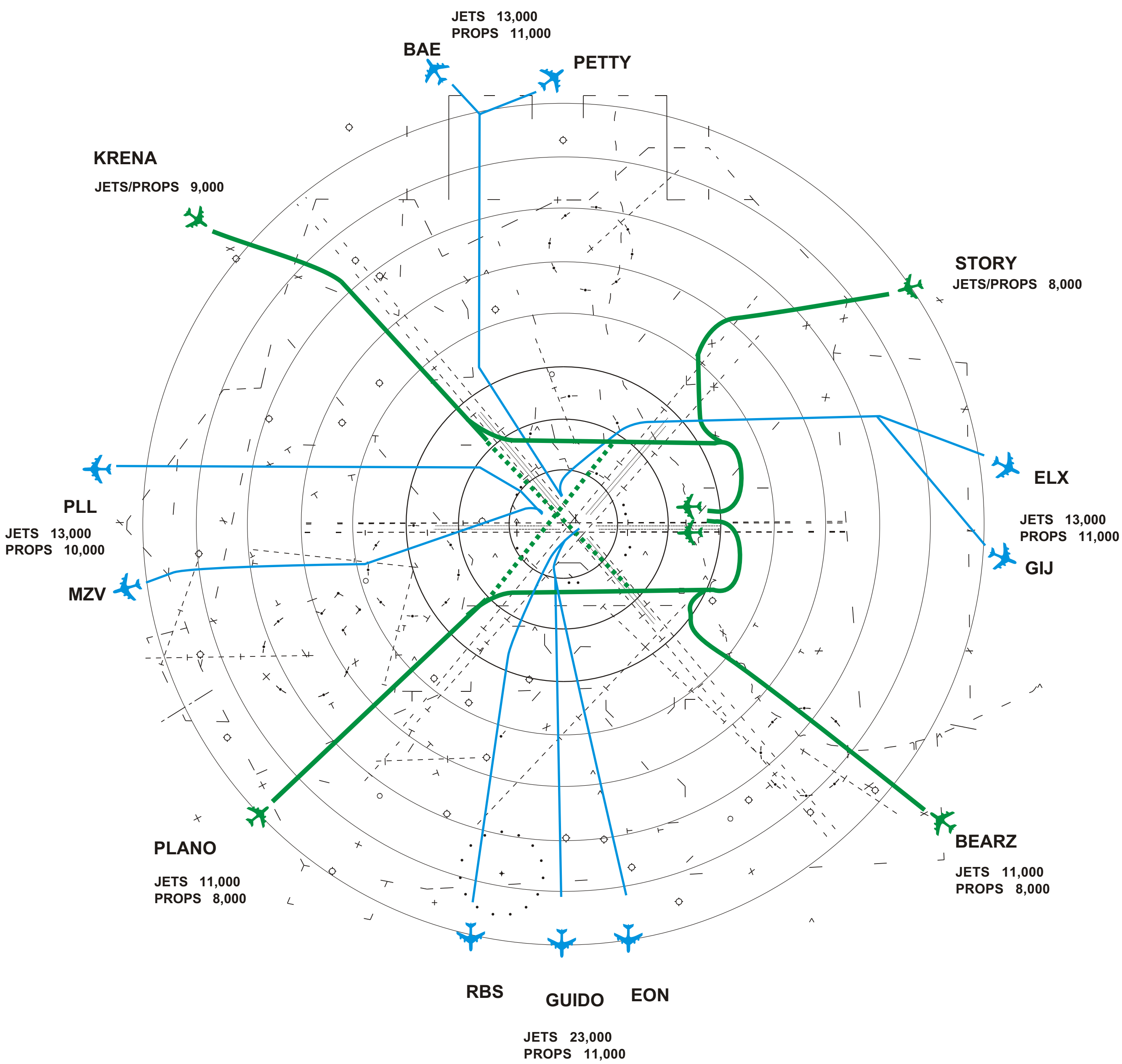

Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-13

North

Primary Arrival Route
Secondary Arrival Route
Departure Route

Airspace Routes
Existing Airfield - Parallel 27s

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5.1.5.2 Departures

Aircraft depart the TRACON airspace as indicated on Exhibit V-13. Departing aircraft are generally assigned runways that are consistent with the intended route of flight. For this configuration, northbound (BAE or PETTY) and westbound (DBQ, IOW, or MZV) aircraft are generally assigned Runway 32L. Southbound (EON, RBS, or GUIDO) departures are assigned Runway 22L while eastbound (ELX or GIJ) departures are assigned Runway 32R. The full length of Runway 32L is available for aircraft that require additional runway length. Generally, the full length of Runway 32L will be used by aircraft bound for Pacific Rim destinations.

As with the arrivals, there are a number of off-load strategies used to balance the number of departures at the runways. During periods of heavy eastbound departure traffic, aircraft routed over GUIDO or RBS may be assigned Runway 32L, rather than Runway 22L. During a west departure rush, departures via BAE or PETTY may be assigned Runway 32R, and/or MZV departures may be assigned Runway 22L.

5.1.5.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-14**. The black arrows depict directional flow on the associated taxiway. Red arrows indicate departure queuing areas. Traffic on Taxiway A moves in a clockwise direction while traffic on Taxiway B moves in a counter-clockwise direction. Aircraft departing on Runway 22L will generally use Taxiway D. Runway 32L departures generally depart from the intersection of Taxiway T10.

5.1.6 Parallel 14s

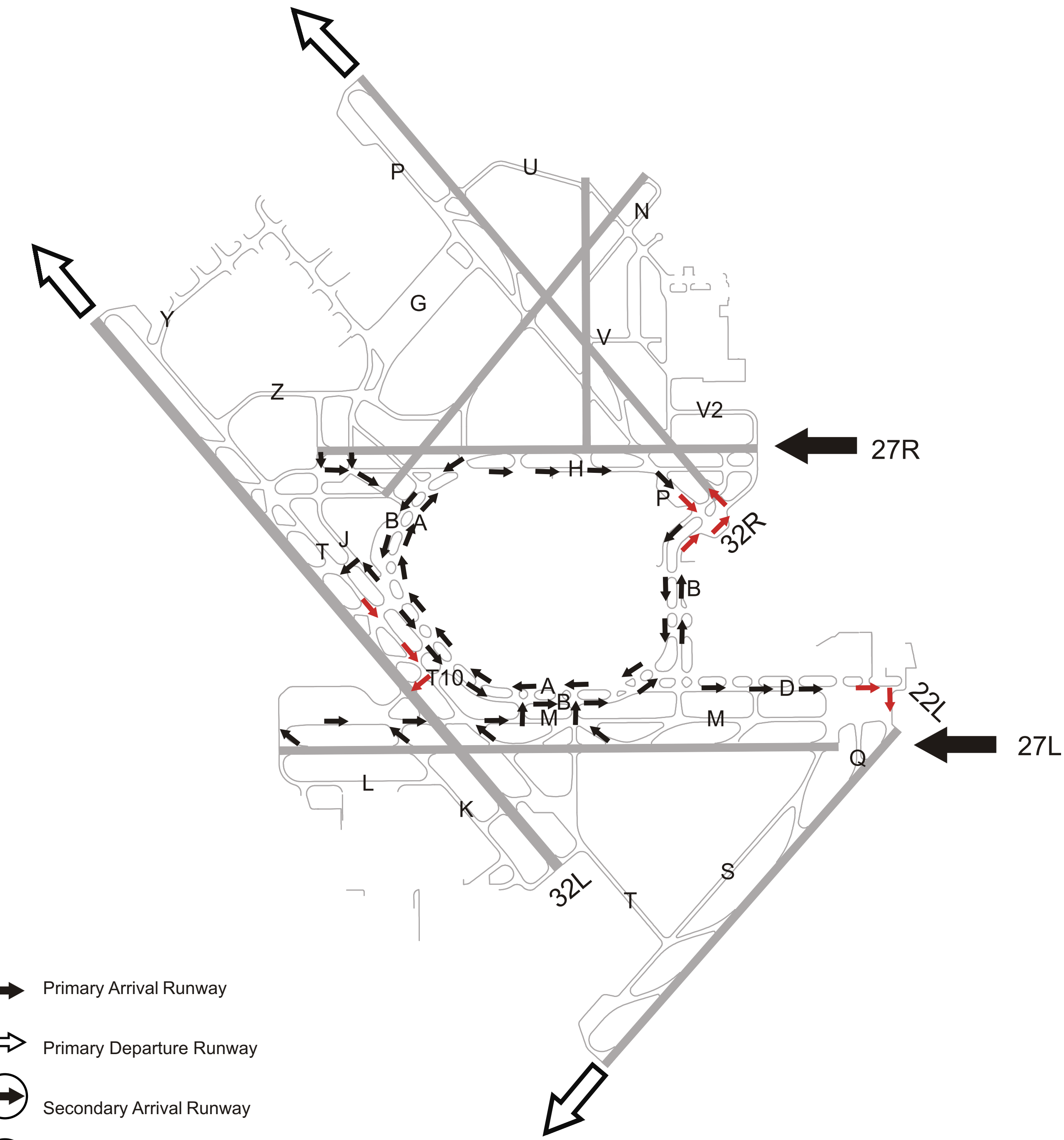
Parallel 14s is the only existing CAT II/III IMC operating configuration at the Airport. For crews that are trained and flying appropriately equipped aircraft, approaches may be conducted to CAT II/III weather minima (RVR 600 feet). Analysis indicates that wind and CAT II/III conditions are consistent with 5.2% annual use of this operating configuration. Historic data collected from the ANMS generally supports this finding. Data collected from January 2000 through December 2000 demonstrates an annualized use of 4.6%. For the purposes of the simulation analysis, the Parallel 14 configuration was used as the representative configuration for all CAT II/III conditions. Therefore a use of 5.2% was used to represent the annual percentage of time for CAT II/III configurations.

The base operating configuration of Parallel 14s consists of aircraft arriving on Runways 14R and 14L, while aircraft depart on Runways 27L, 9L and 22L. There is no third arrival runway alternative.

Exhibit V-15 illustrates the primary arrival and departure flight paths associated with this configuration.

5.1.6.1 Arrivals

Aircraft entering the TRACON airspace from over STORY, through the BEARZ arrival gate, and in the tower en-route structure from MKE and SBN will normally be assigned Runway 14L. Aircraft arriving through the PLANO arrival gate and over the KRENA intersection will normally be assigned Runway 14R. Arrivals to both runways are routinely spaced four miles apart at touchdown to provide sufficient separation to permit aircraft to depart on Runways 9L and 27L



Primary Arrival Runway

Primary Departure Runway

Secondary Arrival Runway

Secondary Departure Runway

Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-14

north

Arrivals and Departures

Departure Queue

Taxiway Routes
Existing Airfield - Parallel 27s

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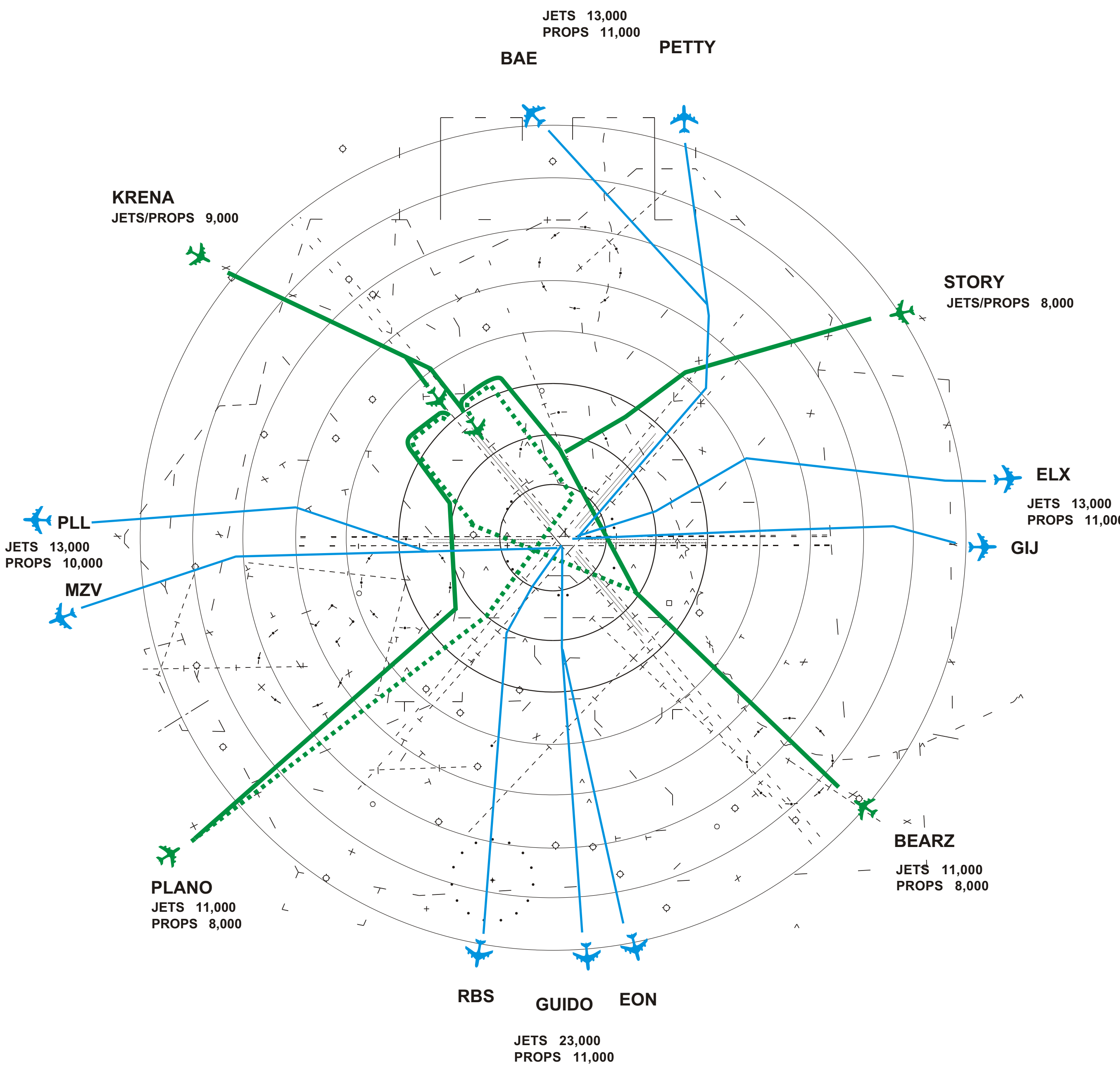

Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-15

North

- Primary Arrival Route
- Secondary Arrival Route
- Departure Route

Airspace Routes
Existing Airfield - Parallel 14s

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During periods of heavy arrival demand two off-load strategies are employed to balance traffic on a given route or runway. Traffic from PLANO may be vectored to a left downwind leg for Runway 14L. At other times, traffic from BEARZ may be vectored to a right downwind to Runway 14R. There are generally no off-load strategies associated with the STORY or KRENA arrival routes.

Arriving aircraft will maintain an altitude of 7,000 feet MSL or above until entering the appropriate descent area. Once in the descent area aircraft routed to Runway 14L will descend to 4,000 feet MSL, while aircraft vectored to Runway 14R will descend to 5,000 feet MSL. Aircraft will maintain these altitudes until established on the final course at least 16 miles from the Airport. This procedure allows for simultaneous approaches to Runways 14L and 14R.

5.1.6.2 Departures

Aircraft depart the TRACON airspace as indicated on Exhibit V-15. Departing aircraft are generally assigned runways that are consistent with the intended route of flight. For this configuration, northbound (BAE or PETTY) and eastbound (ELX or GIJ) departures are assigned Runway 9L. Westbound (DBQ, IOW, or MZV) aircraft are generally assigned Runway 27L with southbound (EON, RBS, or GUIDO) departures using Runway 22L. Runways 22L and 27L are also used to accommodate international departures routed over east and north departure fixes. Runway 14R will be used for departure by aircraft bound for Pacific Rim destinations.

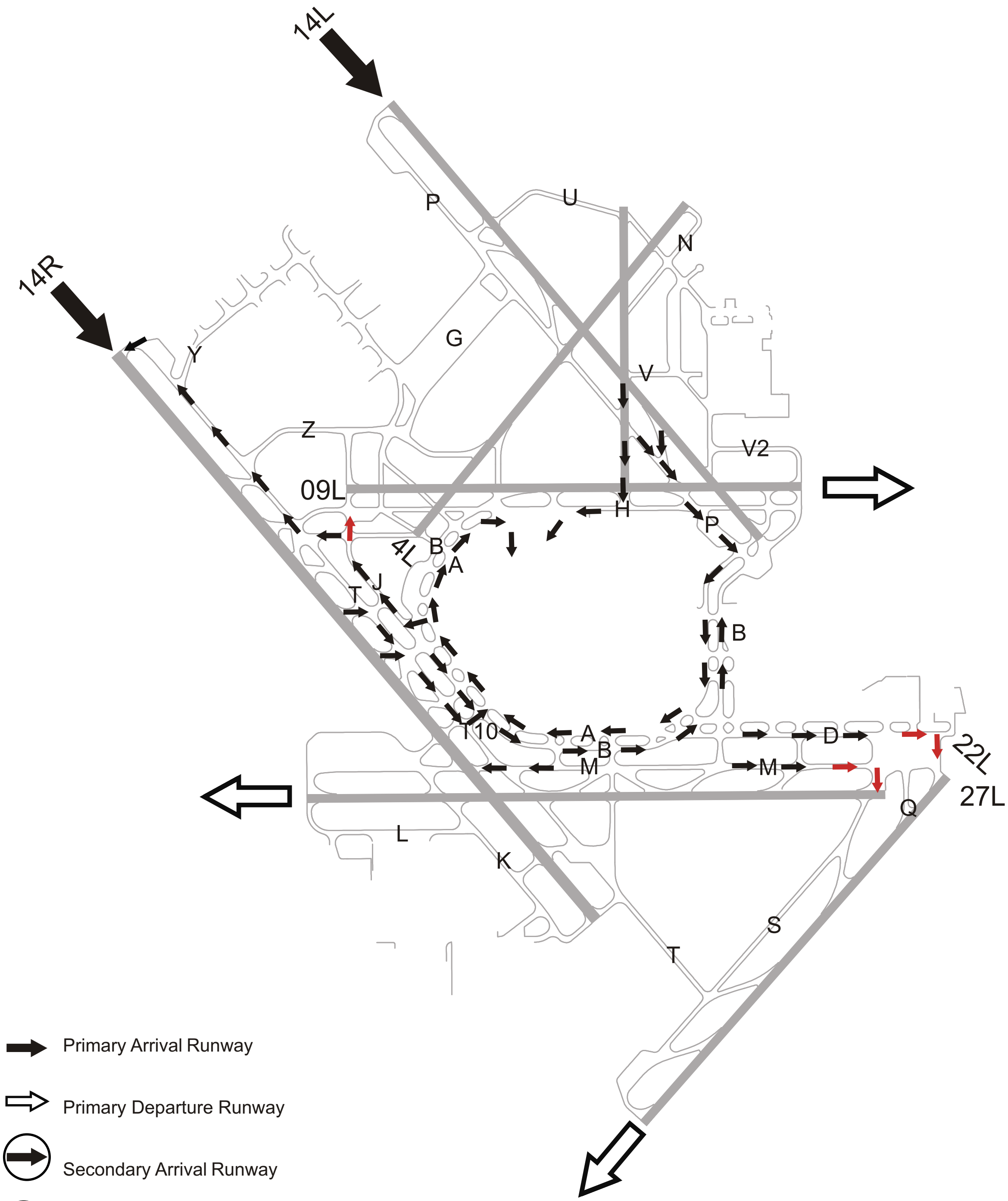
Strategies may be used to balance demand on departure runways. During periods of peak eastbound traffic, aircraft routed over GIJ may be assigned Runway 22L with aircraft departing via GUIDO or RBS departing Runway 27L. During a west departure rush, EON departures may be assigned Runway 9L with MZV departures moved from Runway 27L to Runway 22L.

5.1.6.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-16**. The black arrows denote directional flow on the associated taxiway. Red arrows indicate departure queuing areas.

5.2 Future Airspace Assumptions

The TRACON airspace used in the simulation analyses of each build option is depicted on **Exhibit V-17**. The Chicago TRACON would continue to provide ATC services for aircraft arriving and departing the Airport. The basic lateral boundary of the TRACON airspace would be expanded in the northeast and northwest quadrants, as arrival fixes are moved away from the Airport. This would provide for additional departure fixes to the west and east. The lateral limits for existing airspace shelves, Area B and Area D, shown on Exhibit V-17, would remain as defined in existing airspace. With the provision of three or four parallel approaches in an east-west orientation with the build options, two additional airspace shelves would be created to facilitate the vectoring of arrival aircraft to the center runways for landing. The east arrival shelf would be used when aircraft are landing to the west from the southeast. Aircraft would operate in this area between 13,000 feet MSL and 11,000 feet MSL. Similarly the west arrival shelf would be used when aircraft are landing to the east from the southwest. Aircraft would operate between 13,000 feet MSL and 11,000 feet MSL. The west arrivals would encompass the lateral limits of Area A superceding that particular airspace structure.



Primary Arrival Runway

Primary Departure Runway

Secondary Arrival Runway

Secondary Departure Runway

Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-16

north

Arrivals and Departures

Departure Queue

Taxiway Routes
Existing Airfield - Parallel 14s

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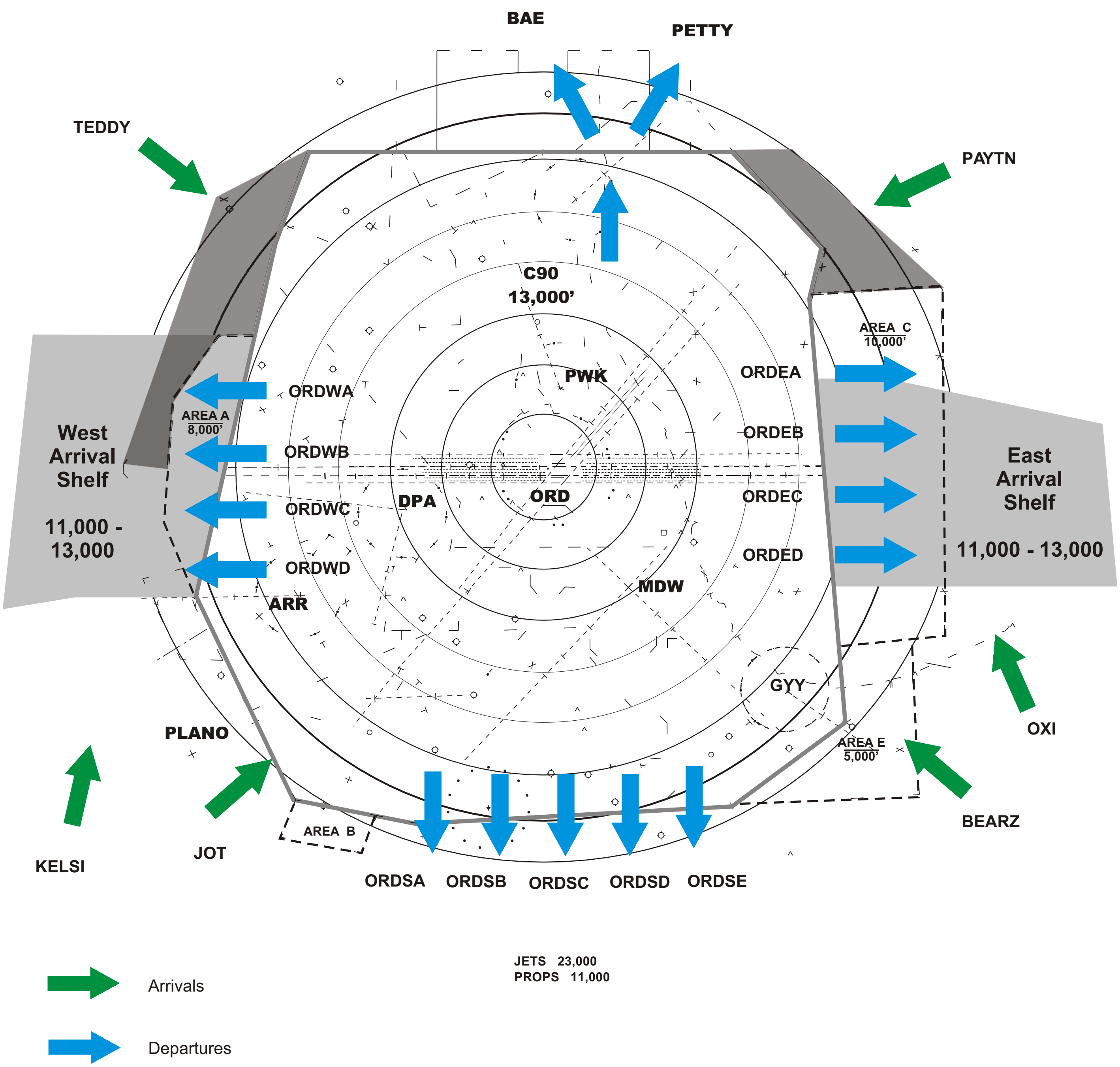

Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-17

north

Shift in Arrivals — Airspace Boundary

Shift in Departures — Airspace Shelves

Potential Future Airspace

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The future operating environment would still be based on a four corner-post structure. Aircraft would still transition from the en-route environment five miles in-trail at speeds of about 250 knots. Higher performance turbojet aircraft would be separated from lower performance propeller driven aircraft by altitude when operationally advantageous.

In the northeast quadrant, aircraft would arrive over the PAYTN intersection. This fix is located approximately 7.5 miles north-northwest from the existing STORY intersection. This fix would serve traffic arriving from cities in the northeastern United States, eastern Canada, and Europe. Turbojet aircraft descending into the Airport would generally cross the PAYTN intersection at 10,000 feet MSL while propeller driven aircraft would cross at 8,000 feet MSL. When aircraft are landing to the west, all aircraft regardless of type would arrive over the PAYTN intersection descending to 8,000 feet MSL.

The southeast arrival gate would remain through the BEARZ gate. The lateral limits of the BEARZ gate would be bounded by 130-degree and 140-degree radials clockwise from the ORD VOR. The BEARZ arrival gate serves as an entryway for aircraft originating from the mid-Atlantic and southeastern United States, the Caribbean, and eastern South America. Turbojet aircraft would be routed through the BEARZ arrival gate at 11,000 feet MSL, with propeller driven aircraft crossing the BEARZ intersection at or below 10,000 feet MSL with a clearance to descend to 8,000 feet MSL.

When aircraft are landing to the west, the BEARZ gate would be used as an off-load route supporting the primary flow over the OXI VORTAC. Traffic off-loaded to the BEARZ gate, regardless of type, would descend to 8,000 feet.

When aircraft are landing to the west, the primary routing from the southeast would be over the OXI VORTAC. Traffic operating on the OXI high and wide route would cross the STYLE intersection (southeast shore of Lake Michigan) at 12,000 feet. This traffic would typically remain at 11,000 feet until established on the approach course approximately 40 to 50 miles east of the Airport.

Aircraft arriving from the southwest would use the PLANO gate. The PLANO gate would be an arrival corridor bounded by the 233 degree radial from the ORD VOR and the extended Runway 4R localizer. This arrival gate would serve traffic originating in cities in the southwestern United States and Mexico. When aircraft would be landing to the west, aircraft would arrive at altitudes of 11,000 feet MSL for turbojets and 8,000 feet MSL for propeller driven aircraft. However, aircraft would track more to the east side of the gate, approximately four to five miles east the existing primary flow.

The northwest arrival fix would change from the present day KRENA intersection to TEDDY intersection located seven miles to the northwest of KRENA on the same airway. Aircraft arriving from the Pacific Northwest, Alaska and Far Eastern cities would arrive via TEDDY. When aircraft would be landing to the west, turbojet aircraft would cross TEDDY at 10,000 feet MSL, and propeller driven aircraft would cross at 9,000 feet MSL. When aircraft would be landing to the east TEDDY would be used as a primary route. Traffic over TEDDY, regardless of aircraft type, would descend to 9,000 feet during this east flow environment.

When aircraft would be landing to the east, the off-load route from the northwest would be over the JVL VORTAC. Traffic operating on the JVL high and wide route would enter the West Arrival Shelf at 13,000 feet. This traffic would normally remain at 11,000 feet until established on the approach course approximately 40 to 50 miles east of the Airport.

The tower en-route structure arrivals from MKE and SBN would use existing routes consistent with the Airport's designated runway configuration.

Departure airspace structure is also depicted on Exhibit V-17. Aircraft departing eastbound would be routed via the airspace fixes ORDEA, ORDEB, ORDEC, or ORDED. New York, Boston, Toronto, and some European destinations are examples of traffic associated with departure routes that would be routed over the ORDEA or ORDEB airspace fixes. Aircraft bound for Pittsburgh, Cleveland, and Washington D.C. area airports, and New York's LaGuardia Airport are examples of city pairs traffic that would be routed over the ORDEC or ORDED airspace fixes. Turbojet aircraft would be cleared to an altitude of 13,000 feet MSL. Propeller driven aircraft would be assigned 10,000 feet MSL or their requested final altitude, if lower.

Southbound departures would utilize the airspace fixes of ORDSA, ORDSB, ORDSC, ORDSD, or ORDSE. Aircraft bound for New Orleans, Dallas and Mexico City are representative of the traffic that would be routed over either ORDSA or ORDSB as appropriate for the destination city. Aircraft bound for destinations in the southeastern portion of the United States and the Caribbean would be routed over ORDSC, ORDSD, or ORDSE. Turbojet aircraft would be instructed to climb to 23,000 feet MSL, while propeller driven aircraft would be cleared to 11,000 feet MSL.

Westbound departures would generally be routed via one of the airspace fixes designated ORDWA, ORDWB, ORDWC, or ORDWD. Aircraft en-route to destinations in the southwestern U.S. would generally use ORDWC or ORDWD, while aircraft heading to the San Francisco area or the Pacific Northwest would use ORDWA or ORDWB. Turbojet aircraft would be cleared to an altitude of 13,000 feet MSL. Propeller driven aircraft would be assigned 11,000 feet MSL or their requested altitude, if lower.

Northbound departures would be routed toward PETTY or BAE. Aircraft destined for Anchorage and the Pacific Rim would be routed over BAE, while aircraft en-route to Europe and Detroit would be routed over PETTY. Turbojet aircraft routed over either BAE or PETTY would be instructed to climb to 13,000 feet MSL, while propeller driven aircraft would generally be cleared to 11,000 feet MSL.

5.3 Option 1 Simulation

The airfield simulated in Option 1 was previously illustrated on Exhibit IV-1 in Section IV, *Alternatives Evaluated*. The Option 1 airfield would consist of new east-west Runways 9L-27R, 9R-27L, 10L-28R and 10R-28L in addition to existing Runways 4L-22R, 4R-22L, 14R-32L and 14L-32R. In this option, a passenger terminal would be constructed on the west side of the existing airfield. This concourses would serve both domestic and international carriers.

Two runway use configurations were modeled for the Option 1 layout. These included VFR East flow and IFR West flow. The following weighting of annual use of these runway use configurations was used in annualizing the simulation results:

VFR East Flow	–	90.8%
IFR West Flow	–	9.2%

5.3.1 VFR East Flow

Arriving aircraft would use either Runways 9L or 10R as primary arrival runways while Runway 9R would be used during periods of peak arrival demand. Departures would utilize Runways 4L, 9R and 10L.

Exhibit V-18 illustrates the primary arrival and departure flight paths associated with this configuration.

5.3.1.1 Arrivals

Arrivals entering the TRACON airspace from the tower en-route structure from MKE and SBN along with PAYTN traffic would be vectored for a left down wind to Runway 9L. During periods of peak arrival demand these same aircraft may be vectored for a right downwind to Runway 9R. Traffic routed over either BEARZ or PLANO would be vectored to a right downwind for Runway 10R or a right downwind to Runway 9R during peak arrival periods. Arrival traffic from the northwest would normally be routed over TEDDY for a left base leg entry to Runway 9L. During periods of peak arrival demand, traffic from the northwest would use the high and wide routing over JVL to intercept the final approach course approximately 40 miles west of the Airport.

5.3.1.2 Departures

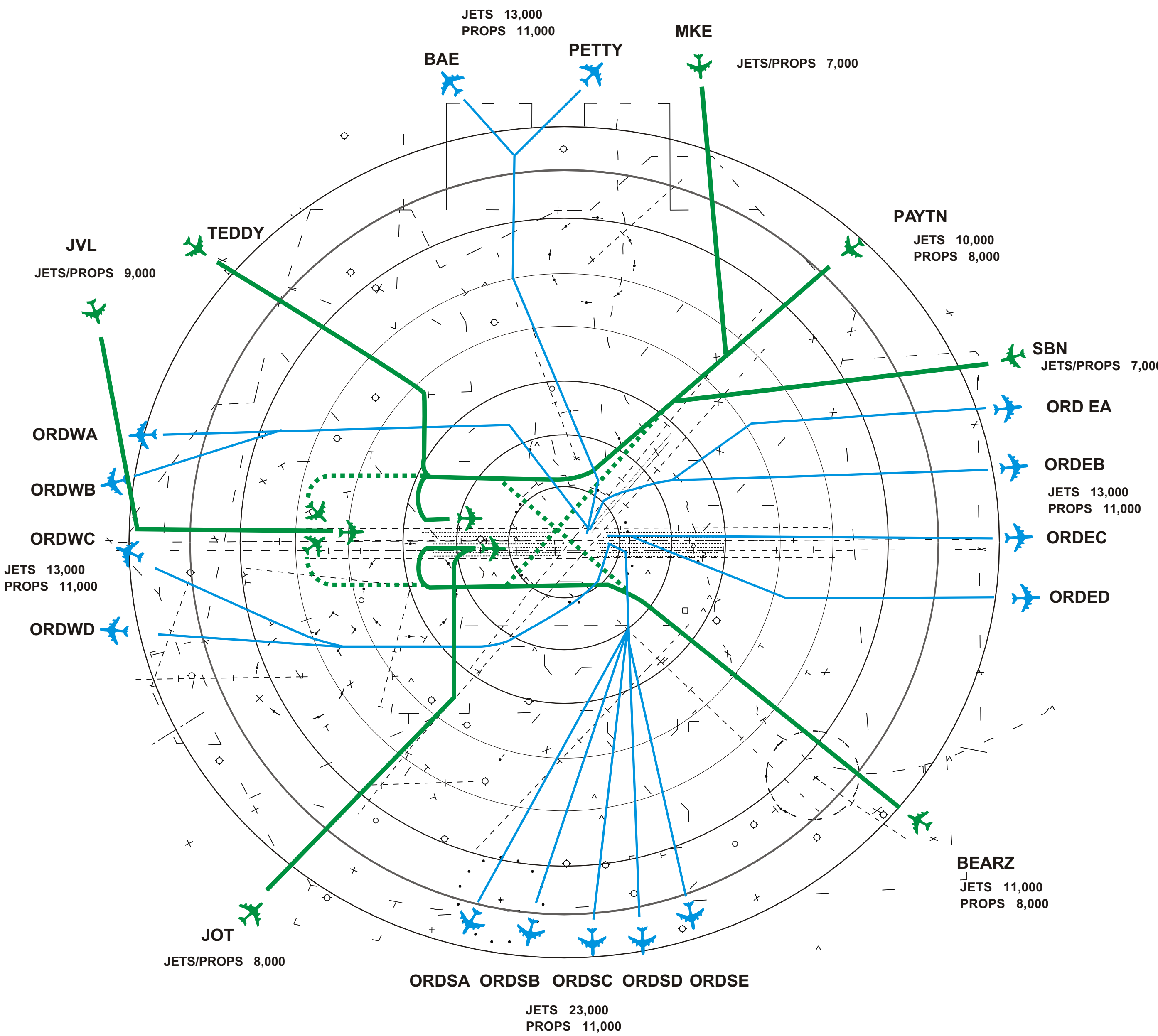
Departure airspace routings for an east runway configuration are also depicted on Exhibit V-18. Runway 9R would be assigned to most traffic departing over the fixes of ORDEA, ORDEB, ORDEC or ORDED. During some periods of peak departure demand on Runway 10L, aircraft departing over ORDSD or ORDSE would also be assigned to Runway 9R. Aircraft departing via ORDSA, ORDSB, ORDSC, ORDSD, ORDSE, ORDWC or ORDWD would be assigned Runway 10L. Most aircraft departing via fixes ORDWA, ORDWB, BAE and PETTY would be assigned Runway 4L for departure. Additionally ORDEA and ORDEB traffic would be assigned to Runway 4L during periods of heavy departure and/or arrival demand.

It is important to note that Runway 10L is the longest runway in Option 1 and would serve aircraft whose performance would be adversely affected by the shorter runway lengths of Runways 4L and 9R. Long haul domestic flights filed over fixes ORDWA or ORDWB would be assigned to Runway 10L when performance requirements would dictate, as would international departures over BAE (Asian), PETTY, ORDEA or ORDEB (European).

5.3.1.3 Airfield Circulation

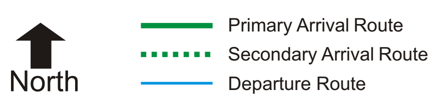
The primary ground movements associated with this configuration are illustrated on **Exhibit V-19**. The black arrows denote directional flow on the associated taxiway. Red arrows indicate departure queuing areas. Aircraft landing on Runway 9L would exit the runway and taxi westbound on the Runway 9L-27R parallel taxiway to the west side of the airfield. Aircraft parking in the new west terminal complex would enter the terminal apron from the north while aircraft parking in the existing east terminal complex (Terminals 1 through 6) would continue to taxi southwest between the existing terminal and new terminal. These aircraft would then join Taxiways A or B at Taxiway T10 as appropriate and proceed to the assigned gate.

Aircraft arriving on Runway 10R would exit the runway and proceed westbound on the Runway 10R-28L parallel taxiway to the end of the taxiway. Aircraft would then cross behind departures using Runway 10L. This traffic would then either proceed to the new west terminal complex or continue



Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-18



Airspace Routes
Option 1 - VFR East Flow

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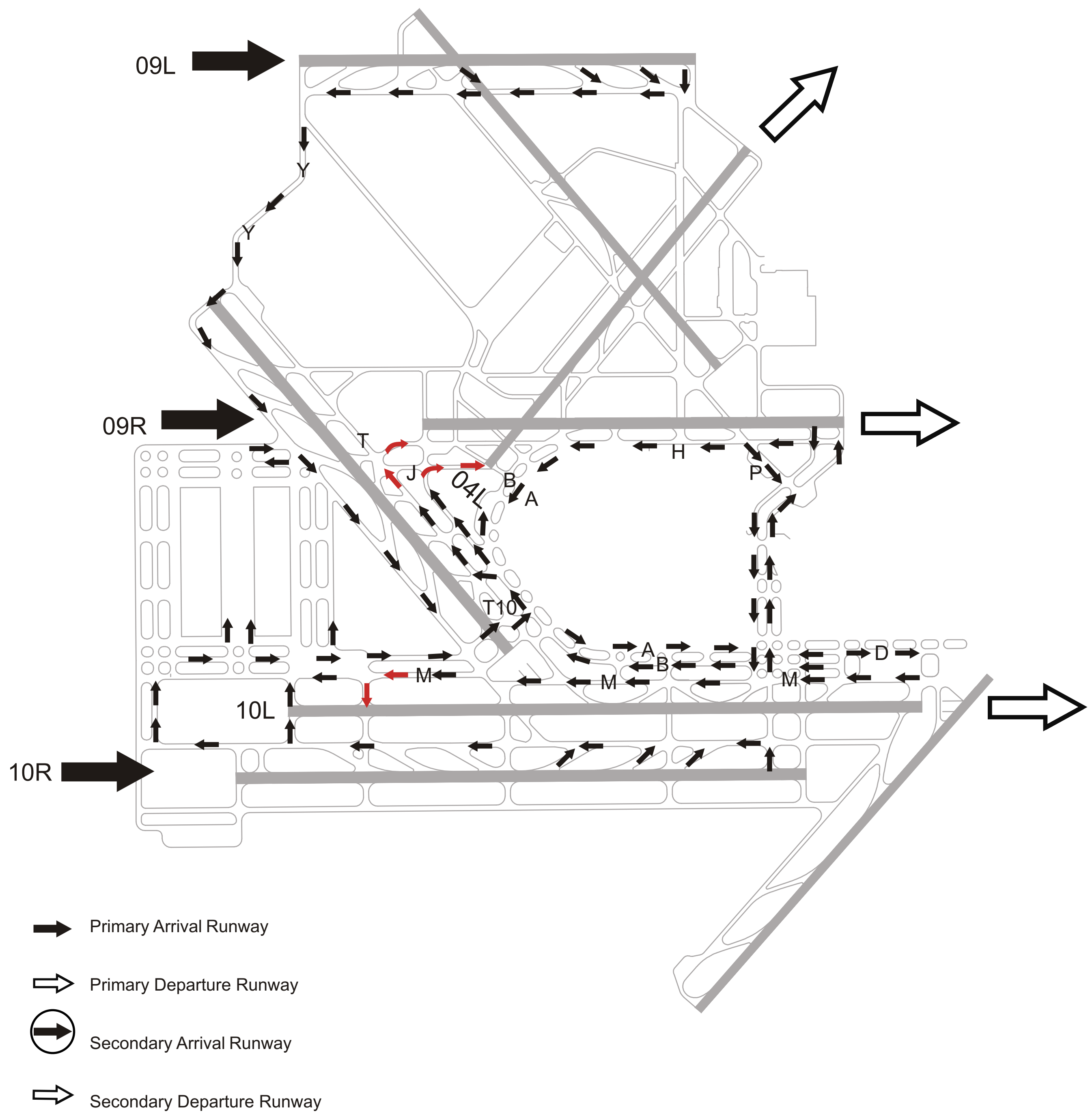


Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-19

Taxiway Routes
Option 1 - VFR East Flow

Z:\\Chicago\ORD\OMP\graphics\project definition notebook\Option 1 Taxiways.cdr eastbound towards Taxiway T10 to join Taxiways A or B to taxi to existing Terminals 1 through 6 as shown on Exhibit V-19.

Departure taxi routings are also shown on Exhibit V-19. Aircraft from Terminals 1 through 6 would generally taxi to Runway 4L via Taxiways B and J. Aircraft parking at the west terminal would proceed towards Taxiway T10 and transition to Taxiway J.

Exhibit V-19 illustrates the routes used by aircraft taxiing to Runway 9R. Aircraft parked in the west terminal complex would proceed towards the vicinity of Taxiway T10 so as to transition to Taxiway T. Aircraft would then proceed northwest on Taxiway T and join Taxiway H for queuing for Runway 9R. Aircraft taxiing to Runway 10L from Terminals 1 through 6 would join Taxiways A or B as appropriate and transition to Taxiway M at the end of the departure queue.

Most aircraft departing Runway 10L would depart using intersection departure. This procedure would allow arrival traffic landing on Runway 10R to cross the departure runways behind departing aircraft. The full departure runway length of Runway 10L would be available for aircraft with performance requirements requiring the maximum runway length.

5.3.2 IFR West Flow

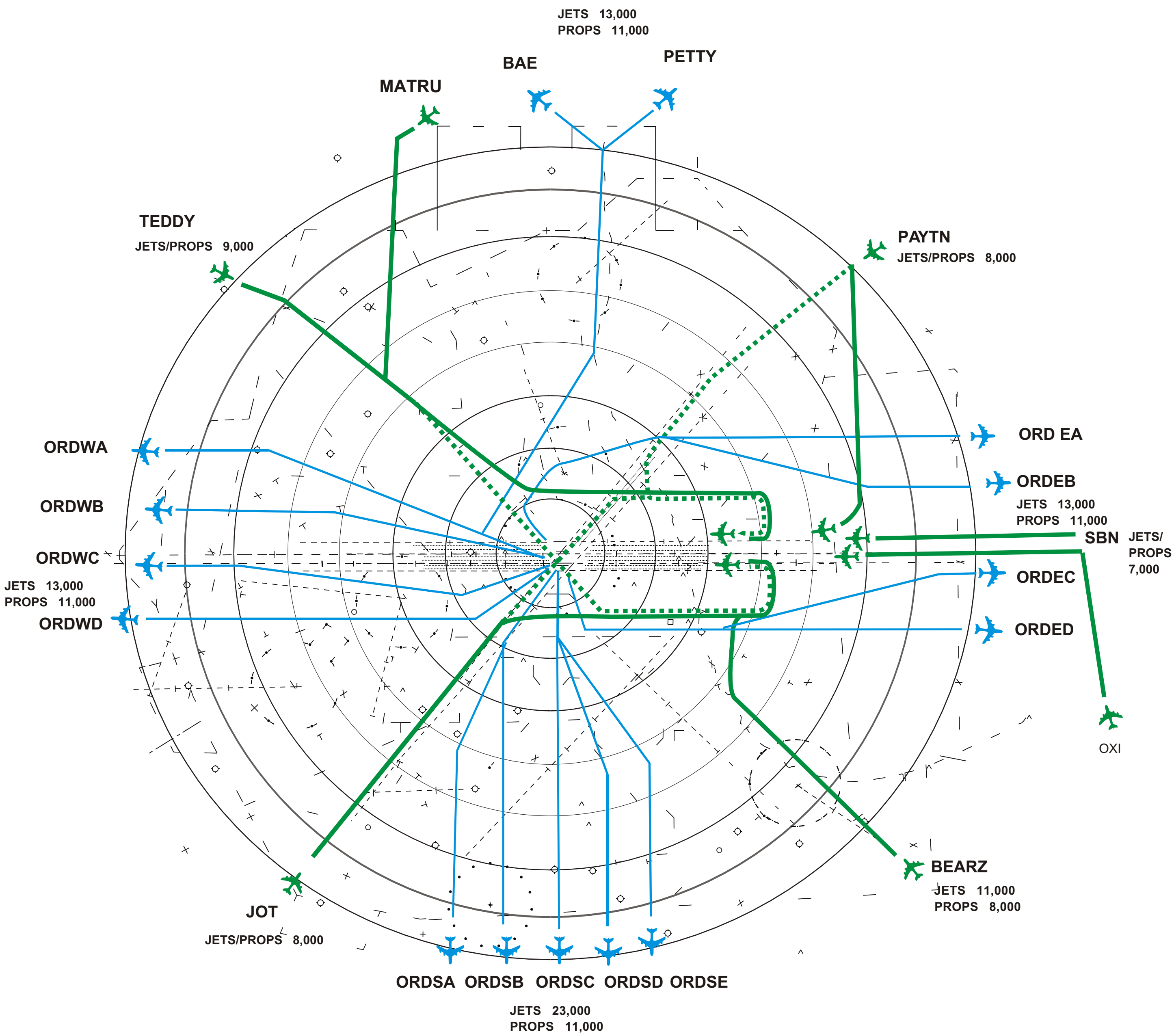
During periods of IMC in which the prevailing winds favor operations to the west, Runways 27L and 28L would be used as primary arrival runways. Runway 27R would also be used, but only during periods of peak arrival demand. Departures would generally be assigned Runways 22L, 28R and 32R. **Exhibit V-20** illustrates the primary arrival and departure flight paths associated with this configuration.

5.3.2.1 Arrivals

Arrivals from PAYTN corner post would be vectored for a right base leg entry to Runway 27L. During periods of peak arrival demand these aircraft may be vectored for a right downwind to Runway 27R. Traffic arriving from the southeast would be routed via the OXI high and wide route to Runway 27L intercepting the final approach course approximately 40 miles east of the Airport. Arrival traffic from the southwest would be routed over JOT for a left downwind entry to Runway 28L. During periods of peak arrival demand, traffic from JOT would also be routed over the top of the Airport for a right downwind to Runway 27R. Traffic from TEDDY would initially be vectored for right downwind for Runway 27L although during periods of heavy arrival demand these aircraft would also be vectored over the top of the airfield for a left downwind to Runway 28L.

5.3.2.2 Departures

Departure airspace routings for a west runway configuration are also depicted on Exhibit V-20. Most aircraft departing via fixes ORDEA and ORDEB would be assigned Runway 32R for departure. Runway 28R would be assigned to most traffic departing over the fixes of BAE, PETTY, ORDWA, ORDWB, ORDWC and ORDWD. Aircraft departing via fixes ORDSA, ORDSB, ORDSC, ORDSD, ORDSE, ORDWC and ORDWD would be assigned Runway 22L. During periods of heavy departure demand on Runway 28R, aircraft filed over ORDWC and ORDWD would be assigned Runway 22L.



Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-20

North

Primary Arrival Route
Secondary Arrival Route
Departure Route

Airspace Routes
Option 1 - IFR West Flow

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5.3.2.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-21**. The black arrows denote directional flow on the associated taxiway. Red arrows indicate departure queuing areas. Aircraft landing on Runway 27R would exit the runway and taxi westbound on the Runway 9R-27L parallel taxiway and would join Taxiway Y and proceed southbound. Aircraft parking in the new western terminal complex would enter the terminal apron from the north while aircraft parking in Terminals 1 through 6 would continue to taxi southwest between the existing terminal and the westside terminal. These aircraft would then join the Taxiways A or B at Taxiway T10 as appropriate and proceed to the arrival gate. Most aircraft departing Runways 28R would depart from the intersection as illustrated on Exhibit V-21. This procedure would allow arrival traffic landing on Runway 28L to cross behind aircraft departing Runway 28R. Full departure runway length would be available for aircraft with performance requirements requiring additional runway length.

Aircraft arriving on Runway 28L would exit the runway and proceed eastbound on the Runway 10R-28L parallel taxiway to the end of the taxiway. Aircraft would then cross behind departures using Runway 28L. This traffic would then either proceed to the Terminals 5 and 6 or continue westbound on Taxiway B as appropriate to taxi to Terminals 1 through 4 or the new west terminal as shown on Exhibit V-21.

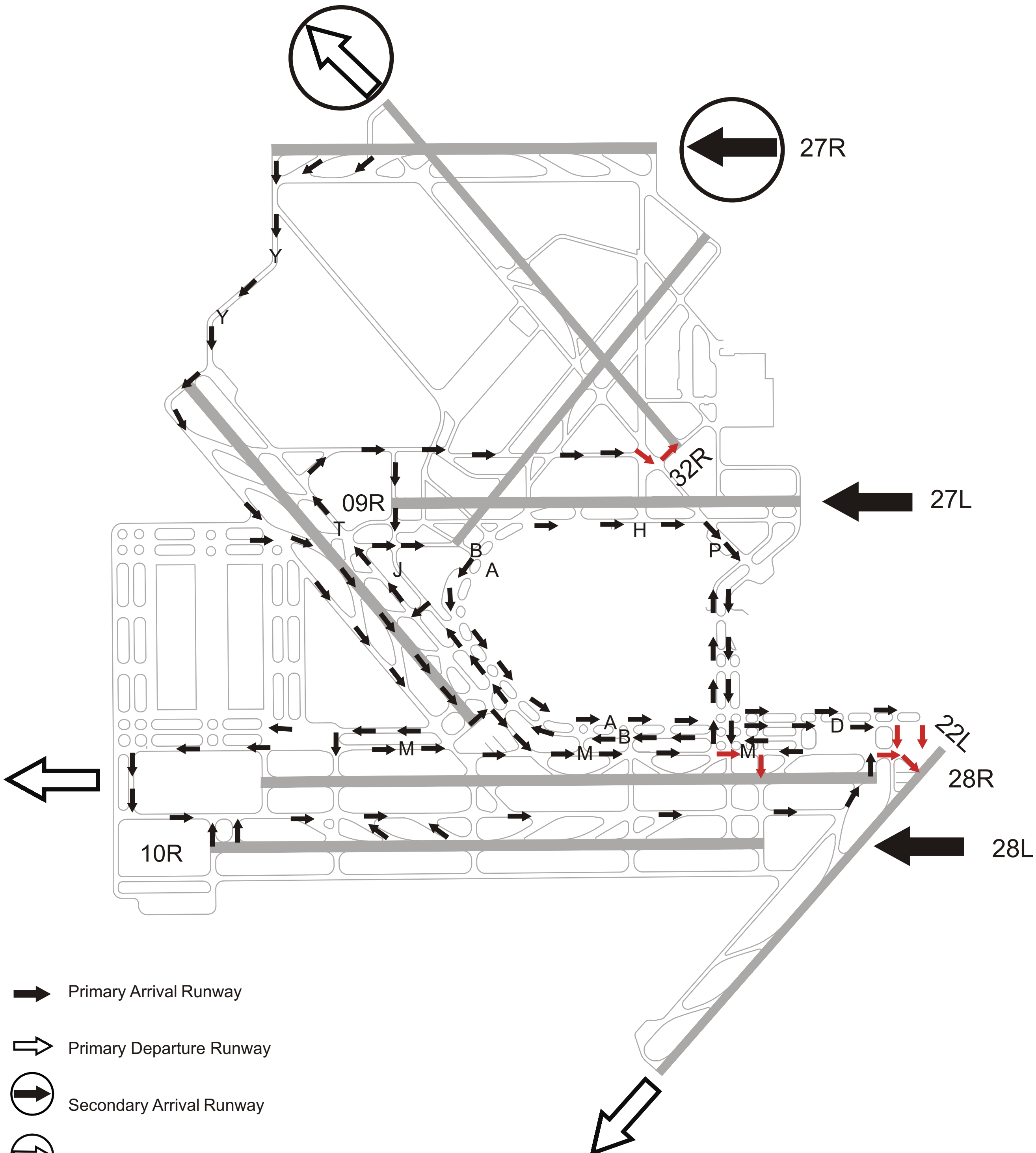
5.4 Option 2 Simulation

The proposed airfield layout for Option 2 is illustrated on Exhibit IV-2 in Section IV, *Alternatives Evaluated*. This proposed layout is based on a series of parallel runways linked via bypass taxiways that would were intended to allow aircraft to taxi between the terminal area and the outer runways without active runway crossings. This layout consists of six runways in an east-west orientation including the existing Runway 9R-27L (future Runway 9R-27L) and an extended Runway 9R-27L (future Runway 10L-28R). It also includes the existing Runways 4L-22R and 4R-22L. Runways 18-36, 14L-32R and 14R-32L would be decommissioned in this configuration.

Full Option 2 simulation experiments analyses were not completed due to the following issuesseveral constraints that came up were identified during the course of developing the model. These concerns constraints are discussed in more detail in Section VI, *Simulation Results*, and are summarized as follows.:

- Future Runways 9C and 9R would have a parallel separation of 1,600 feet with thresholds staggered by approximately 3,600 feet. Because departures on Runway 9C could be airborne before an arrival to Runway 9R is on the ground, there is a the potential for wake turbulence affecting either the arrival or departure operation. [FAA Order 7110.65N, FAA Advisory Circular No. 90-23E: Aircraft Wake Turbulence] This would greatly reduce the potential operational throughput and operational performance of these runways.
- FAA Flight Technologies and Procedures Division, AFS-400 clarified the FAA's operational criteria to be utilized when considering perimeter taxiways in a memorandum dated August 22, 2002. Based on the criteria described in this memorandum, the perimeter taxiways in Option 2 would be treated as controlled crossings. A copy of this memorandum is attached as Appendix A.

These findings are consistent with the FAA Air Traffic Division evaluation of Option 1, 2 and 5 included in their letter dated December 19, 2002, which is attached as Appendix B.



Primary Arrival Runway

Primary Departure Runway

Secondary Arrival Runway

Secondary Departure Runway

Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-21

north

Arrivals and Departures

Departure Queue

Taxiway Routes
Option 1 - IFR West Flow

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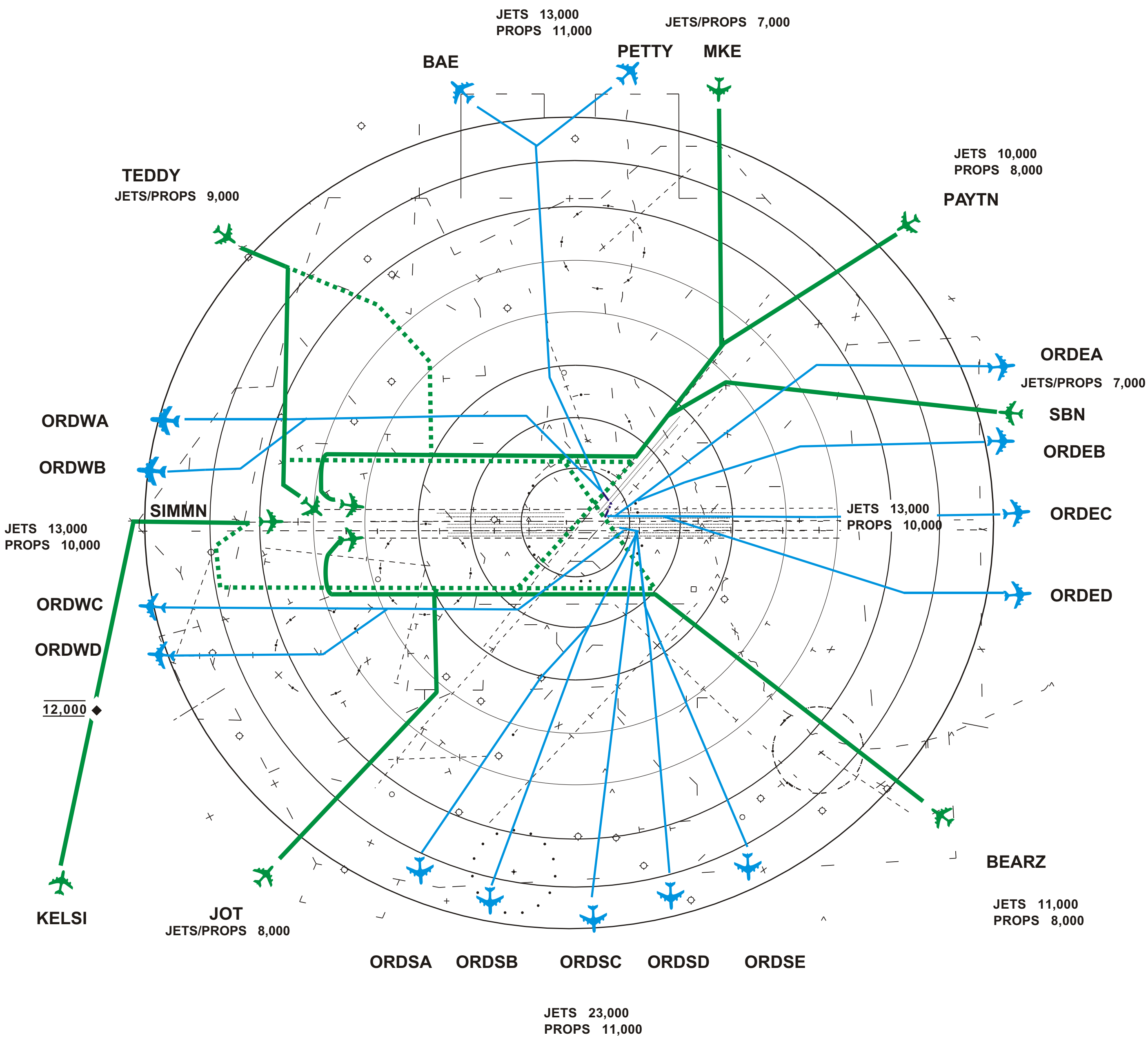

Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-22

north

Primary Arrival Route
Secondary Arrival Route
Departure Route

Airspace Routes
Option 2 - VFR East Flow

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Although full simulations of Option 2 were not performed, the operational parameters of this alternative were developed in enough detail to reject it from further consideration. These parameters are discussed below.

A variety of operating configurations were identified for the runways in Option 2 depending upon wind direction and meteorological conditions. The four primary operating configurations include (1) parallel arrivals to the east (VFR east flow) during VMC (2) parallel arrivals to the west (VFR west flow) during VMC, (3) east flow during IMC (IFR east flow), and (4) west flow during IMC (IFR west flow). The arrival and departure procedures that would be associated with each of the primary operating configurations are described below.

5.4.1 VFR East Flow

VFR east flow would consist of arrivals on Runways 9R, 10L, 09L and, during periods of peak demand, Runway 10R while Runways 4L, 9C, and 10C would be used for departures. **Exhibit V-22** depicts the primary arrival and departure flight paths that would be associated with this operating configuration under Option 2.

5.4.1.1 Arrivals

Aircraft entering the TRACON airspace from the northeast would normally be assigned to Runway 9L. During periods of peak arrival demand, this northeast traffic could be off-loaded to either Runway 9R or 10R. Arrivals from the southeast would normally be assigned to Runway 10L. During periods of peak arrival demand, these southeast arrivals could be off-loaded to either Runway 10R or 9L. Aircraft arriving from the northwest would normally be assigned to Runway 9R and during periods of peak arrival demand could be off-loaded to Runway 9L. Arrivals from the southwest would normally be assigned to Runway 10L. During periods of peak arrival demand, these southwest arrivals could be off-loaded to Runway 10R.

Arriving aircraft would maintain an altitude of 7,000 feet MSL or above until entering the appropriate descent area. Upon entering the descent area, arrivals to the outer Runways 9L or 10R would descend to 4,000 feet and remain at that altitude until within 15 miles of the Airport where they would turn onto the final approaches. Arrivals to the inner Runways 9R or 10L would descend to 5,000 or 6,000 feet MSL respectively and remain at these altitudes until within 25 miles of the Airport where they would turn onto the final approaches. In addition, aArrivals to the center runways from the southwest would follow a high and wide approach path, proceeding directly to SIMMN and remaining at 12,000 feet MSL or above until entering the descent area and then turning onto the final approach at 11,000 feet MSL.

5.4.1.2 Departures

Departure runways would be assigned consistent with the intended route of flight and for balanced airfield operations. In general, departures to the northwest (ORDWA or ORDWB) and north (BAE or PETTY) would be assigned to Runway 4L. Departures to the east (ORDEA, ORDEB, ORDEC, or ORDED) and southeast (ORDSD or ORDSE) would be assigned to Runway 9C. Departures to the south (ORDSA, ORDSB, or ORDSC) and southwest (ORDWC or ORDWD) would be assigned to Runway 10C. International departures to the north fixes requiring a runway length longer than provided by Runway 4L, would depart on Runway 9C.

A number of runway use strategies would be used to balance the airfield demand during periods of peak departures over one or more sets of departures fixes. During periods of peak eastbound traffic, traffic over ORDEC or ORDED could be shifted to Runway 10C. Conversely, during periods of peak westbound demand, traffic over the south fixes could be shifted to Runway 9C.

5.4.1.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-23**. The black arrows depict directional flow on the associated taxiway. Red arrows indicate departure queuing areas.

5.4.2 VFR West Flow

VFR west flow would consist of arrivals on Runways 27L, 28R, and 27R and, during periods of peak demand, Runway 28L while Runways 27C, 28C, and 22L would be used for departures. **Exhibit V-24** depicts the primary arrival and departure flight paths that would be associated with this operating configuration under Option 2.

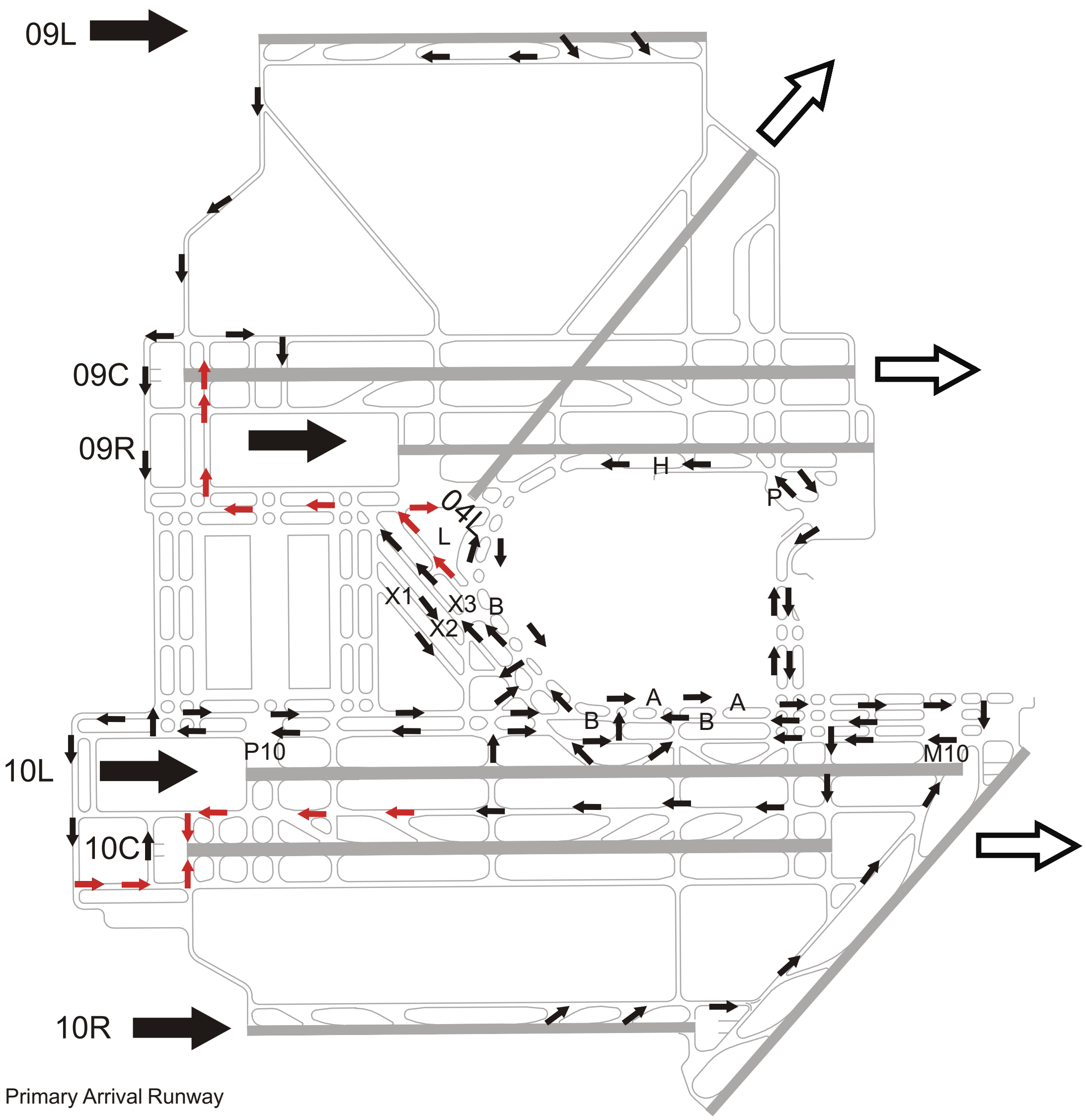
5.4.2.1 Arrivals

Aircraft entering the TRACON airspace from the northeast would normally be assigned to Runway 27L. During periods of peak arrival demand, this northeast traffic could be off-loaded to Runway 27R. Arrivals from the southeast would normally be assigned to Runway 28R. During periods of peak arrival demand, these southeast arrivals could be off-loaded to either Runway 27L or 28L. Aircraft arriving from the northwest would normally be assigned to Runway 27R and during periods of peak arrival demand could be off-loaded to either Runway 28L or 27L. Arrivals from the southwest would normally be assigned to Runway 28R. During periods of peak arrival demand, these southwest arrivals could be off-loaded to Runway 28L or 27R.

Arriving aircraft would maintain an altitude of 7,000 feet MSL or above until entering the appropriate descent area. Upon entering the descent area, arrivals to the outer Runways 27R or 28L would descend to 4,000 feet and remain at that altitude until within 15 miles of the Airport where they would turn onto the final approaches. Arrivals to the inner Runways 27L or 28R would descend to 5,000 or 6,000 feet MSL respectively and remain at these altitudes until within 25 miles of the Airport where they would turn onto the final approaches. In addition, arrivals to the center runways from the southwest would follow a high and wide approach path, proceeding directly to OXI and remaining at 12,000 feet MSL or above until entering the descent area and then turning onto the final approach at 11,000 feet MSL.

5.4.2.2 Departures

Departure runways would be assigned consistent with the intended route of flight and for balanced airfield operations. In general, departures to the northeast (ORDEA or ORDEB) and north (BAE or PETTY) would be assigned to Runway 27C. Departures to the west (ORDWA, ORDWB, ORDWC, or ORDWD) and southwest (ORDSA, ORDSB, or ORDSC) would be assigned to Runway 28C. Departures to the south (ORDSD or ORDSE) and southeast (ORDEC or ORDED) would be assigned to Runway 22L.



Primary Arrival Runway

Primary Departure Runway

Secondary Arrival Runway

Secondary Departure Runway

Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-23

north

Arrivals and Departures

Departure Queue

Taxiway Routes
Option 2 - VFR East Flow

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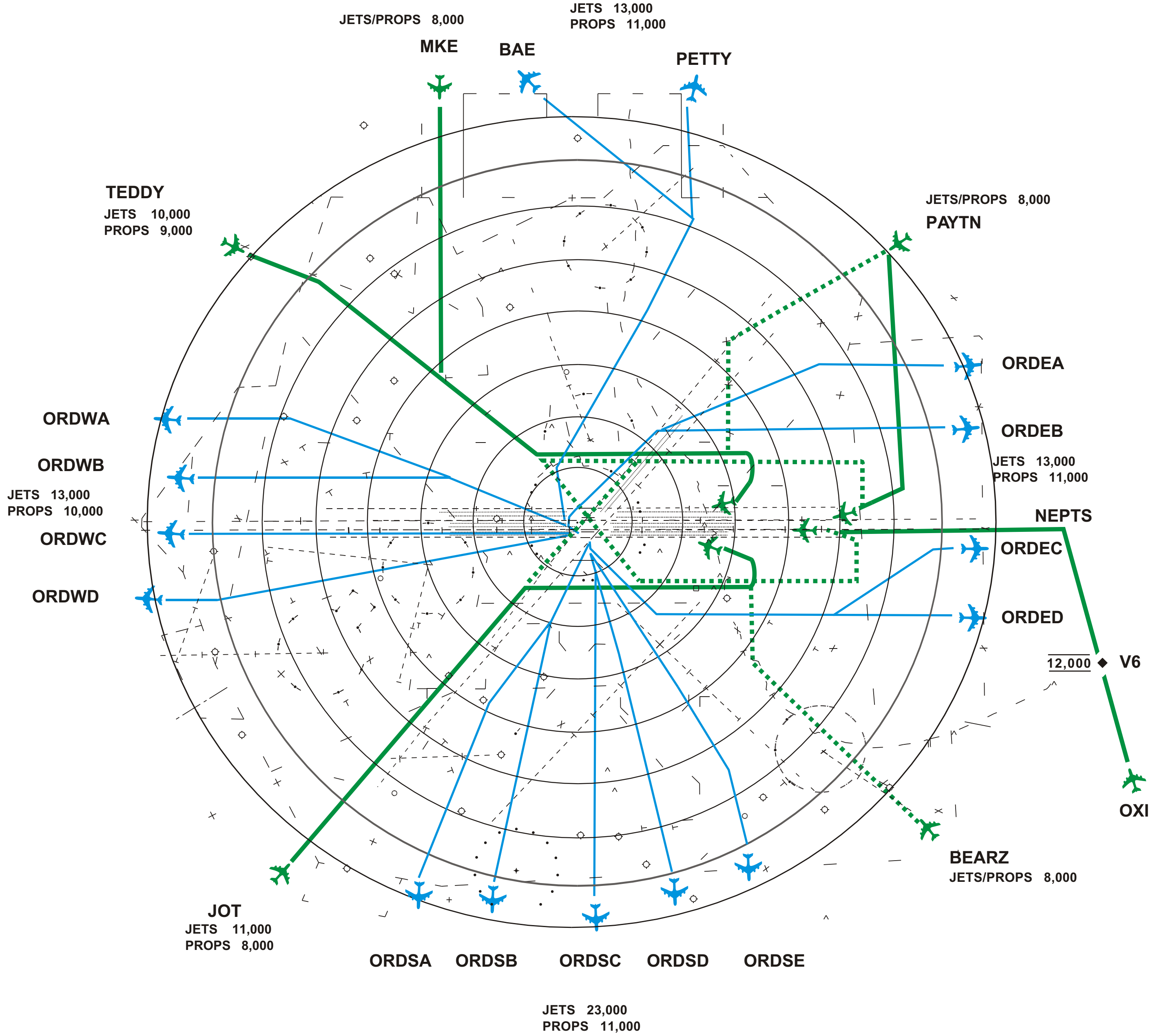

Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-24

north

Primary Arrival Route
Secondary Arrival Route
Departure Route

Airspace Routes
Option 2 - VFR West Flow

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A number of runway use strategies would be used to balance the airfield demand during periods of peak departures over one or more sets of departures fixes. During periods of peak eastbound traffic, traffic over BAE or PETTY could be shifted from Runway 27C to Runway 28C and traffic over ORDSD or ORDSE could be shifted from Runway 22L to Runway 28C. Conversely, during periods of peak westbound demand, traffic over the northwest fixes ORDWA or ORDWB could be shifted from Runway 28C to Runway 27C.

5.4.2.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-25**. The black arrows depict directional flow on the associated taxiway. Red arrows indicate departure queuing areas.

5.4.3 IFR East Flow

IFR east flow would consist of arrivals on Runways 9R, 10C, and 9L with departures on Runways 9C and 10L. **Exhibit V-26** depicts the primary arrival and departure flight paths that would be associated with this operating configuration under Option 2.

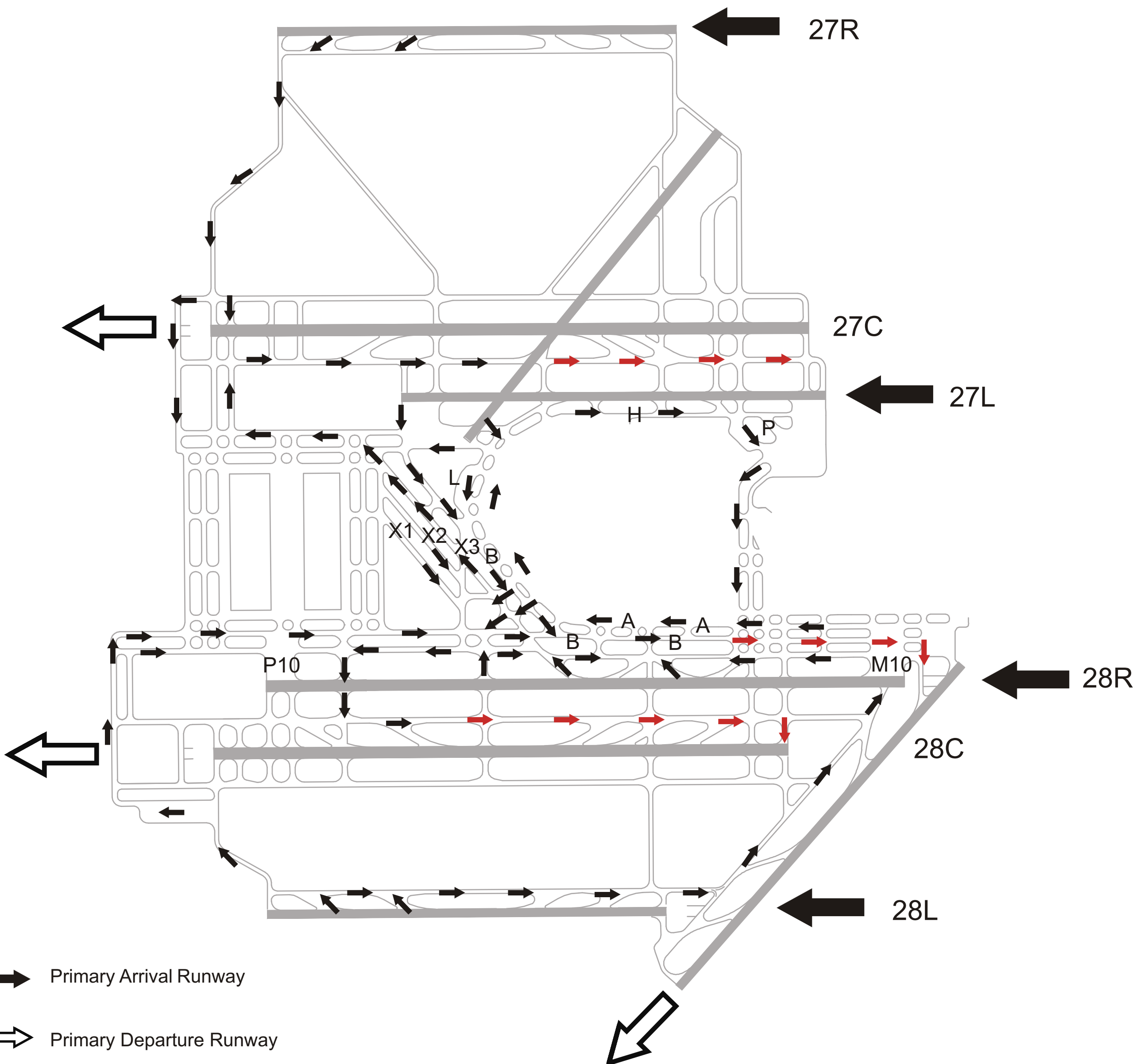
5.4.3.1 Arrivals

Aircraft entering the TRACON airspace from the northeast would normally be assigned to Runway 9L. During periods of peak arrival demand, this northeast traffic could be off-loaded to Runway 10C. Arrivals from the southeast would normally be assigned to Runway 10C. During periods of peak arrival demand, these southeast arrivals could be off-loaded to Runway 9L. Aircraft arriving from the northwest would normally be assigned to Runway 9R and during periods of peak arrival demand could be off-loaded to Runway 9L. Arrivals from the southwest would normally be assigned to Runway 10C. During periods of peak arrival demand, these southwest arrivals could be off-loaded to Runway 9R.

Arriving aircraft would maintain an altitude of 7,000 feet MSL or above until entering the appropriate descent area. Upon entering the descent area, arrivals to Runway 9L would descend to 4,000 feet and remain at that altitude until within 15 miles of the Airport where they would turn onto the final approach. Arrivals to the inner Runways 9R or 10C would descend to 5,000 or 6,000 feet MSL respectively and remain at these altitudes until within 25 miles of the Airport where they would turn onto the final approaches. In addition, arrivals to the center runways from the southwest would follow a high and wide approach path, proceeding directly to SIMMN and remaining at 12,000 feet MSL or above until entering the descent area and then turning onto the final approach to either Runway 9R or 10C at 11,000 feet MSL. High and wide approaches to Runway 9R would then descend to 5,000 feet MSL 25 miles from the Airport while high and wide approaches to Runway 10C would then descend to 6,000 feet MSL 25 miles from the Airport.

5.4.3.2 Departures

Departures to the northwest (ORDWA or ORDWB), north (BAE or PETTY), and northeast (ORDEA or ORDEB) would be assigned to Runway 9C. Departures to the southeast (ORDEC or ORDED), south (ORDSA, ORDSB, ORDSC, ORDSD, or ORDSE), and southwest (ORDWC or ORDWD) would be assigned to Runway 10L.



Primary Arrival Runway

Primary Departure Runway

Secondary Arrival Runway

Secondary Departure Runway

Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-25

north

Arrivals and Departures

Departure Queue

Taxiway Routes
Option 2 - VFR West Flow

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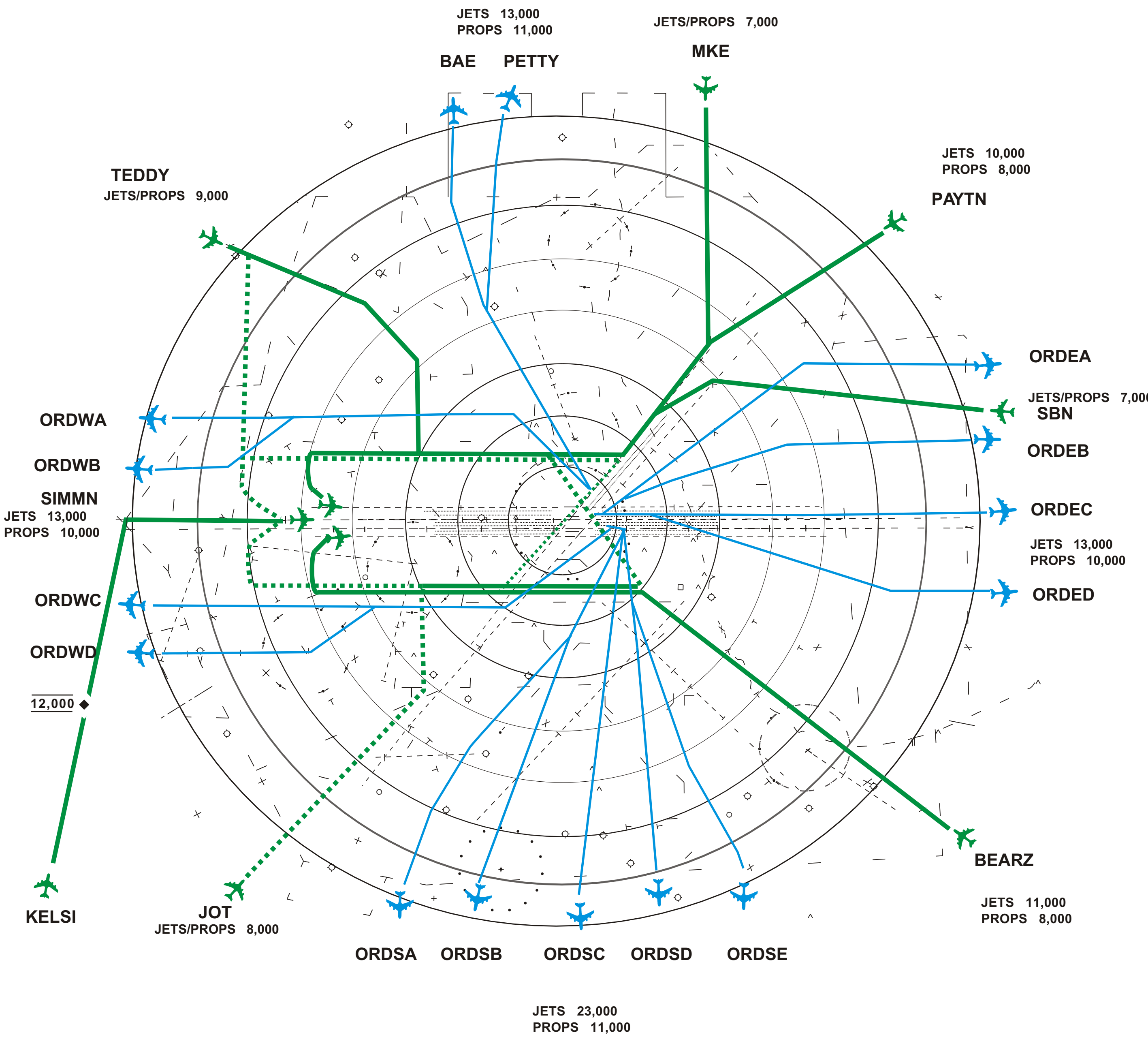
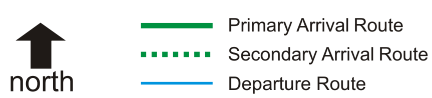


Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-26



Airspace Routes
Option 2 - IFR East Flow

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Runway off-load strategies would be used to balance the airfield demand during periods of peak departures over one or more sets of departures fixes. During periods of peak east or westbound traffic, traffic over ORDEA, ORDEB, ORDEC, or ORDED could be shifted between Runways 9C and 10L to balance demand between the departure runways.

5.4.3.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-27**. The black arrows depict directional flow on the associated taxiway. Red arrows indicate departure queuing areas.

5.4.4 IFR West Flow

IFR west flow would consist of arrivals on Runways 27L, 28R, and 27R while Runways 27C, 28C, and 22L would be used for departures. **Exhibit V-28** depicts the primary arrival and departure flight paths that would be associated with this operating configuration under Option 2.

5.4.4.1 Arrivals

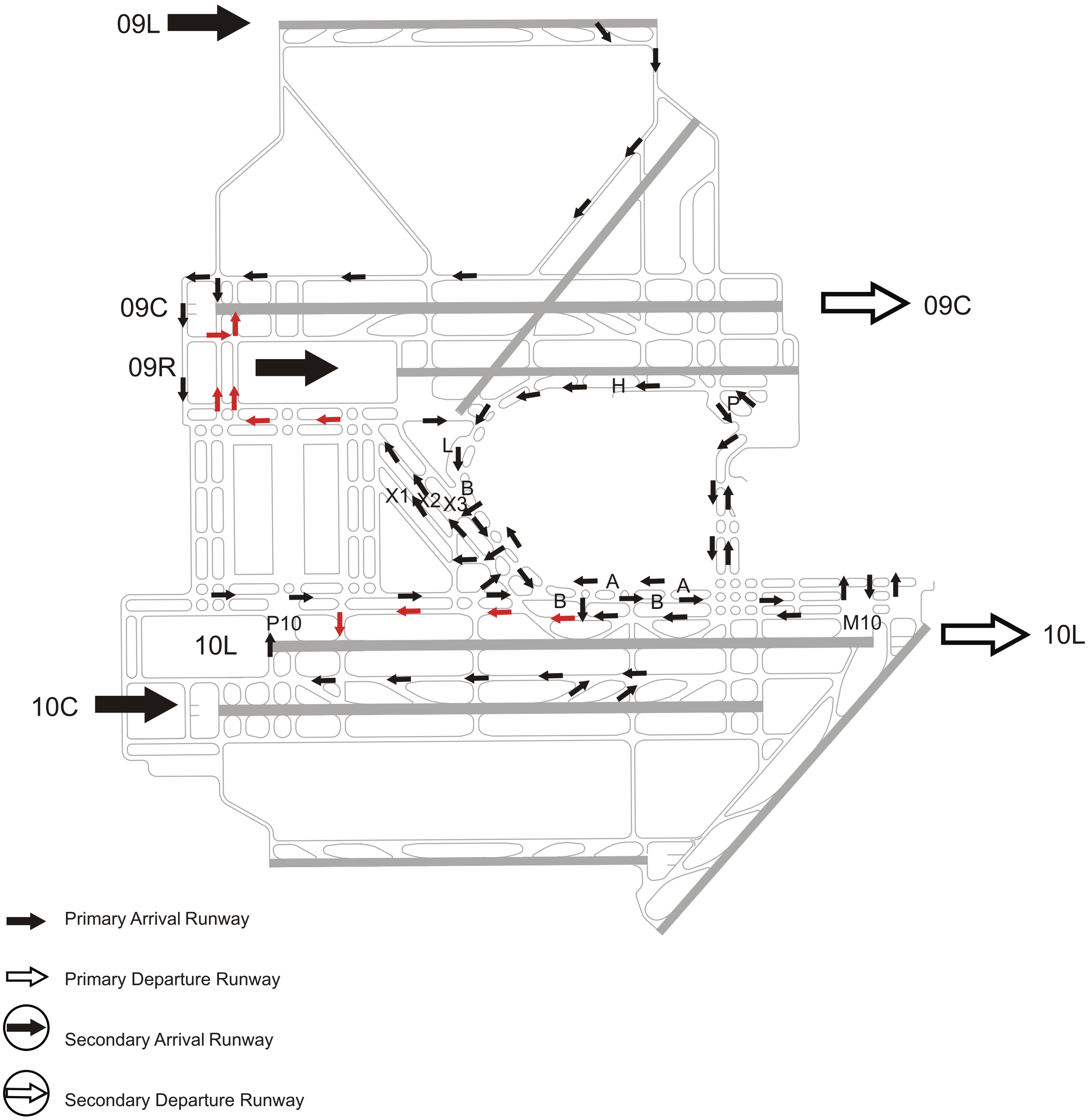
Arrivals from the northeast would be assigned primarily to Runway 27L. However, the following assignments would be made during periods of peak arrival demand. Arrivals from the northeast could be off-loaded to Runway 27R. Arrivals from the southeast would normally be assigned to Runway 28R. and would be off-loaded to Runway 27L. Arrivals from the northwest would normally be assigned to Runway 27R. and could be off-loaded to Runway 28R. Traffic arriving from the southwest would normally be assigned to Runway 28Rand could be off-loaded to Runway 27R.

Arriving aircraft would maintain an altitude of 7,000 feet MSL or above until entering the appropriate descent area. Upon entering the descent area, arrivals to Runway 27R would descend to 4,000 feet and remain at that altitude until within 15 miles of the Airport where they would turn onto the final approach. Arrivals to the inner Runways 27L or 28R would descend to 5,000 or 6,000 feet MSL respectively and remain at these altitudes until within 25 miles of the Airport where they would turn onto the final approaches. In addition, arrivals to the center runways from the southeast could follow a high and wide approach path, proceeding directly from OXI to NEPTS and remaining at 12,000 feet MSL or above until entering the descent area and then turning onto the final approach to either Runway 27L or Runway 28R at 11,000 feet MSL. High and wide approaches to Runway 27L would then descend to 5,000 feet MSL 25 miles from the Airport while high and wide approaches to Runway 28R would then descend to 6,000 feet MSL 25 miles from the Airport.

5.4.4.2 Departures

In general, departures to the northeast (ORDEA and ORDEB), north (BAE and PETTY), and northwest (ORDWA and ORDWB) would be assigned to Runway 27C. Departures to the southwest (ORDWC and ORDWD) and south (ORDSA, ORDSB, and ORDSC) would be assigned to Runway 28C. Runway 22L would be used by departures to the south (ORDSD and ORDSE) and southeast (ORDEC and ORDED). Departures that require a longer runway length than provided by Runway 22L would be assigned to Runway 28C.

A number of runway off-load strategies would be used to balance the airfield demand during periods of peak departures over one or more sets of departures fixes. During peak eastbound traffic periods, traffic over ORDWA, ORDWB, ORDSD, and ORDSE could be shifted to Runway 28C to provide additional departure capacity to the other two departure runways for eastbound departures only.



Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-27

Taxiway Routes
Option 2 - IFR East Flow

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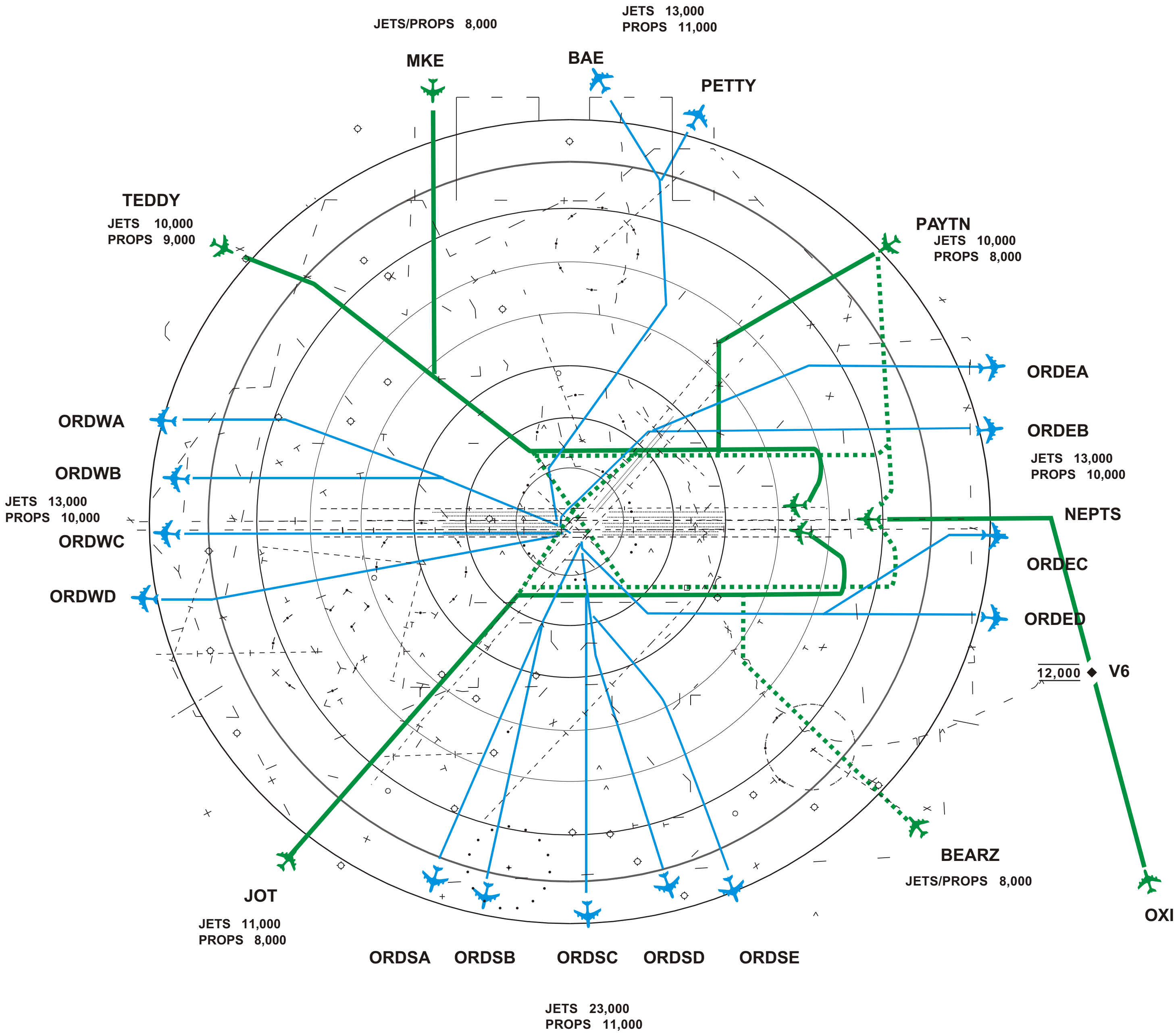
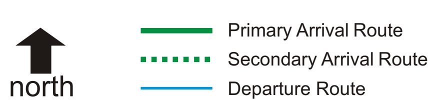


Sources: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit V-28



Airspace Routes
Option 2 - IFR West Flow

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Conversely, during periods of peak westbound demand, traffic over the south fixes ORDSA, ORDSB, and ORDSC could be shifted to Runway 22L to provide additional departure capacity on Runway 28C to serve westbound departures.

5.4.4.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-29**. The black arrows depict directional flow on the associated taxiway. Red arrows indicate departure queuing areas.

5.5 Option 5 Simulation

This option provides six parallel runways that could support up to four simultaneous arrival streams while at the same time supporting two to four simultaneous departure streams. Runway/taxiway interactions would be minimized in this option through the use of intersection departures on the closely spaced parallel runways and routings on the parallel taxiways that avoid active runway crossings.

The proposed airfield layout for Option 5 is previously illustrated on Exhibit IV-3 in Section IV, *Alternatives Evaluated*. The airfield layout consists of six runways in an east-west orientation, including extensions to the existing Runways 9L-27R and 9R-27L. It also includes the existing Runways 4L-22R and 4R-22L.

The runways in Option 5 would be used in different operating configurations depending upon wind direction and meteorological conditions. The four primary operating configurations would include (1) parallel arrivals to the east or east flow during VMC (2) parallel arrivals to the west or west flow during VMC, (3) east flow during IMC, and (4) west flow during IMC.

The following weighting was calculated for the expected use of these configurations at the Airport in the future as explained in Section 2.3, *Wind and Weather Conditions*. These weighting were used in annualizing the simulation results.

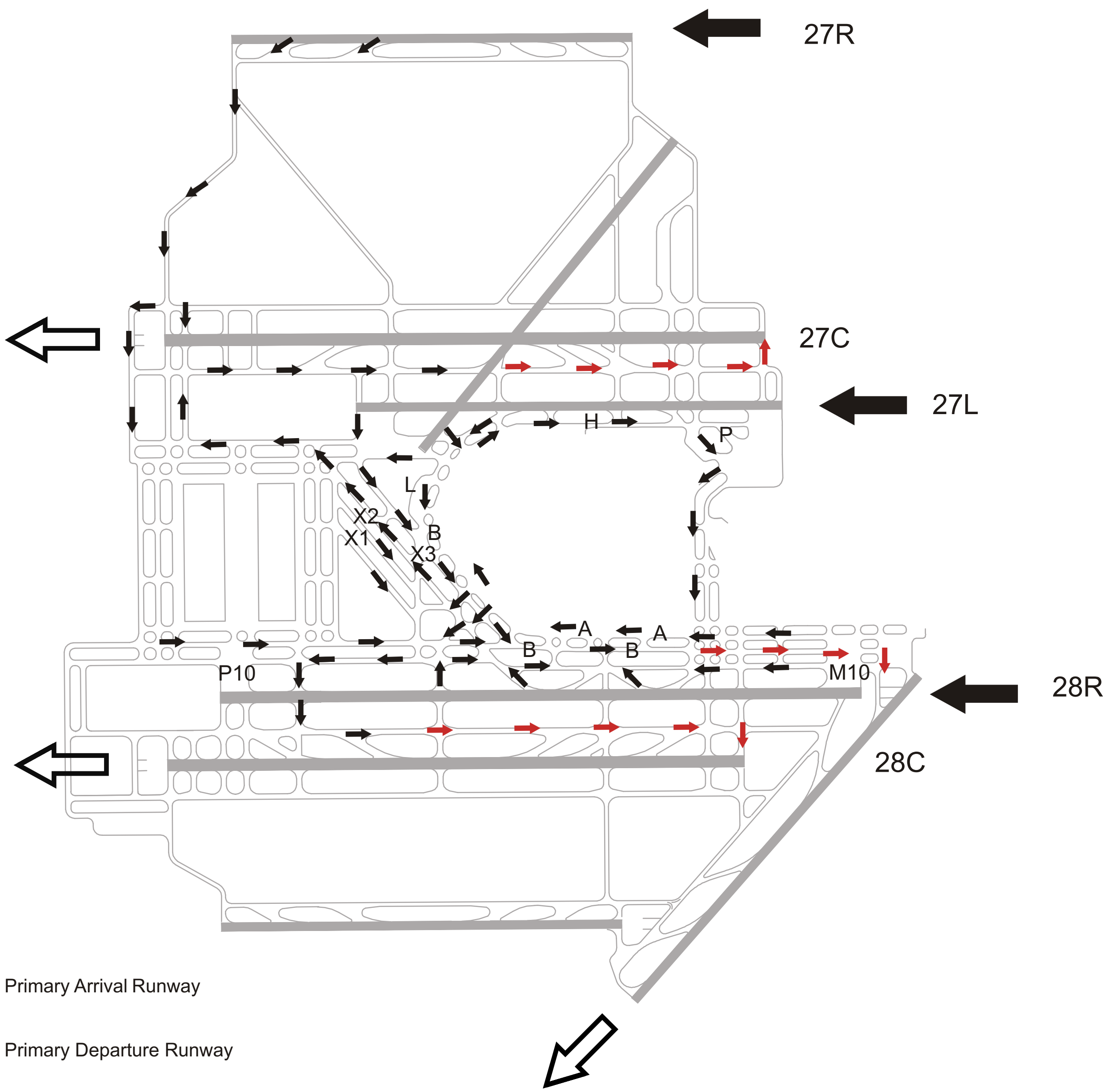
VFR East Flow	–	32.2%
VFR West Flow	–	58.6%
IFR East Flow	–	5.3%
IFR West Flow	–	3.9%

5.5.1 VFR East Flow

VFR east flow would consist of arrivals on Runways 9L, 10L, 10R and, during periods of peak demand, Runway 9C. Runways 4L, 9R, 10C and, during periods of peak departure demand, Runway 9C, would be used for departures. **Exhibit V-30** depicts the primary arrival and departure flight paths that would be associated with this operating configuration under Option 5.

5.5.1.1 Arrivals

Aircraft entering the TRACON airspace from the northeast would normally be assigned to Runway 9L. During periods of peak arrival demand, this northeast traffic could be off-loaded to either Runway 9C or 10R. Arrivals from the southeast would normally be assigned to Runway 10L and could be off-loaded to either Runway 10R or 9L. Aircraft arriving from the northwest would normally be assigned to Runway 9C and could be off-loaded to Runway 9L. Arrivals from the



Primary Arrival Runway

Primary Departure Runway

Secondary Arrival Runway

Secondary Departure Runway

Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-29

north

Arrivals and Departures

Departure Queue

Taxiway Routes Option 2 - IFR West Flow

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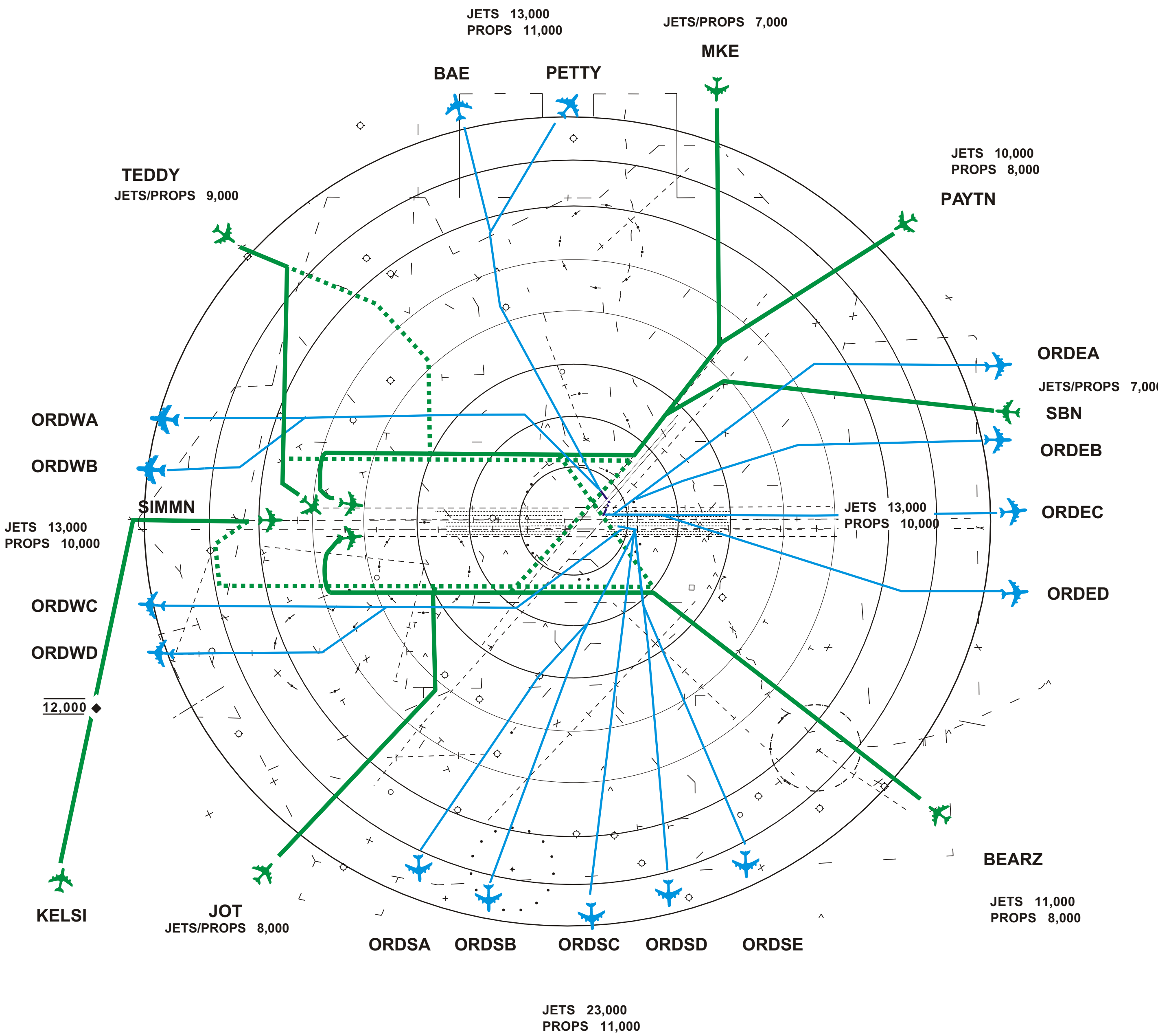
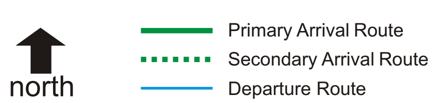


Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-30



Airspace Routes
Option 5 - VFR East Flow

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southwest would normally be assigned to Runway 10L. During periods of peak arrival demand, these southwest arrivals could be off-loaded to Runway 10R.

Arriving aircraft would maintain an altitude of 7,000 feet MSL or above until entering the appropriate descent area. Upon entering the descent area, arrivals to the outer Runways 9L or 10R would descend to 4,000 feet and remain at that altitude until within 15 miles of the Airport where they would turn onto the final approaches. Arrivals to the inner Runways 9C or 10L would descend to 5,000 or 6,000 feet MSL respectively and remain at these altitudes until within 25 miles of the Airport where they would turn onto the final approaches. Arrivals to the center runways from the southwest would follow a high and wide approach path, proceeding directly to SIMMN and remaining at 12,000 feet MSL or above until entering the descent area and then turning onto the final approach at 11,000 feet MSL.

5.5.1.2 Departures

Departure runways would be assigned consistent with the intended route of flight and for balanced airfield operations. In general, departures to the northwest (ORDWA and ORDWB) and north (BAE and PETTY) would be assigned to Runway 4L. Departures to the east (ORDEA, ORDEB, ORDEC, and ORDED) and southeast (ORDSD and ORDSE) would be assigned to Runway 9L. Departures to the south (ORDSA, ORDSB, and ORDSC) and southwest (ORDWC and ORDWD) would be assigned to Runway 10C. International departures to the north fixes requiring a runway length longer than provided by Runway 4L would depart on Runway 9L or 9C.

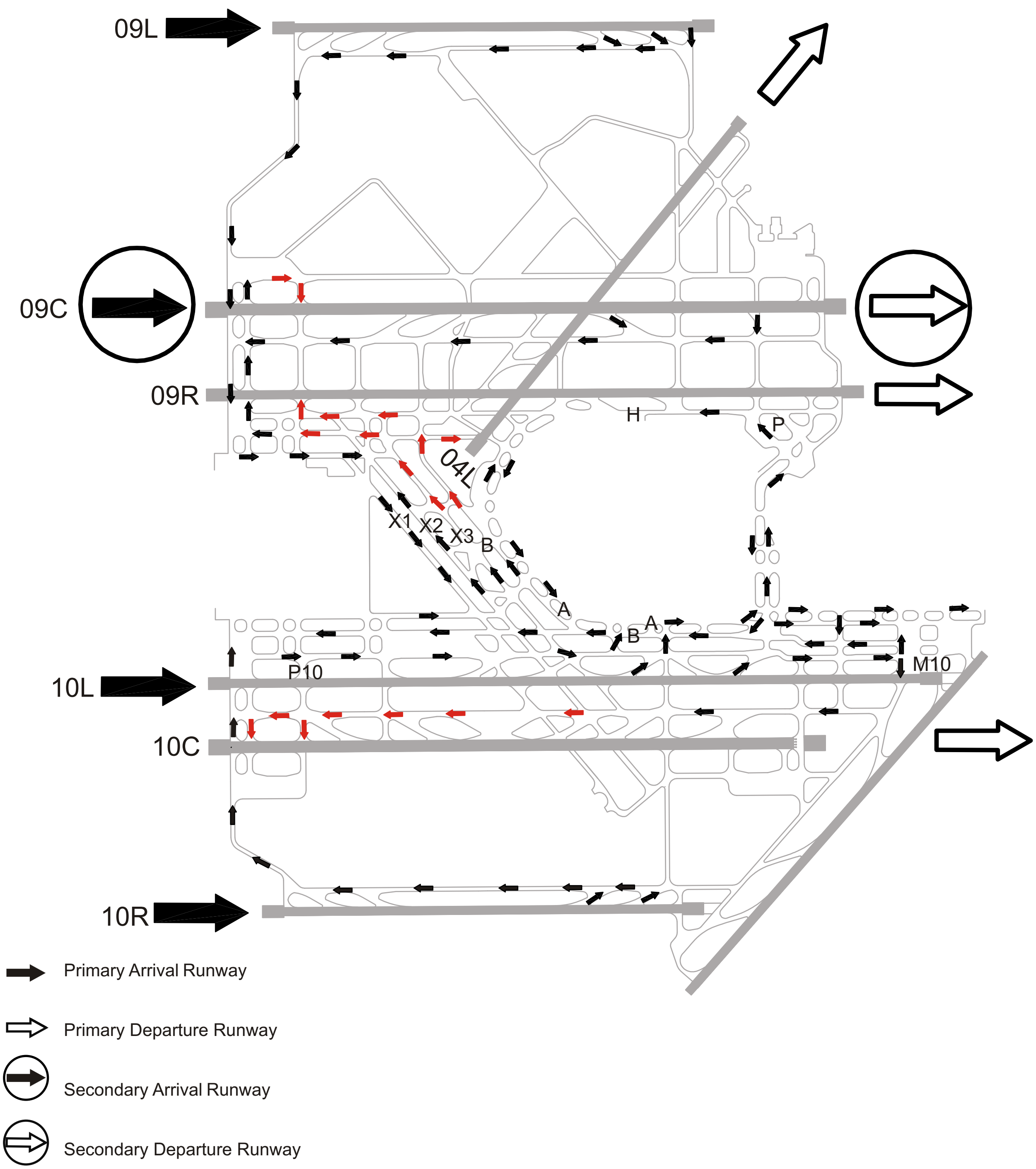
A number of runway use strategies would be used to balance airfield demand during periods of peak departures over one or more sets of departures fixes. During peak eastbound traffic periods, traffic over ORDEC and ORDED could be shifted to Runway 10C. Conversely, during periods of peak westbound demand, traffic over the south fixes could be shifted to Runway 9L.

5.5.1.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-31**. The black arrows depict directional flow on the associated taxiway. Red arrows indicate departure queuing areas. Traffic on Taxiway A would move in a counter-clockwise direction taxiway while Taxiway B would be a clockwise direction taxiway. Aircraft departing on Runways 9C, 9R, and 4L would use Taxiways X2, X3, and B to queue respectively. Aircraft departing on Runway 10C would cross Runway 10L using Taxiway M10 while the majority of Runway 10L arrivals would use LAHSO procedures to exit prior to Taxiway M10. Runway 10C and 9C departures would use intersection departures from the point indicated in Exhibit V-31, which would allow aircraft arriving on Runway 10R and 9L respectively to taxi behind them. Aircraft arriving on Runway 9L and 9C would use Taxiway X1 to access the terminal areas.

5.5.2 VFR West Flow

VFR west flow would consist of arrivals on Runways 27C, 28R, 27R, and Runway 28L during periods of peak demand, while Runways 27L, 28C, and 22L would be used for departures. **Exhibit V-32** depicts the primary arrival and departure flight paths that would be associated with this operating configuration under Option 5.



Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-31

Taxiway Routes
Option 5 - VFR East Flow

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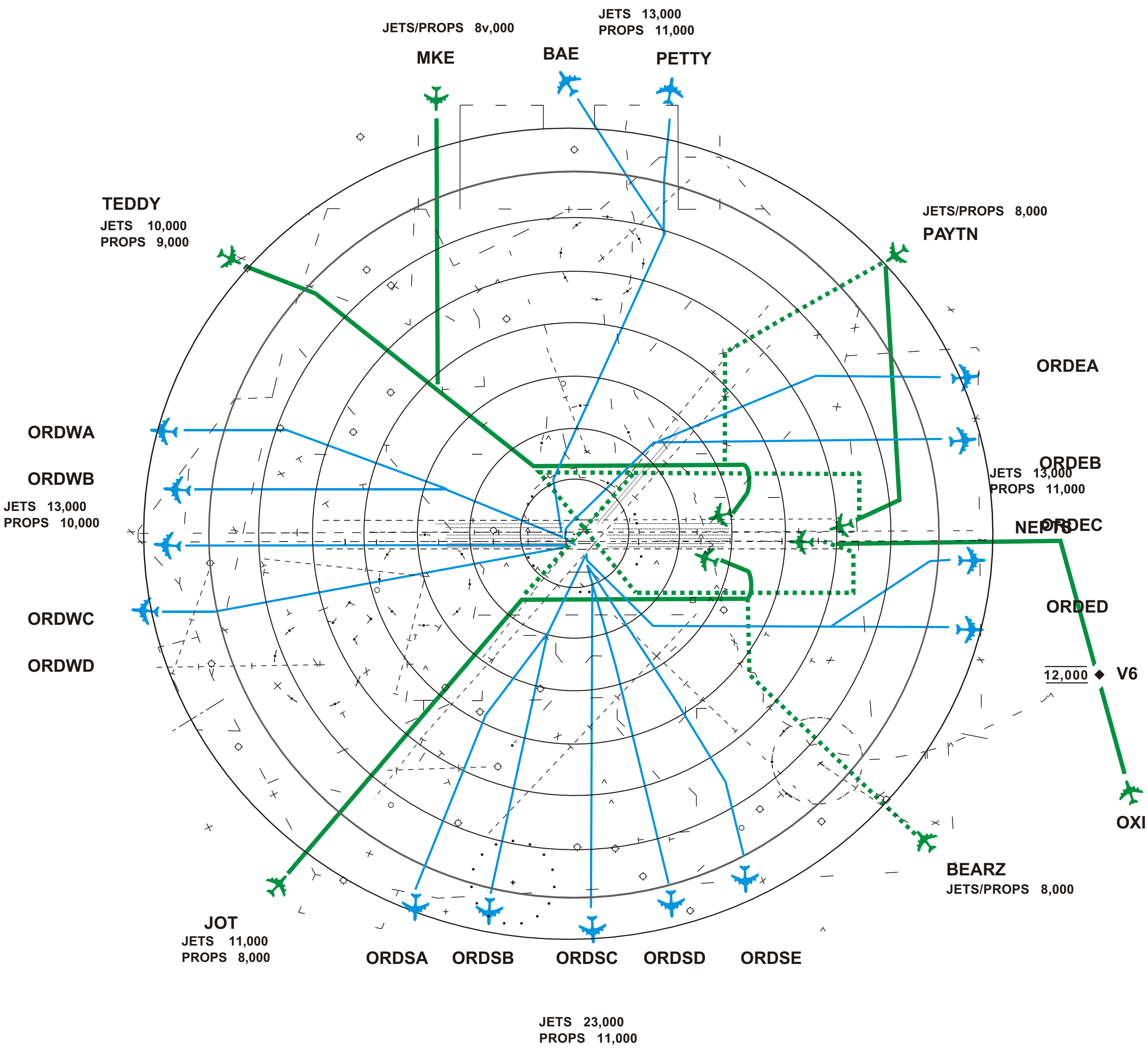
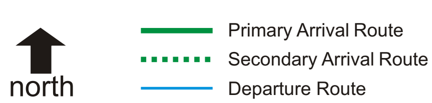


Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-32



Airspace Routes
Option 5 - VFR West Flow

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5.5.2.1 Arrivals

Arrivals from the northeast would be assigned primarily to Runway 27C. However, the following assignments would be made during periods of peak arrival demand. Arrivals from the northeast could be off-loaded to Runway 27R. Arrivals from the southeast would normally be assigned to Runway 28R and would be off-loaded to either Runway 27C or 28L. Arrivals from the northwest would normally be assigned to Runway 27R.and could be off-loaded to Runway 27C or 28L. Traffic arriving from the southwest would normally be assigned to Runway 28R and could be off-loaded to either Runway 28L or27R.

Arriving aircraft would maintain an altitude of 7,000 feet MSL or above until entering the appropriate descent area. Upon entering the descent area, arrivals to the outer Runways 27R or 28L would descend to 4,000 feet and remain at that altitude until within 15 miles of the Airport where they would turn onto the final approaches. Arrivals to the inner Runways 27C or 28R would descend to 5,000 or 6,000 feet MSL respectively and remain at these altitudes until within 25 miles of the Airport where they would turn onto the final approaches. In addition, arrivals to the center runways from the southeast could follow a high and wide approach path, proceeding directly from OXI to NEPTS and remaining at 12,000 feet MSL or above until entering the descent area and then turning onto the final approach at 11,000 feet MSL.

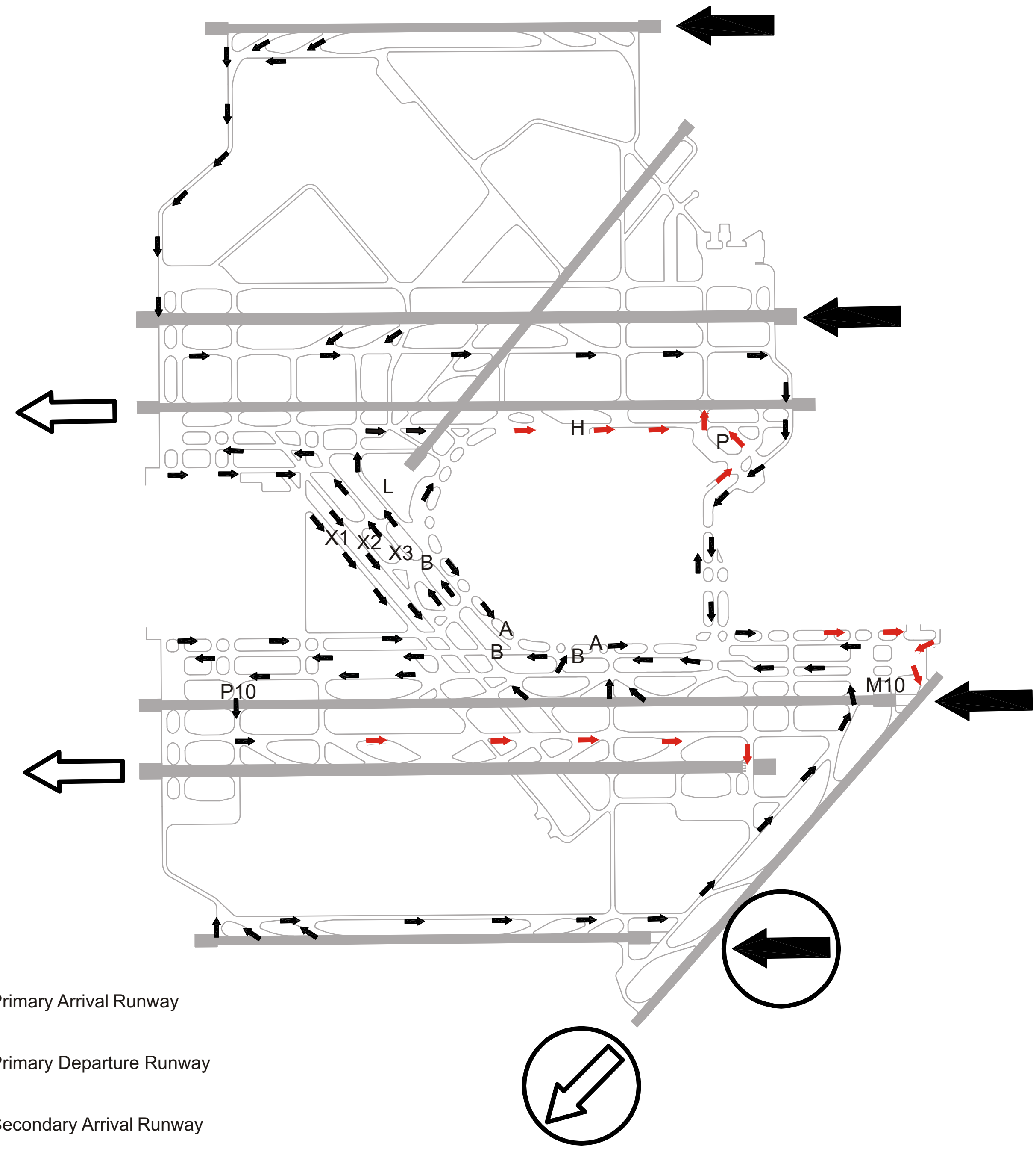
5.5.2.2 Departures

In general, departures to the northeast (ORDEA or ORDEB), north (BAE or PETTY), and northwest (ORDWA or ORDWB) would be assigned to Runway 27L. Departures to the southwest (ORDWC or ORDWD) and south (ORDSA, ORDSB, or ORDSC) would be assigned to Runway 28C. Runway 22L would be used by departures to the south (ORDSD or ORDSE) and southeast (ORDEC or ORDED). Departures that require a longer runway length than provided by Runway 22L would be assigned to Runway 28C.

A number of runway use strategies would be used to balance the airfield demand during periods of peak departures over one or more sets of departures fixes. During periods of peak eastbound traffic, traffic over ORDWA, ORDWB, ORDSD, or ORDSE could be shifted to Runway 28C to provide additional departure capacity on the other two departures runways for eastbound departures only. Conversely, during periods of peak westbound demand, traffic over the south fixes ORDSA, ORDSB, or ORDSC could be shifted to Runway 22L to provide additional departure capacity on Runway 28C to serve westbound departures. It should also be noted that during periods of arrival demand that would require the use of four arrival runways, the use of Runway 28L for arrivals would prevent the use of Runway 22L for departures. In this case, departures normally assigned to Runway 22L would be shifted to Runway 28C and some of the demand on Runway 28C would be shifted to 27L.

5.5.2.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-33**. The black arrows depict directional flow on the associated taxiway. Red arrows indicate departure queuing areas. Taxiway A would move traffic in a counter-clockwise direction while Taxiway B would be a clockwise direction taxiway. Aircraft departing on Runway 27L would use an intersection departure as indicated on Exhibit V-33 and would use Taxiway H to queue. This would allow aircraft arriving on Runways 27C and 27R to taxi behind the departures. Aircraft departing on Runway 28C would cross Runway 28R using Taxiway P10 while the majority of arrivals on Runway 28R would use LAHSO prior to Taxiway P10.



Primary Arrival Runway

Primary Departure Runway

Secondary Arrival Runway

Secondary Departure Runway

Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-33

north

Arrivals and Departures

Departure Queue

Taxiway Routes
Option 5 - VFR West Flow

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5.5.3 IFR East Flow

IFR east flow would consist of arrivals on Runways 9C, 9L, and 10C with departures on Runways 9R, 10L and 10R. **Exhibit V-34** depicts the primary arrival and departure flight paths that would be associated with this operating configuration under Option 5.

5.5.3.1 Arrivals

Aircraft entering the TRACON airspace from the northeast would normally be assigned to Runway 9L. During periods of peak arrival demand, this northeast traffic could be off-loaded to Runway 9C. Arrivals from the southeast would normally be assigned to Runway 10C and could be off-loaded to Runway 9L. Aircraft arriving from the northwest would normally be assigned to Runway 9C and could be off-loaded to Runway 9L. Arrivals from the southwest would normally be assigned to Runway 10C and could be off-loaded to Runway 9C.

Arriving aircraft would maintain an altitude of 7,000 feet MSL or above until entering the appropriate descent area. Upon entering the descent area, arrivals to Runway 9L would descend to 4,000 feet and remain at that altitude until within 15 miles of the Airport where they would turn onto the final approach. Arrivals to the inner Runways 9C or 10C would descend to 5,000 or 6,000 feet MSL respectively and remain at these altitudes until within 25 miles of the Airport where they would turn onto the final approaches. In addition, arrivals to the center runways from the southwest would follow a high and wide approach path, proceeding directly to SIMMN and remaining at 12,000 feet MSL or above until entering the descent area and then turning onto the final approach to either Runway 9C or 10C at 11,000 feet MSL. High and wide approaches to Runway 9C would then descend to 5,000 feet MSL 25 miles from the Airport while high and wide approaches to Runway 10C would then descend to 6,000 feet MSL 25 miles from the Airport.

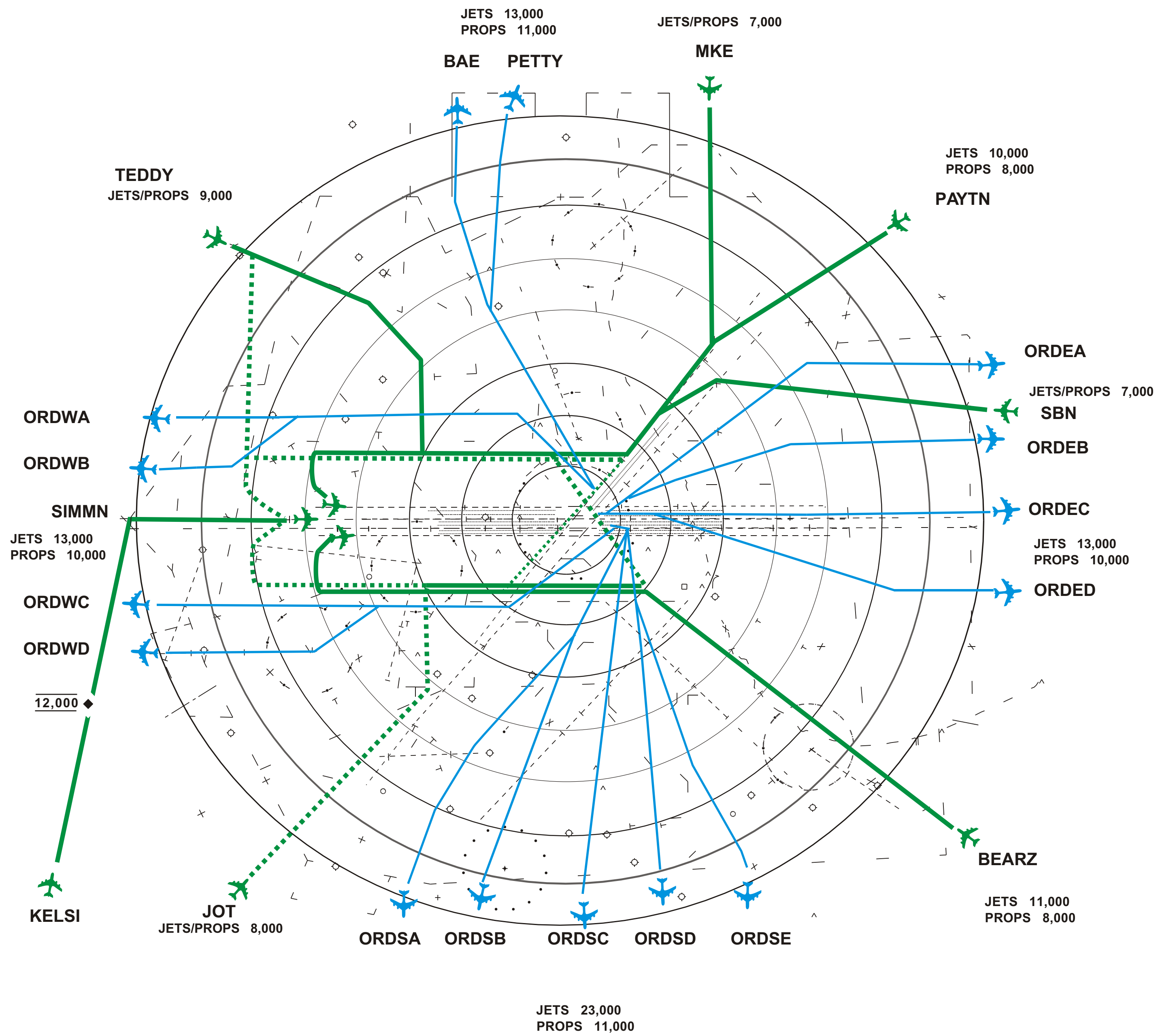
5.5.3.2 Departures

Departures to the northwest (ORDWA or ORDWB) and north (BAE or PETTY) would be assigned to Runway 9R. Departures to the east (ORDEA, ORDEB, ORDEC, or ORDED) would be assigned to Runway 10L. Departures to the south (ORDSA, ORDSB, ORDSC, ORDSD, or ORDSE) and southwest (ORDWC or ORDWD) would be assigned to Runway 10R. Heavy aircraft and other aircraft that require a longer runway length would depart from Runway 10L.

Runway use strategies would be used to balance the airfield demand during periods of peak departures over one or more sets of departures fixes. During peak eastbound traffic periods, traffic over ORDEA or ORDEB could be shifted to Runway 9R. Conversely, during periods of peak westbound demand, traffic over the south fixes could be shifted to Runway 10L.

5.5.3.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-35**. The black arrows depict directional flow on the associated taxiway. Red arrows indicate departure queuing areas. Taxiway A would move traffic in a clockwise direction while Taxiway B would be a counter-clockwise direction taxiway. Aircraft departing on Runway 10L and 9R would use intersection departures from the point indicated on Exhibit V-31. This would allow aircraft landing on Runways 10C and 9C to taxi behind the departures. Aircraft departing on Runway 10R would taxi on Runway 22L to avoid interfering with Runway 10C glide slope and localizer critical areas.



Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-34

north

Primary Arrival Route
Secondary Arrival Route
Departure Route

Airspace Routes
Option 5 - IFR East Flow

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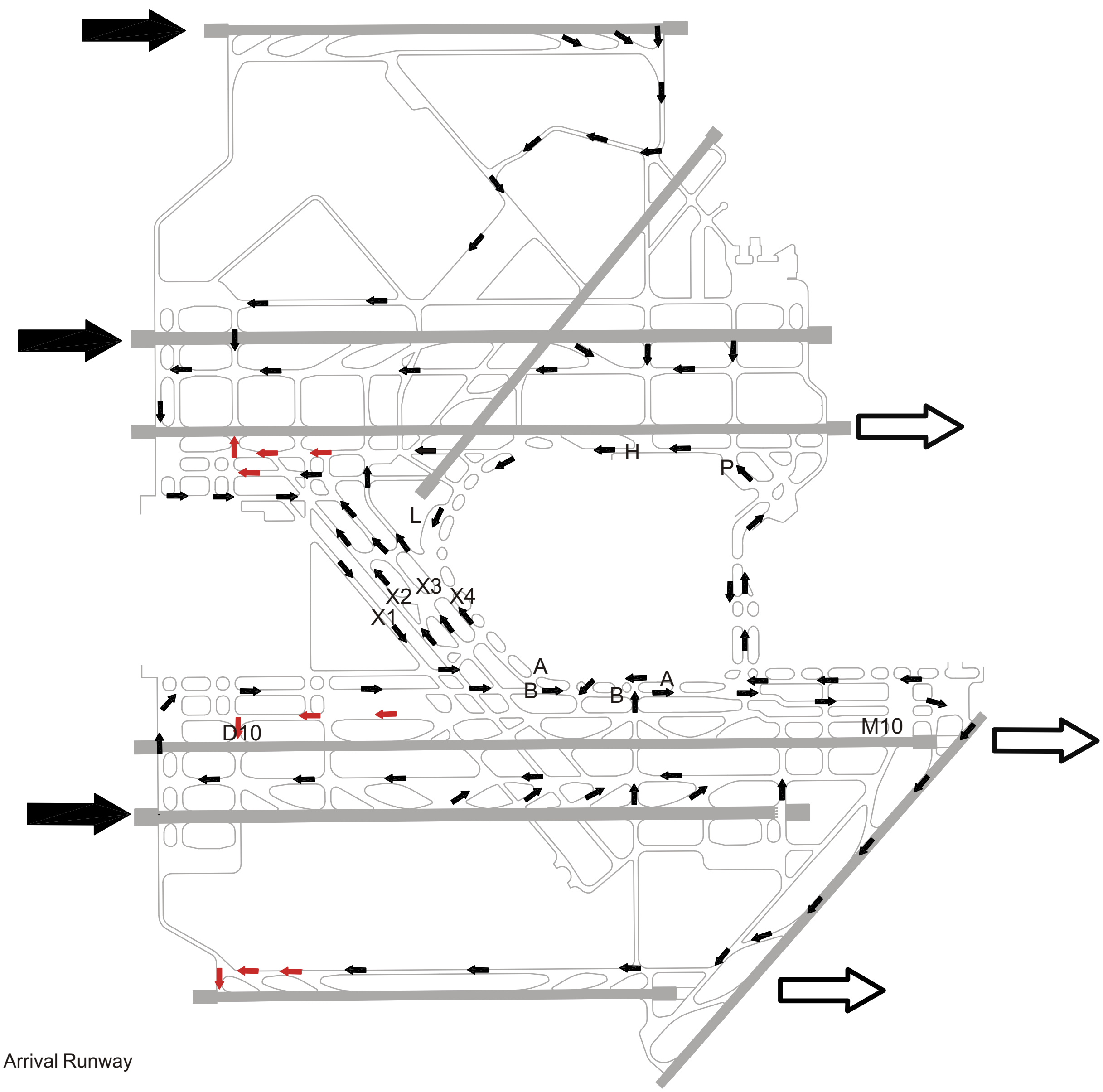

Primary Arrival Runway

Primary Departure Runway

Secondary Arrival Runway

Secondary Departure Runway

Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-35

north

Arrivals and Departures

Departure Queue

Taxiway Routes
Option 5 - IFR East Flow

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5.5.4 IFR West Flow

IFR west flow would consist of arrivals on Runways 27C, 28C, and 27R while Runways 27L, 28R, and 22L would be used for departures. **Exhibit IV-36** depicts the primary arrival and departure flight paths that would be associated with this operating configuration under Option 5.

5.5.4.1 Arrivals

Arrivals from the northeast would be assigned primarily to Runway 27C. During periods of peak arrival demand, arrivals from the northeast could be off-loaded to Runway 27R. Arrivals from the southeast would normally be assigned to Runway 28C and could be off-loaded to Runway 27C. Arrivals from the northwest would normally be assigned to Runway 27R and could be off-loaded to Runway 28C. Traffic arriving from the southwest would normally be assigned to Runway 28C and could be off-loaded to Runway 27R during periods of peak arrival demand.

Arriving aircraft would maintain an altitude of 7,000 feet MSL or above until entering the appropriate descent area. Upon entering the descent area, arrivals to Runway 27R would descend to 4,000 feet and remain at that altitude until within 15 miles of the Airport where they would turn onto the final approach. Arrivals to the inner Runways 27C or 28C would descend to 5,000 or 6,000 feet MSL respectively and remain at these altitudes until within 25 miles of the Airport where they would turn onto the final approaches. Arrivals to the center runways from the southeast could follow a high and wide approach path, proceeding directly from OXI to NEPTS and remaining at 12,000 feet MSL or above until entering the descent area and then turning onto the final approach to either Runway 27C or Runway 28C at 11,000 feet MSL. High and wide approaches to Runway 27C would then descend to 5,000 feet MSL 25 miles from the Airport while high and wide approaches to Runway 28C would then descend to 6,000 feet MSL 25 miles from the Airport.

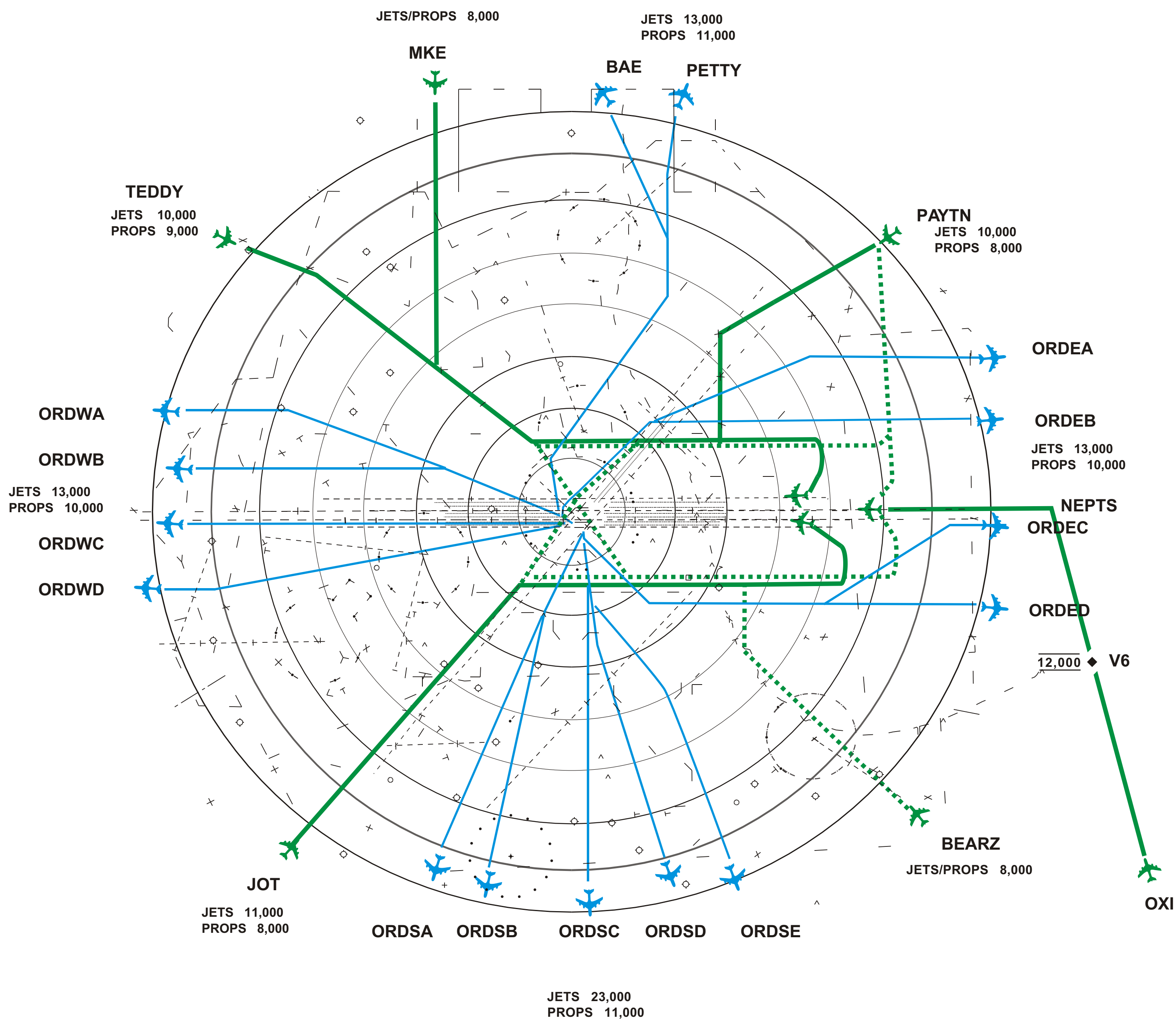
5.5.4.2 Departures

In general, departures to the northeast (ORDEA or ORDEB), north (BAE or PETTY), and northwest (ORDWA or ORDWB) would be assigned to Runway 27L. Departures to the southwest (ORDWC or ORDWD) and south (ORDSA, ORDSB, and ORDSC) would be assigned to Runway 28R. Runway 22L would be used by departures to the south (ORDSD or ORDSE) and southeast (ORDEC or ORDED). Departures that require a longer runway length than provided by Runway 22L would be assigned to Runway 28R.

A number of runway use strategies would be used to balance airfield demand during periods of peak departures over one or more sets of departures fixes. During peak eastbound traffic periods, traffic over ORDWA, ORDWB, ORDSD, or ORDSE could be shifted to Runway 28R to provide additional departure capacity to the other two departures runways for eastbound departures only. Conversely, during periods of peak westbound demand, traffic over the south fixes ORDSA, ORDSB, or ORDSC could be shifted to Runway 22L to provide additional departure capacity on Runway 28R to serve westbound departures.

5.5.4.3 Airfield Circulation

The primary ground movements associated with this configuration are illustrated on **Exhibit V-37**. The black arrows depict directional flow on the associated taxiway. Red arrows indicate departure queuing areas. Taxiway A would move traffic in a counter-clockwise direction while Taxiway B would be a clockwise direction taxiway. Aircraft departing on Runway 27L and 28R would use an intersection departure as indicated in Exhibit V-33 to allow aircraft arriving on Runway 27C and 28C to taxi behind the departures.



Sources: Ricondo & Associates, Inc., C90 TRACON
Prepared by: Ricondo & Associates, Inc.

Exhibit V-36

Airspace Routes
Option 5 - IFR West Flow

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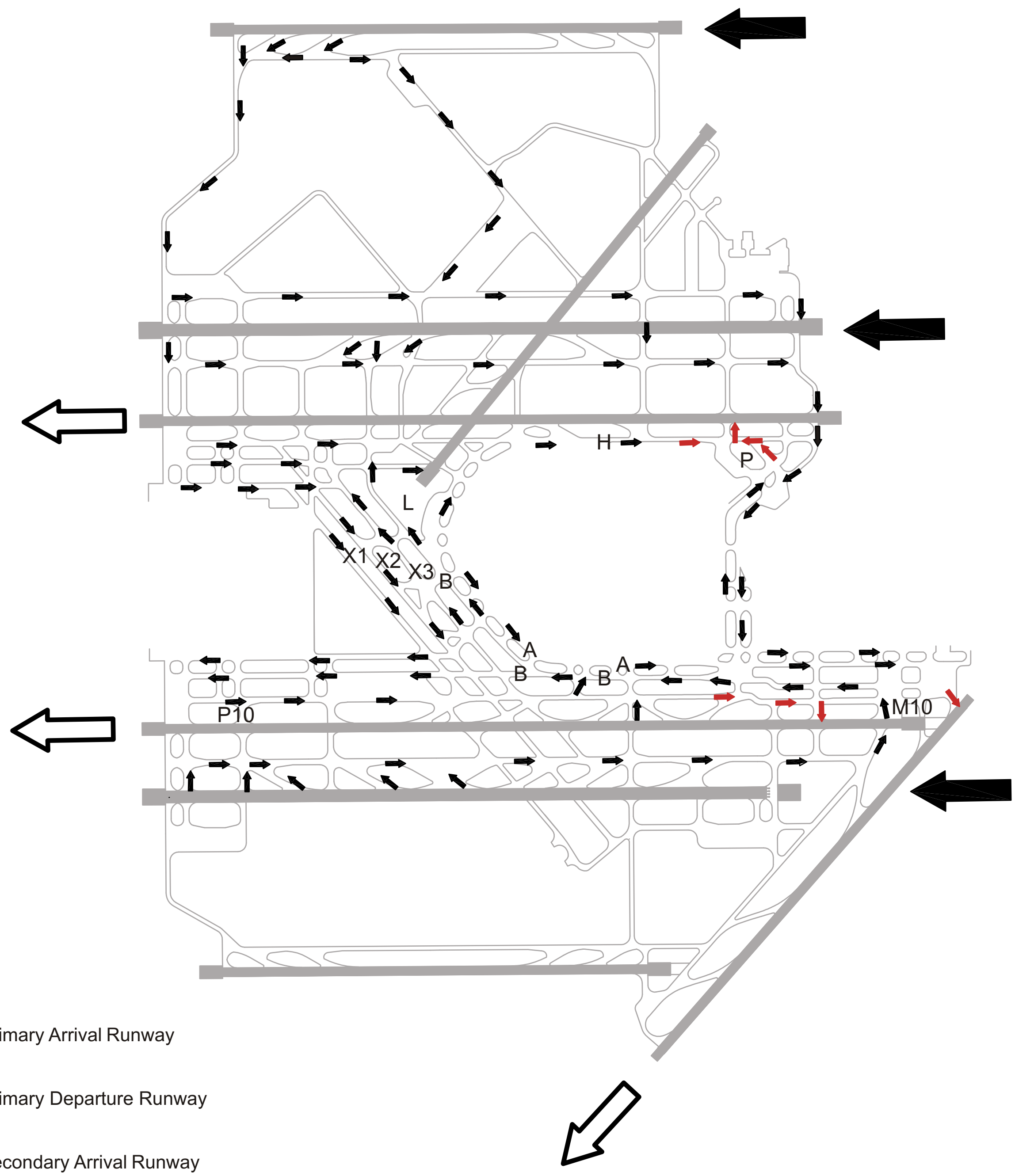

Primary Arrival Runway

Primary Departure Runway

Secondary Arrival Runway

Secondary Departure Runway

Sources: Ricondo & Associates, Inc., ORD ATCT
Prepared by: Ricondo & Associates, Inc.

Exhibit V-37

north

Arrivals and Departures

Departure Queue

Taxiway Routes
Option 5 - IFR West Flow

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VI. Simulation Results

6.1 Operating Characteristics of Alternatives

This section describes the findings of the simulation analysis in terms of operating characteristics, throughput, delay, and travel times. As described in Section IV, *Alternatives Evaluated*, the three airfield layout concepts, Option 1, Option 2, and Option 5, share many of the same attributes and utilize the same proposed airspace structure. Arriving aircraft conceptually would use the existing airspace procedures, i.e., corner-post structure, with some exceptions necessitated by the requirements to route aircraft to the center runways and accommodate additional departure tracks in both the east and west directions.

Generally, the center runways in each scenario would be fed by routing traffic to points approximately 25 NM and 40 NM east or west of the Airport depending on the airfield operating configuration. From these points aircraft would proceed straight in to the intended landing runway. Exhibit V-17 in Section V, *Airfield and Airspace Procedures*, depicted the proposed TRACON airspace as developed by the FAA air traffic team assigned to assist with the airside design and procedures of the OMP. The existing TRACON airspace is shadowed in the background for reference.

Aircraft departing the Airport would continue to exit TRACON airspace along broad departure corridors aligned with the four cardinal directions (i.e., north, east, south, and west). Departures would be positioned in departure corridors consistent with their direction of flight, and would be cleared to altitudes consistent with the current operating environment. The greatest change associated with the new airspace is the establishment of additional departure fixes to the east, south, and west.

East departures that once exited TRACON airspace over two departure fixes, the ELX and GIJ VORs, would depart over four routes under this airspace structure. West departures that once operated in two departure tracks would now depart over four fixes, and south departure routes would increase from the current three to five fixes. The addition of these departures routes would generally result in a more efficient flow of traffic, however, it should be noted that the effects of the additional airspace changes are estimated to be of significantly less impact than the addition of the new runways.

Another more subtle change associated with the OMP airspace is that east departures would be routed both north and south of the arrival descent area simultaneously on west parallel operating configurations. In comparison, east departures currently use a north or south route depending on the runway configuration in use in the existing airspace. Conversely, on east parallel configuration, west departures would be routed north and south of the east flow-descent area simultaneously. Departures destined for cities in the northwestern U.S. and Canada, and some Pacific Rim traffic, would be routed north of the arrival descent area, while traffic destine to cities between Dallas and the Los Angeles basin would be routed south of the decent area.

Based on the information provided by the FAA Great Lakes Region Air Traffic Division, the proposed OMP airspace and procedural environment described above is consistent with current planning associated with the National Airspace Review (NAR), yet, it is not dependent on the implementation of NAR departure fix strategies.

Other shared attributes of the alternatives, include the development of taxi flows that avoid runway crossings to the maximum extent possible. LAHSO procedures and intersection departures are used to facilitate unimpeded movement on the airfield. Each alternative could accommodate simultaneous triple approaches regardless of weather condition.

Qualitative findings associated with each of the studied alternatives are discussed below.

6.1.1 Option 1

Option 1 would allow for the continued use of many of the existing runways. The majority of the operating configurations used today would continue to be used in the future. The two new runways enhance the performance capabilities of many VFR operating configurations. In addition, the shortening of Runways 14R and 14L is viewed as beneficial because it may exclude the need for LAHSO procedures on a number of operating configurations.

However, this alternative lacks departure capability in the IFR east scenario. In east flow, Runways 9L, 9R, and 10L are used as arrival runways. Aircraft depart on Runways 9R and 10R. This disproportional allocation of runway resources results in a departure capacity that is estimated to be 40% below that of the arrival capacity, and a considerable reduction in operational capacity from that of the configuration under VFR conditions.

The development of the west terminal complex may also affect the performance of this alternative. Using existing traffic demand levels, ATCT staff estimates the daily number of runway crossings needed to support movement to and from the west terminal is approximately 900 crossings. ATCT staff believe this number of runway crossings would diminish the operational effectiveness of many configurations, affords too great a potential for runway incursions, and thus, detracts from the feasibility of this alternative.

6.1.2 Option 2

Option 2 provides for a six parallel runway layout orientated in an east-west direction. The layout was specifically developed to allow unrestricted aircraft movement around the ends of arrival and departure runways by establishing perimeter taxiways. The concept requires that Runway 9R be kept at it current length.

Option 2 would result in two major operational deficiencies. The first relates to the geometric layout of Runways 9C and 9R. The runways are approximately 1,600 feet apart with thresholds staggered by approximately 3,600 feet. By air traffic rule, these runways are dependent from a wake turbulence perspective. In other words, should a heavy jet be arriving Runway 9R and a regional jet (RJ) or large jet be departing Runway 9C slightly behind it, it is likely that the RJ or some large jets would become airborne prior to the point where heavy jets would typically land. This would require the application of the two-minute wake turbulence separation/dependency rule. Conversely, should a B-757 be departing Runway 9C and become airborne prior to the Runway 9R touchdown point, the next arrival on Runway 9R would have to be spaced five miles or two minutes behind the departing B-757. This complex wake turbulence interaction greatly reduces the potential operational throughput of these two runways.

The second issue relates to the viability of using perimeter taxiways as a means of maintaining unrestricted ground movements. In the Spring of 2002, the FAA Great Lakes Region Office Flight Standards Division, AGL-200, requested an interpretation from the Flight Technologies and Procedures Division, AFS-400 on this issue. AFS-400 clarified the FAA's operational criteria to be utilized when considering perimeter taxiways in a memorandum dated August 22, 2002. Based on the criteria described in this memorandum, the perimeter taxiways in Option 2 would be treated as controlled crossings. A copy of this memorandum is attached as Appendix A.

6.1.3 Option 5

Option 5, like Option 2, provides six parallel runways orientated in an east-west direction. Option 5 provides for triple approaches with balanced departure and arrival capacity under all weather conditions. It allows for the use of quadruple approaches under VFR conditions to accommodate peak arrival demands, and (although not modeled) potentially quadruple IFR approaches with FAA site-specific approval. LASHO procedures and intersection departure strategies would be used to facilitate unimpeded ground movements, thereby minimizing runway crossings to the maximum extent possible.

One issue with Option 5 relates to the use of Runway 10R for departures in the IFR east scenario. Runway 10R is a 7,500 foot runway located at the far south end of the Airport. In the IFR east scenario, some west and southbound departures would be assigned Runway 10R. Due to the location of the glide slope critical area, aircraft en route to Runway 10R must cross the departure course of Runway 10L. Potential opportunities for improving this situation are currently under study.

Based on the operating characteristics of the alternatives, Options 1 and 5 were carried through for detailed simulation. Results of those analyses are discussed in the following sections.

6.2 Simulation Throughput

Throughput rates (numbers of arriving and departing aircraft in peak hours) were assessed based on the simulation analysis of the Base Case (Existing Airfield) and Options 1 and 5. The maximum throughput rates observed during simulation are presented in **Table VI-1**.

It should be noted that throughput rates may not reflect true airfield capacity as simulation throughput rate is an interaction between airfield capacity and operational demand reflected by scheduled operations. Only if demand were balanced between arrival and departure operations for the duration of one hour or more would simulation throughput approximate balanced airfield capacity. This is unlikely to occur in everyday operations due to schedule banking that results in distinct periods of high arrival or departure demand, but rarely both simultaneously.

Table VI-1

Simulation Throughput Rates (operations per hour)

Airfield Layout	Operating Configuration	Weather	Peak Arrivals	Peak Departures	Peak Total Operations
Base Case	Plan X	VFR	112	136	216
	Plan W	VFR	118	112	213
	Plan B	VFR	105	123	206
	Plan B Modified	VFR	117	107	213
	Parallel 27s	IFR	83	109	183
	Parallel 14s	IFR	76	92	168
Option 1	East Flow	VFR	116	129	238
	West Flow	IFR	103	120	203
Option 5	East Flow	VFR	142	144	274
	West Flow	VFR	144	150	270
	East Flow	IFR	117	127	234
	West Flow	IFR	117	125	232

Sources: ORD ATCT staff, Ricondo & Associates. Inc.
Prepared By: Ricondo & Associates, Inc.

6.3 Aircraft Delays and Operating Times

"Delay" is the additional operating time attributable to congestion at an airport, where congestion constitutes any impediment to the free flow of aircraft and/or people through the system. Delay reductions to aircraft operations resulting from the increased airside capacity/efficiency offered by the proposed improvements are the primary benefits considered in this analysis. Some delay reductions are partially offset by increases in taxi or airspace operating time. Therefore, for comparisons between alternatives, both delay benefits as well as overall changes in travel time are evaluated. Changes in overall travel time may be used in estimating the annual cost savings associated with each option.

Primary outputs from each simulation analysis include average aircraft delay statistics for airspace and ground operations, and operating times. Delay and operating time statistics for each simulation analysis are available in Appendix C. Results of individual analyses were combined at each demand level based on the weighted percent of annual use associated with each analysis for the existing facilities and procedures and for each of the alternatives evaluated. The combined delay statistics for each Option are shown in **Table VI-2**.

Table VI-2

Average Aircraft Delay

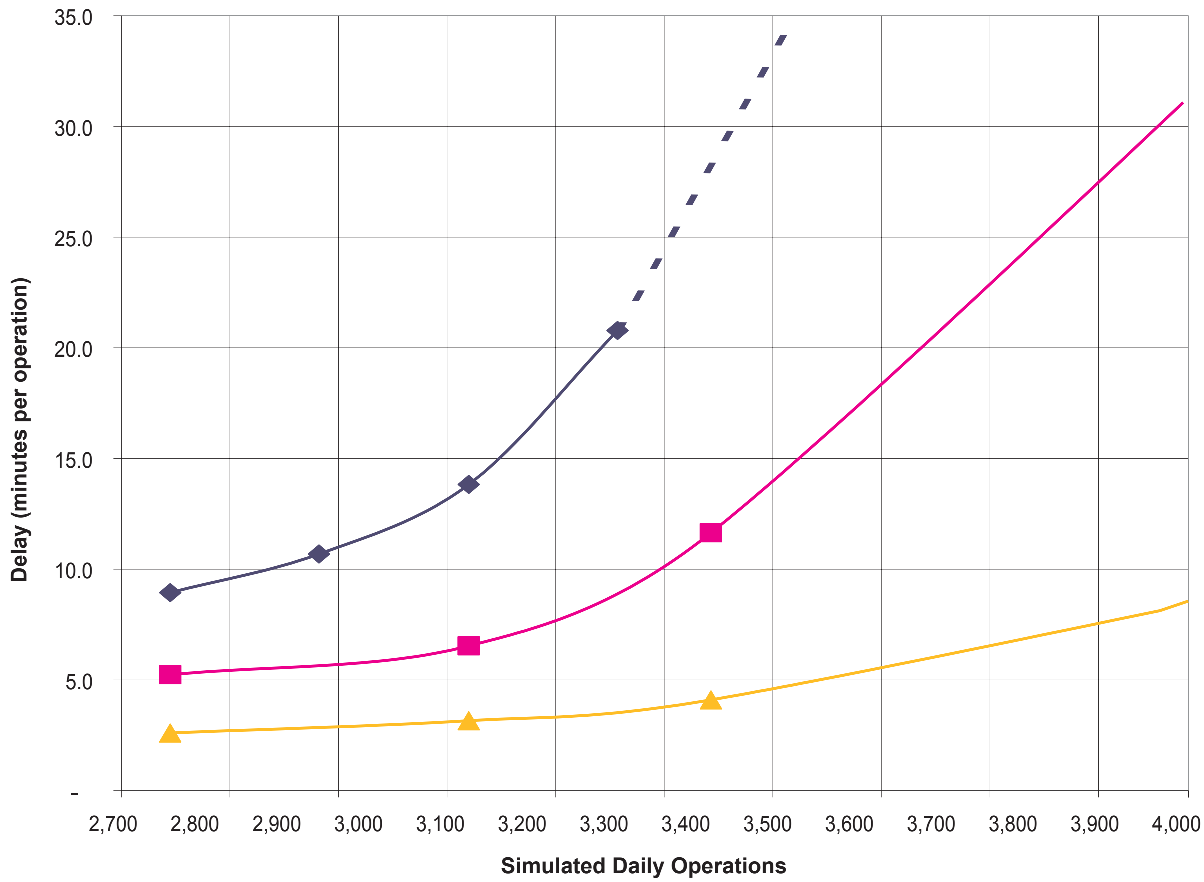
Option	Demand Level[1]	Daily Operations Simulated	Annual Operations	Average Aircraft Delay (minutes per operation)			
				Gate	Taxi-Out/In	Airborne	Total
Base Case	PAL 0	2,745	912,000	2.8	3.0	3.1	8.9
Base Case	PAL 0+5%	2,882	1,003,000	3.5	3.7	3.4	10.7
Base Case	PAL 0+10%	3,020	1,048,000	4.9	4.8	4.1	13.8
Base Case	PAL 0+15%	3,157	1,094,000	9.7	5.9	5.2	20.8
Option 1	PAL 0	2,745	912,000	2.0	1.8	1.5	5.2
Option 1	PAL 0+10%	3,020	1,048,000	2.2	2.2	2.2	6.5
Option 1	PAL 1	3,243	1,123,000	3.1	4.5	4.0	11.6
Option 1	PAL 2	3,864	1,332,000	8.4	12.2	19.0	39.6
Option 5	PAL 0	2,745	912,000	0.5	1.1	1.0	2.6
Option 5	PAL 0+10%	3,020	1,048,000	0.6	1.3	1.3	3.2
Option 5	PAL 1	3,243	1,123,000	0.7	1.7	1.7	4.1
Option 5	PAL 2	3,864	1,332,000	1.6	4.2	4.5	10.2

1. PAL 0 is the design day schedule developed from August 20, 2001 aircraft operations.

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

The delays associated with the existing facilities and procedures and with each of the modeled options are depicted in **Exhibit VI-1**. Flow control techniques were simulated for airspace conditions during IMC by holding arrivals at the origin airports. These delays are included in gate delay statistics.

The existing runway configuration (Base Case) analyses showed excessive delay levels or gridlock at the PAL 1 and PAL 2 levels. Therefore, the average travel times for PAL 0 (2,745 operations) and PAL 0+10% (3,020 operations) are considered in lieu of the PAL 1 and PAL 2 delays. These travel times are the only directly comparable travel time statistics between the options for total travel times throughout the entire airspace system. This is due to the differences in the airborne travel times that result from the change in schedule assumptions (i.e., increased international operations as explained in Section 2.1, and therefore, significantly increased flight distances) rather than by changes due to the new runway configuration. To remove the effect of these longer routes in the PAL 1 and 2 schedules, an average unimpeded airborne travel time was calculated for each of the options at the PAL 0 and 0+10% demand levels. This average unimpeded airborne travel time was then substituted in Option 1 and Option 5 at the PAL 1 and PAL 2 demand levels in place of the actual unimpeded airborne travel times in these options. The average unimpeded airborne travel time calculations are shown in **Table VI-3**.



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit VI-1

Base Case
Option 5
Option 1
Base Case Curve Fit

Average Aircraft Delay Per Operation

Table VI-3

Average Unimpeded Airspace Travel Time Calculation

Option	Demand Level	Daily Operations Simulated	Airborne Travel Time (min)	Airborne Delay (minutes per operation)	Unimpeded Airborne Travel Time (min)
Base Case	PAL 0	2,745	123.0	3.1	119.8
Base Case	PAL 0+5%	2,882	124.2	3.4	120.8
Base Case	PAL 0+10%	3,020	124.4	4.1	120.3
Base Case	PAL 0+15%	3,157	125.8	5.2	120.6
Option 1	PAL 0	2,745	122.2	1.5	120.7
Option 1	PAL 0+10%	3,020	122.4	2.2	120.2
Option 1	PAL 1	3,243	140.7	4.0	136.7
Option 1	PAL 2	3,864	163.5	19.0	144.5
Option 5	PAL 0	2,745	120.7	1.0	119.7
Option 5	PAL 0+10%	3,020	121.1	1.3	119.8
Option 5	PAL 1	3,243	137.2	1.7	135.5
Option 5	PAL 2	3,864	152.7	4.5	148.2
Average Unimpeded Airborne Travel Time (min):					
Base Case					120.4
Option 1 (PAL 0 and PAL 0 + 10% only)					120.5
Option 5 (PAL 0 and PAL 0 + 10% only)					119.8

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

By using the average unimpeded airborne travel times from the PAL 0 and 0+10% demand levels in place of the unimpeded airborne travel times in the Option 1 and Option 5 total travel times at the PAL 1 and PAL 2 demand levels, the effects of longer average routes in future schedules are eliminated. This allows a direct comparison of total travel times with the Base Case. The adjusted total travel times for each of the options evaluated are shown in **Table VI-4**.

Table VI-4

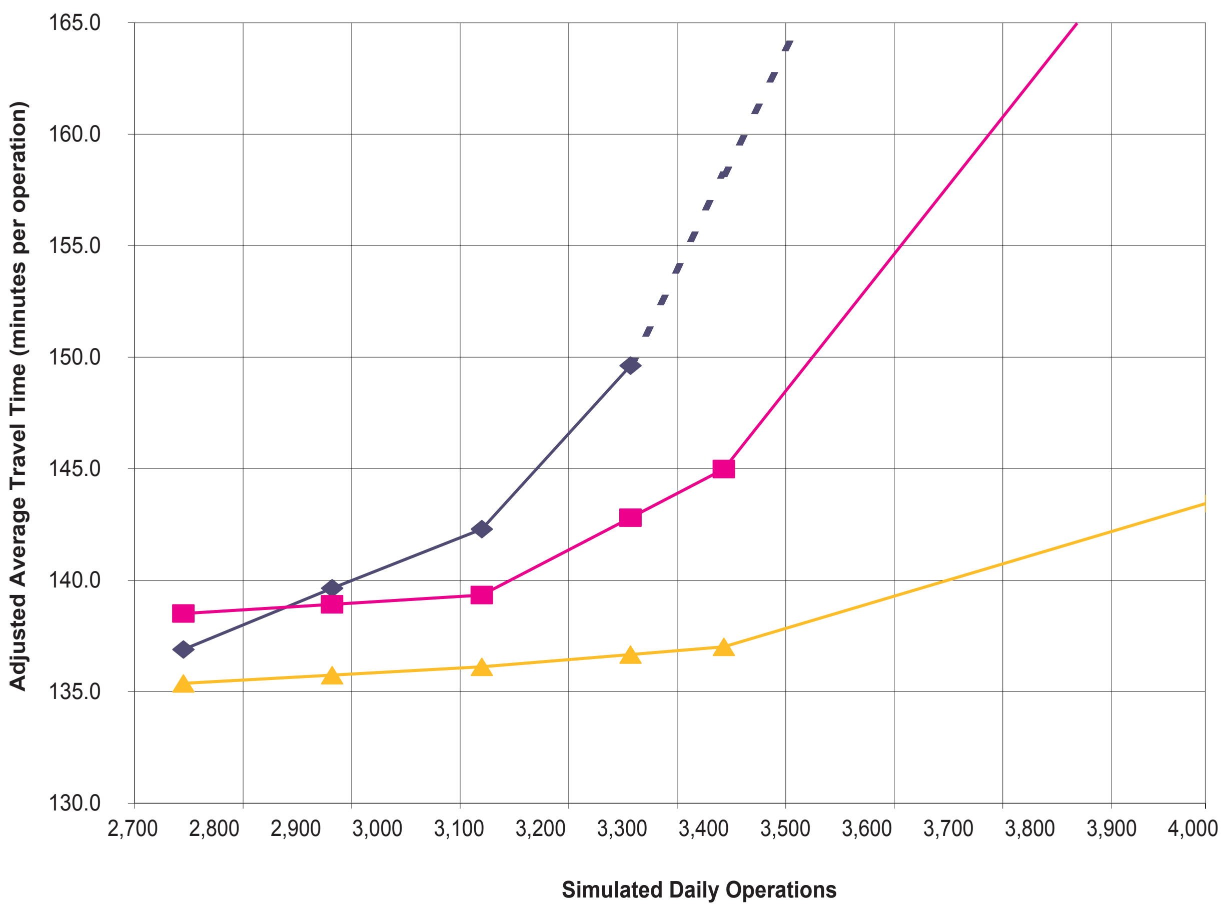
Adjusted Average Aircraft Travel Time

Option	Demand Level	Daily Operations Simulated	Annual Operations	Adjusted Average Aircraft Travel Time (minutes per operation)			
				Gate	Taxi-Out/In	Airborne	Total
Base Case	PAL 0	2,745	912,000	2.8	11.2	123.0	136.9
Base Case	PAL 0+5%	2,882	1,003,000	3.5	11.9	124.2	139.6
Base Case	PAL 0+10%	3,020	1,048,000	4.9	12.9	124.4	142.3
Base Case	PAL 0+15%	3,157	1,094,000	9.7	14.1	125.8	149.6
Extrapolated travel times for Base Case							
Base Case	PAL 1	3,243	1,123,000	17.0	14.9	126.3	158.2
Base Case	PAL 2	3,864	1,332,000	69.1	20.8	130.2	220.2
Option 1	PAL 0	2,745	912,000	2.0	14.3	122.2	138.5
Option 1	PAL 0+5%	2,882	1,003,000	2.1	14.6	122.3	138.9
Option 1	PAL 0+10%	3,020	1,048,000	2.2	14.8	122.4	139.3
Option 1	PAL 0+15%	3,157	1,094,000	2.7	16.4	123.7	142.8
Option 1	PAL 1	3,243	1,123,000	3.1	17.4	124.5	145.0
Option 1	PAL 2	3,864	1,332,000	8.4	24.1	139.5	172.0
Option 5	PAL 0	2,745	912,000	0.5	14.2	120.7	135.4
Option 5	PAL 0+5%	2,882	1,003,000	0.6	14.3	120.9	135.7
Option 5	PAL 0+10%	3,020	1,048,000	0.6	14.4	121.1	136.1
Option 5	PAL 0+15%	3,157	1,094,000	0.6	14.7	121.3	136.7
Option 5	PAL 1	3,243	1,123,000	0.7	14.8	121.5	137.0
Option 5	PAL 2	3,864	1,332,000	1.6	17.6	124.2	143.4

Notes:
1. The PAL 0+5% and PAL 0+15% travel times for Options 1 and 5 were interpolated between PAL 0, PAL 0+10%, and PAL 1 travel times, respectively.
2. Average unimpeded airborne travel time from Option 1 at PAL 0% and PAL 0+10% demand levels were utilized as a proxy for unimpeded airborne travel time. Air delay was then added to this unimpeded time to obtain the total average airborne time.
3. Average unimpeded airborne travel time from Option 5 at PAL 0 and PAL 0+10% demand levels were utilized as a proxy for unimpeded airborne travel time. Air delay was then added to this unimpeded time to obtain the total average airborne time.

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Average aircraft travel times for gate operations represent the gate delay and not the total time an aircraft occupies a gate. This gate time also includes the time that aircraft bound for the Airport are delayed on the ground at their departure airports due to flow control programs at O'Hare International Airport. The adjusted average aircraft travel times are depicted in **Exhibit VI-2**.



Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

Exhibit VI-2

Adjusted Average Aircraft Travel Time

Based on the adjusted average travel times shown in Table VI-4, the average time savings or (increases) for Options 1 and 5 in comparison to the Base Case were calculated. These average aircraft time savings that result from runway improvements are shown in **Table VI-5**.

Table VI-5

Average Aircraft Travel Time Savings

				Average Travel Time Savings or (Increases) (minutes per operation)			
Option	Demand Level	Daily Operations Simulated	Annual Operations	Gate	Taxi-Out/In	Airborne	Total
Option 1	PAL 0	2,745	912,000	0.8	(3.2)	0.7	(1.6)
Option 1	PAL 0+5%	2,882	1,003,000	1.5	(2.7)	1.9	0.7
Option 1	PAL 0+10%	3,020	1,048,000	2.8	(1.8)	2.0	3.0
Option 1	PAL 0+15%	3,157	1,094,000	7.0	(2.2)	2.1	6.8
Option 1	PAL 1	3,243	1,123,000	13.9	(2.4)	1.8	13.2
Option 1	PAL 2	3,864	1,332,000	60.7	(3.3)	(9.3)	48.2
Option 5	PAL 0	2,745	912,000	2.3	(3.0)	2.3	1.5
Option 5	PAL 0+5%	2,882	1,003,000	3.0	(2.4)	3.3	3.9
Option 5	PAL 0+10%	3,020	1,048,000	4.3	(1.5)	3.3	6.2
Option 5	PAL 0+15%	3,157	1,094,000	9.1	(0.6)	4.4	13.0
Option 5	PAL 1	3,243	1,123,000	16.3	0.1	4.8	21.2
Option 5	PAL 2	3,864	1,332,000	67.6	3.2	5.9	76.7

Source: Ricondo & Associates, Inc.
Prepared by: Ricondo & Associates, Inc.

6.4 Findings

Simulation results presented in this section suggest that both Options 1 and 5 would result in higher throughput rates, delay reduction, and lower travel times when compared to the Base Case. The simulation results also suggest that the throughput would be higher, the delay reduction greater, and the travel times lower with Option 5 when compared with Option 1. It should also be noted that Option 1 reaches excessive delays in VFR East configuration and gridlock in IFR West configuration between PAL 1 and PAL 2 demand levels while the base case configurations reach excessive delays and gridlock between PAL 0+10% and PAL 0+15% demand levels.

APPENDIX A

U.S. Department
of Transportation
Federal Aviation
Administration

Memorandum

Subject: **ACTION**: Separating Arriving and Departing Aircraft from Aircraft Operating on Airport Surfaces

Date: AUG 2 2 2002

From: Manger, Flight Technologies and Procedures Division, AFS-400

Reply to Attn. of:

To: Manager, Flight Standards Division, AGL-200

This is in response to your request for headquarters guidance concerning flight operations over a proposed end around taxiway at Chicago-O'Hare International Airport, KORD.

A. Regardless of taxiway configuration, the basic traditional standard that should be applied for separating arriving and departing aircraft from taxiing aircraft is Title 14 of the Code of Federal Regulation (14 CFR), section 91.119 (c). This rule states in pertinent part, except when **necessary** for takeoff or landing [emphasis added] over open water or sparsely populated areas, no person may operate an aircraft closer than 500 feet to any person, vessel, vehicle, or structure. In the past, this has been described as the "500 foot bubble" rule and has been applied to airport traffic pattern operations. 14 CFR 91.119 and its predecessors are one of the most frequently violated operating rules resulting in a voluminous amount of legal enforcement action, including much case law. Though challenged many times in legal proceedings up to and including the U. S. Circuit Court of Appeals, the basic separation standards set forth in this rule have prevailed for decades. Waivers and exemptions to the "500 foot bubble" rule are rarely granted.

B. Compliance with this rule results in the following ground taxi operation restrictions.

1. Ground taxi operations less than 6,000 feet from runway end. At 6,000 feet from the runway end or displaced threshold, aircraft on approach would cross 364 feet above taxiway. Aircraft continuing with the departure with one engine inoperative would cross the 6,000 foot point from the runway end at 96 feet assuming 14 CFR sections 121.189 and 25.111 requirements are met. Therefore, in this area, taxiing aircraft must be positively controlled to cross the extended runway centerline. Required hold lines should meet International Civil Aviation Organization (ICAO) requirements.

2. Ground taxi operations 6,000 feet or more but less than 9,000 feet from runway end. At 9,000 feet from the runway end or displaced threshold, aircraft on approach would cross 521 feet above the taxiway. Aircraft continuing with the departure with one engine inoperative would cross the 9,000 foot point from the runway end at 144 feet assuming 14 CFR sections 121.189 and 25.111 requirements are met. At 9,000 feet (1.5 nautical miles) from the runway end, it is reasonable to assume an aircraft departing with one engine inoperative and the taxiing aircraft could still maneuver sufficiently to clear each other by 500 feet. Therefore, in this area, taxiing aircraft may cross the extended runway centerline without clearance but cannot stop between hold lines. Hold lines based on ICAO requirements are mandatory for contingency use.

3. Ground taxi operations 9,000 feet or more from the runway end. Taxi operations can proceed unrestricted.

C. The foregoing assumes essentially level airport terrain. If a taxiway's elevation was significantly higher or lower than the runway in question, adjustments would need to be applied. In addition, local Flight Standards and Airports Divisions must agree on the airport surface markings and signage standards to apply to these operations.

D. In addition to the 14 CFR 91.119 (C) consideration, the following traditional issues should be addressed:

1. Advisory Circular 150-5300-13, Airport Design, contains guidance on safety areas, obstacle free zones, runway obstacle free areas, runway protection zones, threshold siting standards, jet blast of departing aircraft, and declared distance applications;

2. The protection of various terminal instrument procedures (TERPS) surfaces;

3. Ground based navigation aid (glide slope and localizer antennae, nondirectional beacon, VHF omni directional range, etc.) critical areas;

4. 14 CFR part 77 obstruction lighting requirements;

5. Visual approach slope indictor or precision approach path indicator obstacle identification surfaces;

6. Wake vortex effects under the flight paths;

7. Flight inspection "clear view" requirements; and,

8. Operational safety issues to avoid unwarranted pilot actions (aborted takeoff), unnecessary air traffic control communications, human factor workload issues, etc.

We hope this information is helpful.

John W. McGraw

APPENDIX B

U.S. Department
of Transportation
**Federal Aviation
Administration**

Great Lakes Region
Illinois, Indiana, Michigan,
Minnesota, North Dakota,
Ohio, South Dakota,
Wisconsin

2300 East Devon Avenue
Des Plaines, Illinois 60018

Rec DEC 19 2002

Mr. Chris Arman
City of Chicago
Department of Aviation
P.O. Box 66142
O'Hare International Airport
Chicago, IL 60666

Dear Mr. Arman:

The attached document represents air traffic input on three options for runway configurations at O'Hare Airport presented by the City of Chicago. These were selected from an initial group of six options reviewed by the air traffic team and the city's contractor, Ricondo and Associates. Our team was comprised of FAA management and NATCA representatives from the tower, TRACON and center, and in joint agreement they have forwarded this information for your review.

The document provides operational/procedural input for each option. Advantages and disadvantages are identified and basic arrival/departure capacities are compared for each option. Arrival and departure rates and associated delay components are very basic computations and should not be substituted for high fidelity modeling. These findings are therefore preliminary in nature. We anticipate working closely with other Lines of Business (LOB) in the FAA and the City of Chicago O'Hare Modernization Program (OMP) office to complete a more detailed analysis of the formal Airport Layout Plan (ALP) when it is submitted by the City of Chicago.

It is important to note that while we support the addition of new runways at O'Hare we recommend that removal of existing runways be assessed from an operational/procedural standpoint throughout the project phasing. This will ensure the highest levels of efficiency will be maintained during the life cycle of this program.

Should you have any questions regarding the information presented please contact Mr. Denis Burke, Manager, Airspace Branch at 847-294-7477.

Sincerely,

Nancy B. Shelton
Manager, Air Traffic Division

Executive Summary

The City of Chicago has announced an airport plan to reduce poor weather delays by 95% and reduce overall delays by 79% at Chicago O'Hare International Airport. At the request of the Chicago Department of Aviation (DOA) the FAA's Air Traffic Division identified an operational team from O'Hare Tower, Chicago TRACON and Chicago Center to provide technical input concerning the City's proposal. The air traffic team working with the DOA's contractor Ricondo and Associates initially reviewed six possible airport configurations. Three of these options were identified as the most desirable by the DOA.

The FAA team studied the three options providing operational/procedural input on:

1) Runway and taxiway traffic flows.
2) Arrival and departure traffic patterns.
3) Delay comparison for each of the options.
4) Option One phasing: one initial new runway versus two new runways.

The traffic comparisons contained in this study are very basic computations of demand and capacity within each 15 minute period throughout the day for the top two predicted performing IFR and VFR configurations in each of the three airfield layout options. Any excess demand above the capacity is rolled into the successive available capacity periods. Three traffic levels were identified for comparison purposes. Existing traffic levels are based on actual traffic realized on August 20, 2001. PAL01 traffic is traffic predicted to occur in year 2015, and PAL02 traffic is based on predictions of traffic for the year 2030. Source information for the forecast of these traffic levels is available in the Airfield Modernization Discussion Outline dated April 30, 2002.

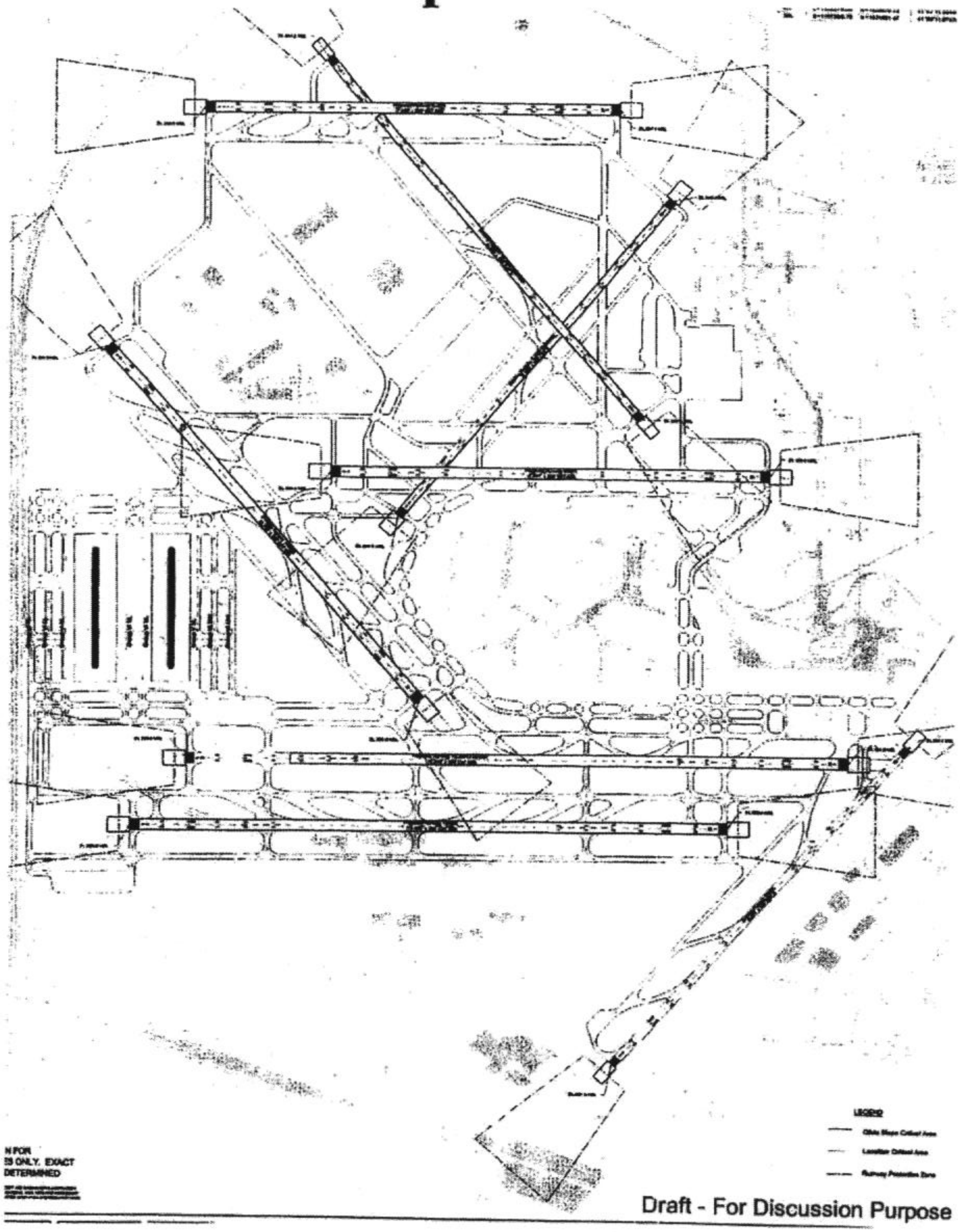
It is assumed that the Department of Aviation will conduct high fidelity modeling to confirm all preliminary findings gathered during this joint effort with the DOA and its contractors.

Facts:

- All options are feasible at varying degrees of efficiency and capacity.
- Option 1 with two additional runways provides 2 sets of parallel east west runways. This option provides an increase in annualized capacity of approximately 12%.
- Option 1 with one additional runway provides 3 parallel east west runways. This option provides an increase in annualized capacity of approximately 6%.
- Option 2 provides an increase in annualized capacity of approximately 13%.
- Option 5 provides an increase in annualized capacity of approximately 22%.

The following discussion will address those issues, comparing three different traffic levels, against each of the above possibilities.

Option 1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Draft - For Discussion Purpose

Option 1

Advantages:

- This option provides continued use of the existing runway layout.
- Reducing the length of Runways 14R and 14L will decouple operations dealing with ongoing Land and Hold Short Operations (LAHSO) problems.
- Perimeter taxiways were added to the west side of Runway 9R/27L, providing access to the closely spaced parallel runway.
- World Gateway taxiway enhancements are included in all three options presented.
- Extending Runway 14L to the northwest will allow for LAHSO operations to hold short of Runway 4L/22R is also shown on this option.

Disadvantages:

- The addition of the west terminal in this option has reduced the ability to provide aircraft to departure runways and terminals without a significant increase in runway crossings.
- Traffic on the M taxiway is restricted by the close proximity of the taxiway to the end of the runway (Runway 14R Safety Area). Operations through this area must be considered runway crossings.
- One flow of traffic (arrivals or departures) must cross Runway14R at taxiway T10 or T1.
- Restrictions by the Flight Standards division require the perimeter taxiway around the approach end of Runway 10L/28R to be place more than 9000' west of the threshold. This requirement eliminates the unrestricted taxi flows and invalidates assumptions used in movements of aircraft.
- In some runway configurations under this layout, Runway 14R is used as a taxiway crossing under the 9C arrival course. The Flight Standards decision extends to this configuration (less than 9000' from the threshold of 9C). All operations from Runway 9L would then require runway crossing to arrive at any terminal on the airport.
- Under current FAA requirements, a Rejected Landing Procedure (RLP) would be required to utilize 14L LAHSO with either arrivals on Runway 22R or departures on Runway 4L. To date, there have been no approved RLP's.
- Under Option 1, only one additional runway, during east configurations, there are no runways 10,000' or longer for departure traffic.
- Additional spacing requirements above and beyond the spacing originally indicated will be necessary to allow movement of at least one aircraft across an arrival runway (at each necessary location) for each arrival on restricted runways. An increase of spacing between ½ to 1 mile will be necessary on Runway 14R to accommodate the crossings necessary at T10 and M. This spacing will reduce the arrival capacity on that runway from 40 to 32 per hour.
- Discussions beginning on June 25 indicate that there will be somewhere near 80 gates at the west terminal. Further discussions have indicated this may be closer

to 50 gates. Existing gates on the airport number approximately 130. This would then equate to a 38% increase in gates. Assuming full utilization of all gates throughout the airport, we can then reason that somewhere around 38% of the traffic generated on the airport would begin and end in the west terminal. Runway crossing would be necessary for 2/3 of the arrivals going into this terminal on some configurations, and also 2/3 of the departures. This would equate to (using existing traffic levels) 930 runway crossings per day, with another 930 runway crossing to get into the terminal.

Option 1, 2 Additional Runways
Delay Reduction from Existing Airfield

	VFR East	VFR West	IFR East	IFR West
PAL0 Traffic				
% Aircraft Reduction	71%	85%	19%	40%
% Minutes Reduction	71%	85%	84%	74%
PAL1 Traffic				
% Aircraft Reduction	70%	81%	2%	81%
% Minutes Reduction	76%	84%	60%	74%
PAL2 Traffic				
% Aircraft Reduction	44%	51%	2%	46%
% Minutes Reduction	83%	89%	46%	19%

Explanations:

PAL0 – Existing traffic levels from August 20, 2001
PAL1 – Planned Activity level for year 2015
PAL2 – Planned Activity level for year 2030
VFR East – Best east operating configuration under Option 1, VFR conditions
VFR West – Best west operating configuration under Option 1, VFR conditions
IFR East – Best east operating configuration under Option 1, IFR conditions
IFR West – Best west operating configuration under Option 1, IFR conditions

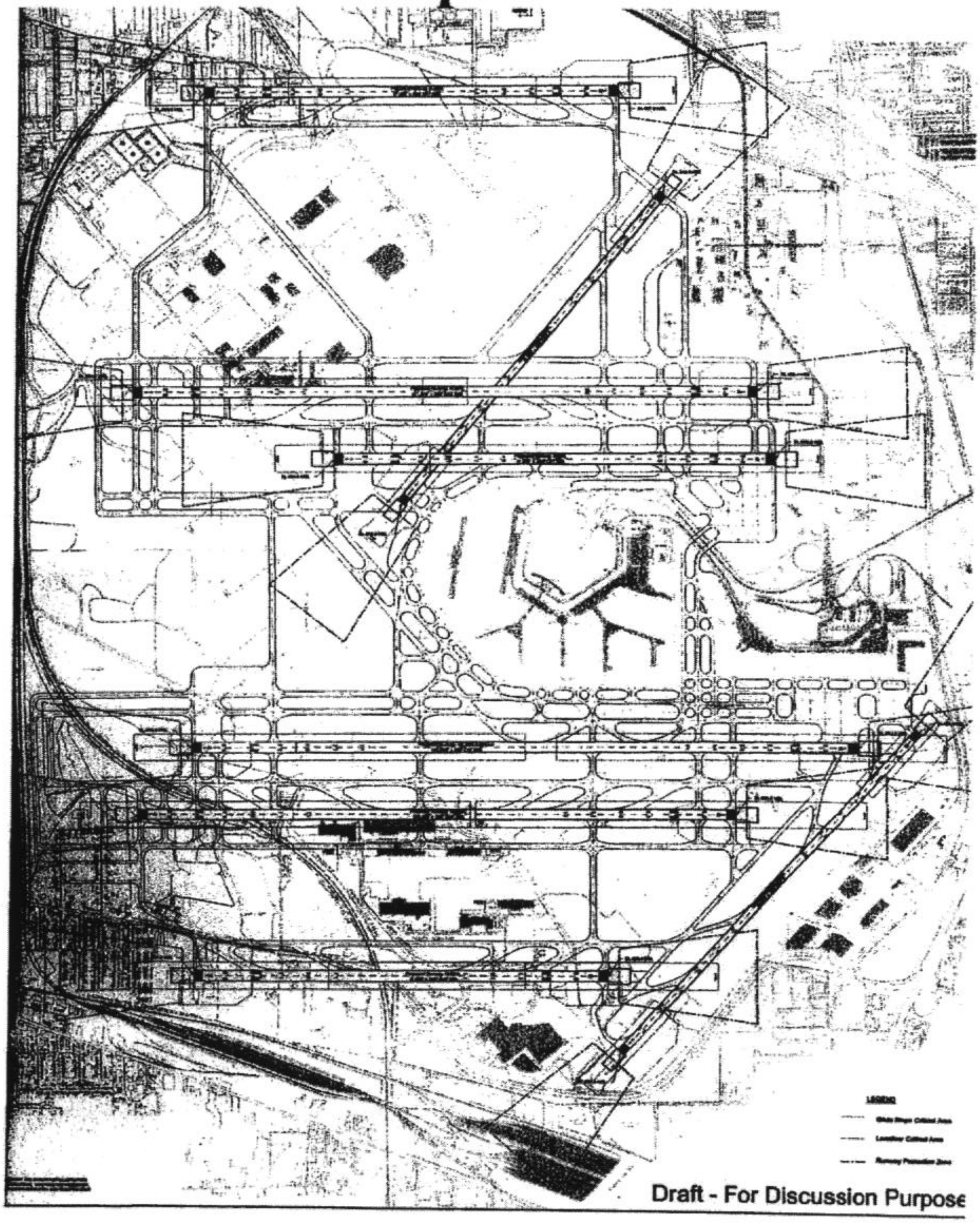
Option 1, 1 Additional Runway
Delay Reduction from Existing Airfield

	VFR East	VFR West	IFR East	IFR West
PAL0 Traffic				
% Aircraft Reduction	71%	0%	1%	20%
% Minutes Reduction	71%	0%	28%	20%
PAL1 Traffic				
% Aircraft Reduction	70%	0%	1%	37%
% Minutes Reduction	76%	0%	18%	29%
PAL2 Traffic				
% Aircraft Reduction	44%	0%	0%	2%
% Minutes Reduction	83%	0%	13%	22%

Explanations:

PAL0 – Existing traffic levels from August 20, 2001
PAL1 – Planned Activity level for year 2015
PAL2 – Planned Activity level for year 2030
VFR East – Best east operating configuration under Option 1, VFR conditions
VFR West – Best west operating configuration under Option 1, VFR conditions
IFR East – Best east operating configuration under Option 1, IFR conditions
IFR West – Best west operating configuration under Option 1, IFR conditions

Option 2



Option 2

Advantages:

- Option 2 provides the unrestricted movement of aircraft through the area formerly Runway 14R.
- The western terminal becomes a non-issue, since aircraft can pass on M and the T10 extension without regard to aircraft arrivals or departures on runways.
- Aircraft movements west of the departure end of Runway 27C , 27R, and 28R would not be slowed or stopped by aircraft arriving those runways.

Disadvantages:

- Aircraft arriving on either the outboard 27 must cross either; a) through the localizer critical area for 27C, or; b) through the departure area for Runway 27C.
- Aircraft would be passing through the departure course for Runway 28R.
- The decision by FAA Flight Standards negated the ability to pass unrestricted under the flight path of Runway 9R with Runway 9C departures until 9000' west of Runway 9R.
- Traffic flows indicate that there would be a substantial wake turbulence problem with Runway 9R arrivals and Runway 9C departures. It is reasonable to assume that Runway 9C departures would be in some form of flight approximately 4000' down the runway from the threshold of the runway. Normal touchdown points on runways, enhanced with Glide Slopes that lead aircraft to these points, are approximately 1000' from the threshold of the runway. Matching these two points on diagrams of Option 2 indicates that both aircraft would be airborne at the same time in almost all cases, when using these closely spaced parallel runways simultaneously, or even in staggered operations. Current air traffic rules require a two minute delay for an arrival with a departing heavy or B757 on Runway 9C, or a two minute delay for a departure with a B757 or heavy jet on Runway 9R. While difficult to get accurate numbers, it is estimated that approximately 1/3 of the aircraft that operate in and out of O'Hare fit this classification of aircraft. It is then reasonable to assume that 1/3 of the arrivals on Runway 9R and 1/3 of the departures on Runway 9C would be either B757 or heavy jet aircraft. In looking at these restrictions on arrivals and departures, it rapidly becomes apparent that 9R should not be considered as an arrival runway, since at some point, the aircraft waiting to depart 9C would back into the terminal.
- Many aircraft will be unable to depart Runway 9R without some form of lengthening. Without lengthening, additional spacing on Runway 9C arrivals to accommodate Runway 9C departure requests. At this time, it is not reasonable to assume that a circling/sidestep approach can be used from Runway 9C to Runway 9R, as aircraft waiting to depart would be located within the Runway Protection Zone (RPZ) for Runway 9R, while waiting to depart Runway 9C. At this time, given the current projection of the layout for this configuration, it is unknown

whether aircraft could be located on the threshold of Runway 9C when landing Runway 9R.

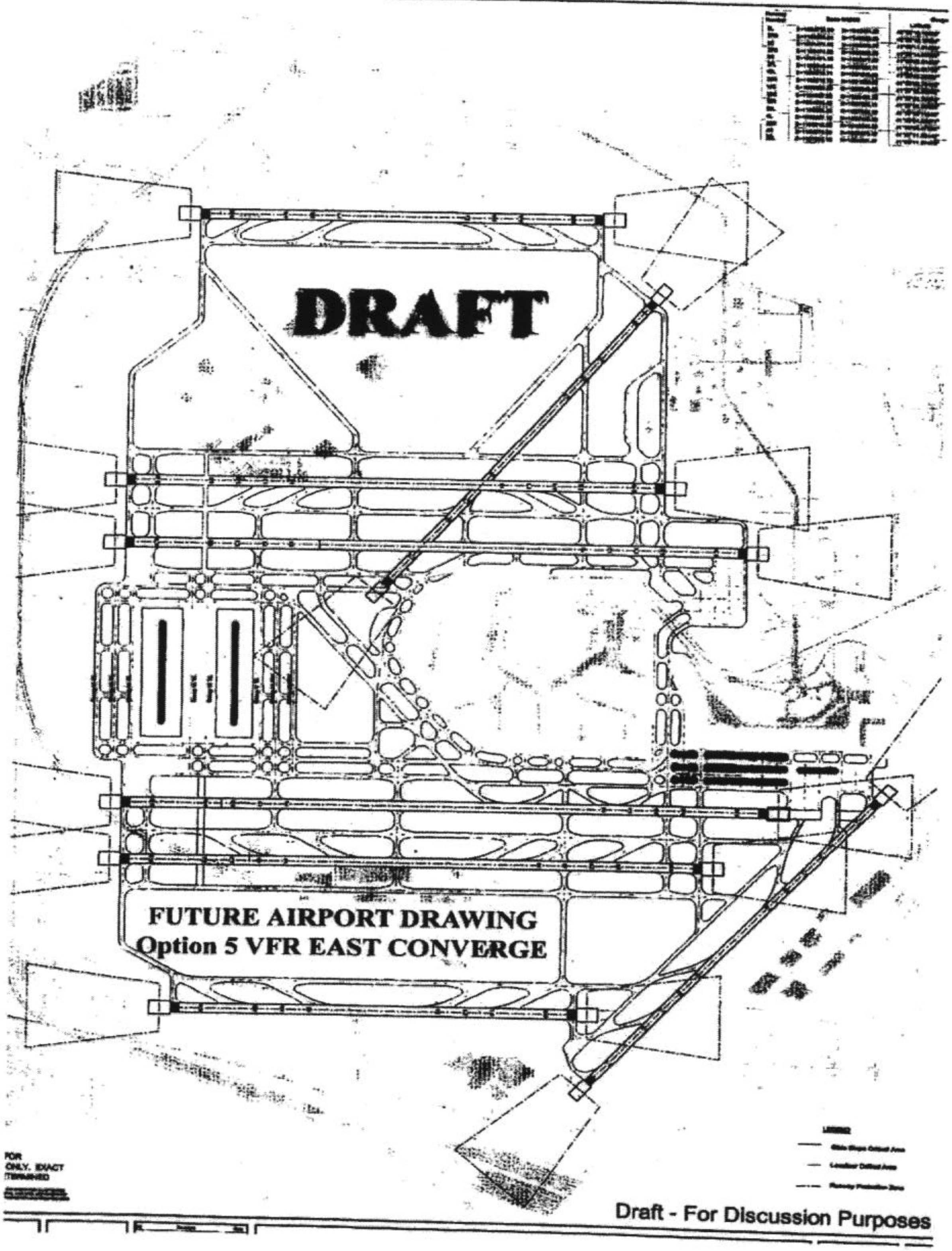
Delay Reduction from Existing Airfield

	VFR East	VFR West	IFR East	IFR West
PAL0 Traffic				
% Aircraft Reduction	71%	85%	47%	84%
% Minutes Reduction	71%	85%	84%	88%
PAL1 Traffic				
% Aircraft Reduction	70%	78%	37%	50%
% Minutes Reduction	76%	82%	72%	94%
PAL2 Traffic				
% Aircraft Reduction	44%	61%	9%	9%
% Minutes Reduction	83%	91%	61%	67%

Explanations:

PAL0 – Existing traffic levels from August 20, 2001
PAL1 – Planned Activity level for year 2015
PAL2 – Planned Activity level for year 2030
VFR East – Best east operating configuration under Option 2, VFR conditions
VFR West – Best west operating configuration under Option 2, VFR conditions
IFR East – Best east operating configuration under Option 2, IFR conditions
IFR West – Best west operating configuration under Option 2, IFR conditions

Option 5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FUTURE AIRPORT DRAWING
Option 5 VFR EAST CONVERGE
Draft - For Discussion Purposes

Option 5

Advantages:

- This option provides the best access to runways using intersection runway departures, and also LAHSO rules currently being used. If LAHSO ceases to exist, traffic flows exist to lessen the impact of active runway crossings.
- IFR capacities increase over all other configurations.

Disadvantages:

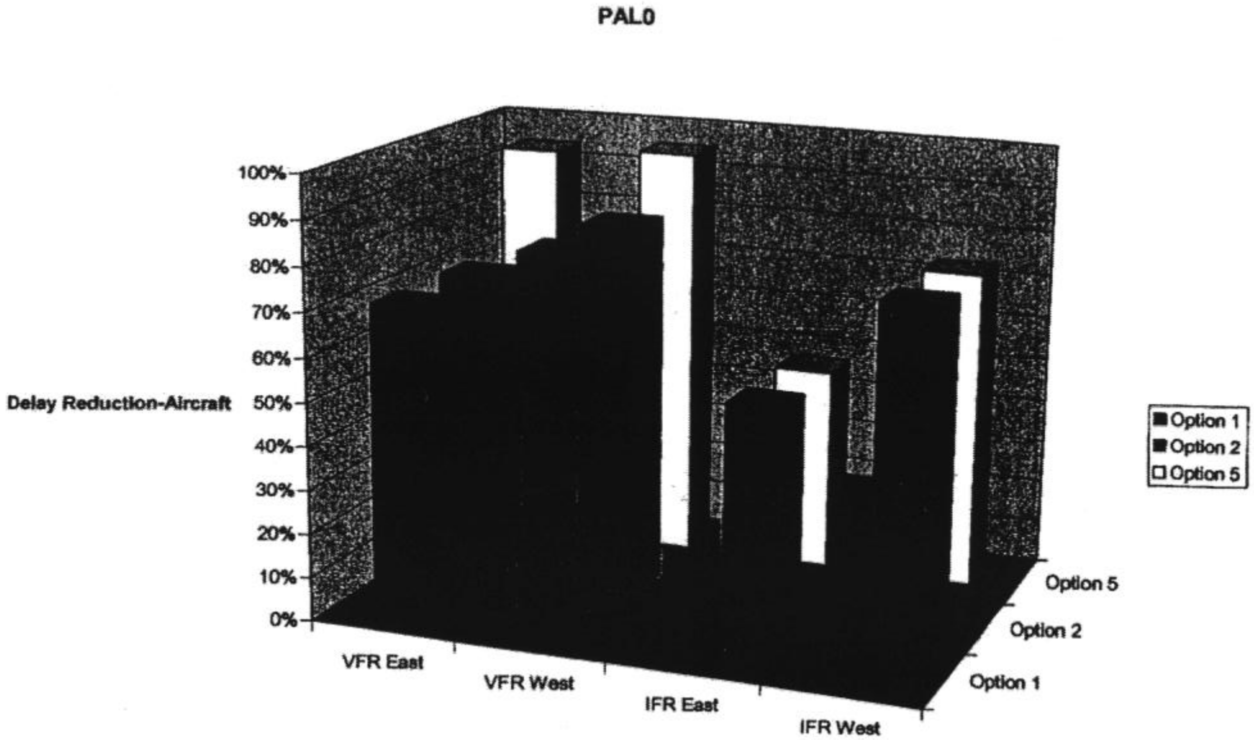
- While this configuration provides the best delay reduction out of the configurations studied, it does not provide adequate capacity during IFR East conditions to prevent significant delay numbers.
- Quadruple approaches (quads) would not be available with weather conditions below 5500/10.
- During IFR weather landing to the east, access to Runway 10R under the current layout is prohibited. Aircraft either to or from this runway would need to pass through the Glide Slope critical area or the Localizer Critical area for Runway 9C.

Delay Reduction from Existing Airfield

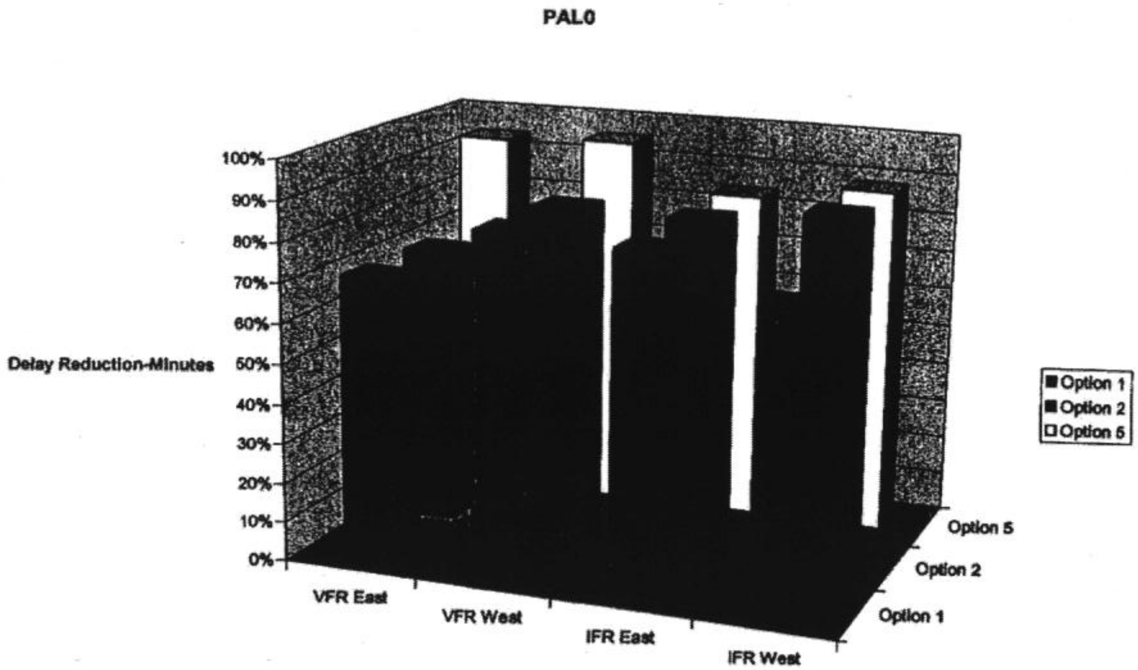
	VFR East	VFR West	IFR East	IFR West
PAL0 Traffic				
% Aircraft Reduction	94%	96%	47%	74%
% Minutes Reduction	94%	96%	84%	88%
PAL1 Traffic				
% Aircraft Reduction	89%	90%	37%	50%
% Minutes Reduction	91%	92%	72%	94%
PAL2 Traffic				
% Aircraft Reduction	84%	81%	9%	9%
% Minutes Reduction	95%	96%	61%	67%

Explanations:

PAL0 – Existing traffic levels from August 20, 2001
PAL1 – Planned Activity level for year 2015
PAL2 – Planned Activity level for year 2030
VFR East – Best east operating configuration under Option 5, VFR conditions
VFR West – Best west operating configuration under Option 5, VFR conditions
IFR East – Best east operating configuration under Option 5, IFR conditions
IFR West – Best west operating configuration under Option 5, IFR conditions



PAL 0. Delay reduction, measured in number of aircraft, by configuration and option.

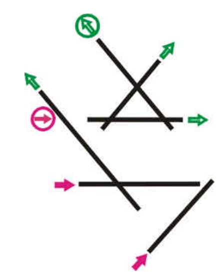
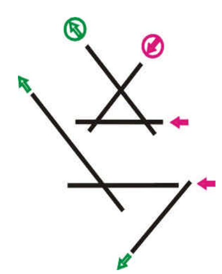
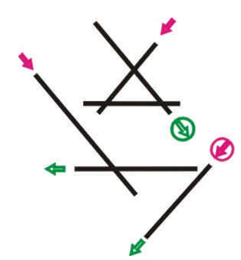
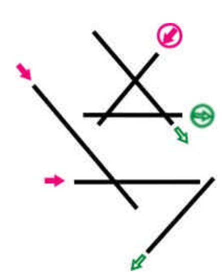


PAL 0. Delay reduction, measured in minutes, by configuration and option.

APPENDIX C

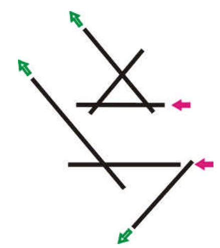
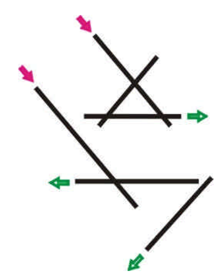
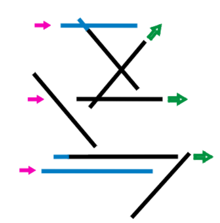
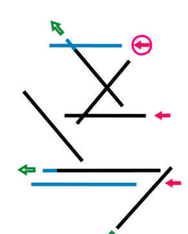
Appendix C
OMP ALP Update Airside Simulation Experimental Results

Existing Runways — Proposed Runways — Primary Arrivals — Overflow Arrivals — Primary Departures — Overflow Departures

Experiment	Runway Option	Weather	Flow	Runway Configurations	Runway Diagram	Percent Utilization	Demand Level	Operations	Average Delay (minutes per aircraft)				Average Operating Time (minutes per aircraft)				Comments
									Gate	Taxi-Out/In	Airborne	Total	Gate	Taxi-Out/In	Airborne	Total	
1	Existing	VFR	East	Plan X		42.8%	Calibration		2.0	2.8	2.1	6.9	2.0	10.9	120.7	133.6	VFR calibration case.
							2001	2,745	2.0	2.8	2.1	6.9	2.0	10.9	120.7	133.6	
							2001 + 5%	2,873	3.2	3.2	2.0	8.4	3.2	11.3	121.6	136.0	
							2001 + 10%	3,020	5.6	4.1	2.5	12.2	5.6	12.1	121.4	139.1	
							2001 + 15%	3,156	12.0	4.8	2.7	19.6	12.0	12.8	122.0	146.8	
2	Existing	VFR	West	Plan W		30.8%	2001	2,745	2.4	3.0	1.3	6.6	2.4	10.9	119.8	133.0	Runway 32L departures from T10 except for those aircraft requiring full runway length.
							2001 + 5%	2,873	2.8	4.2	1.6	8.5	2.8	12.2	121.0	135.9	
							2001 + 10%	3,020	2.9	4.9	1.7	9.5	2.9	13.0	120.9	136.8	
							2001 + 15%	3,156	5.9	5.6	2.5	13.9	5.9	13.8	121.8	141.5	
3	Existing	VFR	South	Plan B		4.4%	2001	2,745	3.3	5.2	8.4	16.9	3.3	14.1	126.8	144.2	
							2001 + 5%	2,873	3.8	4.3	8.8	16.9	3.8	13.1	127.7	144.7	
							2001 + 10%	3,020	5.8	8.7	10.7	25.2	5.8	18.0	129.9	153.7	
							2001 + 15%	3,156	8.2	9.0	17.1	34.3	8.2	18.5	135.5	162.2	
3A	Existing	VFR	South	Plan B Modified		12.7%	2001	2,745	0.5	4.7	3.5	8.7	0.5	13.2	121.3	135.0	
							2001 + 5%	2,873	0.5	5.9	3.9	10.3	0.5	14.7	122.3	137.6	
							2001 + 10%	3,020	0.6	7.7	4.3	12.5	0.6	16.3	122.3	139.2	
							2001 + 15%	3,156	7.1	11.8	4.4	23.3	7.1	20.6	122.6	150.3	

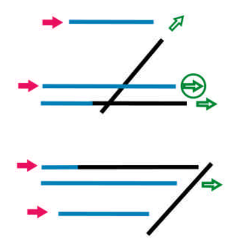
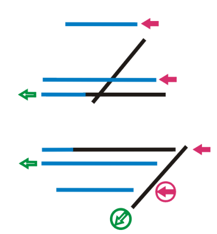
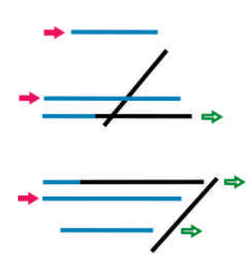
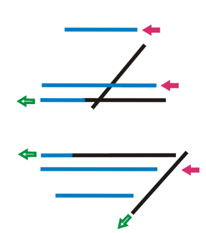
Appendix C
OMP ALP Update Airside Simulation Experimental Results

Existing Runways — Proposed Runways — Primary Arrivals — Overflow Arrivals — Primary Departures — Overflow Departures

Experiment	Runway Option	Weather	Flow	Runway Configurations	Runway Diagram	Percent Utilization	Demand Level	Operations	Average Delay (minutes per aircraft) Gate	Average Delay Taxi-Out/In	Average Delay Airborne	Average Delay Total	Average Operating Time (minutes per aircraft) Gate	Average Operating Time Taxi-Out/In	Average Operating Time Airborne	Average Operating Time Total	Comments
6	Existing	CAT I IFR	West	Parallel 27's		4.1%	Calibration		0.5	0.9	5.8	7.1	0.5	8.2	127.9	136.6	Runway 32L departures from T10 except for those aircraft requiring full runway length.
							2001	2,745	16.1	1.1	21.0	38.2	16.1	8.7	141.1	165.8	IFR calibration case.
							2001 + 5%	2,873	18.5	1.1	24.2	43.8	18.5	8.7	146.1	173.3	Representative of all CAT I IFR configurations.
							2001 + 10%	3,020	22.8	0.9	31.6	55.3	22.8	8.5	153.5	184.8	
							2001 + 15%	3,156	26.3	1.0	38.9	66.2	26.3	8.5	162.4	197.2	
7	Existing	CAT II/III IFR	East	Parallel 14's		5.2%	20011	1,933	5.9	1.4	3.4	10.6	5.9	9.7	146.9	162.4	[1]Assume minimums below 200 foot ceiling and 1/2 mile visibility. Reduced demand level due to CAT II/III operating conditions.
							2001 + 5%[1]	2,030	6.5	1.7	4.1	12.3	6.5	10.0	149.3	165.8	
							2001 + 10%[1]	2,126	7.2	2.3	4.4	13.9	7.2	10.5	148.0	165.7	Representative of all CAT II/III IFR configurations.
							2001 + 15%[1]	2,222	8.5	3.3	6.1	17.9	8.5	11.6	150.9	171.0	
8B	Option 1	VFR	East	Plan B No LASHO		90.7%[2]	2001	2,745	2.1	1.5	1.1	4.7	2.1	14.1	122.0	138.2	[2]Representative of all VFR configurations.
							2001 + 10%	3,020	2.3	1.8	1.4	5.5	2.3	14.4	121.7	138.4	
							PAL 1	3,243	3.3	3.2	2.7	9.2	3.3	16.1	139.5	158.9	
							PAL 2	3,864	11.2	6.4	12.6	30.2	11.2	19.6	162.1	192.9	
11	Option 1	CAT I IFR	West	Parallel 27's		9.3%[3]	2001	2,745	0.9	4.2	5.0	10.0	0.9	16.3	124.7	141.9	Excessive delays and gridlock at PAL 2 demand levels.
							2001 + 10%	3,020	0.8	6.2	9.9	16.9	0.8	18.5	128.9	148.3	[3]Representative of all CAT I IFR configurations.
							PAL 1	3,243	0.8	17.6	17.4	35.8	0.8	30.2	152.4	183.5	

Appendix C
OMP ALP Update Airside Simulation Experimental Results

Existing Runways (black line) Proposed Runways (blue line) Primary Arrivals Overflow Arrivals Primary Departures Overflow Departures

Experiment	Runway Option	Weather	Flow	Runway Configurations	Runway Diagram	Percent Utilization	Demand Level	Operations	Average Delay (minutes per aircraft)				Average Operating Time (minutes per aircraft)				Comments
									Gate	Taxi-Out/In	Airborne	Total	Gate	Taxi-Out/In	Airborne	Total	
28	Option 5	VFR	East	Parallel 9's		32.2%	2001	2,745	0.3	0.9	0.6	1.8	0.3	15.1	120.1	135.5	
							2001 + 10%	3,020	0.3	1.1	0.7	2.1	0.3	15.3	119.6	135.2	
							PAL 1	3,243	0.3	1.5	1.3	3.1	0.3	15.6	136.8	152.7	
							PAL 2	3,864	0.4	4.4	1.9	6.7	0.4	18.7	150.2	169.2	
30	Option 5	VFR	West	Parallel 27's		58.5%	2001	2,745	0.3	1.1	0.9	2.2	0.3	13.3	120.3	133.9	
							2001 + 10%	3,020	0.3	1.2	1.0	2.5	0.3	13.5	121.1	134.9	
							PAL 1	3,243	0.4	1.6	1.5	3.4	0.4	14.0	136.8	151.1	
							PAL 2	3,864	0.4	3.7	4.5	8.6	0.4	16.5	152.4	169.3	
32	Option 5	CAT I IFR	East	Parallel 9's		4.8%	2001	2,745	2.3	2.0	2.9	7.2	2.3	17.2	123.2	142.6	
							2001 + 10%	3,020	2.7	3.3	3.9	9.8	2.7	18.6	123.4	144.8	
							PAL 1	3,243	3.8	3.7	5.5	13.0	3.8	18.8	141.3	163.8	
							PAL 2	3,864	12.3	6.4	13.8	32.5	12.3	21.6	162.9	196.8	
33	Option 5	CAT I IFR	West	Parallel 27's		4.0%	2001	2,745	3.3	1.5	4.5	9.4	3.3	15.2	124.9	143.4	
							2001 + 10%	3,020	4.1	1.7	7.1	13.0	4.1	15.4	127.0	146.5	
							PAL 1	3,243	4.4	2.6	3.8	10.9	4.4	16.4	139.9	160.8	
							PAL 2	3,864	14.7	6.6	13.0	34.4	14.7	20.9	162.2	197.8	

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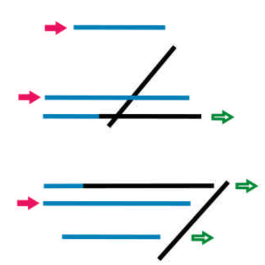
OMP ALP Update Airside Simulation Experimental Results

Existing Runways — Proposed Runways — Primary Arrivals — Overflow Arrivals — Primary Departures — Overflow Departures

Experiment	Runway Option	Weather	Flow	Runway Configurations	Runway Diagram	Percent Utilization	Demand Level	Operations	Average Delay (minutes per aircraft)				Average Operating Time (minutes per aircraft)				Comments
									Gate	Taxi-Out/In	Airborne	Total	Gate	Taxi-Out/In	Airborne	Total	
34	Option 5	CAT II/III IFR	East	Parallel 9's		0.5%	2001	1,933	1.2	0.7	1.1	3.1	1.2	16.5	147.4	165.1	
							2001 + 10%	2,126	1.4	1.0	1.2	3.5	1.4	16.7	147.2	165.4	
							PAL 1	2,462	1.6	1.7	3.2	6.5	1.6	16.9	158.7	177.2	
							PAL 2	3,362	6.0	3.9	9.3	19.2	6.0	19.3	172.6	198.0	

Notes:
IFR: CAT I conditions occur when the ceiling is at or above 200 feet and at or below 1,000 feet and/or visibility is at or above 1/2 statute mile and at or below 3 statute miles.
CAT II/III conditions occur when the ceiling is below 200 feet and/or the visibility is below 1/2 statue miles.

Source: Ricondo & Associates, Inc., January 2003.