APPENDIX D
AIRFIELD AND AIRSPACE MODELING

This appendix contains background material that provides information on the Total Airspace and Airport Modeler (TAAM)[1] version evaluation material and data developed by the Chicago Department of Aviation (CDA) with the direction, oversight, review, and approval by the Federal Aviation Administration (FAA). This material supports the Terminal Area Plan and Air Traffic Procedures (TAP) Environmental Assessment (EA) and its alternatives. This appendix consists of the following sections:

- **D.1** Introduction
- **D.2** TAAM Calibration (see **Attachment D-1**)
- **D.3** FAA Review of Air Traffic Assumptions and TAAM Simulations
- **D.4** Weather Analysis and Operating Configurations (see **Attachment D-6**)
- **D.5** TAAM Operational Forecast

This appendix has seven attachments:

- **Attachment D-1** Appendix A – 2018 O'Hare TAAM Model Calibration
- **Attachment D-2** TAP EA Simulation Data Package – Interim No Action
- **Attachment D-3** TAP EA Simulation Data Package – Build Out No Action
- **Attachment D-4** TAP EA Simulation Data Package – Interim Proposed Action
- **Attachment D-5** TAP EA Simulation Data Package – Build Out Proposed Action
- **Attachment D-6** Appendix B – Weather Analysis and Annualization
- **Attachment D-7** Appendix D – Chicago O'Hare Fly Quiet Program Manual

D.1 INTRODUCTION

TAAM is a computer model that simulates aircraft activity on the ground and in the air. It is capable of modeling gates, taxiways, and runways, along with arrival and departure routes in the air, for a flight schedule. Each runway configuration is modeled for the complete flight schedule and the results for each configuration are combined to provide an average day set of results. These results provide detailed inputs for the noise, air quality, and surface traffic analyses**. Sections D.2** through **D.5** of this appendix describe the use of TAAM for this EA in more detail.

D.2 TAAM CALIBRATION

TAAM was previously used for the simulation models for the 2019 Interim Fly Quiet Written Re-Evaluation of the O'Hare Modernization Program (OMP) Environmental Impact Statement (EIS); it was first developed

[1] TAAM is a product of Jeppesen.

for the 2005 OMP EIS and used for the 2015 Re-Evaluation of the OMP EIS. For this EA, TAAM underwent an iterative process of data collection/analysis, TAAM modeling, animation review, and simulation output metric analysis to verify that the TAAM models reflect real-world operating conditions specific to O'Hare. The calibration effort included evaluation of runway throughput, runway use, arrival taxi in times, departure taxi out times, standoff use, and percentage of day and night operations. This effort produced four calibrated TAAM models as the basis for the EA. A summary of the calibration effort and resulting simulation assumptions is attached as **Attachment D-1**.

D.3 FAA REVIEW OF AIR TRAFFIC ASSUMPTIONS AND TAAM SIMULATIONS

An FAA Air Traffic Workgroup reviewed the TAAM simulation assumptions and experiments supporting the environmental consequences analyses for the EA. The FAA Air Traffic Workgroup, consisting of senior FAA air traffic representatives from Chicago Air Traffic Control facilities (O'Hare Air Traffic Control Tower, Chicago TRACON, and Chicago Center), reviewed and approved all configurations modeled through TAAM. Central Service Center and Chicago Airports District Office representatives also participated in the workgroup.

The process for the TAAM simulations for the EA followed the method used in the original EIS simulations completed in 2003-04, 2014-15 simulations for the 2015 Re-Evaluation, and 2018 simulations for the Interim Fly Quiet Re-Evaluation. The work, conducted by Ricondo & Associates (City of Chicago consultant), was carried out under the FAA's direction, oversight, review, and approval.

The workgroup provided and reviewed operating assumptions including but not limited to airspace routings, taxi routings, runway/fix assignments, and throughput numbers. Each simulation experiment included animations that displayed the planned operation of aircraft at the airport and in the airspace. During each review session, the workgroup reviewed the animations and results. Any issues or inconsistencies with the TAAM animations were discussed with Ricondo & Associates, who then made appropriate modifications to the experiments and later delivered the results for additional review and ultimate approval. This process was completed for each configuration.

The simulation process consisted of the following steps for each condition:

- A 24-hour design day flight schedule (DDFS) was created and incorporated into the TAAM model.
- Analyses of wind and weather data determined the percent occurrence of major operating configurations[2] and weather conditions, as well as which of the operating configurations had high enough occurrences to model.
- Simulations from the TAAM calibration were modified to reflect the future airfield and terminal layout depicted in the future Airport Layout Plan .
- The Air Traffic Workgroup drafted, reviewed, and confirmed an experimental design identifying the combinations of operating configurations, weather conditions, and aircraft activity levels to be modeled.[3]

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[2] An airport operating configuration refers to the direction or flow of the airport and identifies which runways are in use.

[3] The Air Traffic Workgroup is comprised of representatives from O'Hare Tower (ORD ATCT), Chicago TRACON (C90), Chicago ARTCC (ZAU), the National Air Traffic Controllers Association (NATCA), the FAA Central Service Center (AJV-C25), the FAA Airports Great Lakes Region (AGL-600), the FAA Chicago Airports District Office (ADO-CHI-600), the FAA's third-party contractor Harris Miller Miller & Hanson (HMMH), and Ricondo & Associates, Inc.

- Operating assumptions for each TAAM experiment were developed, reviewed, and refined by the Air Traffic Workgroup.
- The simulation team developed initial TAAM models for each experiment specified in the design. The Air Traffic Workgroup reviewed the animations and output statistics for these models and provided comments and refinements to the simulation team.
- The simulation team created refined TAAM models based on the FAA's direction and comments. These refined animations and output statistics were reviewed and additional comments and refinements provided to the simulation team.
- When a particular TAAM experiment or set of TAAM experiments was refined to the simulation team and the FAA's satisfaction, the FAA prepared a memorandum stating concurrence with the assumptions used in the model(s) and that the experiments were a reasonable representation of how the airfield and airspace would operate under those conditions.

Based on the workgroup's comprehensive review, the FAA workgroup is satisfied that the TAAM modeling simulation experiments depict a reasonable representation of how the operating configurations would be used at O'Hare for the future conditions. Additional details on each simulated condition are provided in **Attachments D-2** through **D-5**.

D.4 WEATHER ANALYSIS AND OPERATING CONFIGURATIONS

A weather conditions analysis was performed to determine the weighting of operating configurations at O'Hare for the EA future conditions. The analysis determined the weighting of airfield operating configurations estimated to occur over a future 12-month calendar year (January 1–December 31). The Air Traffic Workgroup identified six operating configurations to model for the EA. Weather conditions (cloud ceiling height, visibility, wind velocity and direction, and precipitation) and airfield condition (dry or wet/contaminated pavement) determined the airfield and airspace operating procedures modeled for each operating configuration.

To establish weightings for the operating configurations modeled for each condition, weather data gathered from the National Centers for Environmental Information and airfield condition data extracted from the CDA's Electronic Logging System were used to determine the percentage of the year that each operating configuration that could be used. Ten full years of data (from January 1, 2009, to December 31, 2018) were reviewed; 99.3 percent of the analyzed historical weather and airfield condition data fit the criteria (wind, ceiling height, visibility, and airfield pavement condition) of the six modeled operating configurations. This resulted in six simulated operating configurations for each condition, two Visual Flight Rules (VFR) configurations and one Instrument Flight Rules (IFR) configuration in each direction as follows:

- VFR West with Land and Hold Short Operations (LAHSO),
- VFR West without LAHSO,
- IFR West,
- VFR East with LAHSO,
- VFR East without LAHSO, and
- IFR East.

Additional details are provided in **Attachment D-6**.

D.5 TAAM OPERATIONAL FORECAST

The CDA developed a DDFS for each condition. As shown in **Table D-1**, the Interim No Action and the Interim Proposed Action level of operations are the same. The Build Out No Action and the Build Out Proposed Action level of operations are also the same, but they are forecasted higher than the Interim Condition. For further details on the DDFS, see **Chapter 1.3** and **Appendix B**.

TABLE D-1
ANNUAL AND DAILY OPERATIONS FOR EACH SIMULATED ALTERNATIVE

	Interim No Action	Interim Proposed Action	Build Out No Action	Build Out Proposed Action
Annual Operations	952,489	952,489	1,013,856	1,013,856
Daily Operations	2,820	2,820	2,993	2,993
Source: CDA, 2020				

The TAAM simulations are consistent with the existing Fly Quiet Program preferred runways and procedures. The CDA and the FAA provided guidance on the times that the existing Fly Quiet Program procedures should be included in the model. Fly Quiet Program procedures start at or after 10:30:00 p.m. and stop at or prior to 5:30:00 a.m., based on the air traffic demands for each scenario.

See **Attachment D-7** for further details on the existing Fly Quiet Program.

ATTACHMENT D-1

APPENDIX A – 2018 O'HARE TAAM MODEL CALIBRATION

This attachment contains background material which supplements the TAAM version evaluation material and data developed by the CDA. This material supports this EA and its alternatives.

The simulation models used during the 2019 Interim Fly Quiet Re-Evaluation (which were first developed for the 2005 OMP EIS and subsequently used for the 2015 Re-Evaluation of the OMP EIS) underwent an iterative process of data collection/analysis, TAAM modeling, animation review, and simulation output metric analysis to verify that the TAAM models reflect real-world operating conditions specific to O'Hare. The following sections provide a summary of the calibration effort and resulting simulation assumptions.

Appendix A

2018 O'Hare TAAM Model Calibration


TAAM Model Calibration
Calibration Resolution
August 7, 2019
CDA
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O★HARE 21

AGENDA

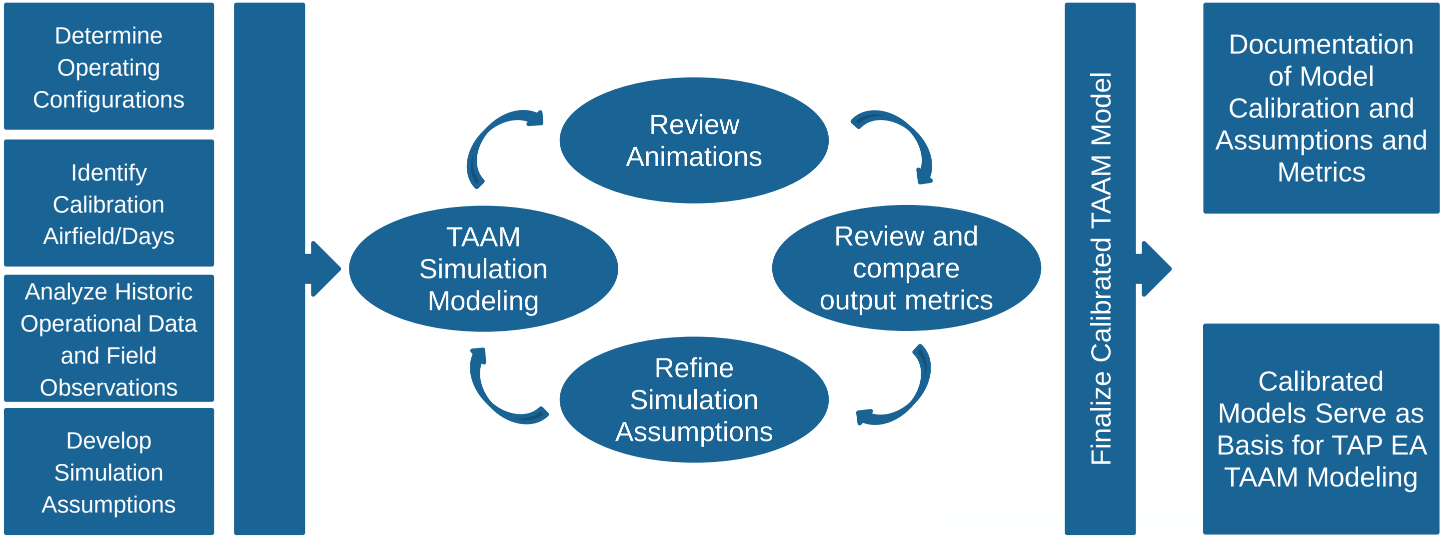
- Calibration Summary
  - Purpose and Objective
  - Methodology
  - Experimental Design
  - Airfield Layout
- Calibration Date Selection
- Airfield and Airspace Operating Assumptions
  - Gating
  - Taxi Routes
  - Airspace Routes
- Data Collection and Analysis
  - Touchdown/Liftoff vs. Scheduled Gate Time
  - Arrival and Departure Throughput
  - Arrival Standoff
  - Taxi Speeds
  - Runway Exit Distribution
  - Runway Crossings
  - Pushback Movements
  - Departure Line Up
- Comparison of Simulated and Historical Operations


Calibration Summary
D-9

PURPOSE AND OBJECTIVE

- Calibration is conducted to achieve a reasonable correspondence between historical operations and simulation model output
  - Iterative process of data collection/analysis, TAAM modeling, animation review, and simulation metric analysis
- TAAM modeling at O'Hare
  - Original model calibration as part of the O'Hare Modernization (OM) Environmental Impact Statement (EIS)
  - Calibrated OM EIS models used for two subsequent TAAM modeling efforts
    - 2015 Re-Evaluation of the OM EIS
    - Interim Fly Quiet Runway Rotation Plan Re-Evaluation
- Opportunity to verify the TAAM models reflect real-world operating conditions specific to O'Hare
  - Significant airfield/aircraft changes since 2005 OM EIS
  - Additional software functionality
- Produce calibrated TAAM models that will serve as the basis for modeling scenarios

METHODOLOGY



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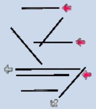
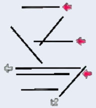
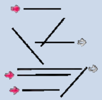
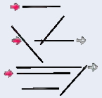
Experiment Number	TAAM Experiment	Operating Configuration	Notes
801	VFR West		
802	IFR West		Triple simultaneous ILS approaches; dependency b/w 28R/C operations; below 800/2
803	VFR East		
804	IFR East		Triple simultaneous ILS approaches; dependency b/w 10L/C operations; mixed use on 9R; below 800/2

Existing runway
Primary arrivals
Primary departures

O'HARE 21
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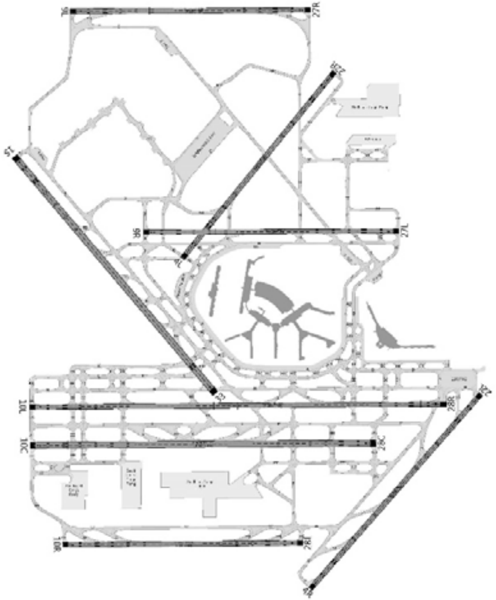
AIRFIELD LAYOUT

MAY 2017

- Existing Condition from *O'Hare International Airport Draft Future Airport Layout Plan*

- Runway 9C-27C East Package winter suspension
- Pre-Runway 9C-27C Package 1 construction



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Calibration Date Selection

OVERVIEW

- Calibration days are chosen to represent typical real-world operating performance for each of the modeled airfield operating configurations
  - Runway allocation and throughput
  - Taxi times
  - Gate and hold pad usage
  - Aircraft towing (maintenance and remote parking)
- The process for identifying calibrations days includes an analysis of airfield conditions and operating performance to ensure that acceptable days are selected

METHODOLOGY

- Airport construction documentation was used to determine the range of dates when airfield conditions matched the calibration airfield
  - Short Term Operational Phasing (STOP) and FAA daily briefings were reviewed for daily airfield closures and NAVAID outages
  - Taxiways G and E south of the Scenic Pad closed June 22, 2017 as part of Runway 9C-27C Package 1
- Historic schedule and operational data were evaluated to determine acceptable for calibration dates
  - The airfield operating configuration in use was determined using FAA Aviation System Performance Metrics (ASPM) data
  - Daily operations numbers were calculated using FAA Operations Network (OPSNET) data
  - Aerobahn, Airport Noise Monitoring System (ANMS), and air carrier schedules were used to verify that weather conditions or other uncommon events did not affect the airport
    - Delays, unscheduled runway closures, etc.

SELECTED CALIBRATION DATES

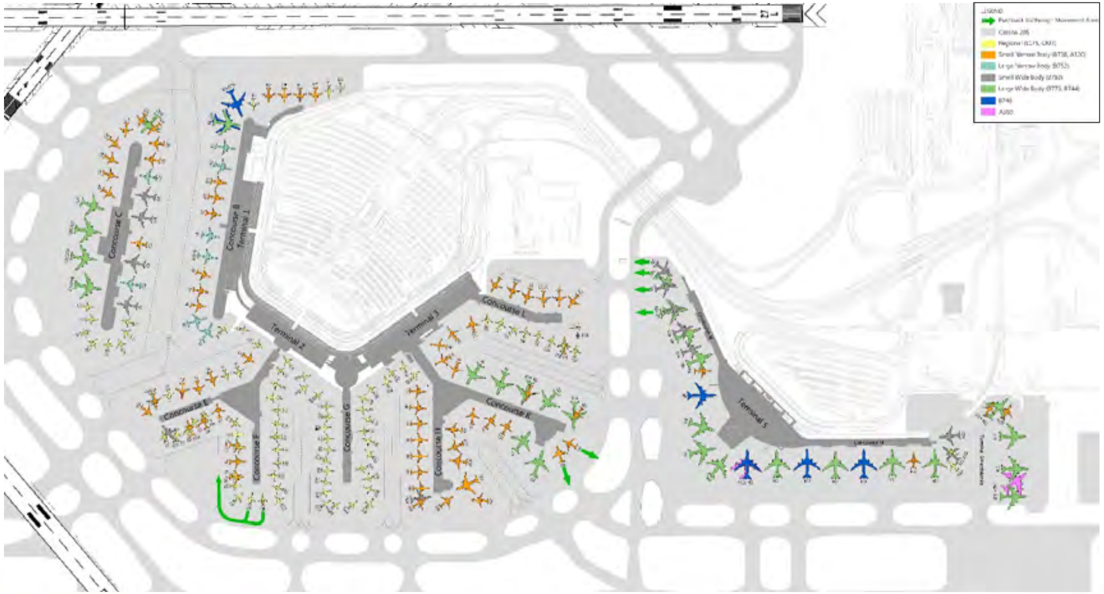
Configuration	Simulation Schedule Date	Operational Metric Dates
VFR West	May 23	May 2, 22, 29, 30, and 31
VFR East	May 23	May 5, 8, 12, 15, and 26
IFR West	February 7	February 7
IFR East	April 30	April 30

- VFR Calibration
  - The selected dates are comprised entirely of the modeled airfield operating configuration
  - Proximity of dates means similar activity profiles and simplifies simulation schedule preparation
- IFR Calibration Days
  - Limited choice of days with a significant number of hours of the modeled airfield operating configuration
  - Weather data (precipitation and freezing temperatures) was reviewed to verify the selected dates are acceptable for calibration


Airfield/Airspace
Operating Assumptions

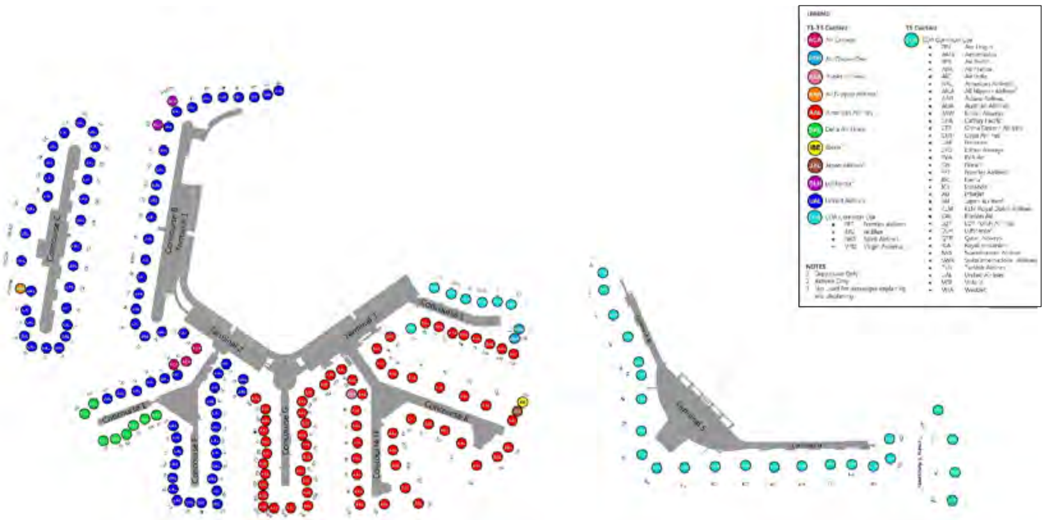
GATE LAYOUT

GATE GAUGE AND MOVEMENT AREA PUSHBACKS



GATE LAYOUT

SCHEDULED PASSENGER AIRLINE GATE ALLOCATION



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TAXI ROUTES

WEST FLOW

EXPERIMENT 801: VFR WEST

EXPERIMENT 802: IFR WEST

SOURCE: Ricondo & Associates, Inc., *Draft O'Hare International Airport Future Airport Layout Plan*, August 10, 2018 (basemap).

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TAXI ROUTES
EAST FLOW

EXPERIMENT 803: VFR EAST

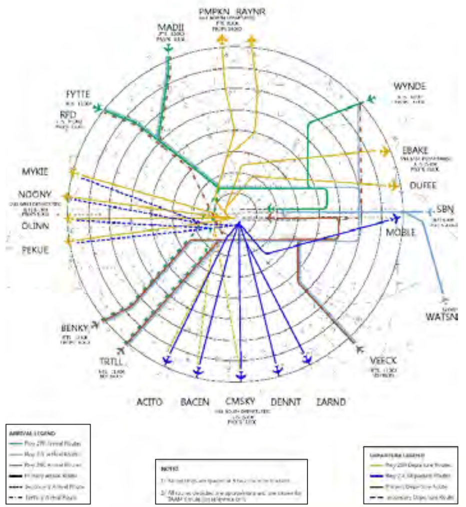
EXPERIMENT 804: IFR EAST

SOURCE: Ricondo & Associates, Inc., *Draft O'Hare International Airport Future Airport Layout Plan*, August 10, 2018 (basemap).

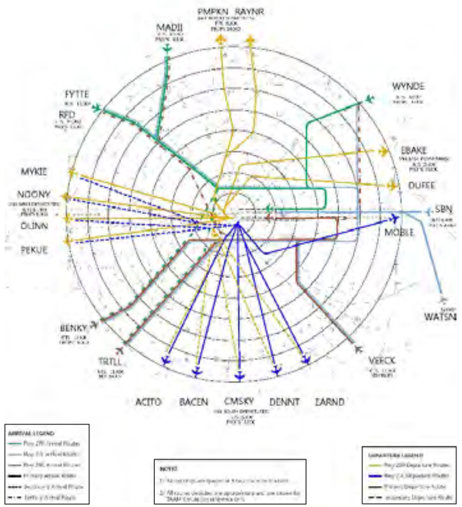
AIRSPACE ROUTES

WEST FLOW

EXPERIMENT 801: VFR WEST



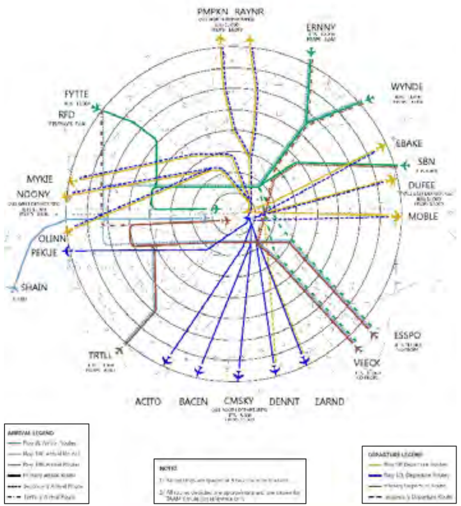
EXPERIMENT 802: IFR WEST



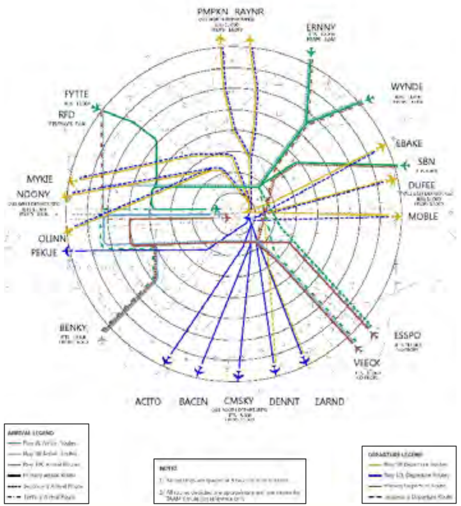
SOURCE: Federal Aviation Administration, August 2017 (radar map).

AIRSPACE ROUTES
EAST FLOW

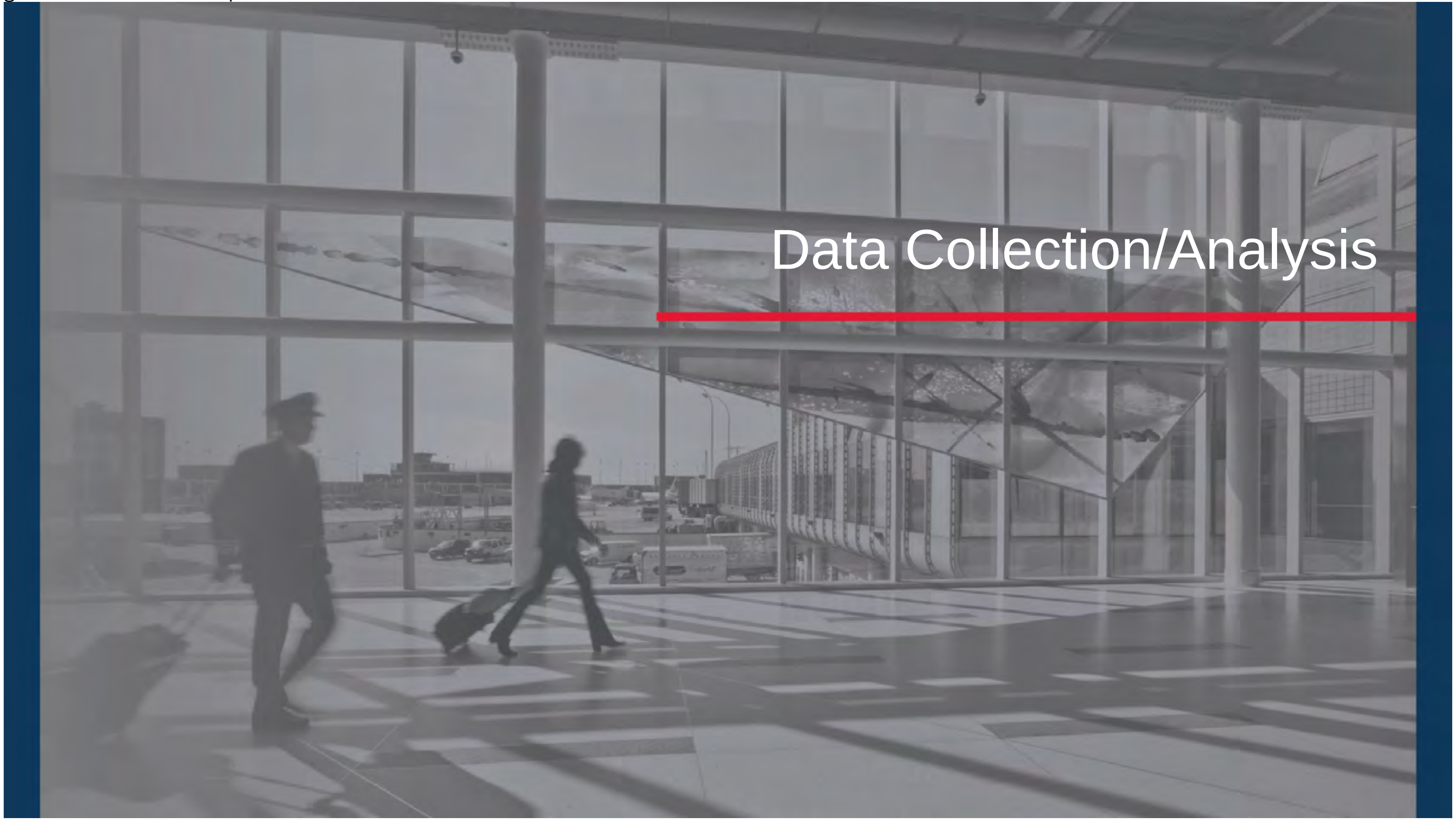
EXPERIMENT 803: VFR EAST



EXPERIMENT 804: IFR EAST



SOURCE: Federal Aviation Administration, August 2017 (radar map).


Data Collection/Analysis

OVERVIEW

- Operational data was collected in two ways:
  - Field observations recorded from the CDA Airfield Operations Tower
    - Monday September 17, 2018: West Flow
    - Tuesday September 18, 2018: East Flow
  - Saab Sensis Aerobahn Surface Management System
    - Animation
    - Data Reports
- Statistical analysis of operational data was compiled to look for any trends and quantify typical aircraft behavior

TOUCHDOWN/LIFTOFF VS. SCHEDULED GATE TIME
OBJECTIVES

- Replicate typical observed trends in historical runway movement and gate times
  - Key times for calibration are arrival touchdown and departure pushback
  - Modeling of ground movements will produce appropriate arrival gate and departure liftoff times
  - Focus on reproducing historical day/night percentages
- Maintain simulation flight schedule integrity at ORD
  - Scheduled departure and arrival times
- Utilize native TAAM functionality to vary times of arrivals and departures
  - Estimated time of departure (ETD) randomization
  - Creates variation from iteration to iteration

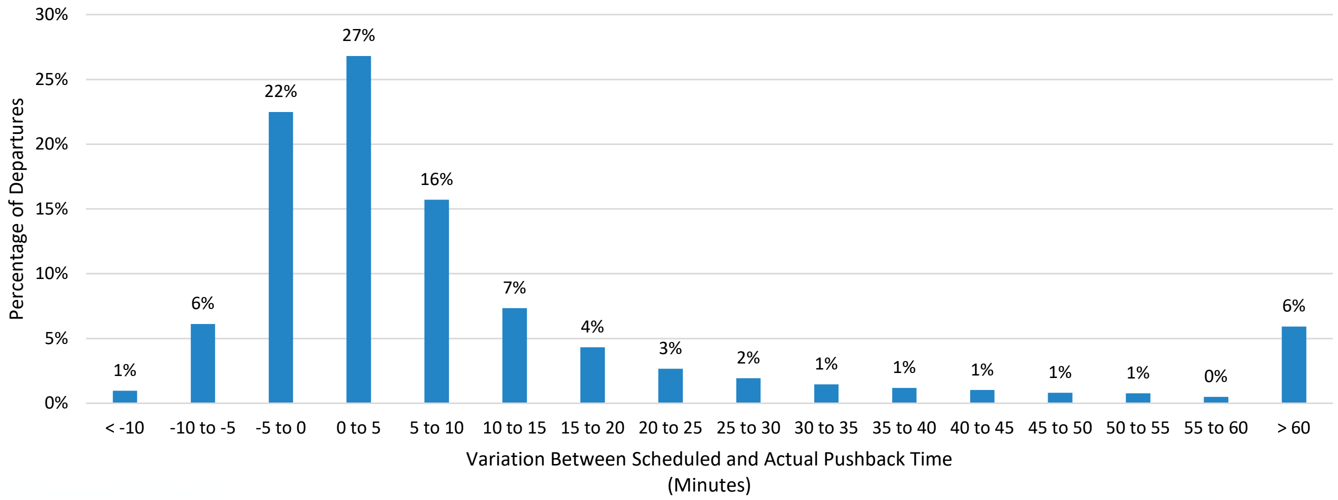
TOUCHDOWN/LIFTOFF VS. SCHEDULED GATE TIME

METHODOLOGY

- Typical trends were identified by analyzing 10 days of historical data from May 2017
  - 5 days of VFR West
  - 5 days of VFR East
- Aerobahn was used to compile:
  - Scheduled departure pushback time
  - Actual departure pushback time
  - Scheduled arrival gate time
  - Actual arrival touchdown time
- Compiled data were used to calculate the variation between
  - Scheduled and actual pushback time
  - Scheduled arrival gate and actual touchdown time

TOUCHDOWN/LIFTOFF VS. SCHEDULED GATE TIME

ACTUAL PUSHBACK VS. SCHEDULED GATE TIME – MAY 2017 VFR WEST/EAST DAYS



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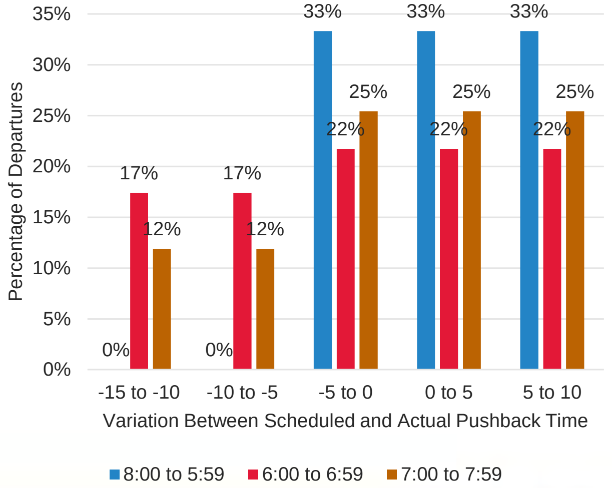
TOUCHDOWN/LIFTOFF VS. SCHEDULED GATE TIME

SIMULATION ASSUMPTIONS - DEPARTURES

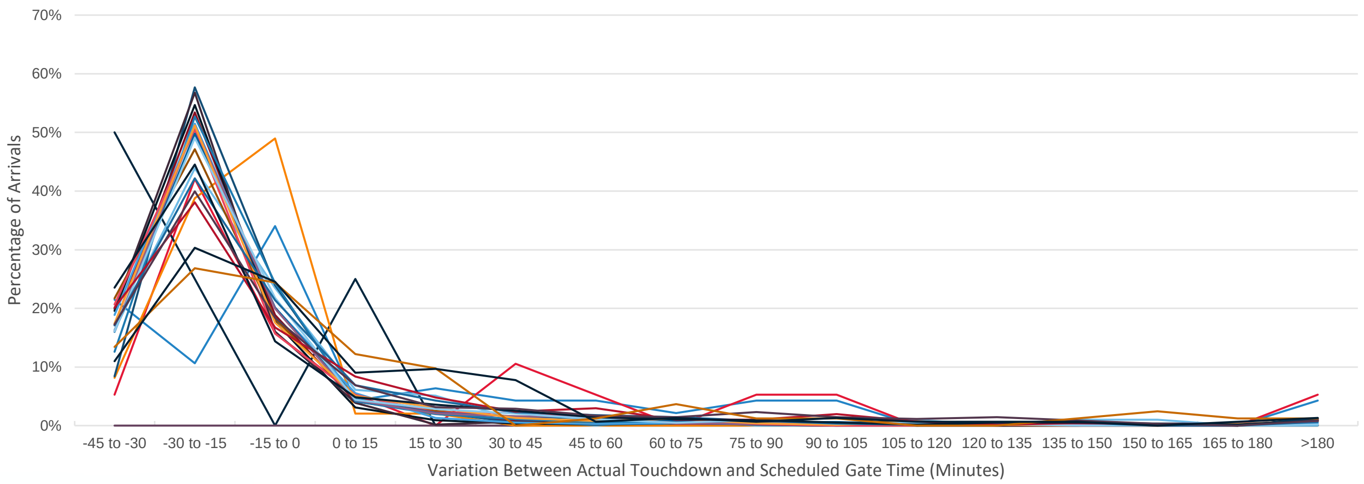
- TAAM ETD randomization distributes pushback times evenly between minimum and maximum values
- Accounts for large percentage of variation in historical pushback times
- Accounts for increased frequency of departures pushing back early/on-time during first departure bank
- Focus on hours immediately before/after the day/night cutoff

AGGREGATE PUSHBACK DISTRIBUTION



TOUCHDOWN/LIFTOFF VS. SCHEDULED GATE TIME

ACTUAL TOUCHDOWN VS. SCHEDULED GATE TIME – MAY 8, 2017 ROLLING HOUR

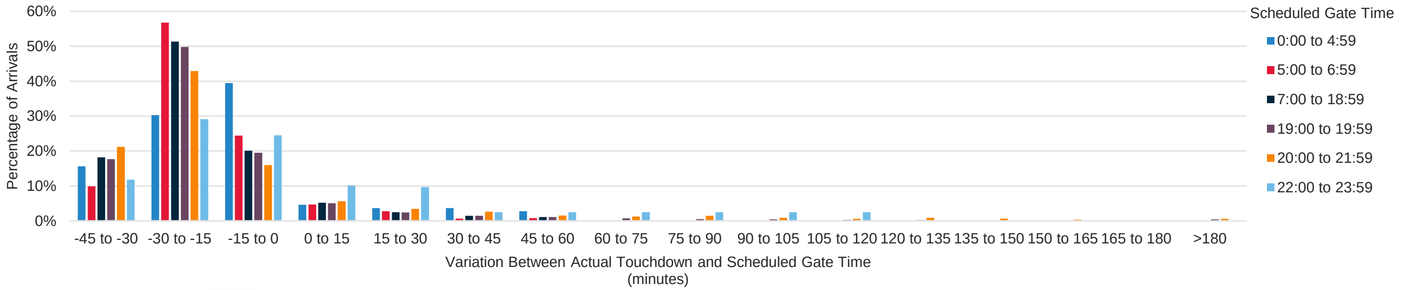


TOUCHDOWN/LIFTOFF VS. SCHEDULED GATE TIME

SIMULATION ASSUMPTIONS - ARRIVALS

- Allow TAAM to calculate arrival ETD using point-to-point method
- Adjust TAAM-calculated arrival ETD consistent with aggregate touchdown distribution buckets
  - Focus on hours immediately before/after the day/night cutoff
- Allow TAAM ETD randomization to vary arrival ETD consistent with the aggregate touchdown distribution limits

AGGREGATE TOUCHDOWN DISTRIBUTION



TOUCHDOWN/LIFTOFF VS. SCHEDULED GATE TIME
CALIBRATION RESULTS - VFR

EXPERIMENT 801: VFR WEST									
	Arrivals			Departures			All Operations		
Time Period	Scheduled	Historical	Simulated	Scheduled	Historical	Simulated	Scheduled	Historical	Simulated
7:00 to 21:59	90.3%	88.8%	88.8%	93.1%	91.9%	91.9%	91.7%	90.4%	90.3%
22:00 to 6:59	9.7%	11.2%	11.2%	6.9%	8.1%	8.1%	8.3%	9.6%	9.7%

EXPERIMENT 803: VFR EAST									
	Arrivals			Departures			All Operations		
Time Period	Scheduled	Historical	Simulated	Scheduled	Historical	Simulated	Scheduled	Historical	Simulated
7:00 to 21:59	90.3%	88.8%	88.8%	93.1%	91.9%	91.8%	91.7%	90.4%	90.3%
22:00 to 6:59	9.7%	11.2%	11.2%	6.9%	8.1%	8.2%	8.3%	9.6%	9.7%

TOUCHDOWN/LIFTOFF VS. SCHEDULED GATE TIME

CALIBRATION RESULTS - IFR

EXPERIMENT 802: IFR WEST									
	Arrivals			Departures			All Operations		
Time Period	Scheduled	Historical	Simulated	Scheduled	Historical	Simulated	Scheduled	Historical	Simulated
7:00 to 21:59	91.5%	90.5%	90.3%	94.7%	93.0%	93.0%	93.1%	91.7%	91.6%
22:00 to 6:59	8.5%	9.5%	9.7%	5.3%	7.0%	7.0%	6.9%	8.3%	8.4%

EXPERIMENT 804: IFR EAST									
	Arrivals			Departures			All Operations		
Time Period	Scheduled	Historical	Simulated	Scheduled	Historical	Simulated	Scheduled	Historical	Simulated
7:00 to 21:59	92.0%	91.5%	91.0%	94.9%	88.8%	92.9%	93.5%	90.2%	92.0%
22:00 to 6:59	8.0%	8.5%	9.0%	5.1%	11.2%	7.1%	6.5%	9.8%	8.0%

- Historical hourly weather data recorded thunderstorms with lighting in the vicinity of O'Hare on April 30, 2017 after 20:00
- This weather delayed some departure operations, pushing a greater than typical number of operations to the nighttime
- Thunderstorms and lightning are a non-modeled weather condition and the observed difference between historical and simulated nighttime departures is anticipated/acceptable

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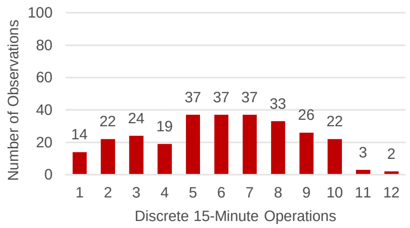
ARRIVAL AND DEPARTURE THROUGHPUT
OBJECTIVES AND METHODOLOGY

- Objectives
  - Adjust TAAM arrival and departure settings to produce accurate/sustainable arrival and departure rates
  - Calibrated arrival and departure throughput will be carried forward into future simulation analyses
- Methodology
  - Compiled historical 15-minute throughput using Airport Noise Management System (ANMS) data
    - 5 days of VFR West
    - 5 days of VFR East
    - 1 day of IFR West
    - 1 day of IFR East
  - Identified maximum frequently occurring throughput and adjusted TAAM settings to produce the identified arrival/departure rate

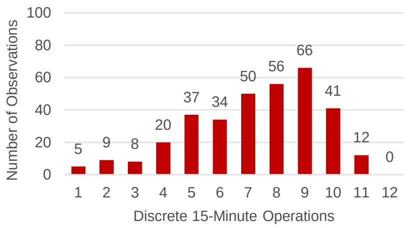
ARRIVAL AND DEPARTURE THROUGHPUT

VFR WEST ARRIVALS – MAY 2017

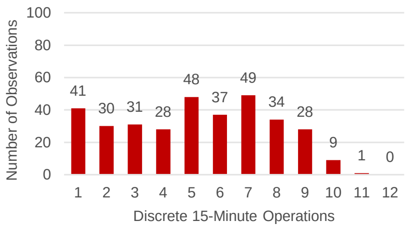
RUNWAY 27R



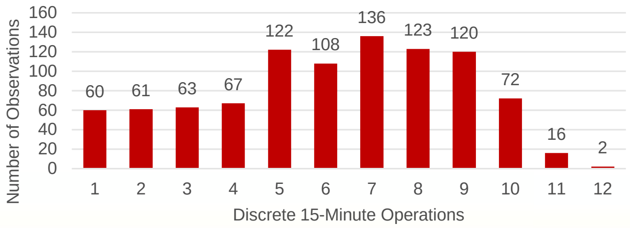
RUNWAY 27L



RUNWAY 28C



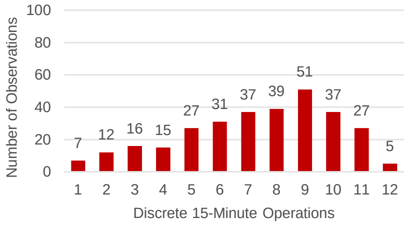
ALL ARRIVAL RUNWAYS



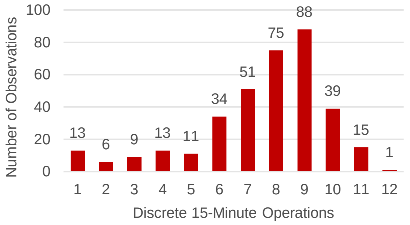
ARRIVAL AND DEPARTURE THROUGHPUT

VFR EAST ARRIVALS – MAY 2017

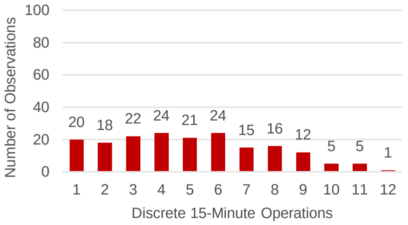
RUNWAY 9L



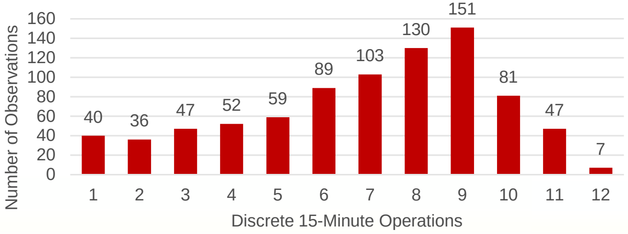
RUNWAY 10C



RUNWAY 10R



ALL ARRIVAL RUNWAYS

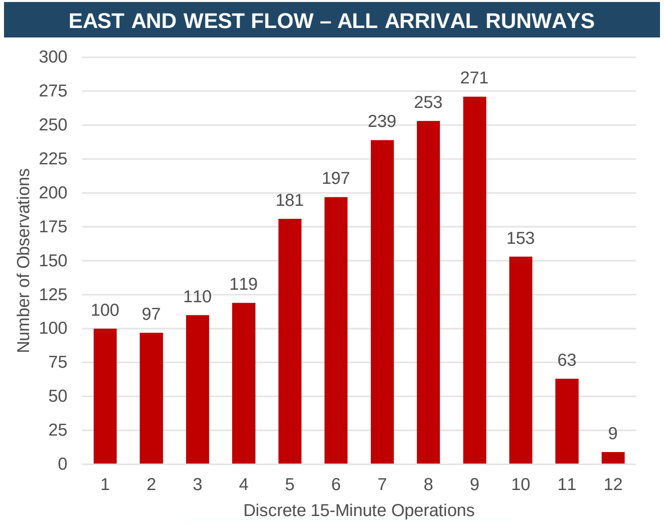


ARRIVAL AND DEPARTURE THROUGHPUT

VFR ARRIVALS MODELING ASSUMPTIONS

- An arrival rate of 11 operations was observed multiple times per day and for successive 15-minute periods
- TAAM final approach separation adjusted to produce an arrival rate of 11 operations when wake turbulence separation is not required

- Adding one Category C or higher aircraft reduced the observed arrival rate to 10 operations
- TAAM final approach separation was confirmed to produce an arrival rate of 10 operations when at least one aircraft requires wake turbulence separation



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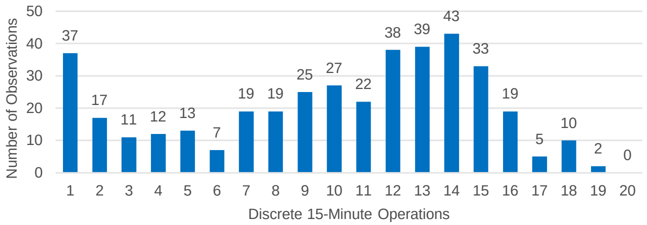
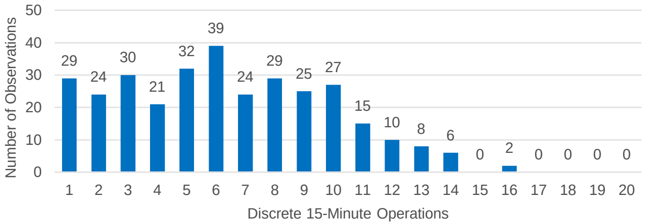
ARRIVAL AND DEPARTURE THROUGHPUT

VFR WEST DEPARTURES – MAY 2017

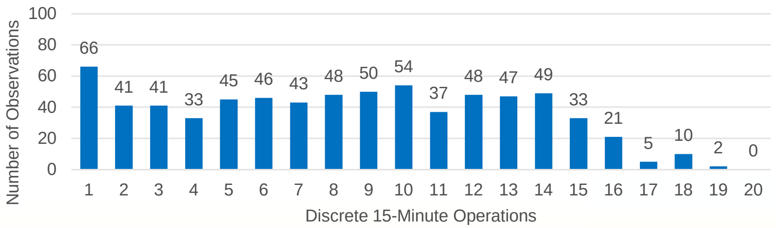
RUNWAY 28R



RUNWAY 22L



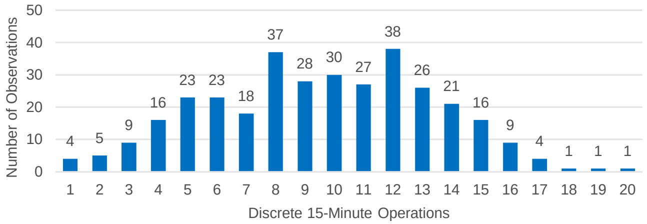
ALL DEPARTURE RUNWAYS



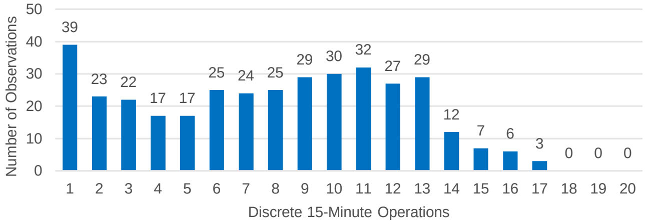
ARRIVAL AND DEPARTURE THROUGHPUT

VFR EAST DEPARTURES – MAY 2017

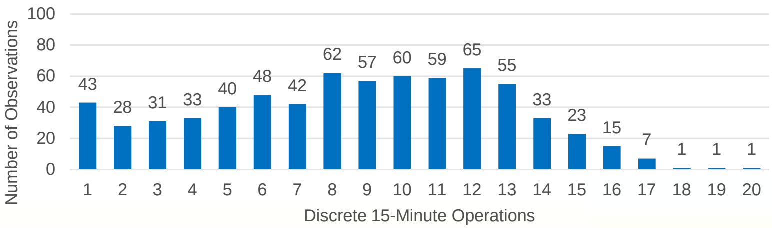
RUNWAY 9R



RUNWAY 10L



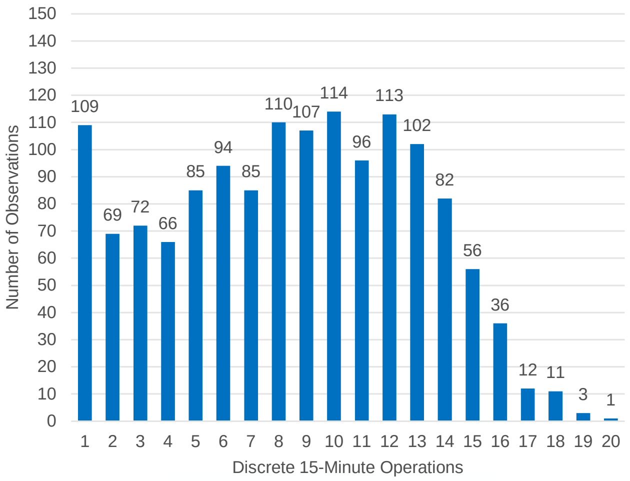
ALL DEPARTURE RUNWAYS



ARRIVAL AND DEPARTURE THROUGHPUT
VFR DEPARTURES MODELING ASSUMPTIONS

- A departure rate of 16 operations was observed multiple times per day and for successive 15-minute periods
- TAAM departure settings were modified to produce a departure rate of 16 operations when all aircraft within the 15-minute period can utilize 6,000 feet and airborne separation

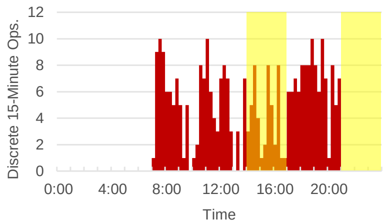
EAST AND WEST FLOW – ALL DEPARTURES RUNWAYS



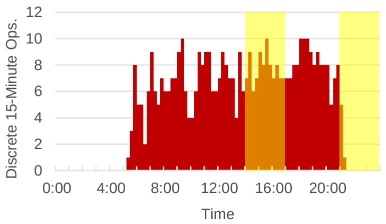
ARRIVAL AND DEPARTURE THROUGHPUT

IFR WEST ARRIVALS – FEBRUARY 7, 2017

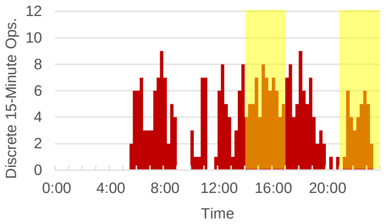
RUNWAY 27R



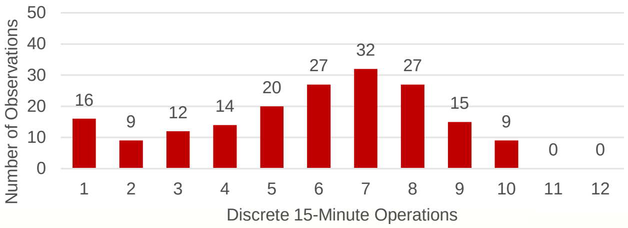
RUNWAY 27L



RUNWAY 28C



ALL ARRIVAL RUNWAYS

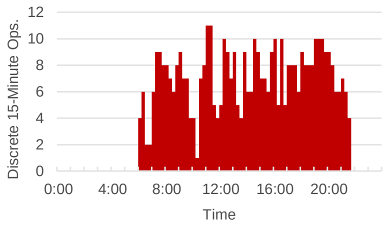


Legend

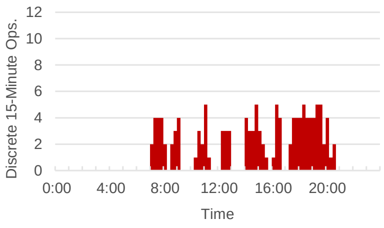
ARRIVAL AND DEPARTURE THROUGHPUT

IFR EAST ARRIVALS – APRIL 30, 2017

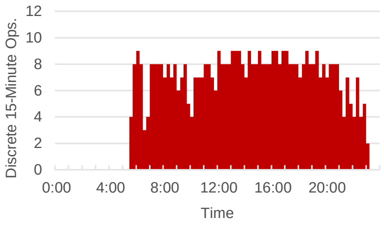
RUNWAY 9L



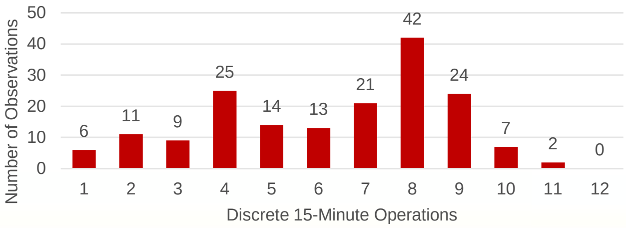
RUNWAY 9R



RUNWAY 10C



ALL ARRIVAL RUNWAYS



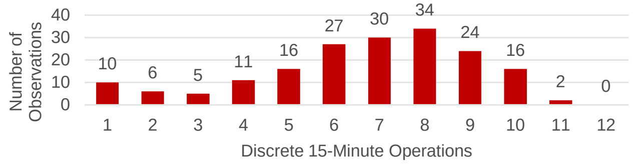
ARRIVAL AND DEPARTURE THROUGHPUT

IFR ARRIVALS MODELING ASSUMPTIONS

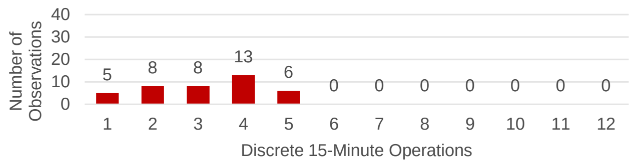
– TAAM final approach separation adjusted to produce the following arrival rates when no wake turbulence separation is required:
  - Runways 9L, 27R, and 27L – 10 arrivals
  - Runway 9R – 4 to 5 arrivals
  - Runways 10C and 28C – 9 arrivals

– Adding one Category C or higher aircraft does not always reduce the simulated throughput because the TAAM minimum final approach separations for some runways are approaching wake turbulence separation minima

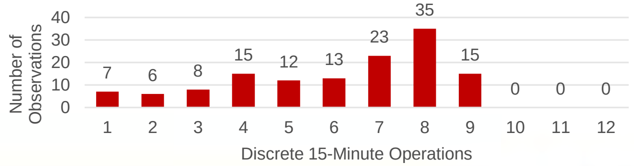
RUNWAYS 9L, 27R AND 27L



RUNWAY 9R



RUNWAYS 10C AND 28C



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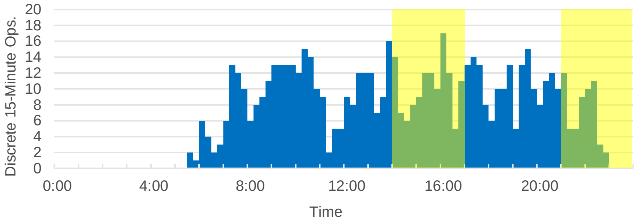
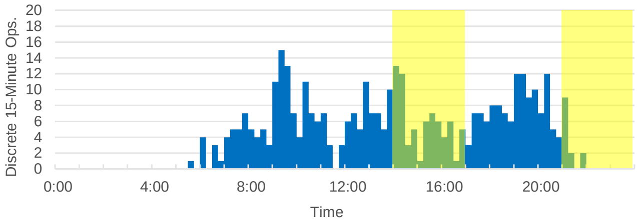
ARRIVAL AND DEPARTURE THROUGHPUT

IFR WEST DEPARTURES – FEBRUARY 7, 2017

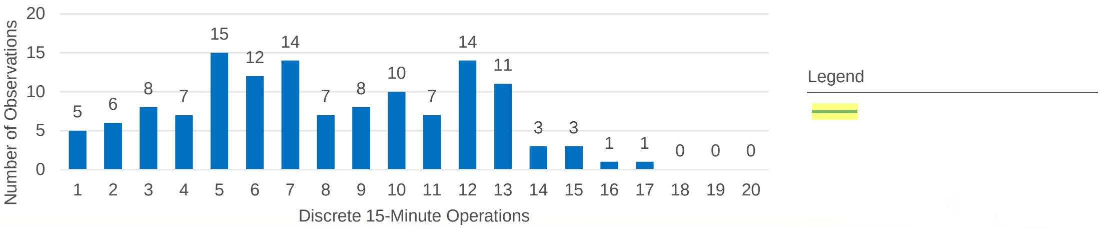
RUNWAY 28R



RUNWAY 22L



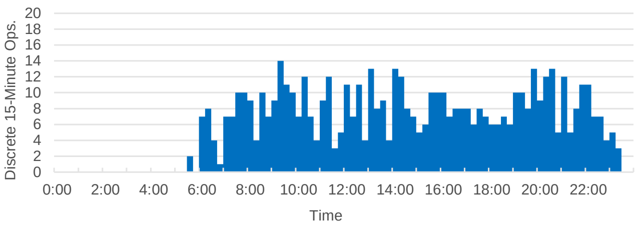
ALL DEPARTURE RUNWAYS



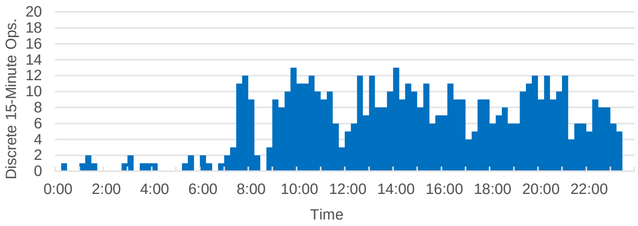
ARRIVAL AND DEPARTURE THROUGHPUT

IFR EAST DEPARTURES – APRIL 30, 2017

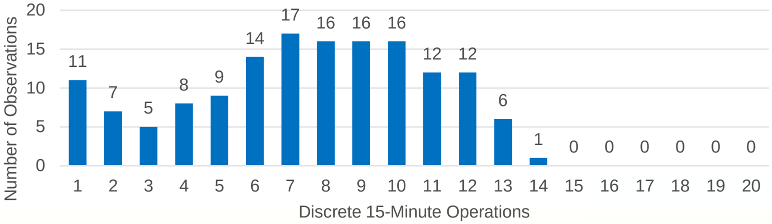
RUNWAY 9R



RUNWAY 10L



ALL DEPARTURE RUNWAYS

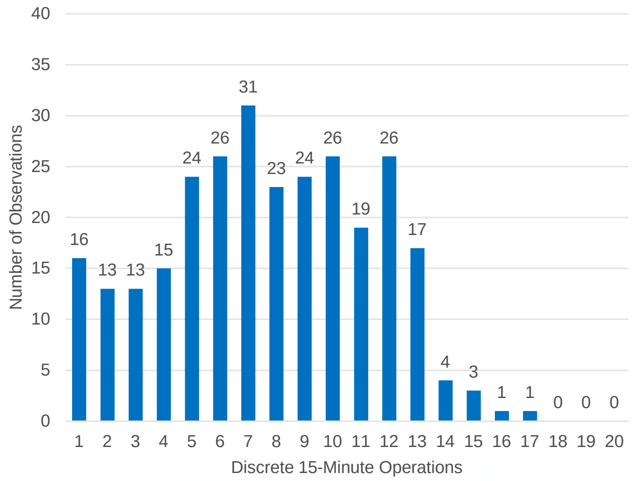


ARRIVAL AND DEPARTURE THROUGHPUT

IFR DEPARTURES MODELING ASSUMPTIONS

– The observed reduction in departure throughput during IFR when compared to VFR was assumed to be attributable to dependent arrivals
– VFR TAAM departure settings were retained

EAST AND WEST FLOW – ALL DEPARTURES RUNWAYS



ARRIVAL STANDOFF

Sample Gate Activity – C26

Origin	Destination	Arrival Time	Departure Time	Buffer Time
RON[1]	KPHL	n/a	7:42	**0:20**
KMSP	MMUN	8:02	9:05	0:38
KCLE	KFLL	9:43	10:47	1:48
KPDX	KALB	12:35	13:28	**0:21**
KIAD	KATL	13:49	14:45	**0:17**
KMCO	KMSP	15:02	15:59	0:39
KSAN	KDCA	16:38	18:05	1:17
KSNA	KSMF	19:22	20:10	
KEWR	KSFO	21:34	22:45	1:24

TAXI SPEEDS

WEST FLOW

EAST FLOW

SOURCE: Ricondo & Associates, Inc., *Draft O'Hare International Airport Future Airport Layout Plan*, August 10, 2018 (basemap); Saab Sensis Corporation, Aerobahn Surface Management System, May 8, 2918 and 23, 2018 (taxiway speed data); Ricondo & Associates, Inc., September 2018 (analysis).

RUNWAY EXIT DISTRIBUTION

VFR WEST

Runway 27R

Aircraft Group	Taxiway Z	Taxiway C1
Small Regional	2.7%	97.3%
Large Regional	1.1%	98.9%
Small Narrow Body	2.8%	97.2%
Large Narrow Body	4.5%	95.5%
Small Wide Body	-	-
Large Wide Body	-	-
B747-8	-	-

Runway 27L

Aircraft Group	Taxiway J	Taxiway E	Runway 4L-22R	Taxiway A1
Small Regional	-	100.0%	-	-
Large Regional	100.0%	-	-	-
Small Narrow Body	100.0%	-	-	-
Large Narrow Body				
Small Wide Body	-	-	-	-
Large Wide Body	-	-	-	-
B747-8	-	-	-	-

Aircraft Group	Taxiway J	Taxiway E	Runway 4L-22R	Taxiway A1
Small Regional		-	10.5%	89.5%
Large Regional	-	-	12.4%	87.6%
Small Narrow Body	-	-	44.0%	56.0%
Large Narrow Body	-	-	58.6%	41.4%
Small Wide Body	-	-	-	100.0%
Large Wide Body				
B747-8				

Runway 28C

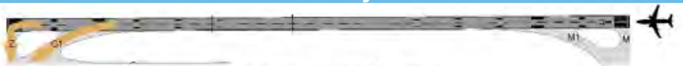
Aircraft Group	Taxiway AA	Taxiway BB	Taxiway CC	Taxiway DD	Taxiway P1	Taxiway P2	Taxiway P3
Small Regional	-	-	-	-	20.7%	72.4%	6.9%
Large Regional	-	-	0.9%	3.7%	29.4%	63.3%	2.8%
Small Narrow Body			3.7%	17.1%	54.9%	22.0%	2.4%
Large Narrow Body		-	8.0%	20.0%	52.0%	20.5%	-
Small Wide Body	-	-	-	20.0%	60.0%	20.0%	-
Large Wide Body			9.6%	25.0%	63.5%	1.9%	
B747-8			42.9%	28.6%	28.6%		

Aircraft Group	Taxiway AA	Taxiway BB	Taxiway CC	Taxiway DD
Small Regional	-	-	-	-
Large Regional	-	-	-	-
Small Narrow Body	-	-	-	-
Large Narrow Body	-	-	-	-
Small Wide Body	-	100%	-	100%
Large Wide Body	-	-	100.0%	-
B747-8	-	-	-	-

RUNWAY EXIT DISTRIBUTION

IFR WEST

Runway 27R



Aircraft Group	Taxiway Z	Taxiway C1
Small Regional		100.0%
Large Regional	0.7%	99.3%
Small Narrow Body	-	100.0%
Large Narrow Body	4.3%	95.7%
Small Wide Body	-	100.0%
Large Wide Body	-	-
B747-8	-	-

Runway 27L

Aircraft Group	Taxiway J	Taxiway E	Runway 4L-22R	Taxiway A1
Small Regional	-		-	100.0%
Large Regional	-	-	-	-
Small Narrow Body	100.0%	-	-	-
Large Narrow Body	-	100.0%	-	-
Small Wide Body	-	-	-	-
Large Wide Body	-		-	-
B747-8	-	-	-	-

Aircraft Group	Taxiway J	Taxiway E	Runway 4L-22R	Taxiway A1
Small Regional	-	3.5%		95.4%
Large Regional	-	-	3.3%	96.7%
Small Narrow Body	-	-	7.1%	92.9%
Large Narrow Body	2.5%	-	38.5%	59.0%
Small Wide Body	-	-	-	100.0%
Large Wide Body				
B747-8				

Runway 28C

Aircraft Group	Taxiway AA	Taxiway BB	Taxiway CC	Taxiway DD	Taxiway P1	Taxiway P2	Taxiway P3
Small Regional	-	-	-	3.4%	17.2%	79.3%	-
Large Regional	-	-	-	1.1%	16.5%	80.2%	2.2%
Small Narrow Body				2.4%	28.6%	65.5%	3.6%
Large Narrow Body	-	-		-	53.6%	46.4%	
Small Wide Body	-	-	-	-	70.0%	30.0%	-
Large Wide Body			2.9%	5.7%	42.9%	48.6%	
B747-8				50.0%	50.0%		

Aircraft Group	Taxiway AA	Taxiway BB	Taxiway CC	Taxiway DD
Small Regional	-	-	-	-
Large Regional	-	-	-	-
Small Narrow Body	-	-	-	-
Large Narrow Body	-	-	-	-
Small Wide Body	-	[illegible]	-	[illegible]
Large Wide Body	-	-	-	100.0%
B747-8	-	-	-	100.0%

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RUNWAY EXIT DISTRIBUTION

VFR EAST

Runway 9L

Aircraft Group	Taxiway ML	Taxiway M
Small Regional	100.0%	-
Large Regional	100.0%	-
Small Narrow Body	100.0%	-
Large Narrow Body	100.0%	-
Small Wide Body	100.0%	
Large Wide Body	-	-
B747-8	-	-

Runway 10C

Aircraft Group	Taxiway P2	Taxiway P3	Taxiway P5	Taxiway P6	Taxiway F	Taxiway HH	Taxiway GG
Small Regional	2.4%	36.3%	43.3%	7.5%	-	-	-
Large Regional	-	20.7%	66.8%	12.9%	-	-	-
Small Narrow Body	0.8%	1.6%	68.8%	28.1%	0.0%		0.6%
Large Narrow Body	-	-	33.7%	54.3%	1.6%	-	-
Small Wide Body	-	5.3%	17.4%	66.4%	5.4%	5.3%	-
Large Wide Body		1.9%	10.3%	79.8%	1.9%	1.9%	1.9%
B747-8					50.0%	50.0%	

Aircraft Group	Taxiway T	Taxiway F	Taxiway HH	Taxiway GG
Small Regional	-	-	-	-
Large Regional				
Small Narrow Body				
Large Narrow Body	-	-	-	-
Small Wide Body			100.0%	
Large Wide Body	50.0%	50.0%		
B747-8	50.0%	25.0%	25.0%	-

Runway 10R

Aircraft Group	Taxiway W3	Taxiway W4	Taxiway W5
Small Regional	63.0%	37.0%	-
Large Regional	62.9%	37.1%	
Small Narrow Body	[illegible]	20.7%	-
Large Narrow Body	31.3%	62.5%	6.3%
Small Wide Body			
Large Wide Body			
B747-8	-	-	-

RUNWAY EXIT DISTRIBUTION

IFR EAST

Runway 9L

Aircraft Group	Taxiway M1	Taxiway M
Small Regional	100.0%	
Large Regional	100.0%	
Small Narrow Body	100.0%	–
Large Narrow Body	100.0%	–
Small Wide Body	100.0%	–
Large Wide Body		–
B747-8	–	–

Runway 9R

Aircraft Group	Taxiway M	Taxiway U	Taxiway H1	Taxiway H2	Taxiway H3
Small Regional	40.0%	40.0%	20.0%		
Large Regional	21.6%	14.4%	–	–	–
Small Narrow Body	6.7%	81.0%	8.9%	–	–
Large Narrow Body	12.5%	75.0%	12.5%	–	–
Small Wide Body	–	100.0%	–	–	–
Large Wide Body	–	100.0%	–	–	–
B747-8	–		–	–	

Runway 10C

Aircraft Group	Taxiway P2	Taxiway P4	Taxiway P5	Taxiway P6	Taxiway F	Taxiway HH	Taxiway GG
Small Regional	7.1%	29.7%	[illegible]	[illegible]		–	–
Large Regional	1.5%	20.0%	56.2%	11.0%	7.1%	–	–
Small Narrow Body	3.7%	[illegible]	56.2%	[illegible]	–	–	–
Large Narrow Body		3.1%	50.0%	40.6%	[illegible]		
Small Wide Body			46.2%	34.8%			
Large Wide Body	–	–	41.9%	48.1%	–	–	–
B747-8				50.0%	16.7%	16.7%	16.7%

Aircraft Group	Taxiway T	Taxiway F	Taxiway HH	Taxiway GG
Small Regional	–	–	–	–
Large Regional			–	
Small Narrow Body			–	
Large Narrow Body			–	
Small Wide Body	38.9%	61.1%	–	–
Large Wide Body	70.5%	13.8%	7.7%	–
B747-8	100.0%	–	–	–

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RUNWAY CROSSINGS
METHODOLOGY

- Two runway crossing types were observed
  - Free Flow Crossing
    - The crossing aircraft proceeds immediately across the runway without having to wait for arriving/departing aircraft
  - Impeded Crossing
    - Runway crossings requiring the crossing aircraft to wait for arriving/departing aircraft
    - Number of observations were very limited due to the design of typical taxi routes
- Two times were recorded for each crossing:
  - Acceleration Pause: time elapsed between runway operation clearing the intersection and start of movement
  - Travel Time: time elapsed to clear the runway

RUNWAY CROSSINGS

OBSERVATIONS

- Free Flow Crossing
  - The average time to travel from hold line to hold line was approximately 25 seconds
  - Average crossing time translates to 15 knot taxi speed
- Impeded Crossing
  - The average time required to begin acceleration after the arriving/departing aircraft clears the runway/taxiway intersection was 15 seconds
  - The average speed time to travel from hold line to hold line was approximately 34 seconds, including acceleration from a stop
  - Average crossing time translates to 10.5 knot taxi speed

RUNWAY CROSSINGS
MODELING ASSUMPTIONS

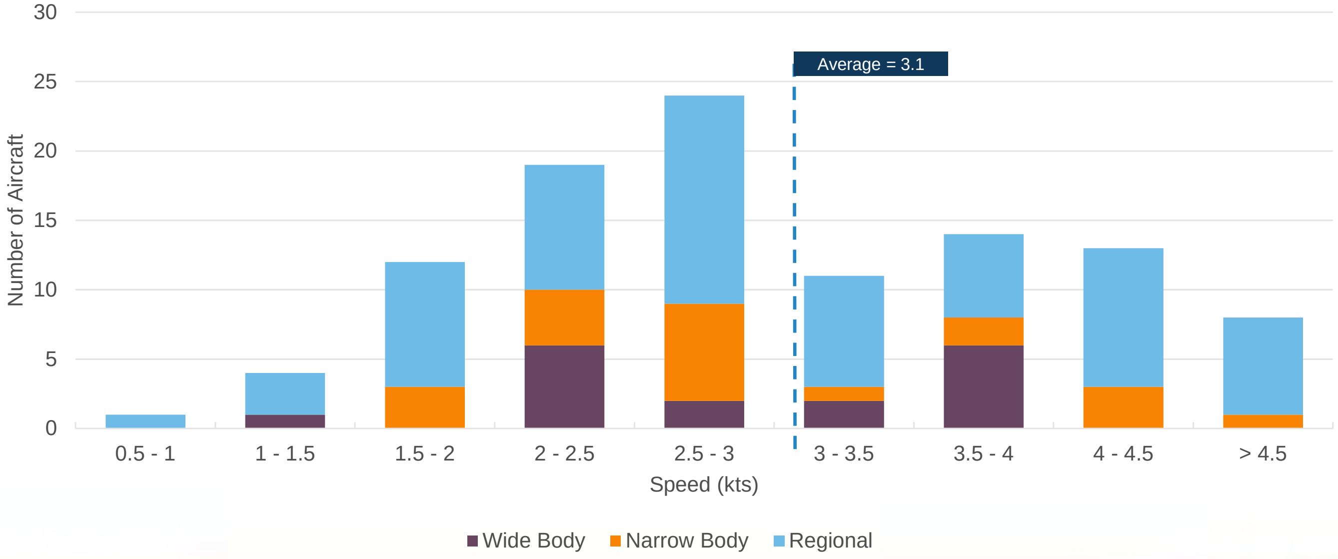
- Taxiing speeds on taxiways crossing runway centerlines will be 15 knots
- Impeded runway crossing aircraft will pause for 25 seconds before beginning a runway crossing
  - Observed 15 second pause after arriving/departure aircraft clears the runway/taxiway intersection
  - Additional 10 seconds to account for slower average crossing speed due to acceleration
- Aircraft crossing an active arrival runway will clear the hold line before the next arriving aircraft is 0.5 NM from the runway threshold (consistent with OM EIS)

PUSHBACK MOVEMENTS
METHODOLOGY

- Pushback procedure observations tracked the time elapsed from when an aircraft commenced its pushback movement until the aircraft began to taxi under its own power
- Apron area movement observations within the Operations Tower occurred on September 17th and 18th, 2018
  - Additional observations were recorded for the same days through Aerobahn
- Several times were recorded for each operations, the times were used to calculate the following:
  - Average Pushback Speed
    - Pushback Time
      - Elapsed time of tug maneuvering the aircraft from the gate to the engine spool up position
      - Starts when tug commences movement and ends when tug stops
    - Average speed calculated using measured distances of typical maneuvers by concourse and pushback movement time recorded during observations
  - Engine Spool Up
    - Elapsed time to between when the tug stops and the aircraft moves under its own power
    - Includes tug disconnect, engine spool up, and control surface check

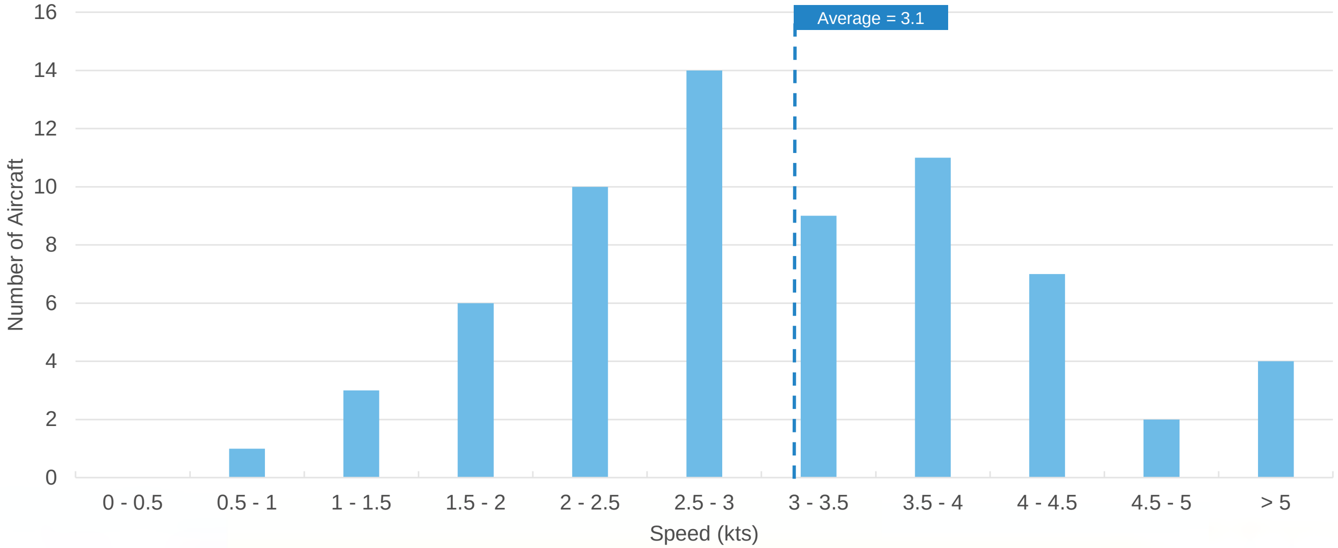
PUSHBACK MOVEMENTS

OBSERVATIONS - AVERAGE PUSHBACK SPEED – ALL AIRCRAFT



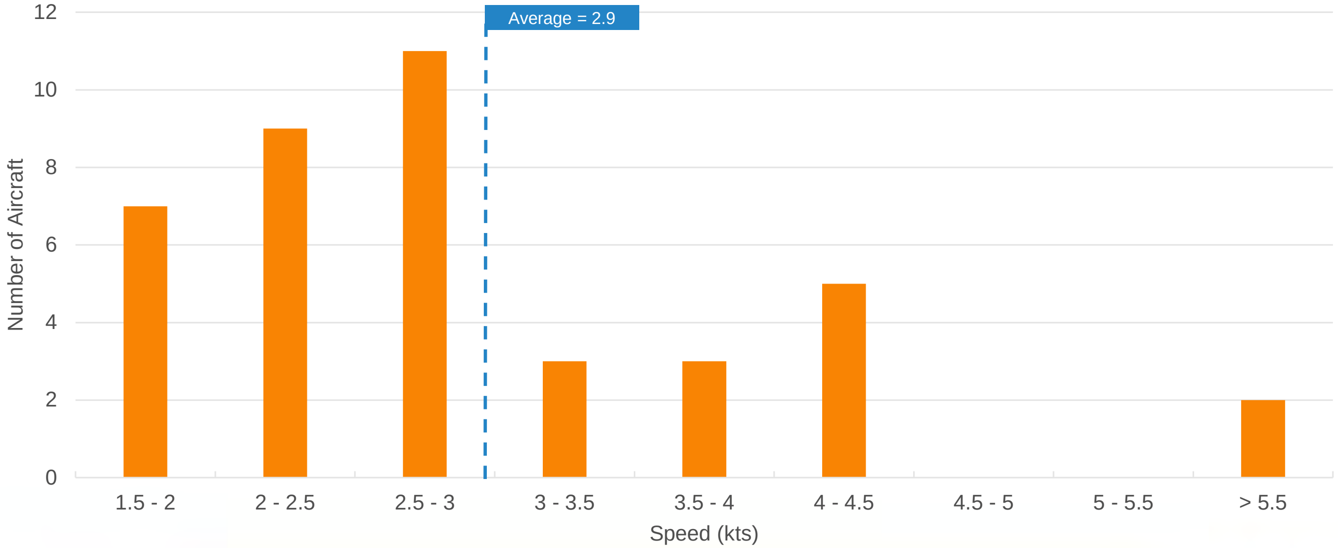
PUSHBACK MOVEMENTS

OBSERVATIONS - AVERAGE PUSHBACK SPEED – REGIONAL AIRCRAFT



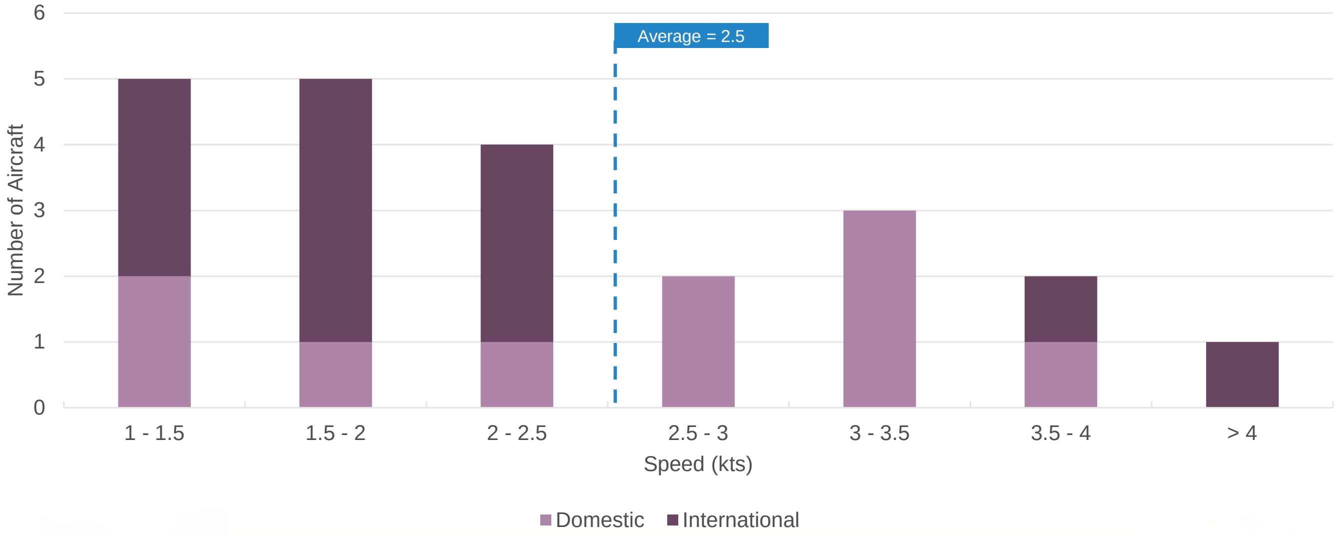
PUSHBACK MOVEMENTS

OBSERVATIONS - AVERAGE PUSHBACK SPEED – NARROW BODY AIRCRAFT



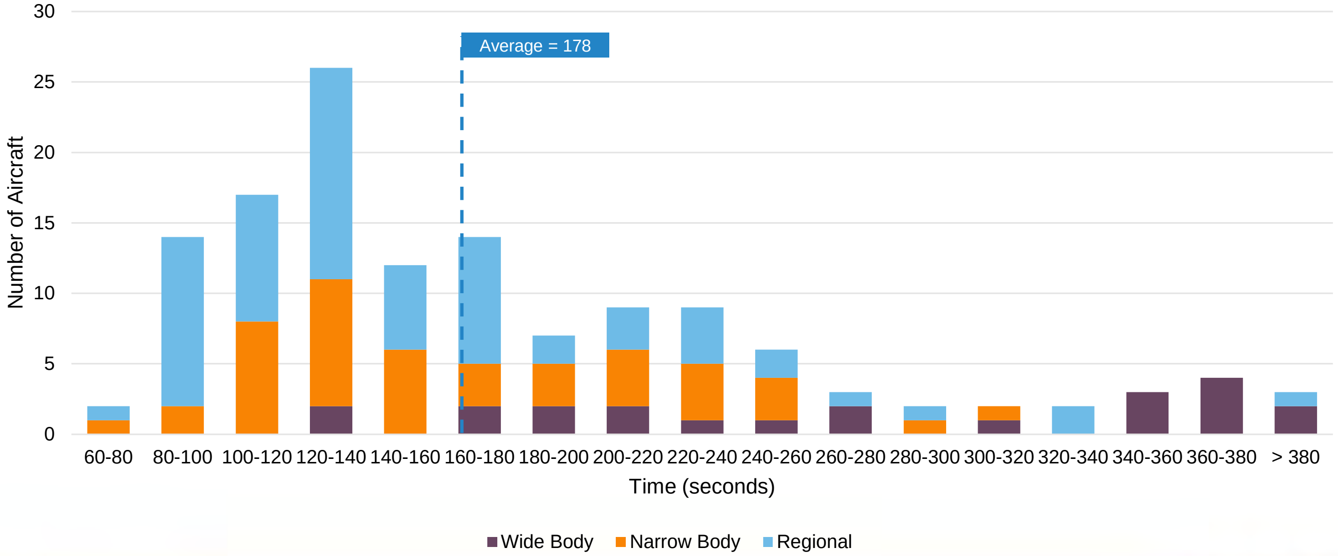
PUSHBACK MOVEMENTS

OBSERVATIONS - AVERAGE PUSHBACK SPEED – WIDE BODY AIRCRAFT



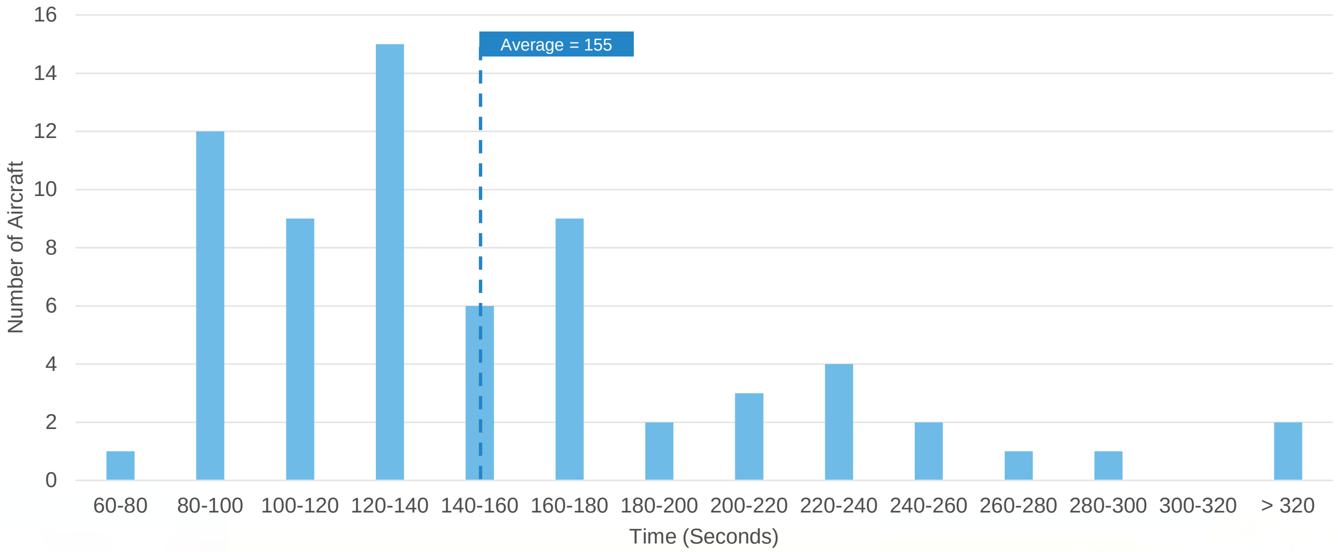
PUSHBACK MOVEMENTS

OBSERVATIONS - ENGINE SPOOL UP – ALL AIRCRAFT



PUSHBACK MOVEMENTS

OBSERVATIONS - ENGINE SPOOL UP – REGIONAL JETS



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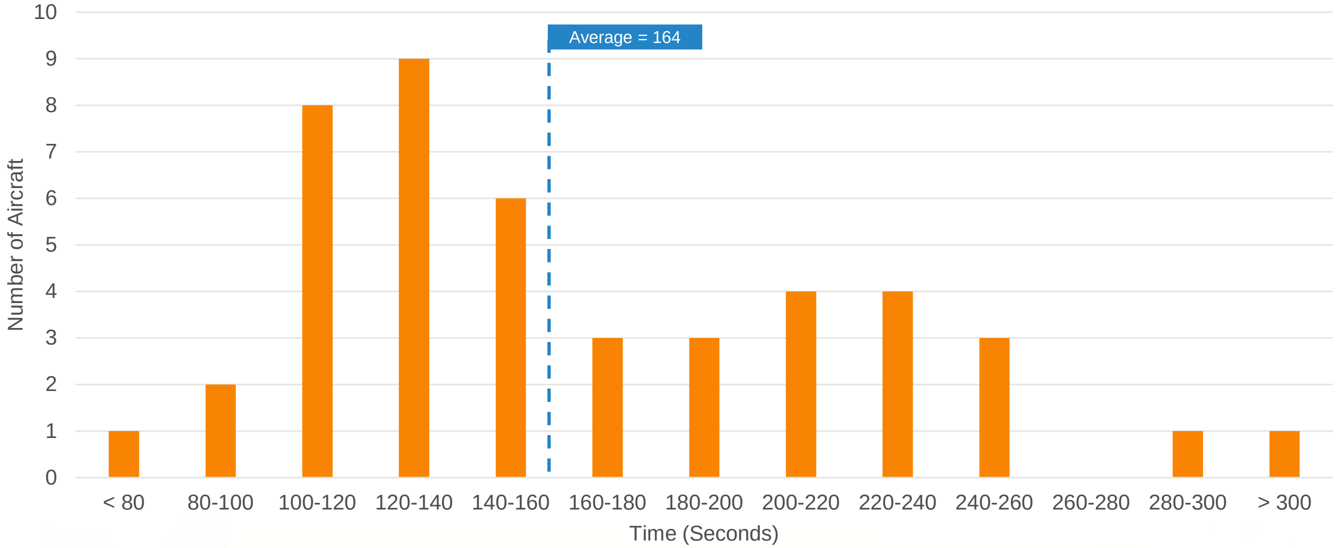
PUSHBACK MOVEMENTS

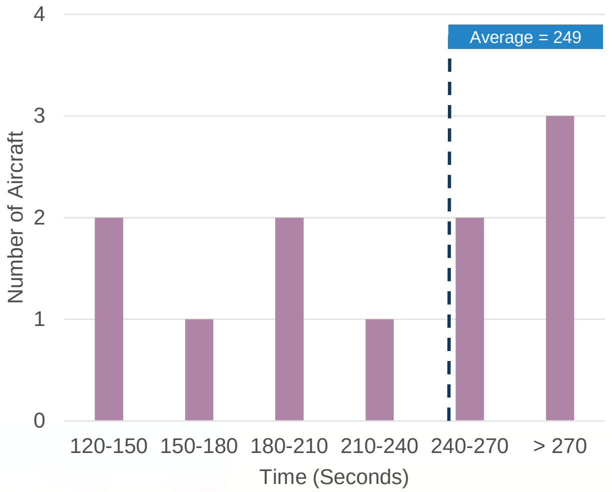
OBSERVATIONS - ENGINE SPOOL UP – NARROW BODY AIRCRAFT



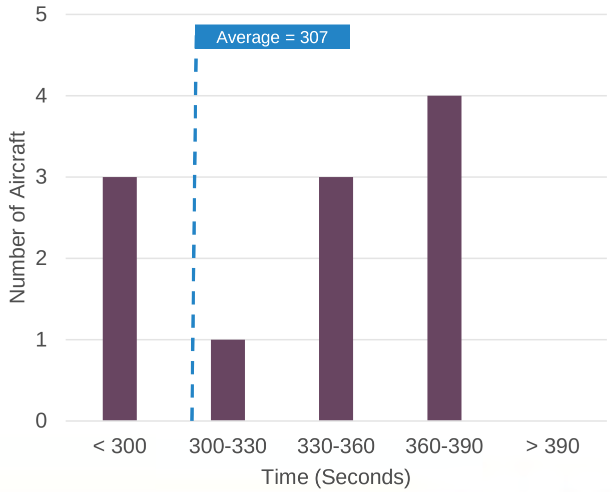
PUSHBACK MOVEMENTS

OBSERVATIONS - ENGINE SPOOL UP – WIDE BODY AIRCRAFT

Domestic Wide Body

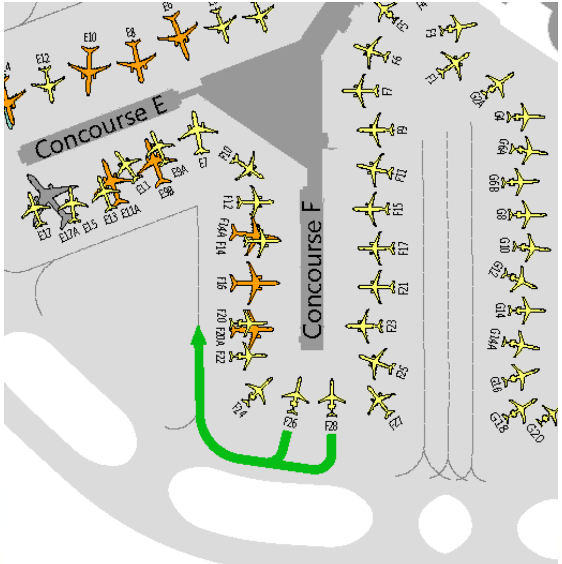


International Wide Body



PUSHBACK MOVEMENTS

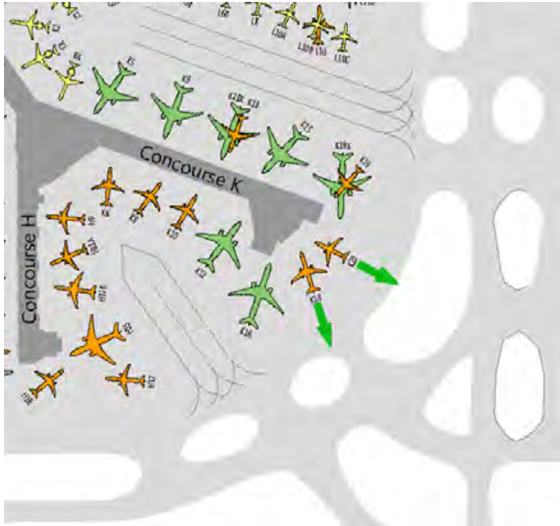
UNIQUE PUSHBACK OPERATIONS – GATES F26 & F28



- Require extended pushback distance to allow for engine spool up outside movement area
- Pushback procedure for F26 was recorded from inside terminal
  - Total pushback time: 69 seconds
  - Pushback distance estimated based on observed route tug follows ~ 560 feet
  - Average pushback speed: 4.81 kts
  - Engine spool up same as typical non-movement area operations

PUSHBACK MOVEMENTS

UNIQUE PUSHBACK OPERATIONS – GATES K18 & K20



- Aircraft pushed into movement area
- Pushback procedure for K18 was recorded from inside terminal
- Confirmed that pushback speed and engine spool up were consistent with non-movement area operations

PUSHBACK MOVEMENTS
MODELING ASSUMPTIONS

– Regional Jet and Narrow Body: 3.0 knots
– Wide Body: 2.5 knots

– Regional Jet: 155 seconds
– Narrow Body: 164 seconds
– Domestic Wide Body: 249 seconds
– International Wide Body: 307 seconds

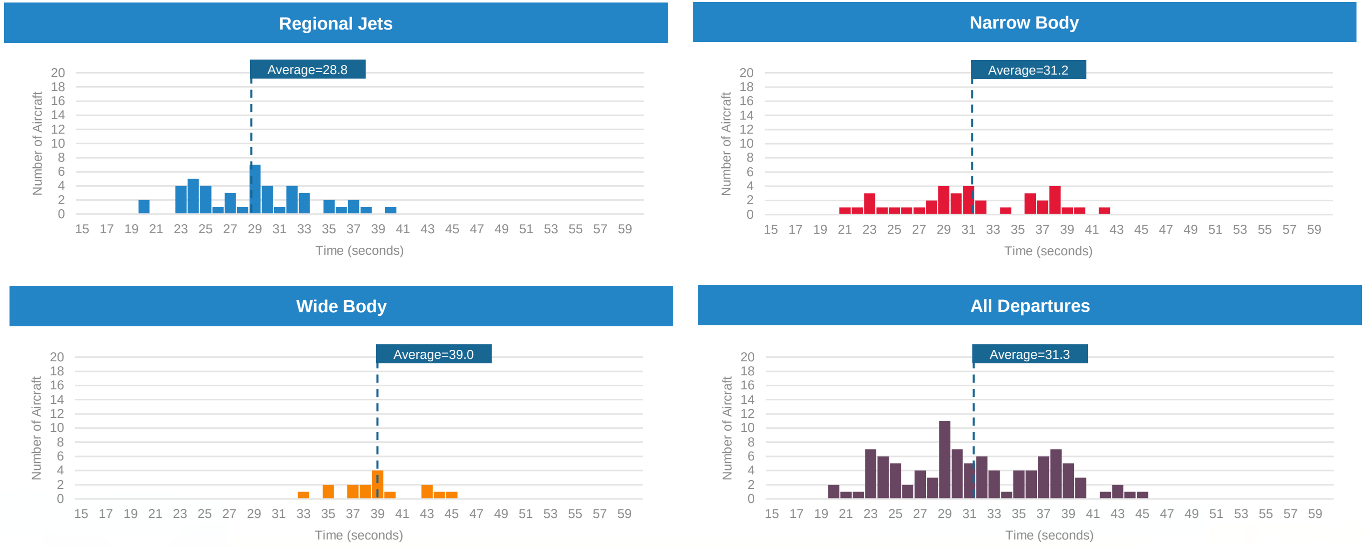
DEPARTURE LINE UP
METHODOLOGY

- Acceleration Pause: elapsed time between proceeding departure and start of movement
- Line Up Time: time elapsed between the start of movement and in position on the runway
- Times were summed to determine complete line up time

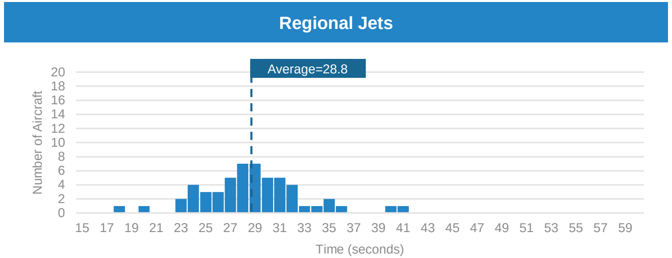
- Regional Jets (CRJ7, E170, etc.)
- Narrow Body (B738, A321, etc.)
- Wide Body (B772, B744, etc.)

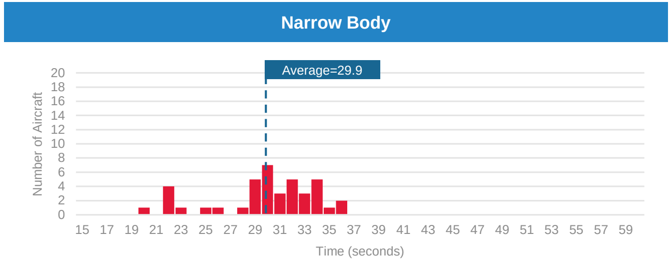
DEPARTURE LINE UP

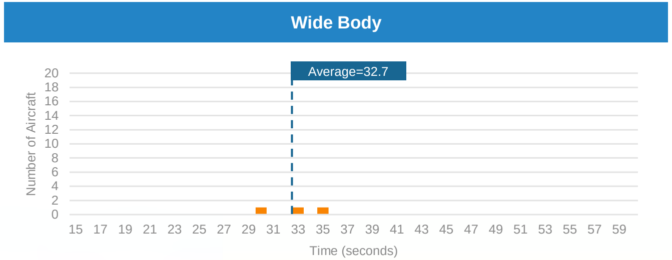
OBSERVATIONS – RUNWAY 28R

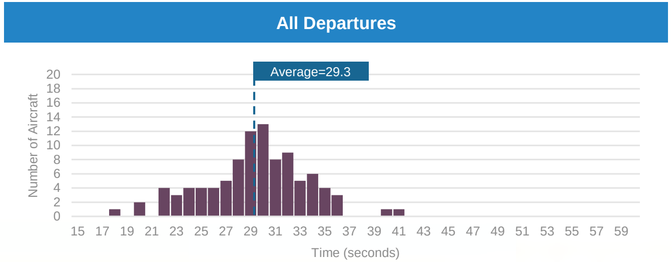


DEPARTURE LINE UP
OBSERVATIONS – RUNWAY 22L



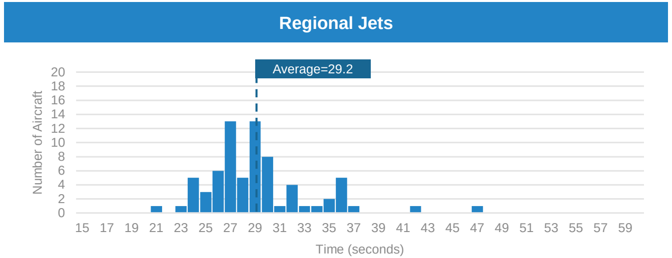


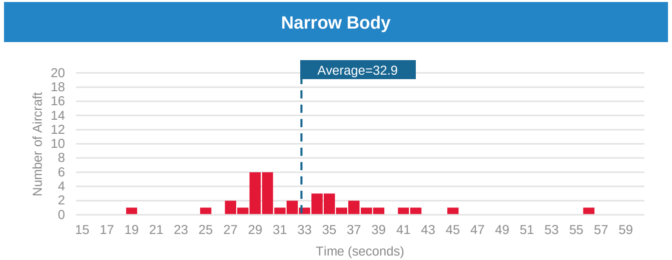


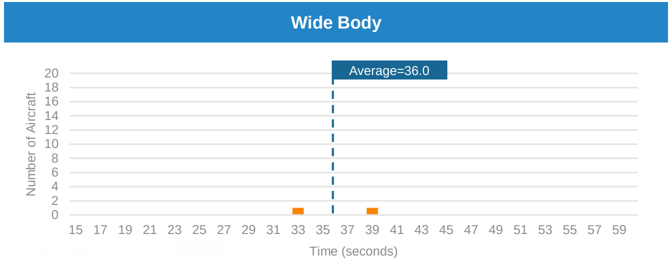


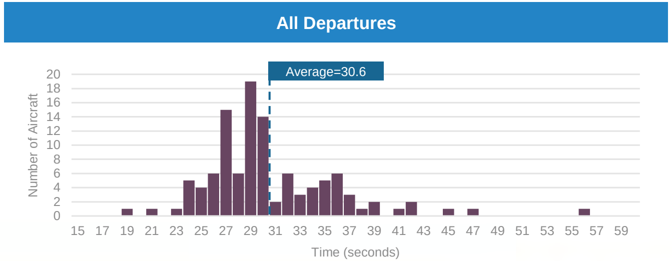
DEPARTURE LINE UP

OBSERVATIONS – RUNWAY 9R



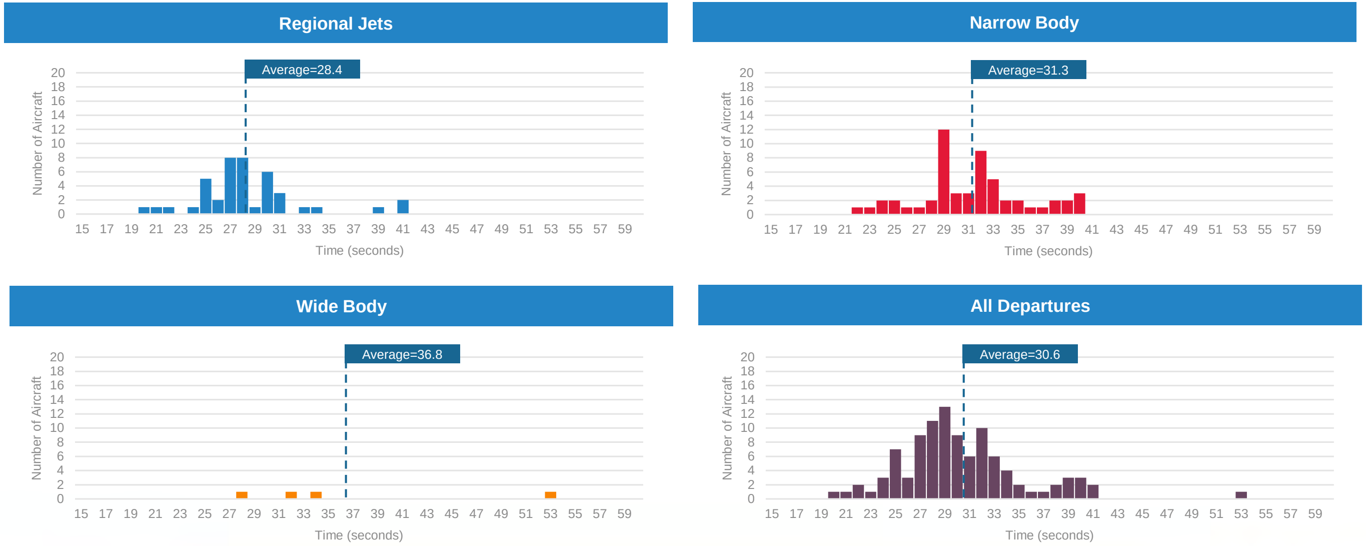






DEPARTURE LINE UP

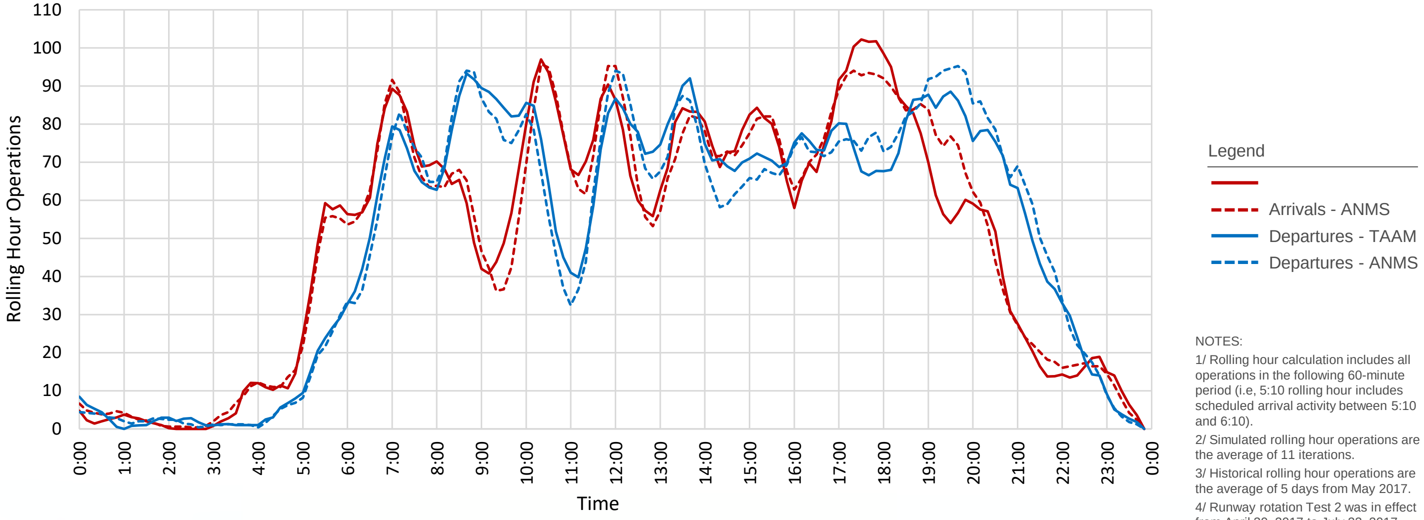
OBSERVATIONS – RUNWAY 10L



DEPARTURE LINE UP
MODELING ASSUMPTIONS

- Longest observed line up times (wide bodies) do not exceed successive departure separation


Comparison of Simulated
and Historical Operations



NOTES:
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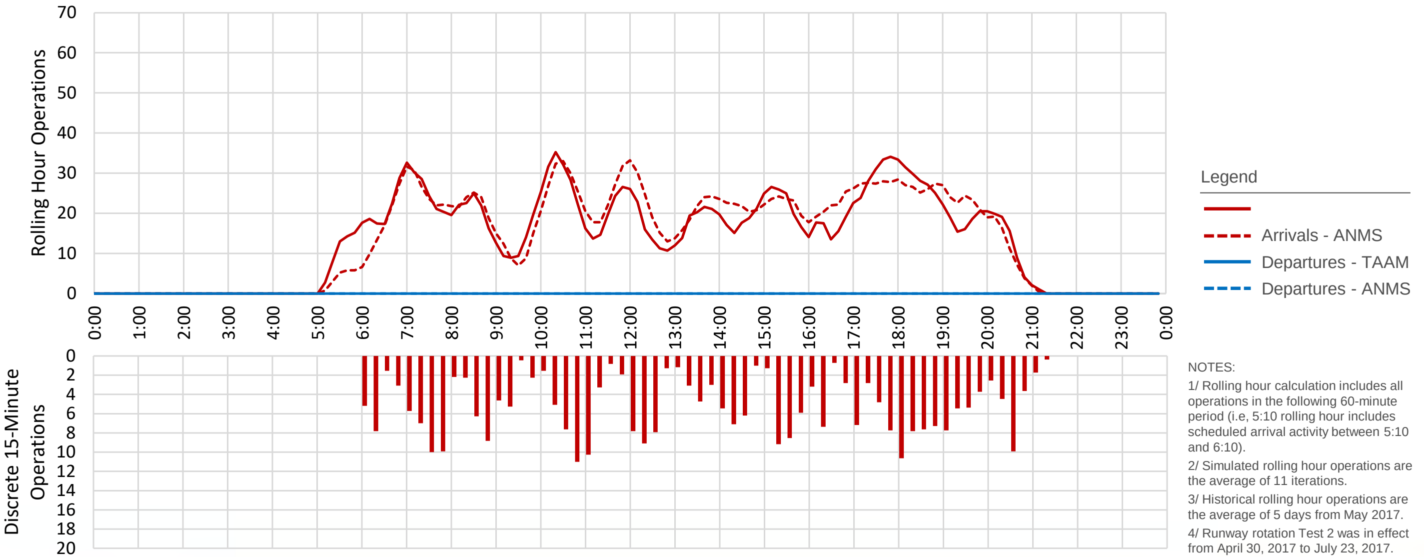
2/ Simulated rolling hour operations are the average of 11 iterations.
3/ Historical rolling hour operations are the average of 5 days from May 2017.
4/ Runway rotation Test 2 was in effect from April 30, 2017 to July 23, 2017. Runway rotation will not be modeled and utilization of rotation runways is not depicted.

SOURCES:
O'Hare International Airport, Airport Noise Management System, May 2017(actual runway time); Ricondo & Associates, Inc., December 2018 (TAAM modeling).



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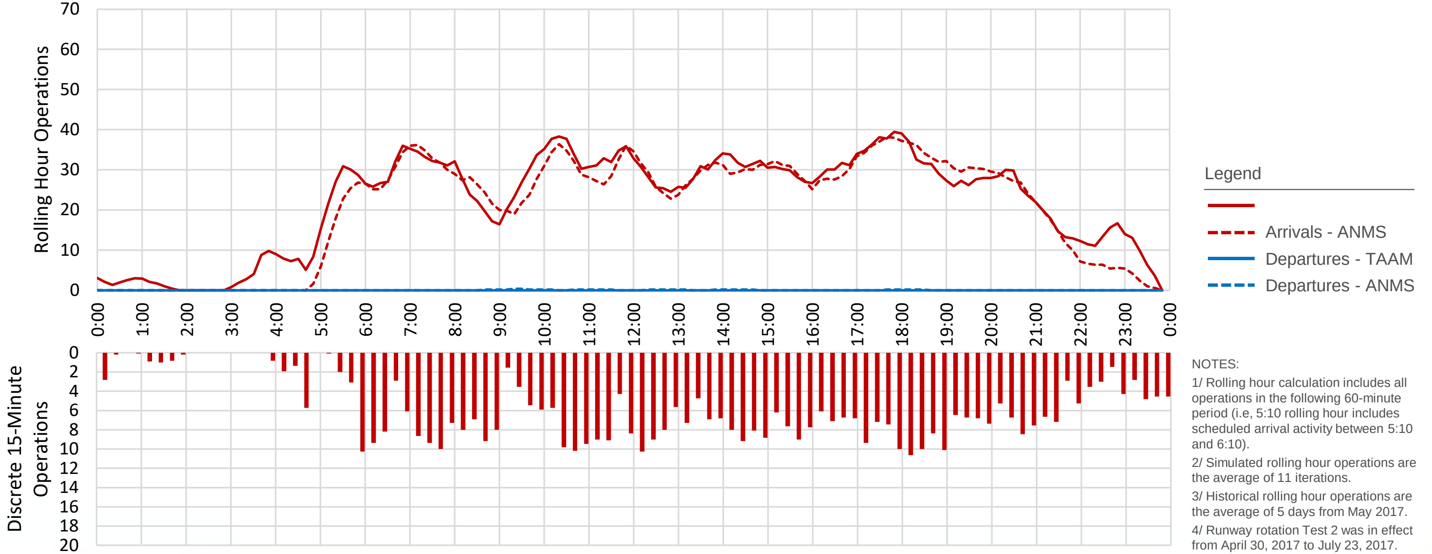

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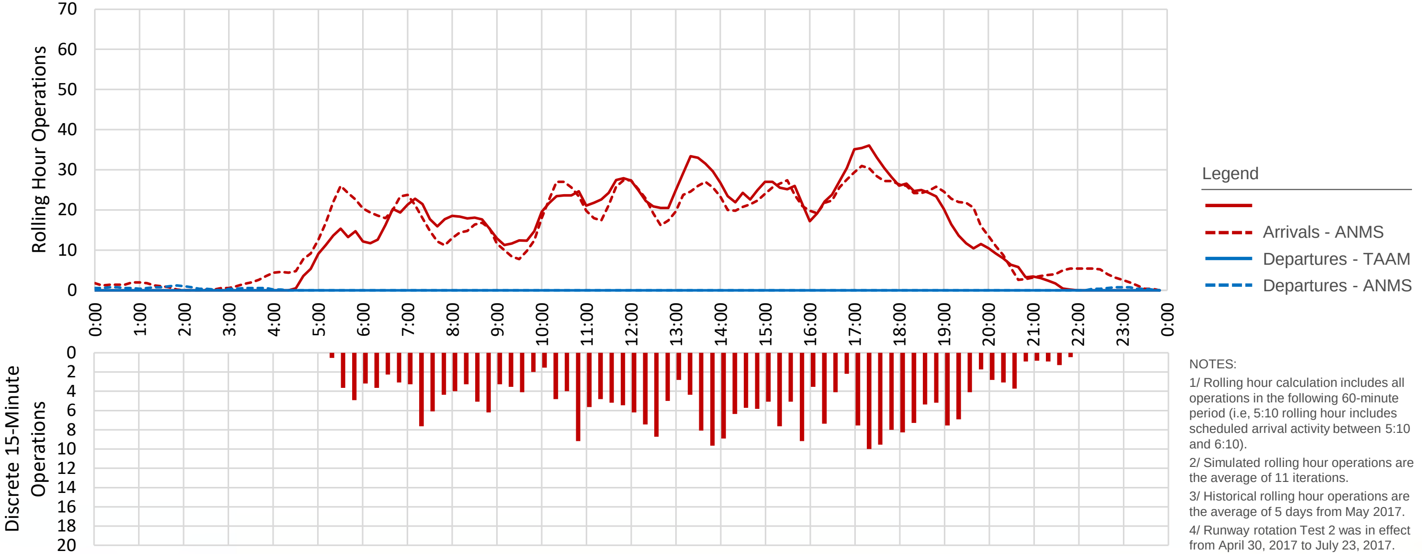

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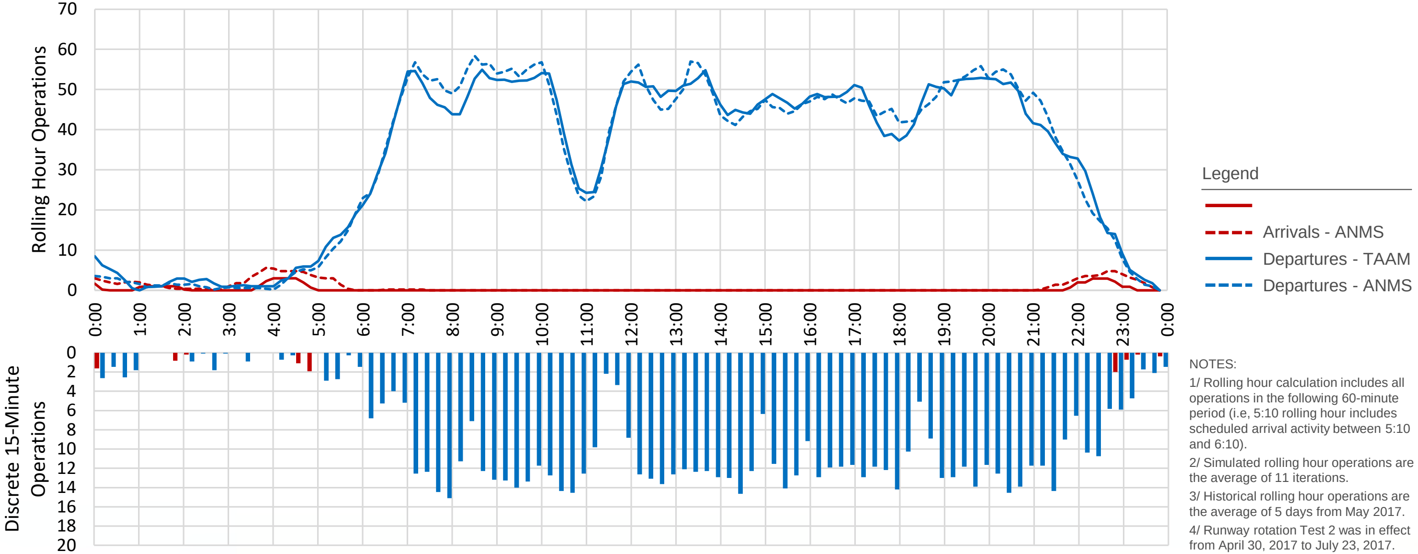

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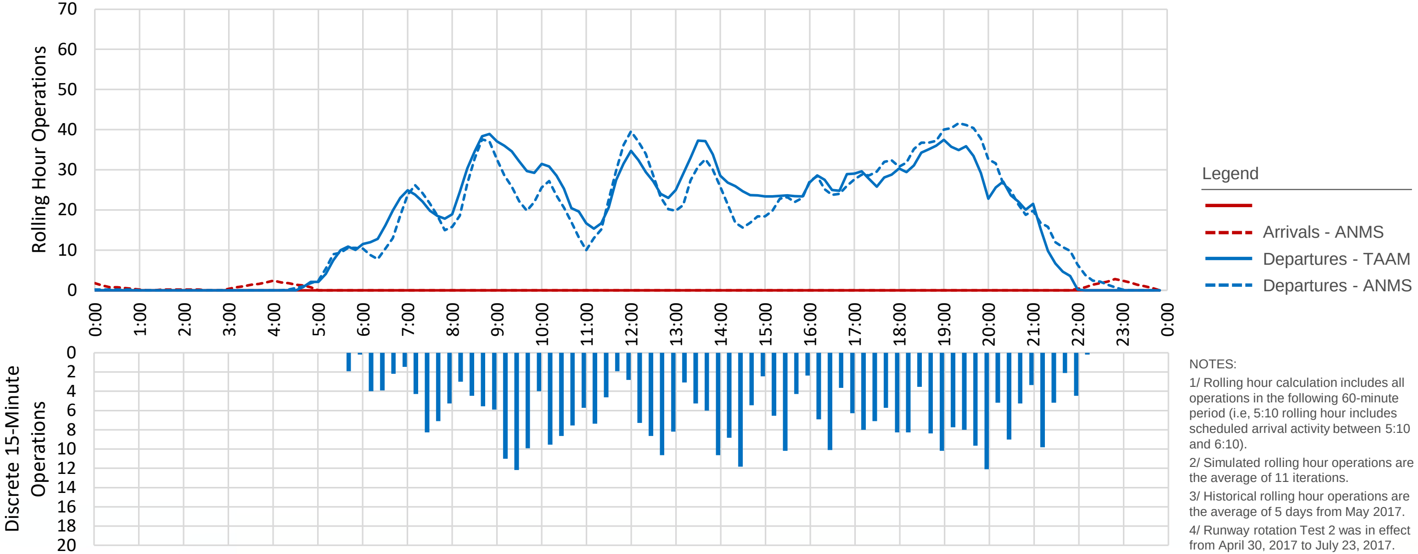

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SOURCES:
O'Hare International Airport, Airport Noise Management System, May 2017(actual runway time); Ricondo & Associates, Inc., December 2018 (TAAM modeling).

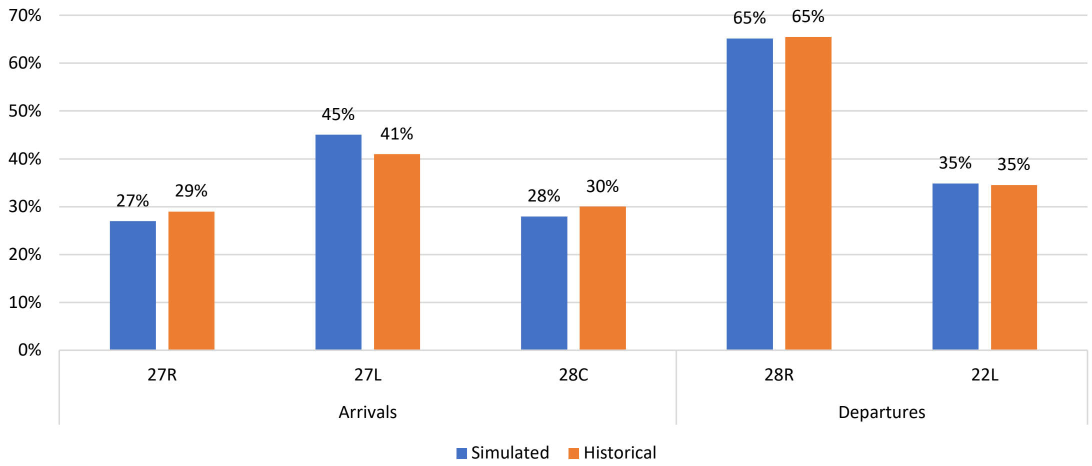
Arrivals

Runway	Taxi Time: Simulated	Taxi Time: Historical	Operations: Simulated	Operations: Historical
27R	13:55	14:10	322	339
27L	9:50	9:59	537	479
28C	12:41	12:39	333	351
All	11:44	12:00	1,192	1,169

Departures

Runway	Taxi Time: Simulated	Taxi Time: Historical	Operations: Simulated	Operations: Historical
28R	15:19	13:01	790	776
22L	13:39	14:47	423	409
All	14:44	13:38	1,213	1,185

NOTES:
1/ Simulated taxi times are the average of 11 iterations.
2/ Historical taxi times are the average of 5 days from May 2017.
3/ Arrival taxi times measure from touchdown to gate.
4/ Departure taxi times measure from start of pushback to liftoff.



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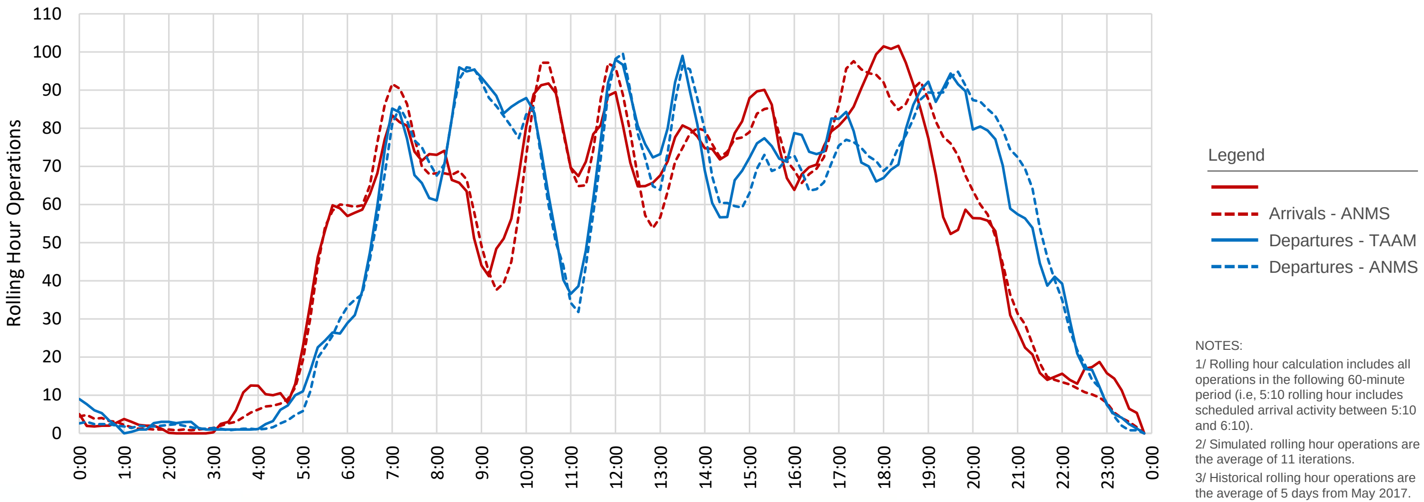

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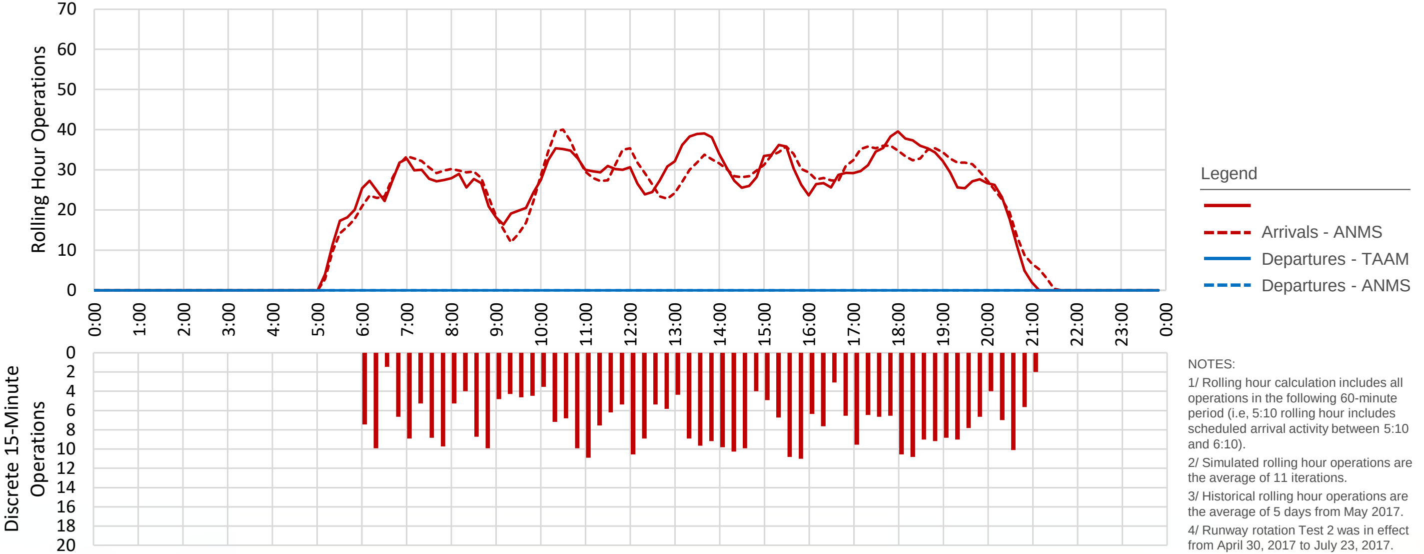

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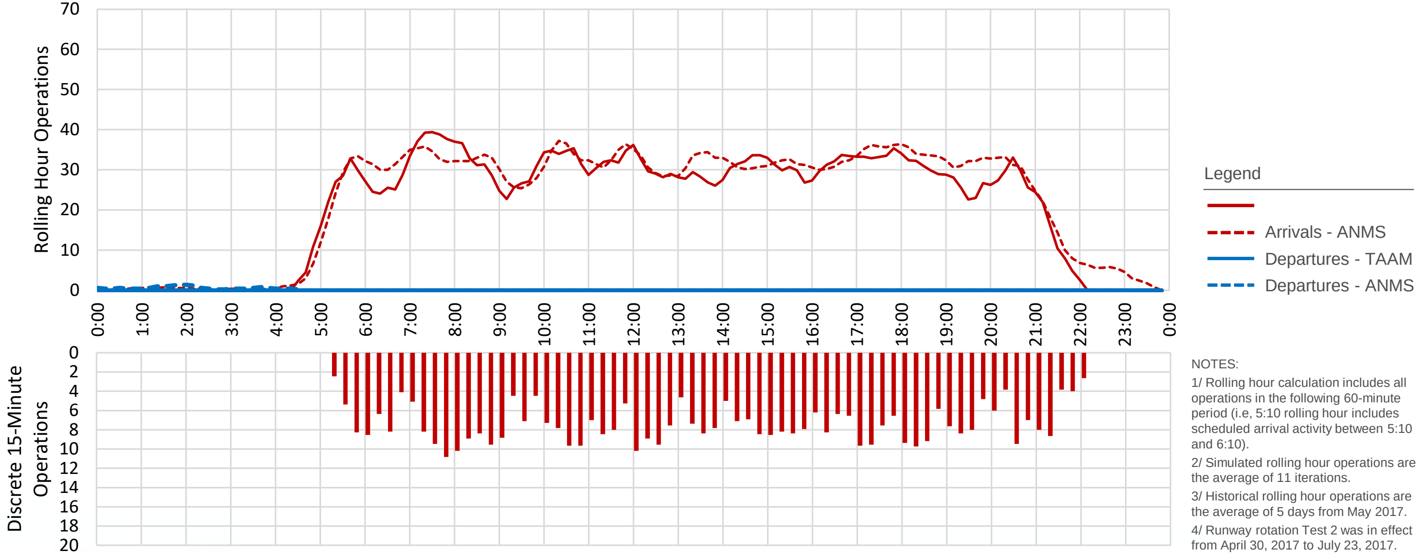

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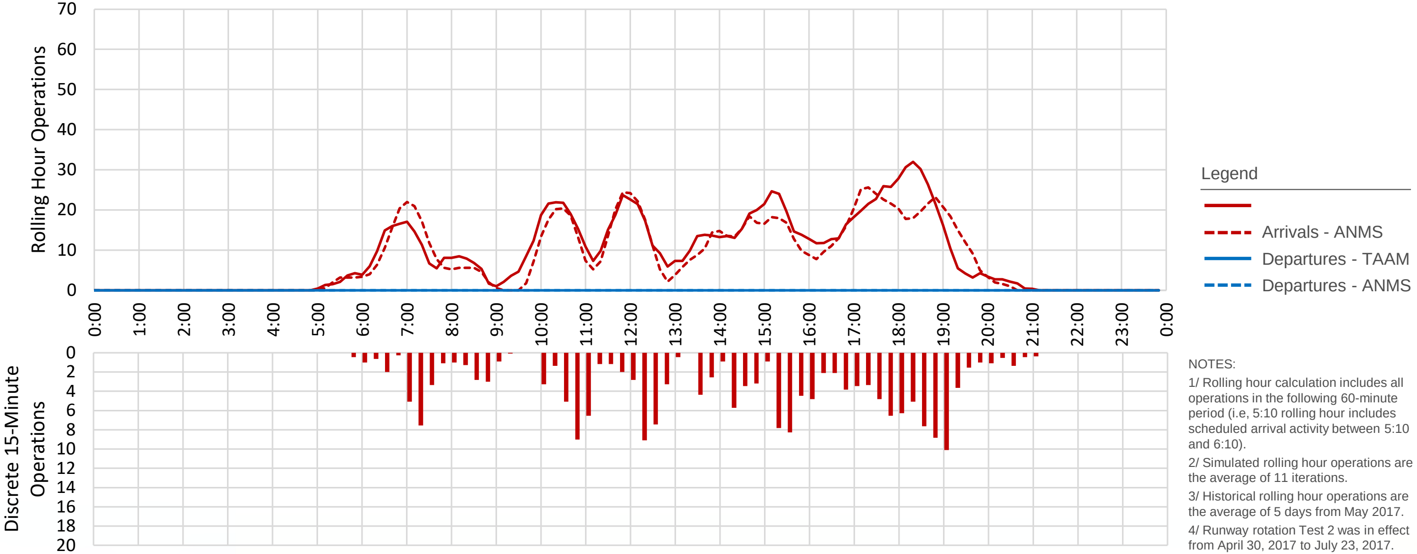

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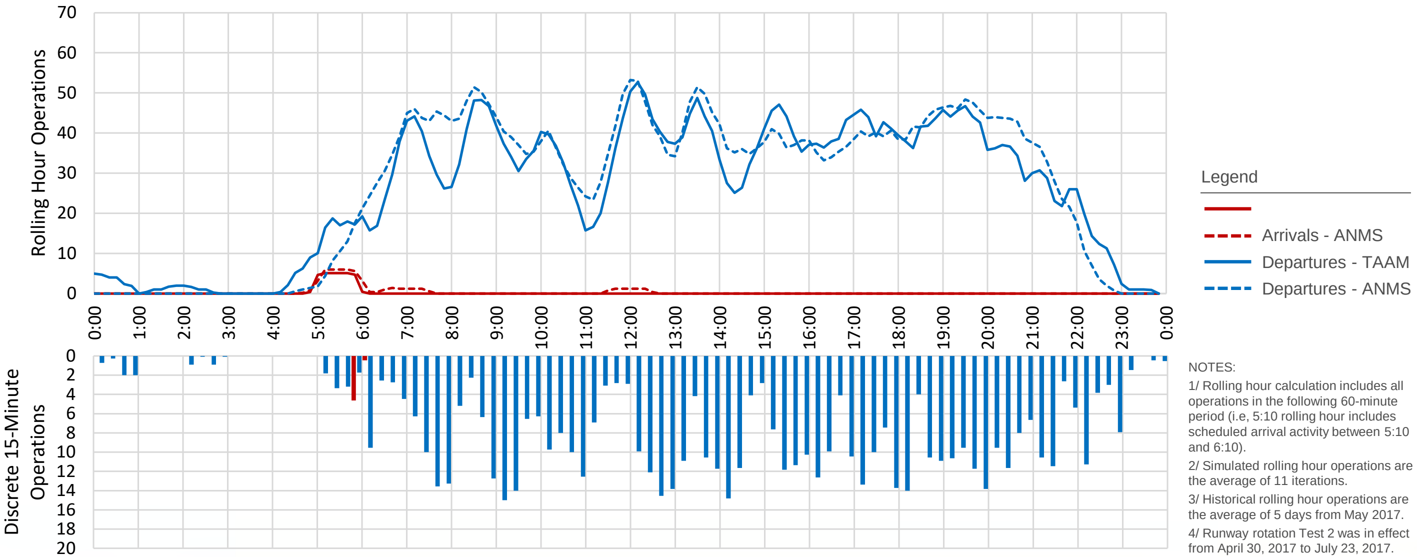

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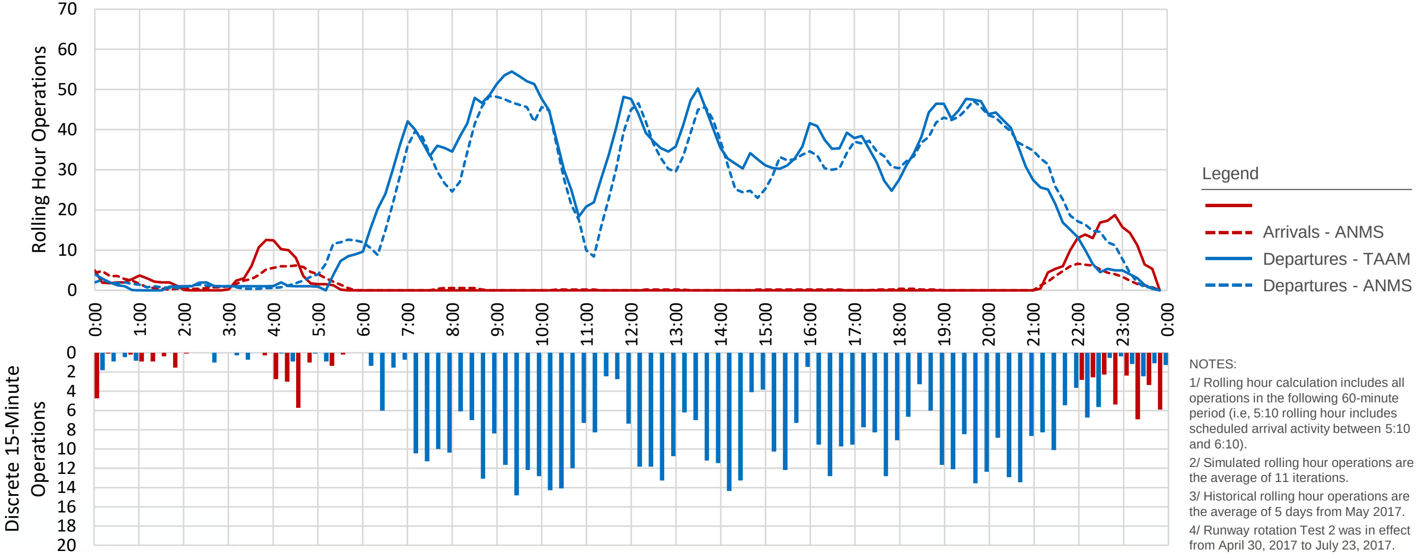

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SOURCES:
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Arrivals				
	Taxi Time		Operations	
Runway	Simulated	Historical	Simulated	Historical
9L	16:43	16:55	445	451
10C	12:32	13:36	503	539
10R	18:39	18:14	204	188
All	15:14	15:36	1,153	1,178

Departures				
	Taxi Time		Operations	
Runway	Simulated	Historical	Simulated	Historical
9R	13:07	13:15	627	643
10L	16:21	15:49	6108	568
All	14:43	14:27	1,236	1,211

NOTES:
1/ Simulated taxi times are the average of 11 iterations.
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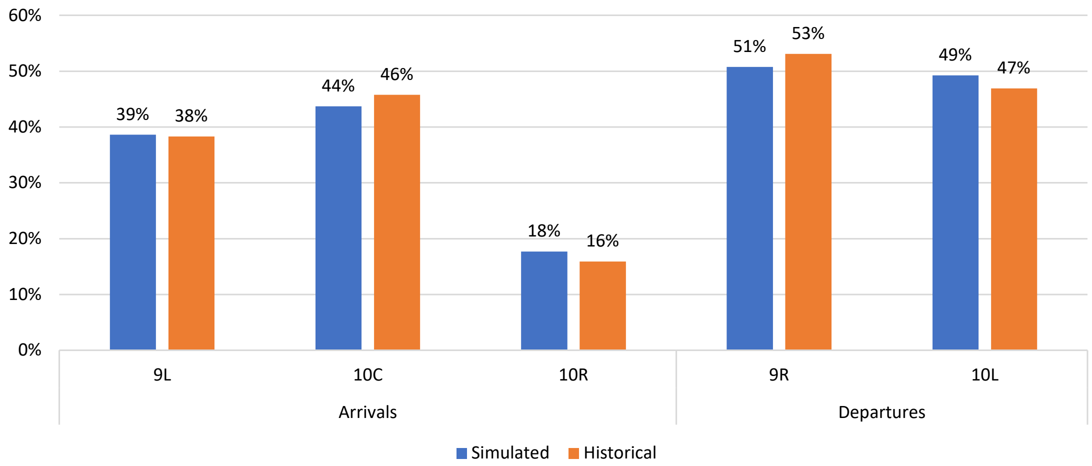
4/ Departure taxi times measure from start of pushback to liftoff.



NOTES:
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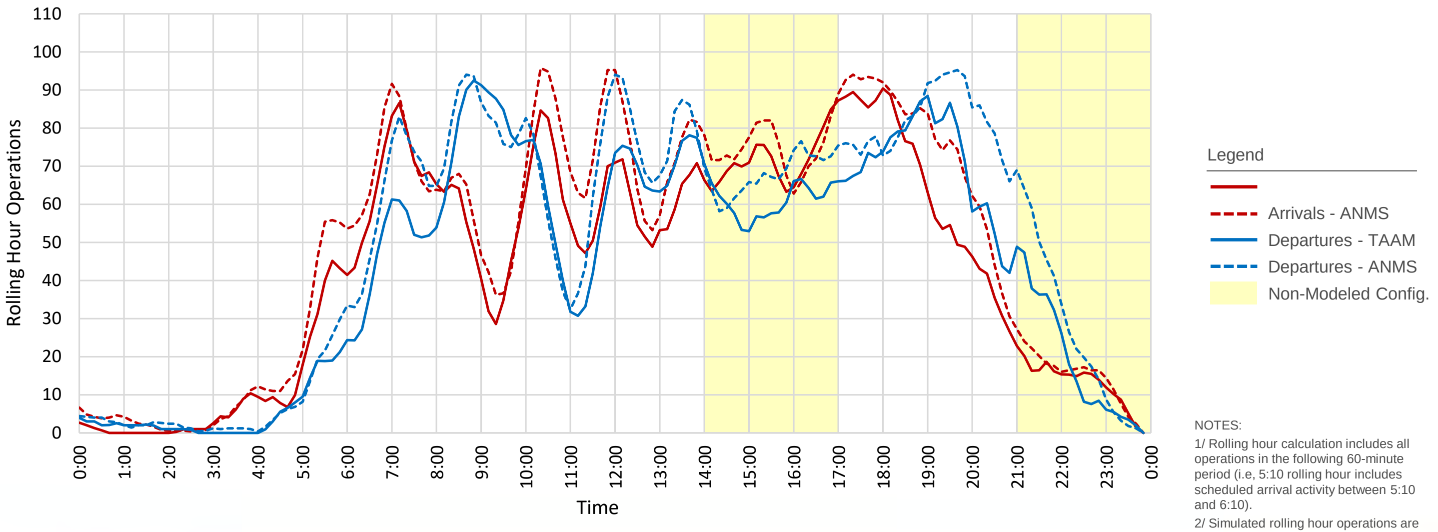

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3/ Historical rolling hour operations are from February 7, 2017.

SOURCES:

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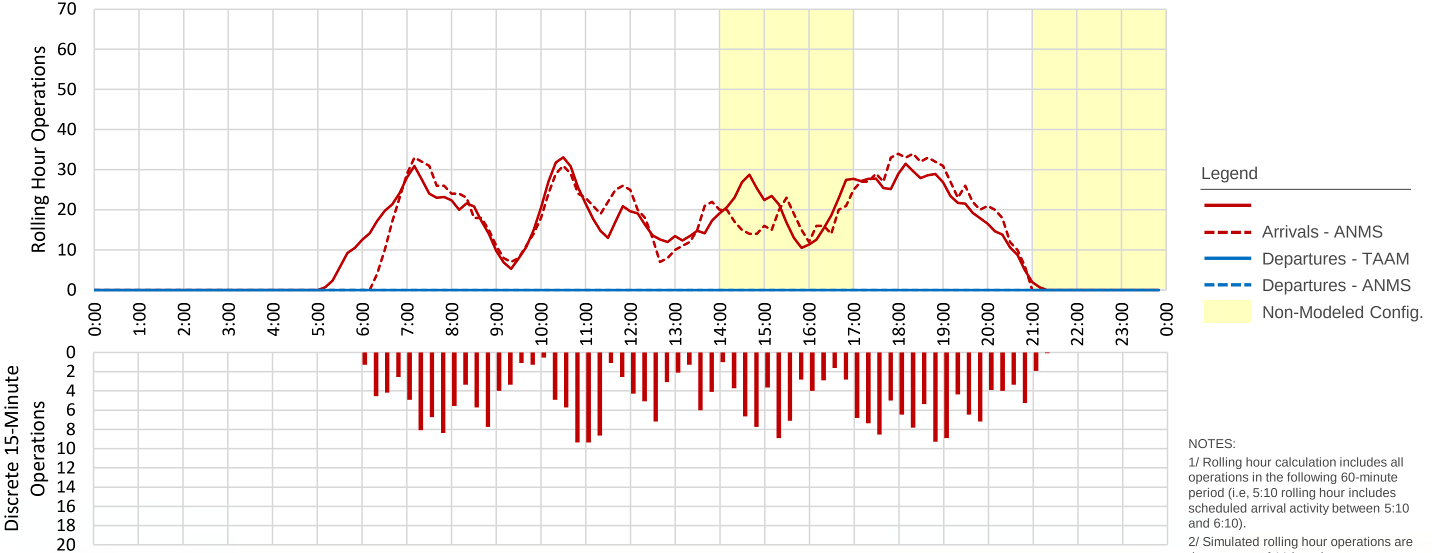

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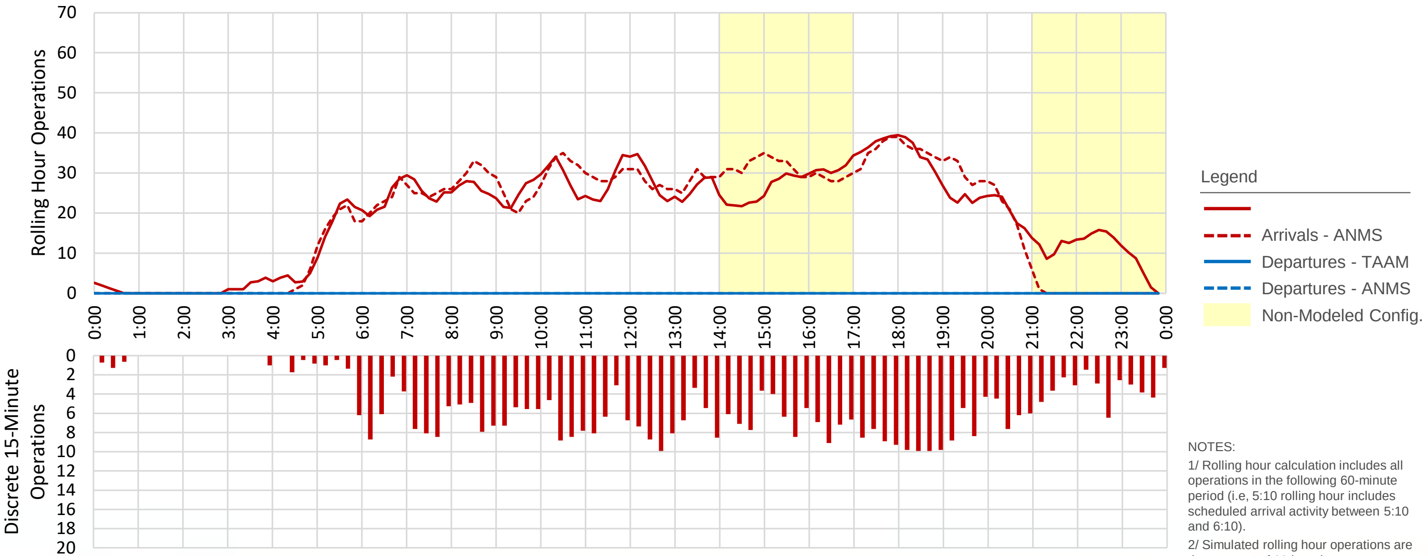

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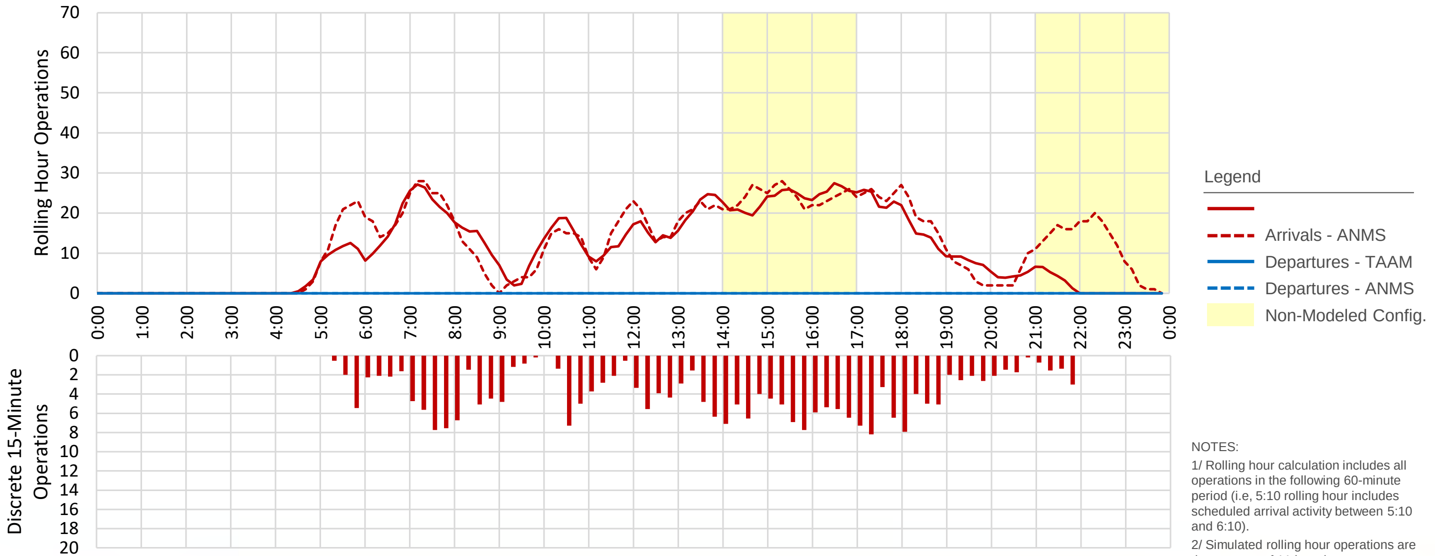

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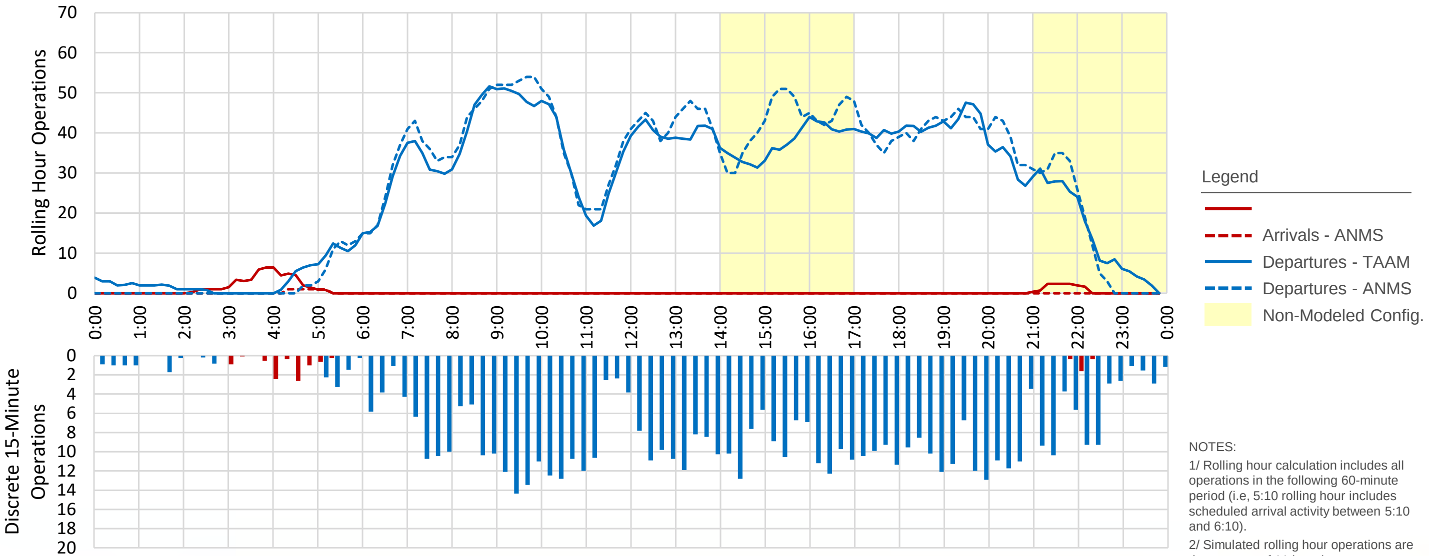

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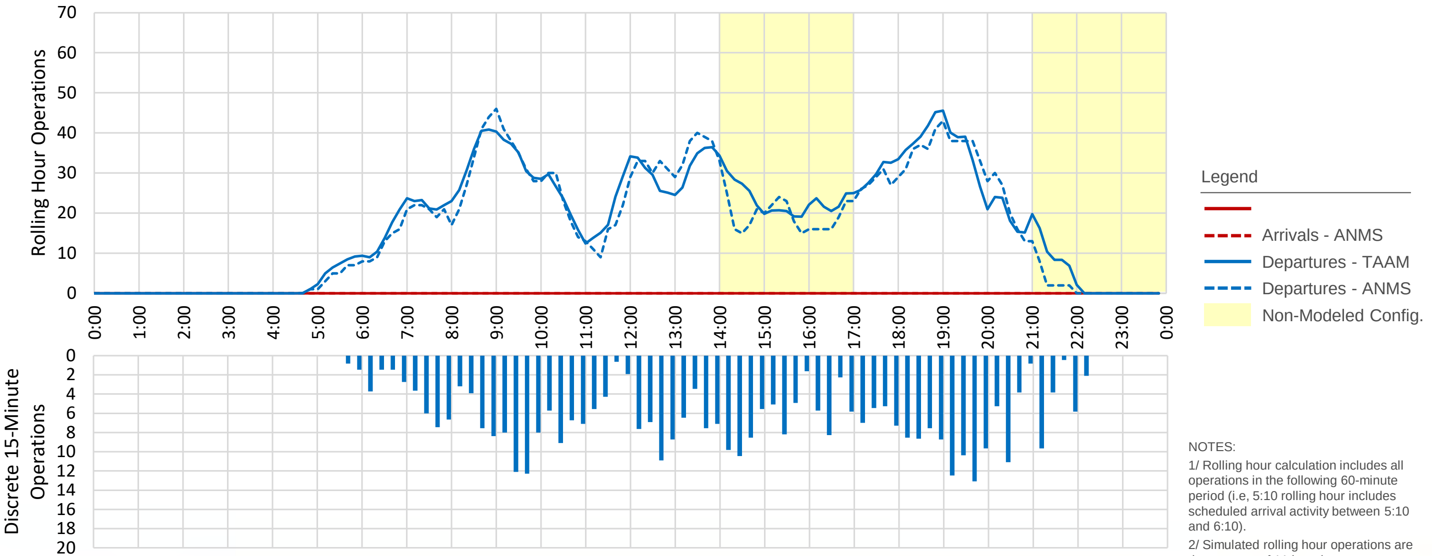

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Arrivals				
	Taxi Time		Operations	
Runway	Simulated	Historical	Simulated	Historical
27R	14:50	13:15	303	299
27L	9:57	9:12	470	450
28C	12:29	11:39	261	300
All	12:01	11:03	1,034	1,049

Departures				
	Taxi Time		Operations	
Runway	Simulated	Historical	Simulated	Historical
28R	16:07	15:27	629	647
22L	14:35	13:15	422	392
All	15:30	14:37	1,050	1,039

NOTES:
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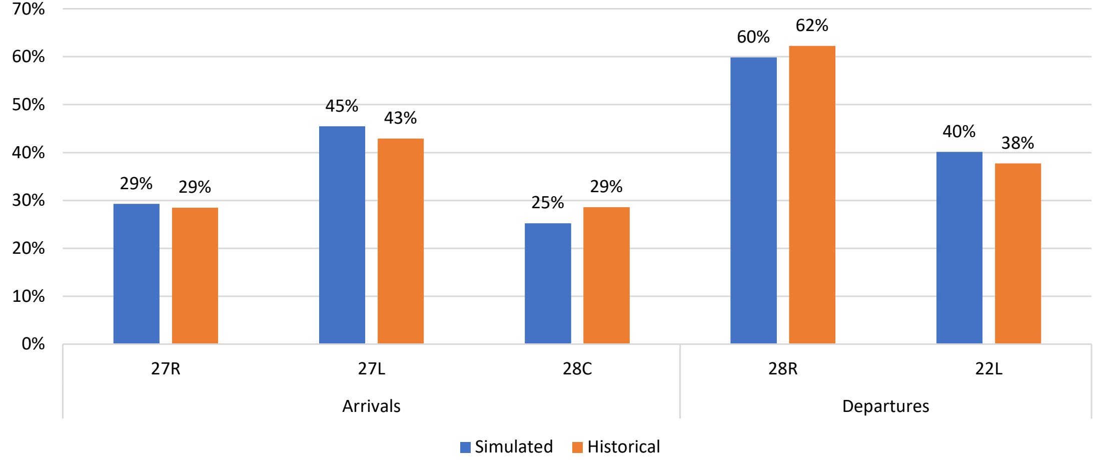
4/ Departure taxi times measure from start of pushback to liftoff.



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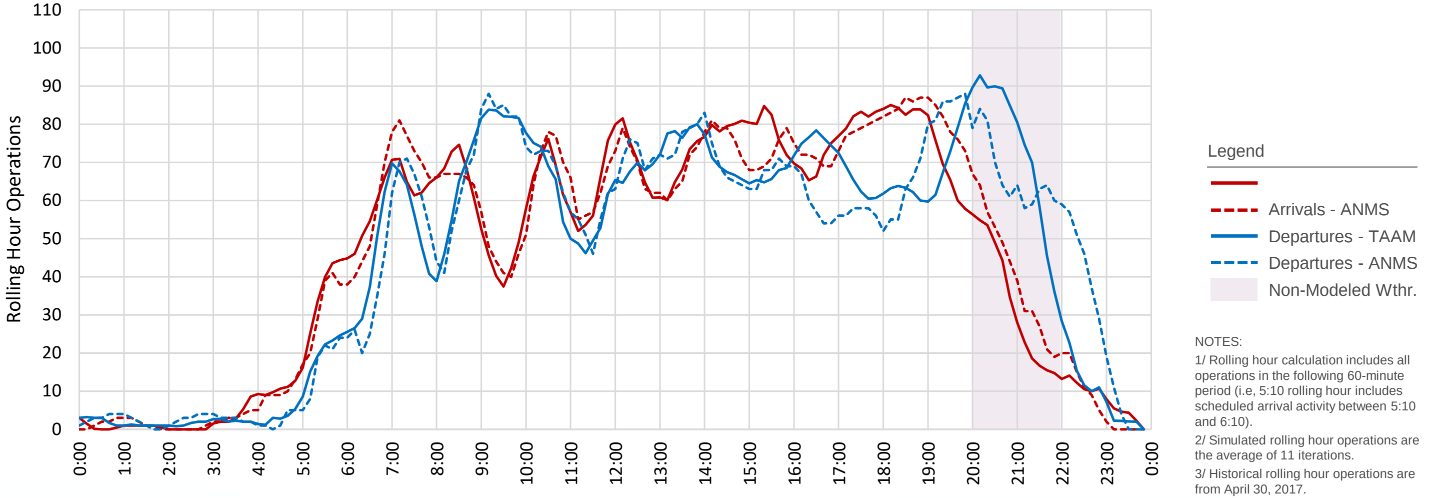
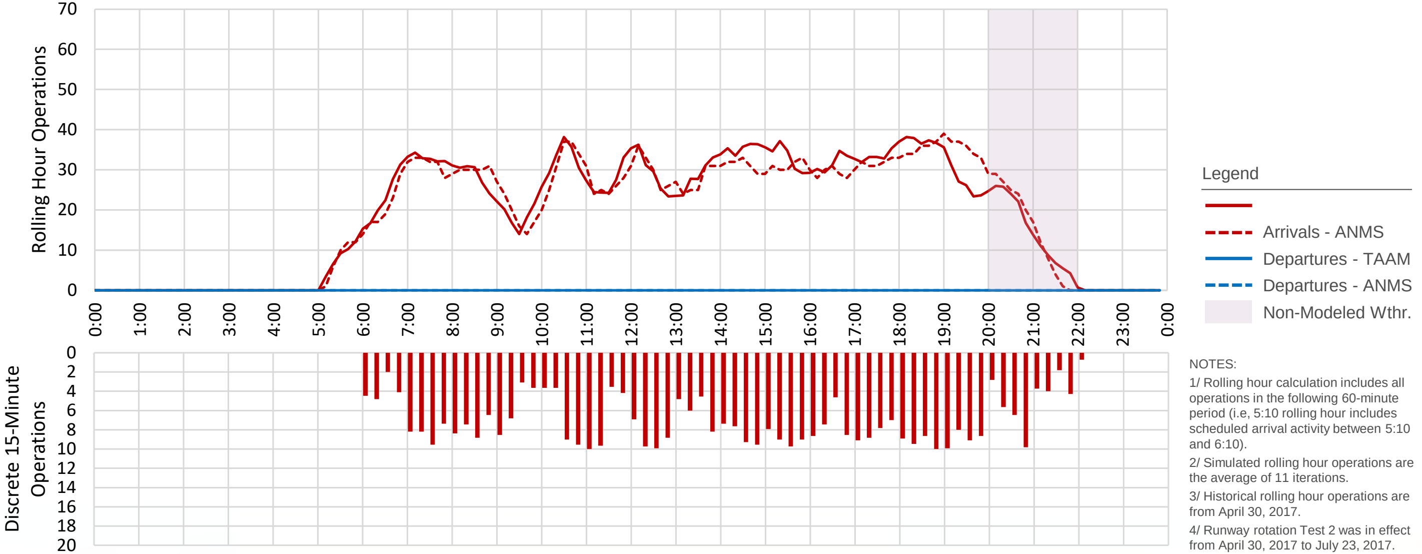
1/ Simulated runway utilization is the average of 11 iterations.
2/ Historical runway utilization is from February 7, 2017.



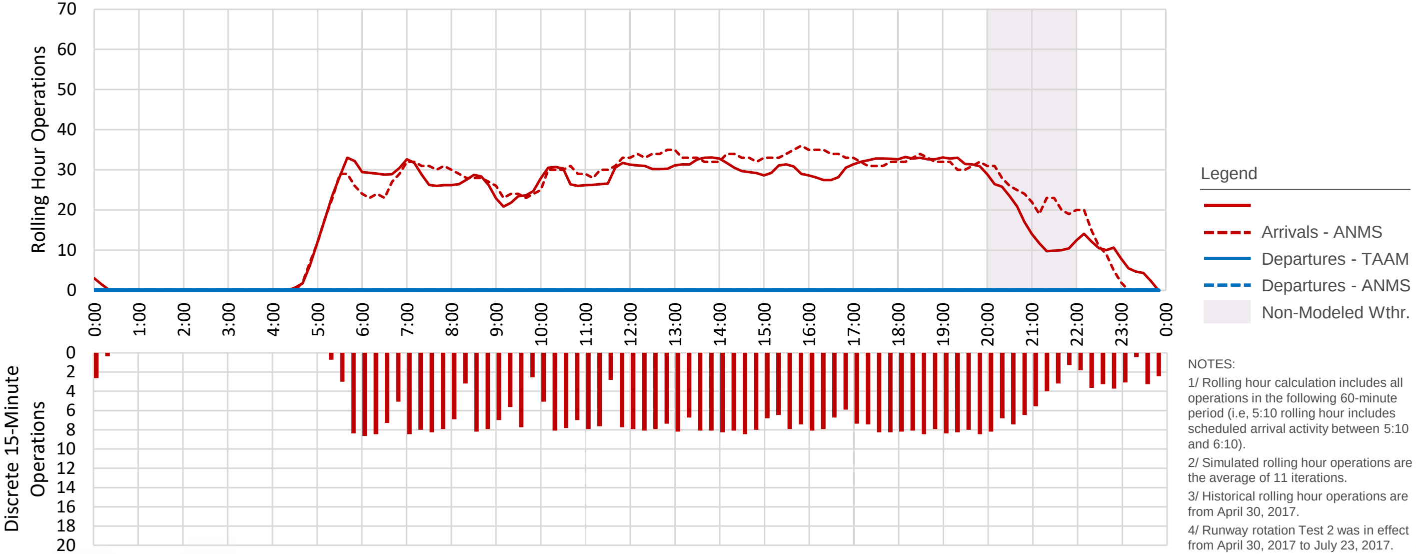
NOTES:
1/ Rolling hour calculation includes all operations in the following 60-minute period (i.e, 5:10 rolling hour includes scheduled arrival activity between 5:10 and 6:10).
2/ Simulated rolling hour operations are the average of 11 iterations.
3/ Historical rolling hour operations are from April 30, 2017.
4/ Runway rotation Test 2 was in effect from April 30, 2017 to July 23, 2017. Runway rotation will not be modeled and utilization of rotation runways is not depicted.

SOURCES:
O'Hare International Airport, Airport Noise Management System, May 2017 (actual runway time); Ricondo & Associates, Inc., December 2018 (TAAM modeling).



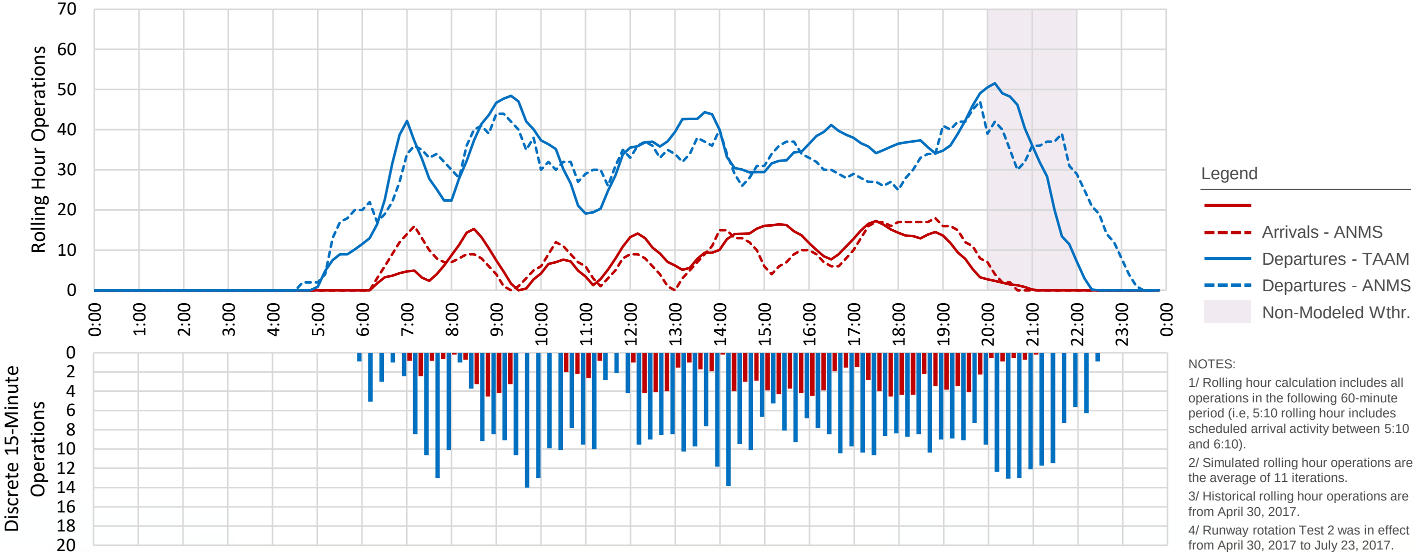
NOTES:
1/ Rolling hour calculation includes all operations in the following 60-minute period (i.e, 5:10 rolling hour includes scheduled arrival activity between 5:10 and 6:10).
2/ Simulated rolling hour operations are the average of 11 iterations.
3/ Historical rolling hour operations are from April 30, 2017.
4/ Runway rotation Test 2 was in effect from April 30, 2017 to July 23, 2017. Runway rotation will not be modeled and utilization of rotation runways is not depicted.

SOURCES:
O'Hare International Airport, Airport Noise Management System, May 2017 (actual runway time); Ricondo & Associates, Inc., December 2018 (TAAM modeling).



NOTES:
1/ Rolling hour calculation includes all operations in the following 60-minute period (i.e, 5:10 rolling hour includes scheduled arrival activity between 5:10 and 6:10).
2/ Simulated rolling hour operations are the average of 11 iterations.
3/ Historical rolling hour operations are from April 30, 2017.
4/ Runway rotation Test 2 was in effect from April 30, 2017 to July 23, 2017. Runway rotation will not be modeled and utilization of rotation runways is not depicted.

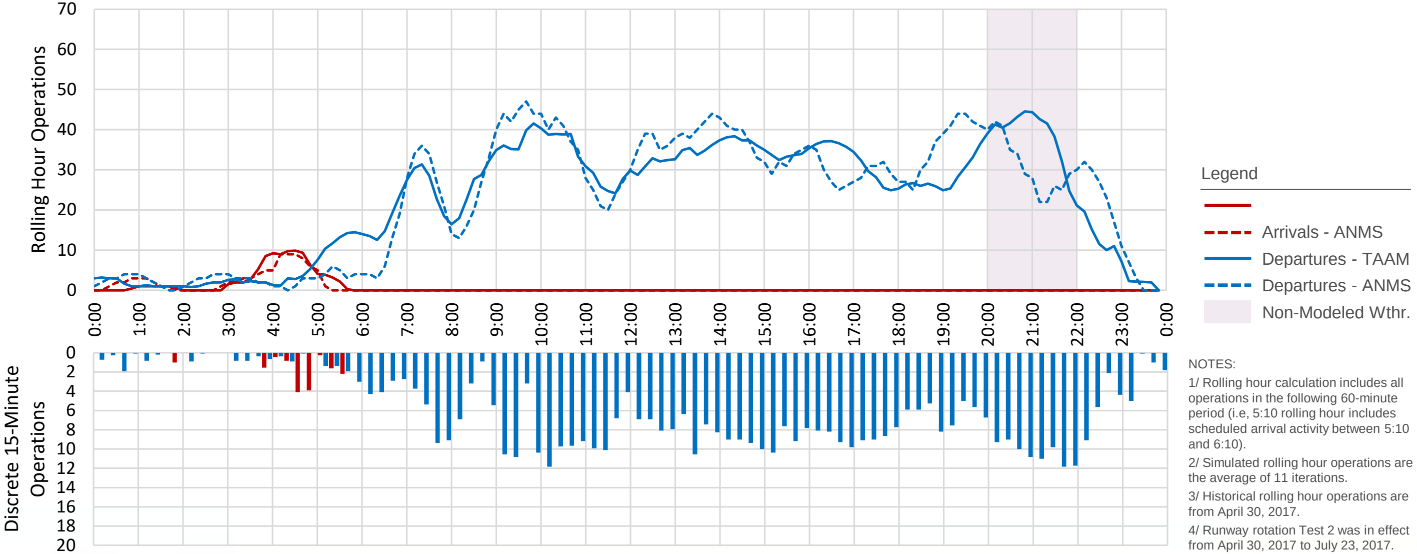
SOURCES:
O'Hare International Airport, Airport Noise Management System, May 2017 (actual runway time); Ricondo & Associates, Inc., December 2018 (TAAM modeling).



NOTES:
1/ Rolling hour calculation includes all operations in the following 60-minute period (i.e, 5:10 rolling hour includes scheduled arrival activity between 5:10 and 6:10).
2/ Simulated rolling hour operations are the average of 11 iterations.
3/ Historical rolling hour operations are from April 30, 2017.
4/ Runway rotation Test 2 was in effect from April 30, 2017 to July 23, 2017. Runway rotation will not be modeled and utilization of rotation runways is not depicted.

SOURCES:
O’Hare International Airport, Airport Noise Management System, May 2017 (actual runway time); Ricondo & Associates, Inc., December 2018 (TAAM modeling).

FINAL 97



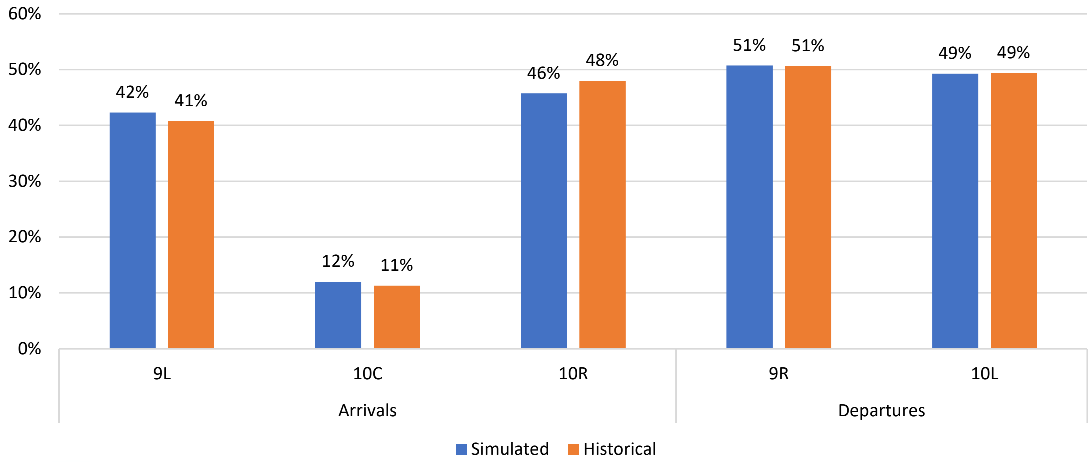
NOTES:
1/ Rolling hour calculation includes all operations in the following 60-minute period (i.e, 5:10 rolling hour includes scheduled arrival activity between 5:10 and 6:10).
2/ Simulated rolling hour operations are the average of 11 iterations.
3/ Historical rolling hour operations are from April 30, 2017.
4/ Runway rotation Test 2 was in effect from April 30, 2017 to July 23, 2017. Runway rotation will not be modeled and utilization of rotation runways is not depicted.

SOURCES:
O'Hare International Airport, Airport Noise Management System, May 2017 (actual runway time); Ricondo & Associates, Inc., December 2018 (TAAM modeling).

Arrivals				
	Taxi Time		Operations	
Runway	Simulated	Historical	Simulated	Historical
9L	17:41	18:33	457	426
9R	10:56	12:42	130	118
10C	12:54	14:52	495	502
All	14:41	16:08	1,082	1,046

Departures				
	Taxi Time		Operations	
Runway	Simulated	Historical	Simulated	Historical
9R	23:57	21:08	564	559
10L	30:41	24:59	548	545
All	27:17	23:02	1,112	1,104

NOTES:
1/ Simulated taxi times are the average of 11 iterations.
2/ Historical taxi times are the average of April 30, 2017.
3/ Arrival taxi times measure from touchdown to gate.
4/ Departure taxi times measure from start of pushback to liftoff.



NOTES:
1/ Simulated runway utilization is the average of 11 iterations.
2/ Historical runway utilization is the average of April 30, 2017.

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ATTACHMENT D-2
TAP EA SIMULATION DATA PACKAGE – INTERIM NO ACTION

This attachment contains background material which supplements the TAAM material and data developed by the CDA. This material supports this EA and its Interim No Action Alternative. Please note that when the TAAM simulations were developed, the No Action Alternatives were originally named No Project and the Proposed Action Alternatives were originally named With Project.

November 2020

Chicago O'Hare International Airport

Terminal Area Plan and Air Traffic Procedures Environmental Assessment

Simulation Data Package – No Project Interim

Prepared on Behalf of:

Chicago Department of Aviation

Prepared for:

Federal Aviation Administration

Prepared by:

RICONDO & ASSOCIATES, INC.

Table of Contents

1. Background and General Operating Assumptions

1.1 Terminal Area Plan and Air Traffic Procedures Environmental Assessment

The O'Hare International Airport (O'Hare or the Airport) Modernization Program (OMP) was approved by the Federal Aviation Administration (FAA) in the 2005 O'Hare Modernization (OM) Environmental Impact Statement (EIS).[1] The OMP resulted in airfield capacity improvements that have been or are in the process of being completed, including construction and lengthening of several runways. The OMP also included additional terminal facilities at the Airport. However, by 2015 the conditions and needs for terminal infrastructure at O'Hare had evolved from those envisioned in the OMP due to airline mergers, formation of airline alliances, and development of international and domestic code-share partners. With these changes in mind, the Terminal Area Plan (TAP) will replace and/or update outdated/insufficient infrastructure and facilities in the terminal core, increase gate frontage,[2] and provide balanced opportunities for all airlines.

Similarly, some air traffic procedures for arriving and departing aircraft operating in the airspace around O'Hare and on the airfield have evolved since the approval of the OM EIS and 2015 Re-Evaluation. In addition, the FAA wishes to retain some existing procedures set to expire upon completion of the OMP runway reconfiguration to provide flexibility and maintain efficiency. These changes, collectively referred to as the Air Traffic Procedures (ATP), include:

- changes to the criteria for conducting land and hold short operations (LAHSO);
- development of consolidated wake turbulence separation standards; and
- retention of the Runway 10R-28L offset final approaches.

This Environmental Assessment (EA) is being conducted to assess the changes associated with the TAP and ATP. The following conditions were evaluated:

- With Project Full Build
- With Project Interim
- No Project Full Build
- No Project Interim

[1] The 2015 Re-Evaluation of the OM EIS assessed the effects from changes to the phased implementation of the OMP that were evaluated during the 2005 OM EIS.

[2] Gate frontage is the available length along terminal buildings that may be used for parking aircraft at individual gate positions.

This report summarizes the airfield, airspace, and other operating assumptions used as inputs for the simulation models for the No Project Interim condition. The simulation models were developed using Jeppesen's Total Airspace and Airport Modeler (TAAM), a fast-time delay and travel time computer simulation model that is used to calculate delay and travel times by simulating aircraft operations on the ground and in the air. The outputs from TAAM provided inputs for air quality, noise, and surface traffic analyses.

1.2 Overview of Simulation Process

The simulation modeling completed for the No Project Interim condition consisted of the following steps:

- Simulations from the No Project Full Build condition[3] were modified to reflect the airfield condition that would exist without the airfield projects being evaluated as part of this EA. Modifications generally included adjusting of the Concourse L gate layout.
- Analyses of wind and weather data were conducted to determine the percent occurrence of major operating configurations and weather conditions, as well as to determine which of the operating configurations had high enough occurrences to model. The previous 10 full calendar years of weather data (2009 to 2018) were used for the analysis.[4]
- Based on FAA guidance, a 24-hour design day flight schedule (DDFS) was created and incorporated into the TAAM model. The DDFS includes 2,820 daily operations (arrivals and departures) and reflects an annual demand of 952,489 operations.
- An experimental design, enumerating the combinations of operating configurations, weather conditions, and the aircraft activity levels to be modeled, was drafted, reviewed, and confirmed by the Air Traffic Workgroup.[5]

[3] The No Project Full Build condition simulation models were derived from the 2018 O'Hare Calibration, an iterative process of data collection/analysis, TAAM modeling, animation review, and simulation output metric analysis to verify the TAAM models reflect real-world operating conditions specific to O'Hare. The calibration effort included evaluation of runway throughput, runway usage, arrival taxi in times, departure taxi out times, standoff usage, and the percentage of day and night operations. The calibration effort produced four calibrated TAAM models to be used as the basis for the TAP and ATP EA. A summary of the calibration effort and resulting simulation assumptions is attached as **Appendix A**.

[4] Additional operating configurations are anticipated to be used at O'Hare that were not modeled as part of the TAP and ATP EA. The estimated annual occurrence of these operating configurations was not high enough to justify modeling.

[5] The Air Traffic Workgroup is comprised of representatives from the Airport's Air Traffic Control Tower (ATCT), Chicago Terminal Radar Approach Control (TRACON) facility (C90), Chicago ARTCC (ZAU), the National Air Traffic Controllers Association (NATCA), the FAA Central Service Center (AJV-C25), the FAA Airports Great Lakes Region (AGL-600), the FAA Chicago Airports District Office (ADO-CHI-600), the FAA's third-party contractor Harris Miller Miller & Hanson (HMMH), and Ricondo & Associates, Inc.

- Operating assumptions for each of the TAAM experiments were developed, reviewed, and refined by the Air Traffic Workgroup.
- Initial TAAM experiment models were developed by the simulation team for each of the experiments specified in the experimental design. The animations and output statistics for these models were reviewed by the Air Traffic Workgroup, which provided comments and refinements to the simulation team.
- Refined TAAM models were developed by the simulation team based on FAA direction and comments. These refined animations and output statistics were again reviewed, and additional comments and refinements were provided to the simulation team.
- When a particular TAAM experiment or set of TAAM experiments were refined to the simulation team and FAA's satisfaction, a memorandum was prepared by the FAA stating that the air traffic members of the Air Traffic Workgroup concurred with the assumptions used in the model(s) and that the experiments were a reasonable representation of how the airfield and airspace would operate under those conditions and, therefore, were acceptable for use in the TAP and ATP EA technical analyses.

1.3 Weather Conditions and Operating Configurations

Six operating configurations were identified by the Air Traffic Workgroup to be modeled for the TAP and ATP EA. Weather conditions (cloud ceiling height, visibility, wind velocity and direction, and precipitation) and airfield condition (dry or wet/contaminated pavement) determine the airfield and airspace operating procedures modeled for each operating configuration.

To establish weightings for the operating configurations modeled as part of the No Project Interim condition, weather data gathered from the National Centers for Environmental Information (NCEI) and airfield pavement condition data extracted from the Chicago Department of Aviation's (CDA) Electronic Logging System (ELS) were utilized to determine the percentage of the year each operating configuration could be used. Ten full years of data, from January 1, 2009, to December 31, 2018, were reviewed; 99.3 percent of the analyzed historical weather and airfield condition data fit within the criteria (wind, ceiling height, visibility, and airfield pavement condition) of the six modeled operating configurations.

Table 1-1 shows the experiment number and annual weighting associated with each modeled operating configuration for the No Project Interim condition. The full weather analysis can be found in **Appendix B**.

TABLE 1-1: WEIGHTING FOR MODELED OPERATING CONFIGURATIONS

TAAM Experiment Number	Operating Configuration	Estimated Annual Occurrence of Modeled Operating Configurations
901	VFR West with LAHSO	37.7%
902	VFR West without LAHSO	14.5%
903	IFR West	4.3%
904	VFR East with LAHSO	24.3%
905	VFR East without LAHSO	16.1%
906	IFR East	3.1%
Total		100.0%

NOTES:

IFR – Instrument Flight Rules

VFR – Visual Flight Rules

LAHSO – Land and Hold Short Operations

TAAM – Total Airspace and Airport Modeler

SOURCES: National Centers for Environmental Information, July 2019 (January 1, 2009, through December 31, 2018, weather data); Chicago Department of Aviation, August 2019 (January 1, 2009, through December 31, 2018, airfield condition data); U.S. Department of Transportation, Federal Aviation Administration, June 2020 (adjustment of modeled configuration occurrence); Ricondo & Associates, Inc., June 2020 (analysis).

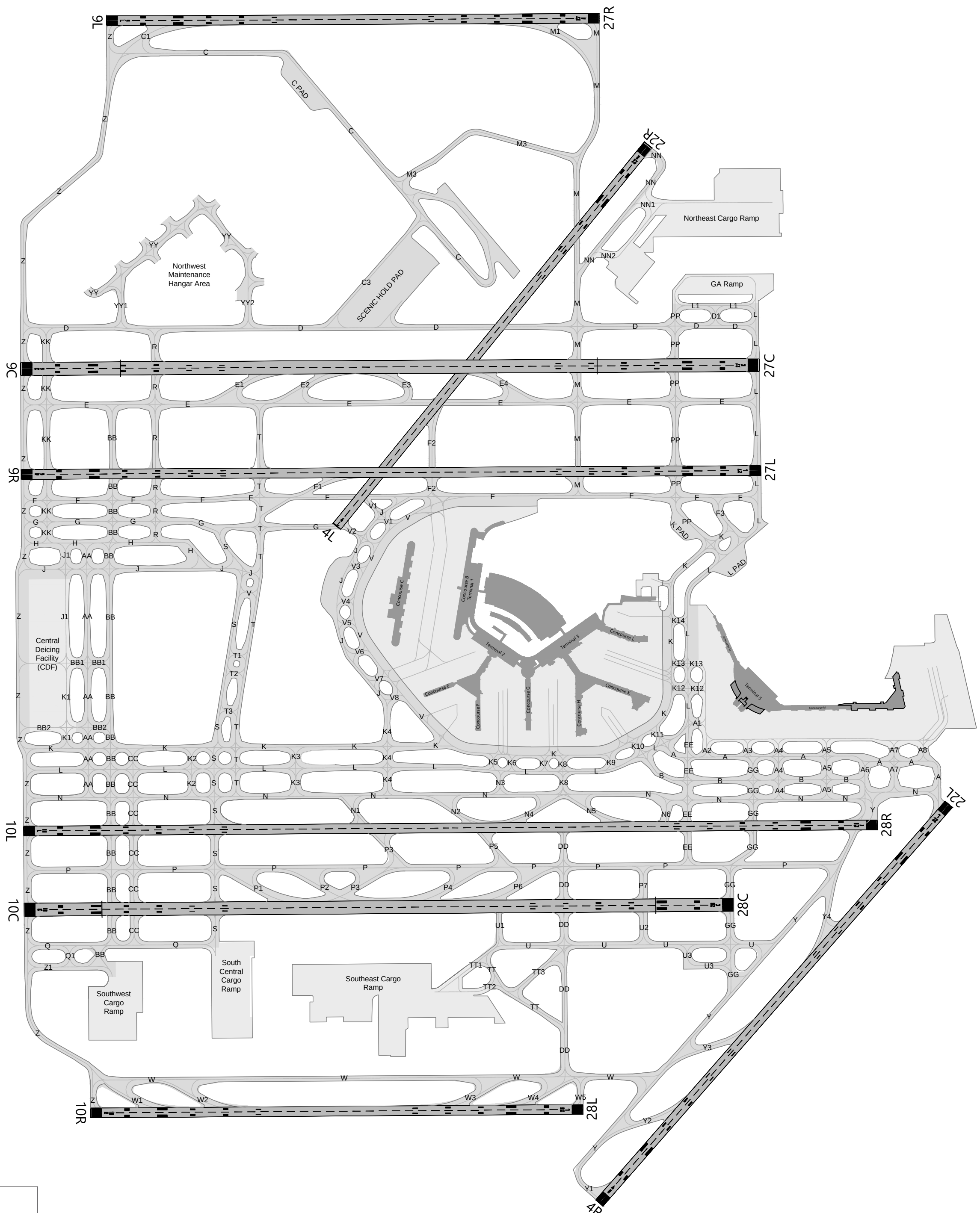
PREPARED BY: Ricondo & Associates, Inc., September 2020.

1.4 Airfield Layout and Runway End Definition Data

Exhibits 1-1 and **1-2** illustrate the airfield layout and runway end points used for the No Project Interim condition TAAM models, respectively. The runway end coordinates and elevations utilized in TAAM and shown on Exhibit 1-2 were gathered from the *O'Hare International Airport Draft Future ALP*.

1.5 Design Day Flight Schedule, Gating, and Aircraft Parking

The DDFS prepared for the No Project Interim condition contains 2,820 total aircraft operations, representing an annual demand of 952,489 operations. Further information regarding forecast assumptions and DDFS development can be found in **Appendix C**.



NOTE

GA - General Aviation

SOURCES: Ricondo & Associates, Inc., *O'Hare International Airport Draft Future Airport Layout Plan*, May 2019; Ricondo & Associates, Inc., *List of Proposed and Baseline Projects*, October 2019; Ricondo & Associates, Inc., June 2019.

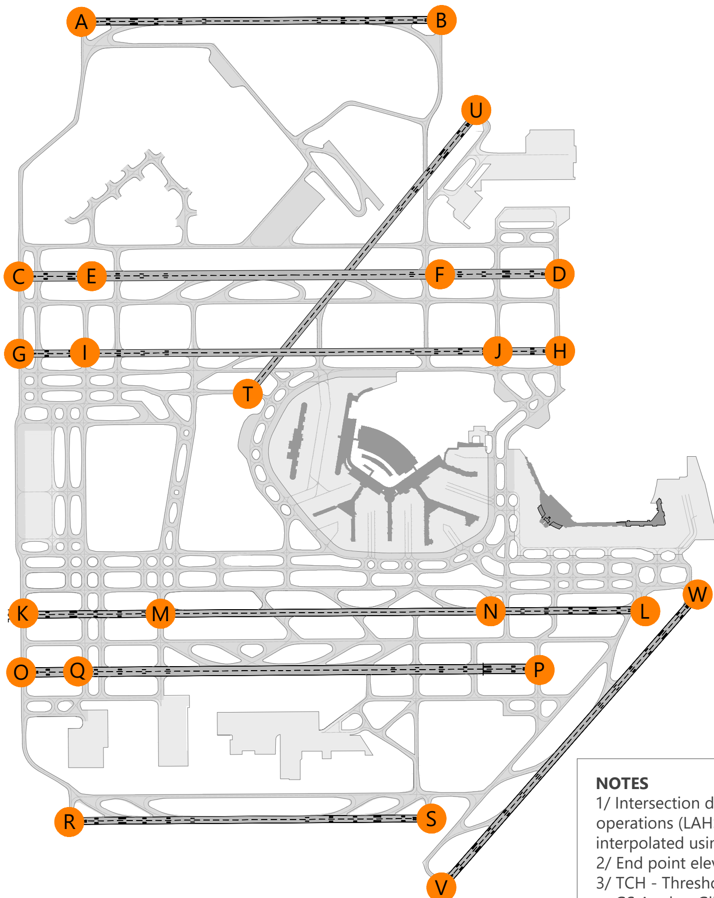
EXHIBIT 1-1

NORTH

0 2,500 ft.

Airfield Layout

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\02-Airfield\AutoCAD\TAP EA - Airfield Layouts.dwgLayout: 02_No Action - Interim Plotted: Oct 30, 2020, 04:07PM



NOTES
1/ Intersection departure and land and hold short operations (LAHSO) coordinates and elevations interpolated using the Airport Layout Plan.
2/ End point elevation in feet above mean sea level (MSL)
3/ TCH - Threshold Crossing Height (feet above grade)
GS Angle - Glide Slope Angle

LEGEND
Movement Area

POINT	RUNWAY ID	DESCRIPTION	TCH	GS Angle	LATITUDE					LONGITUDE					END POINT ELEVATION	RUNWAY WIDTH
					N/S	DEG.	MIN.	SEC.	DECIMAL	W/E	DEG.	MIN.	SEC.	DECIMAL		
A	9L		55	3.00°	N	42	00	10.20	42.002833	W	87	55	36.03	87.926675	668.0	150
B	27R		55	3.00°	N	42	00	10.19	42.002831	W	87	53	56.70	87.899083	663.6	150
C	9C		55	3.00°	N	41	59	17.89	41.988303	W	87	55	53.66	87.931572	673.2	200
D	27C		56	3.00°	N	41	59	17.92	41.988311	W	87	53	24.75	87.890208	652.4	200
E	27C	LAHSO			N	41	59	17.90	41.988306	W	87	55	33.49	87.925969	667.1	200
F	9C	LASHO			N	41	59	17.92	41.988311	W	87	53	57.51	87.899308	652.7	200
G	9R		59	3.00°	N	41	59	02.02	41.983894	W	87	55	53.65	87.931569	668.2	150
H	27L		58	3.00°	N	41	59	02.04	41.983900	W	87	53	24.55	87.890153	650.3	150
I	9R	Intersection Departure			N	41	59	02.02	41.983894	W	87	55	35.24	87.926456	664.9	150
J	27L	Intersection Departure			N	41	59	02.04	41.983900	W	87	53	41.75	87.894931	651.2	150
K	10L		56	3.00°	N	41	58	08.38	41.968994	W	87	55	53.51	87.931531	672.1	150
L	28R		54	3.00°	N	41	58	08.65	41.969069	W	87	53	01.42	87.883728	651.4	150
M	10L	Intersection Departure			N	41	58	08.45	41.969014	W	87	55	15.03	87.920842	665.7	150
N	28R	Intersection Departure			N	41	58	08.59	41.969053	W	87	53	43.99	87.895553	650.4	150
O	10C		55	3.00°	N	41	57	56.53	41.965703	W	87	55	53.48	87.931522	669.4	200
P	28C		55	3.00°	N	41	57	56.76	41.965767	W	87	53	30.52	87.891811	650.1	200
Q	28C	LAHSO			N	41	57	56.55	41.965708	W	87	55	37.74	87.927150	666.6	200
R	10R		55	3.00°	N	41	57	25.92	41.957200	W	87	55	40.30	87.927861	680.0	150
S	28L		55	3.00°	N	41	57	26.09	41.957247	W	87	54	01.04	87.900289	658.0	150
T	4L				N	41	58	53.96	41.981656	W	87	54	50.10	87.913917	655.7	150
U	22R		49	3.00°	N	41	59	51.13	41.997536	W	87	53	46.94	87.896372	647.7	150
V	4R		52	3.00°	N	41	57	11.98	41.953328	W	87	53	57.91	87.899419	661.4	150
W	22L		55	3.00°	N	41	58	11.72	41.969922	W	87	52	47.08	87.879744	654.4	150

SOURCES: Ricondo & Associates, Inc., *O'Hare International Airport Draft Airport Layout Plan*, May 2019 (runway widths, coordinates, and elevations); Ricondo & Associates, Inc., *List of Proposed and Baseline Projects*, October 2019 (airfield layout); U.S. Department of Transportation, Federal Aviation Administration, *U.S. Terminal Procedures Publication*, August 2020 (glide slope angles and threshold crossing heights); Chicago Aviation Runway Designers Joint Venture, *Runway 9R-27L Glideslope Siting*, August 2020 (glide slope angles and threshold crossing heights).

EXHIBIT 1-2

NORTH 0 Not to Scale

Runway End Definition Data

Drawing: P:\Simulation\kord_tap_ea\Assumptions\02-Airfield\AutoCAD\Runway End Coordinates.dwgLayout: 2023_NP_Interim_RWY ENDS Plotted: Nov 3, 2020, 07:47AM

1.5.1 Air Carrier Gating and Repositioning Analysis

A gating analysis was conducted to assign air carrier arrival and departure operations a terminal contact gate. Gate assignments considered factors such as gate allocation and gauge, aircraft turn times (time necessary to load and/or unload aircraft), and gate separation times (time between an aircraft departing a gate and a subsequent arrival at the gate). **Exhibits 1-3** and **1-4** illustrate the gate allocation and gauge and gate assignment ramp charts, respectively.

In addition, some arriving and departing operations were assigned repositioning movements. Repositioning movements are when air carrier aircraft that are not carrying passengers are moved between two gates or moved between a remote location and a gate. The simulated repositioning movements replicate additional aircraft activity that currently occurs at O'Hare and is anticipated to continue in the future.[6] **Exhibit 1-5** depicts the remote locations used for TAAM modeling.

For the No Project Interim condition, 219 repositioning movements, divided among three categories, were simulated:

- Remain Overnight (RON) Parking and Maintenance (98 movements)
  - Aircraft that arrive and are repositioned from the gate to a remote location for RON parking and/or to undergo maintenance; or
  - Aircraft that utilized RON parking and/or underwent maintenance at a remote location that are repositioned to a gate for departure.
- Gate Availability (69 movements)
  - Aircraft with long turn times that are repositioned to/from remote locations so that the gate can be used to accommodate other aircraft; or
  - Aircraft that arrive from foreign airports and unload passengers at Terminal 5 and are subsequently repositioned to Terminal 1, 2, or 3 for departure.
- Aircraft Switches and Maintenance (52 movements)
  - Aircraft that are repositioned to/from remote locations throughout the day to conduct in-depth servicing or maintenance.

1.5.2 Cargo and General Aviation Parking Areas

Exhibit 1-6 depicts the parking areas for general aviation (GA) and cargo operations.

[6] Members of the Air Traffic Workgroup and airline representatives met on August 23, 2019, to discuss existing and future repositioning activity. The topics discussed included the volume of repositioning movements, the remote locations aircraft are repositioned to/from during non-deicing season, and the methods used to reposition aircraft (aircraft taxiing under their own power or towed by aircraft tractors).

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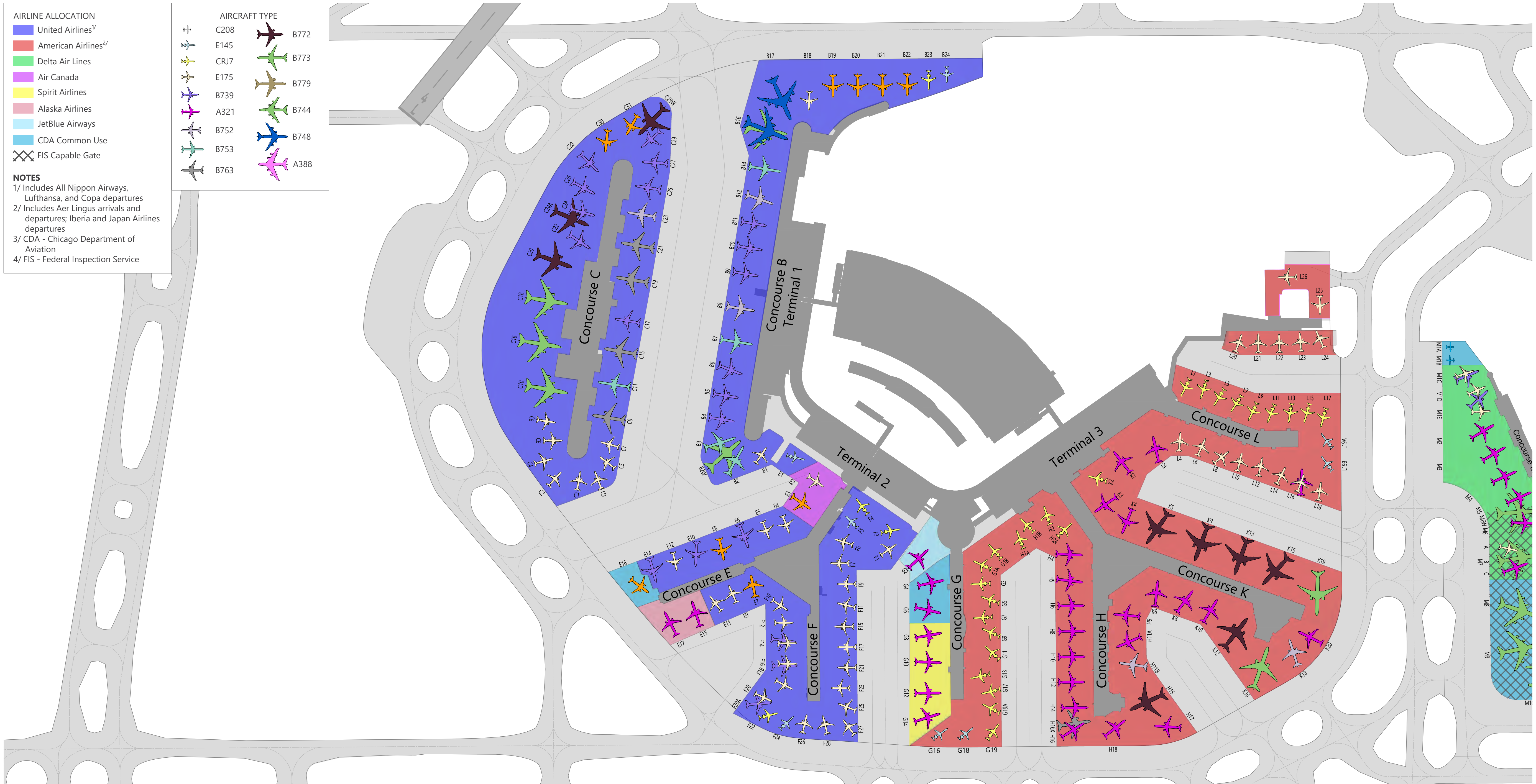


SOURCES: Ricondo & Associates, Inc., *O'Hare International Airport Draft Airport Layout Plan*, May 2019; Ricondo & Associates, Inc., *List of Proposed and Baseline Projects*, October 2019; Ricondo & Associates, Inc., October 2019.

EXHIBIT 1-3 (1 OF 2)

NORTH 0 Not to Scale

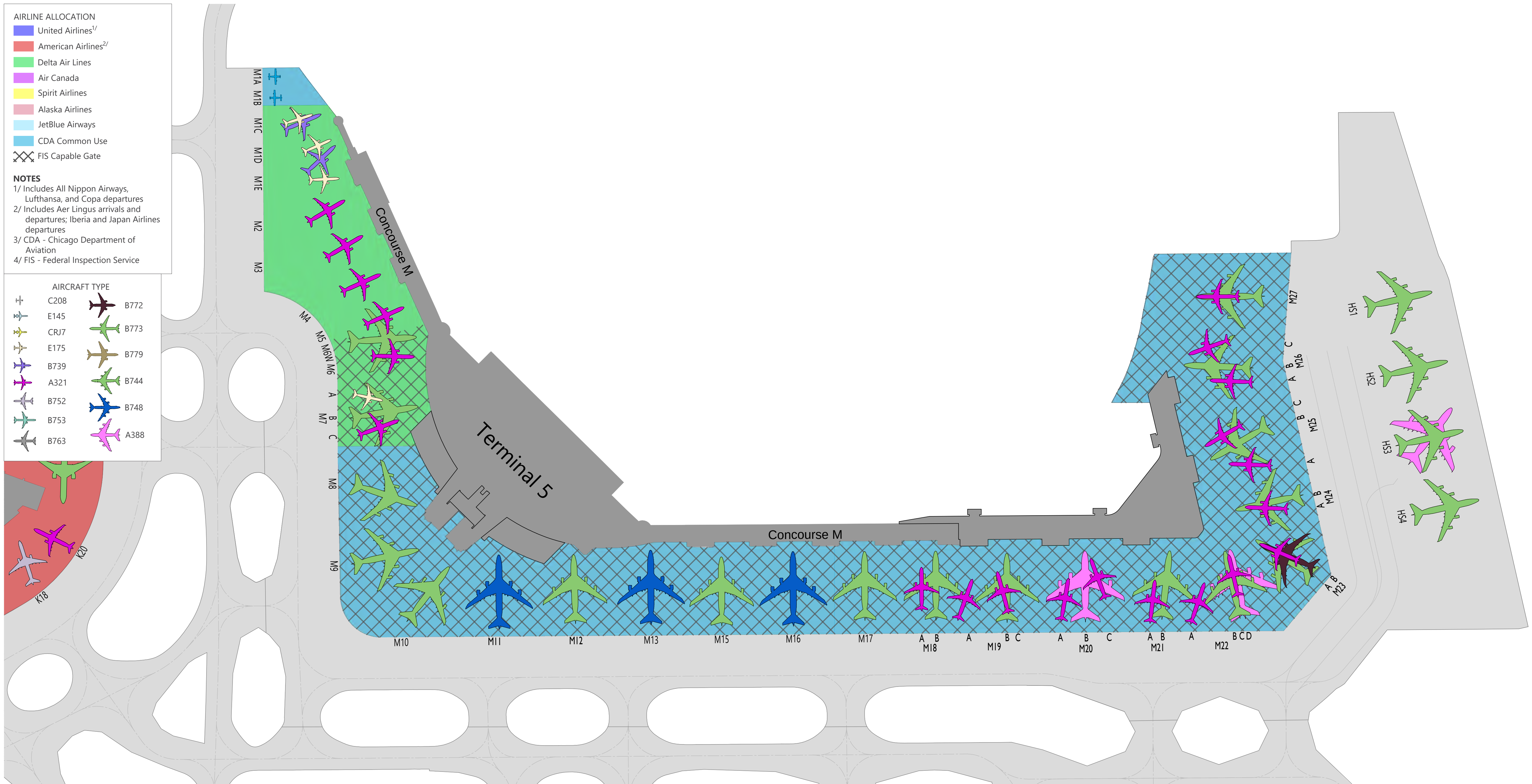
Gate Gauge and Airline Allocation

Drawing: P:\Simulation\kord_tap_ea\Assumptions\05-Gating\AutoCAD\TAP EA - Gating Layout - NA Interim_20191031.dwgLayout: NAInterim_01_CTA Plotted: Nov 3, 2020, 07:56AM

Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

NOVEMBER 2020



SOURCES: Ricondo & Associates, Inc., *O'Hare International Airport Draft Airport Layout Plan*, May 2019; Ricondo & Associates, Inc., *List of Proposed and Baseline Projects*, October 2019; Ricondo & Associates, Inc., October 2019.

EXHIBIT 1-3 (2 OF 2)

NORTH 0 Not to Scale

Gate Gauge and Airline Allocation

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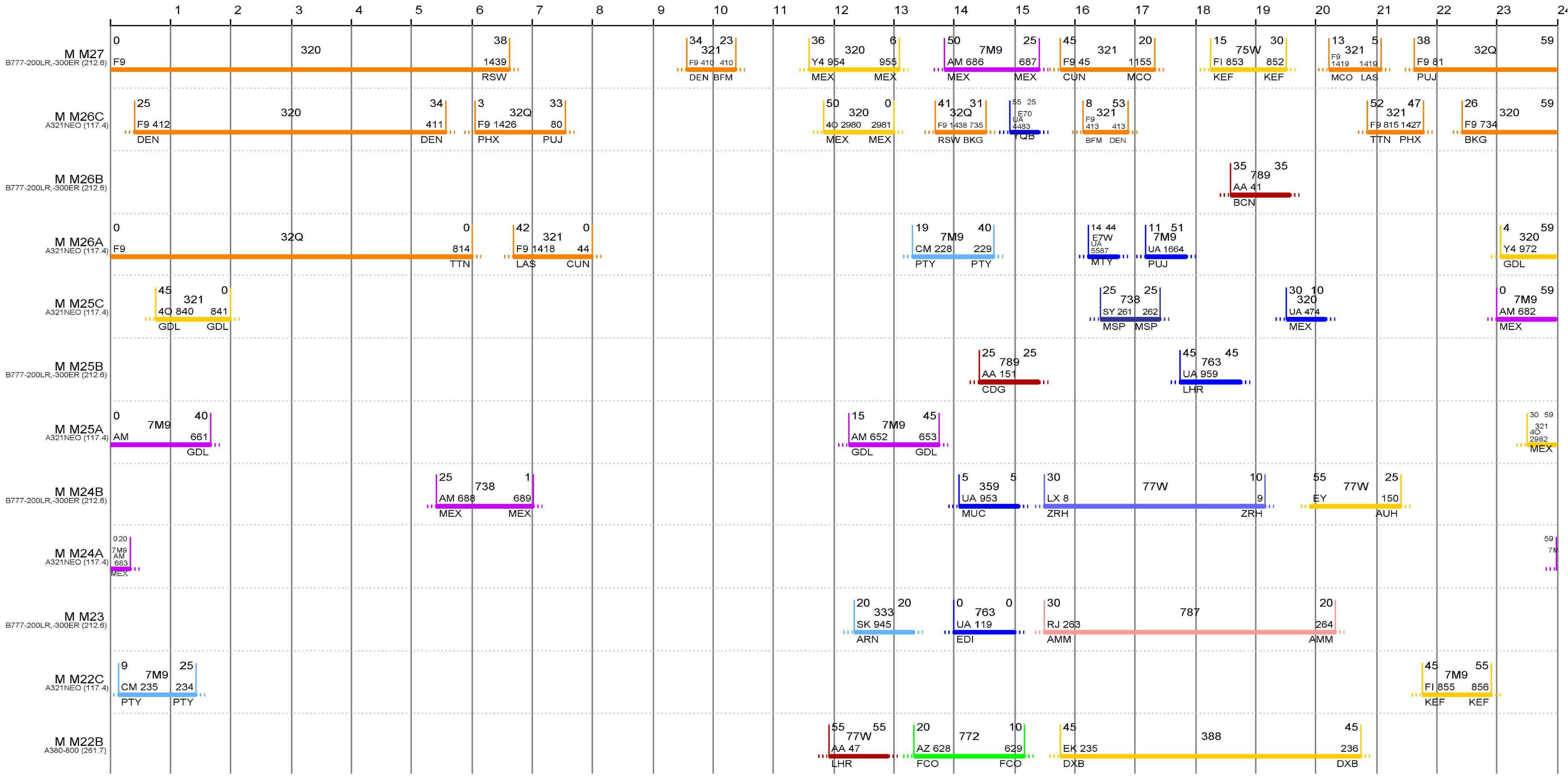
Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (1 OF 19)

Ramp Charts

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (1) Plotted: Nov 4, 2020, 08:44PM

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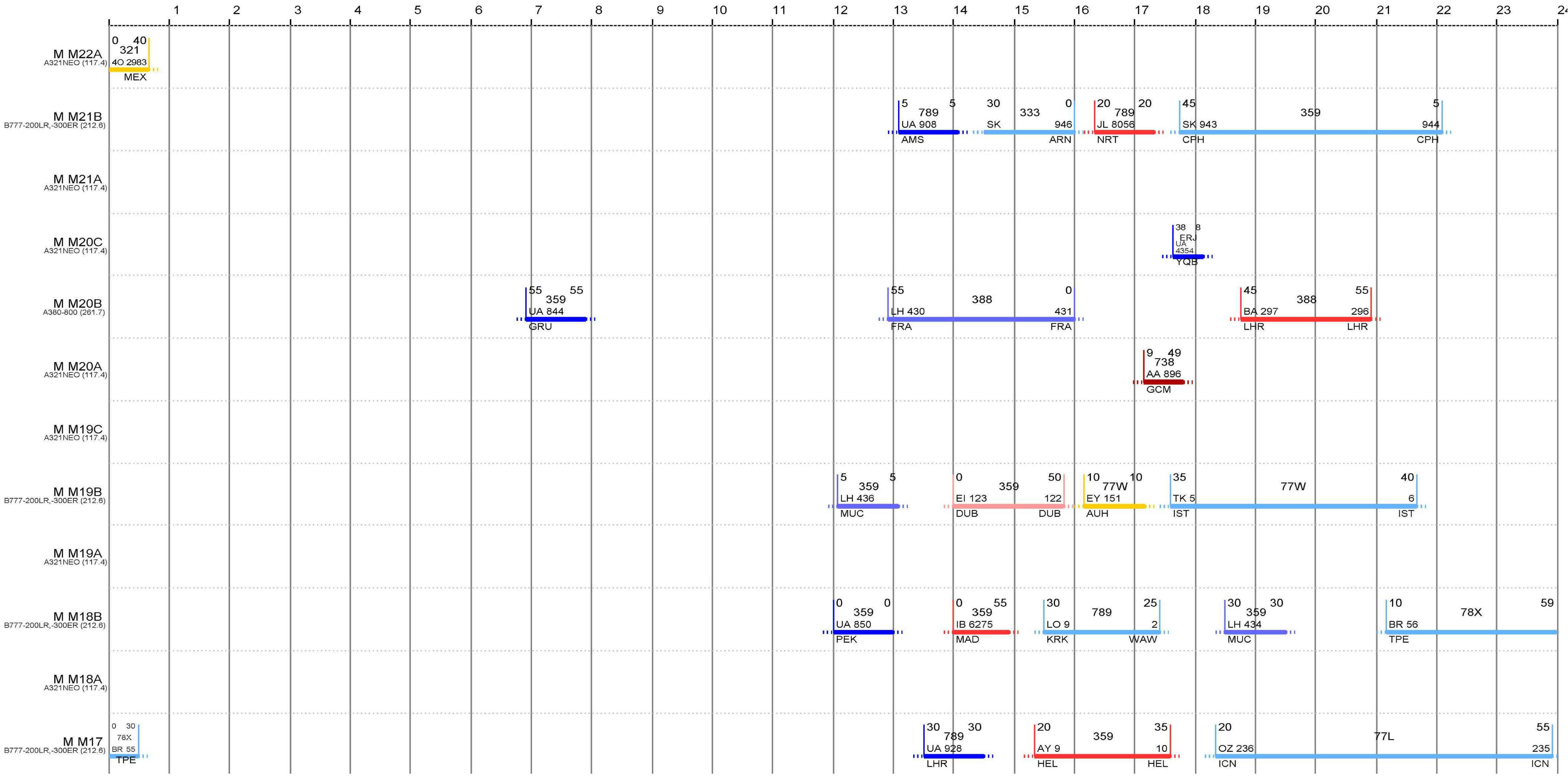
NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (2 OF 19)

Ramp Charts

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Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

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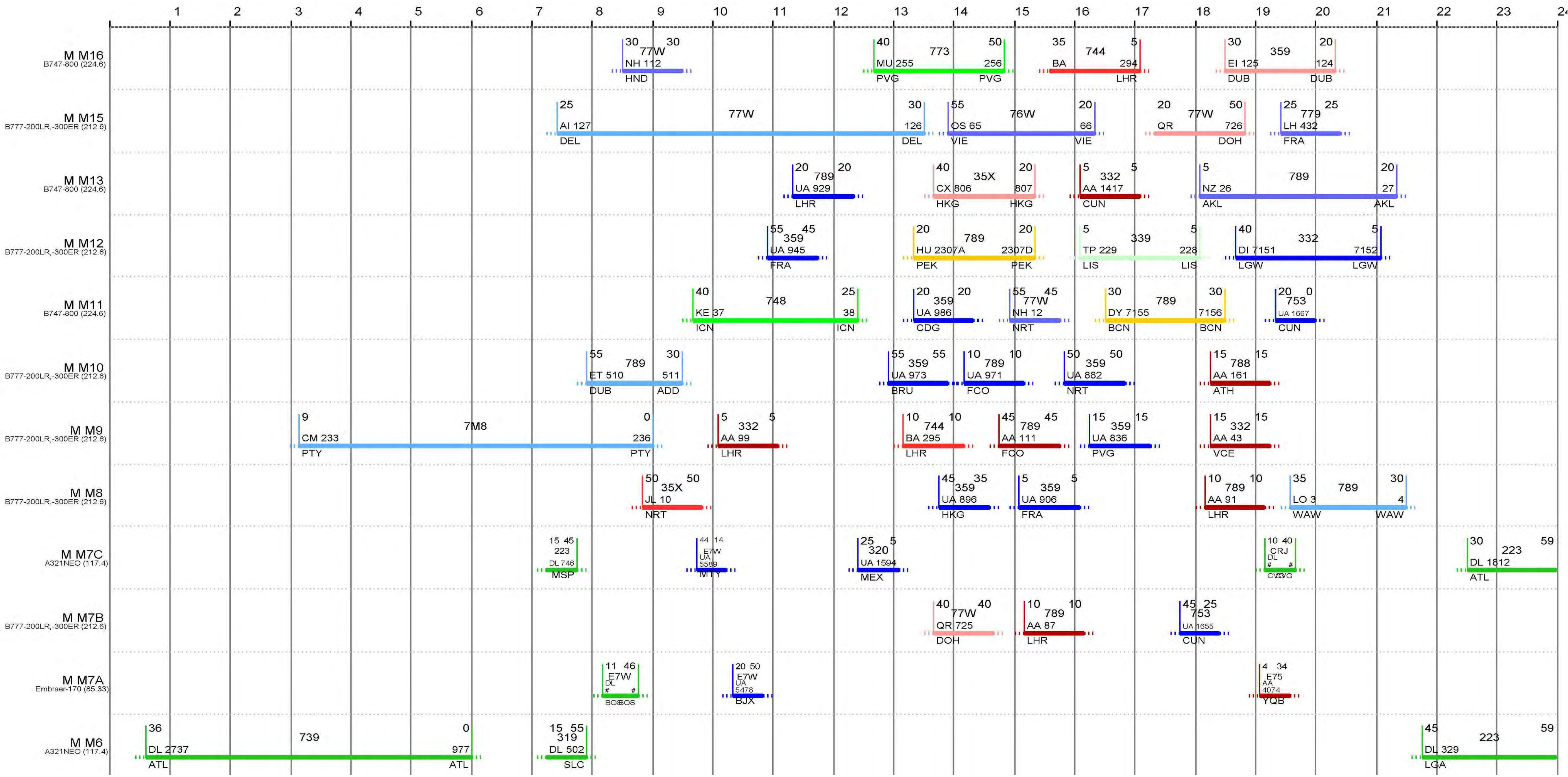
NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (3 OF 19)

Ramp Charts

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Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

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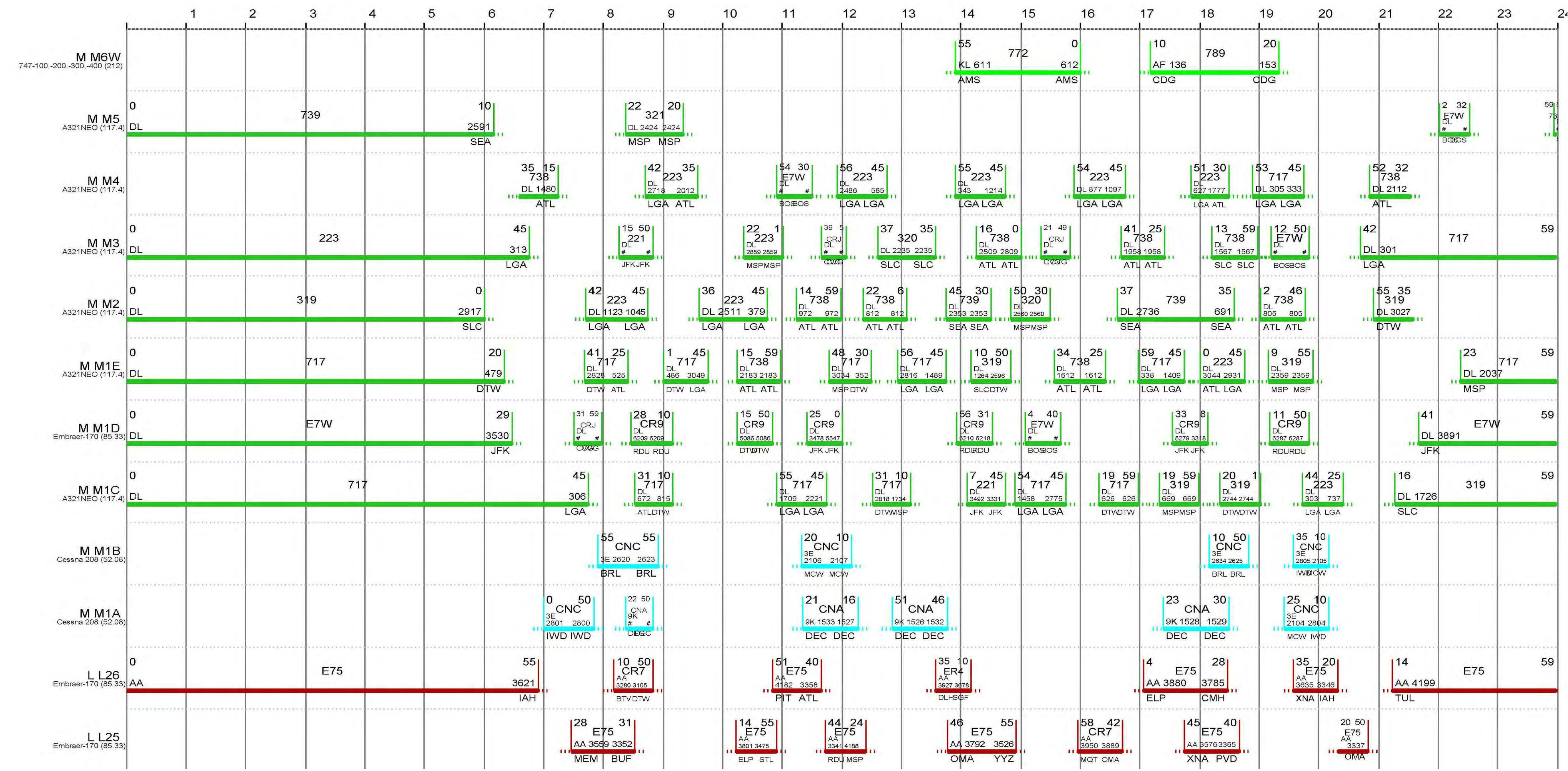
NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (4 OF 19)

Ramp Charts

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Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

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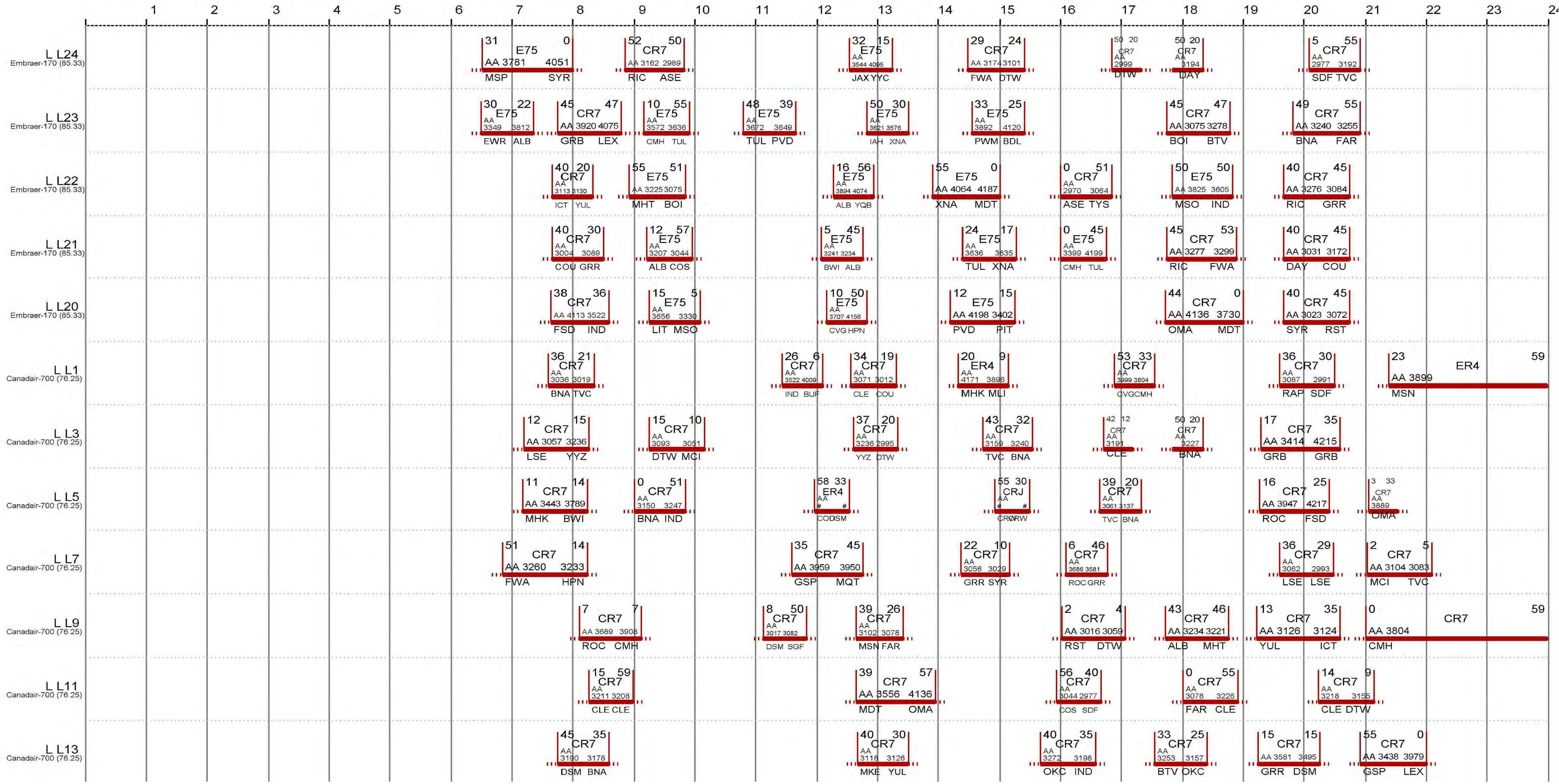
NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (5 OF 19)

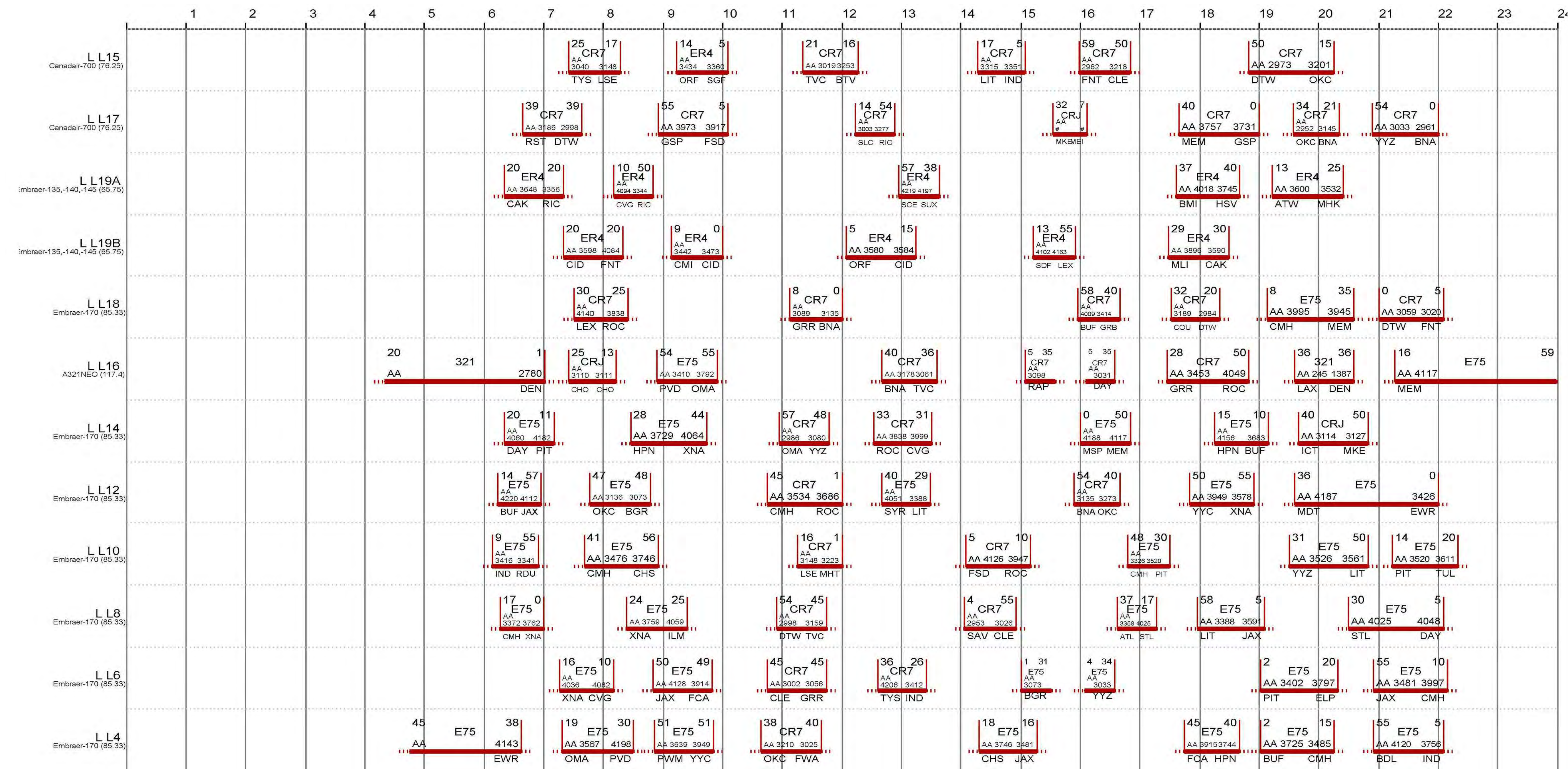
Ramp Charts

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (5) Plotted: Nov 4, 2020, 08:44PM

Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (6 OF 19)

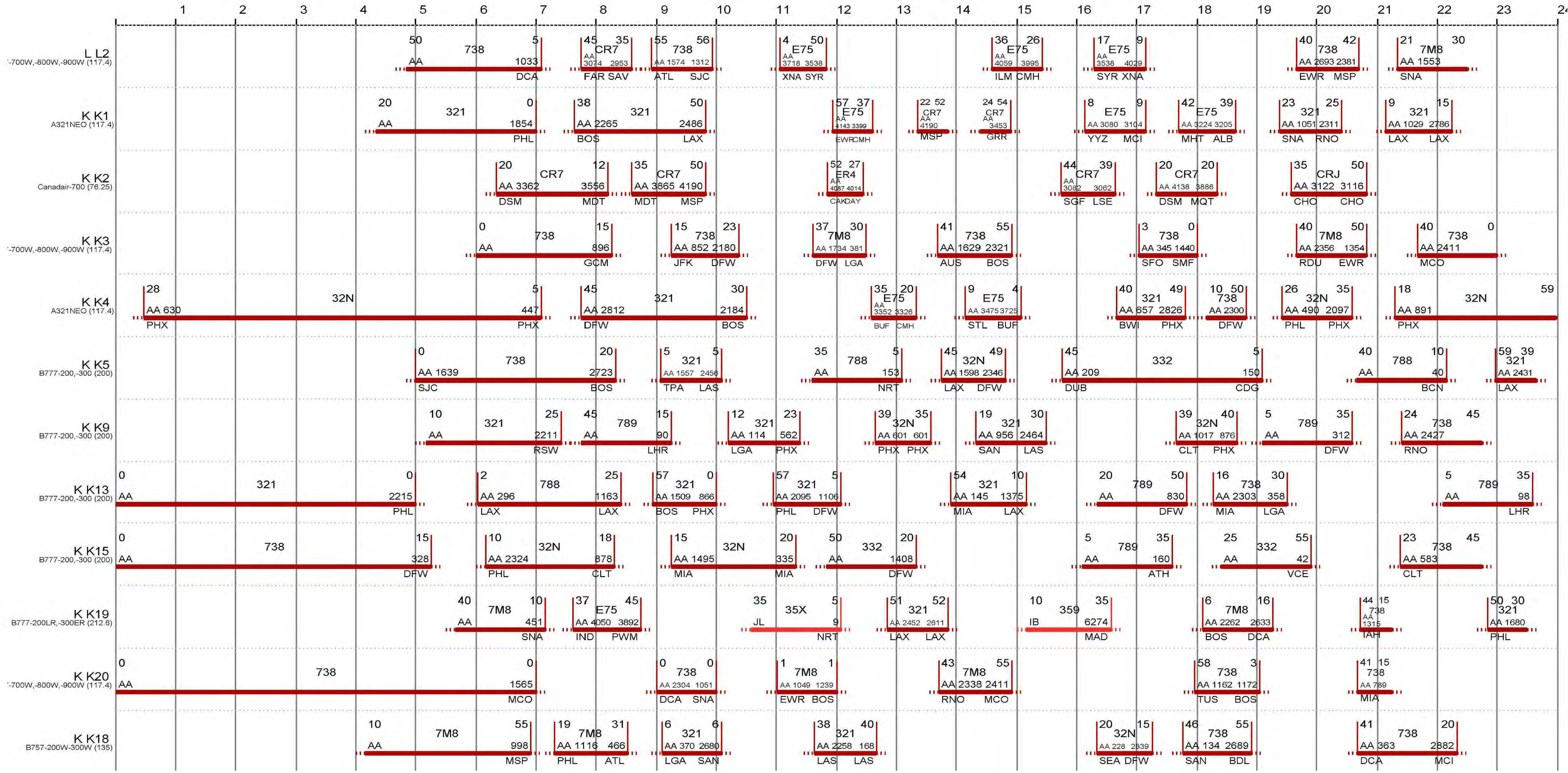
Ramp Charts

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (6) Plotted: Nov 4, 2020, 08:44PM

Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (7 OF 19)

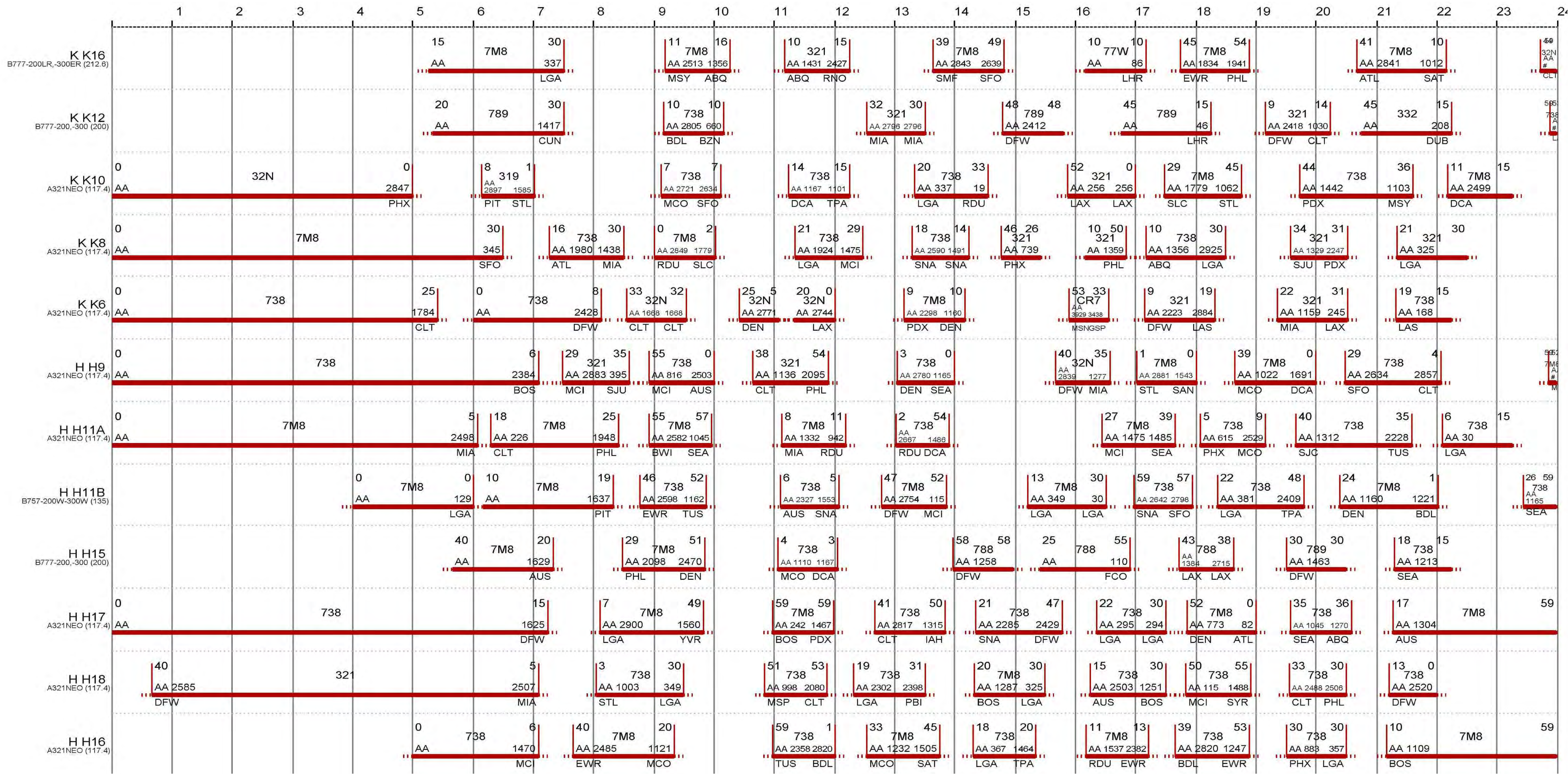
Ramp Charts

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (7) Plotted: Nov 4, 2020, 08:45PM

Terminal Area Plan and Air Traffic Procedures EA
Simulation Data Package - No Project Interim

CDA CHICAGO DEPARTMENT OF AVIATION

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (8 OF 19)

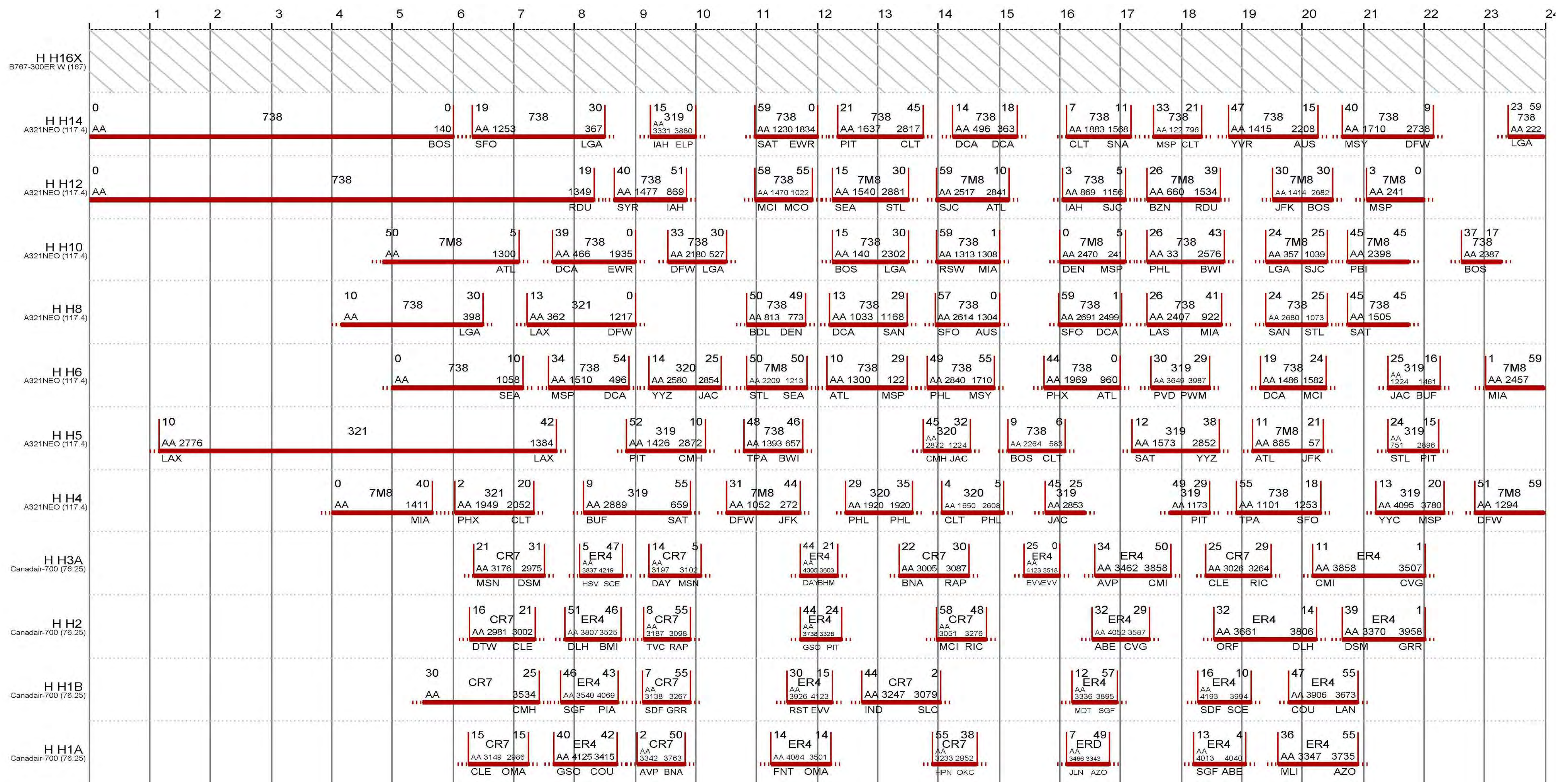
Ramp Charts

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (8) Plotted: Nov 4, 2020, 08:45PM

Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (9 OF 19)

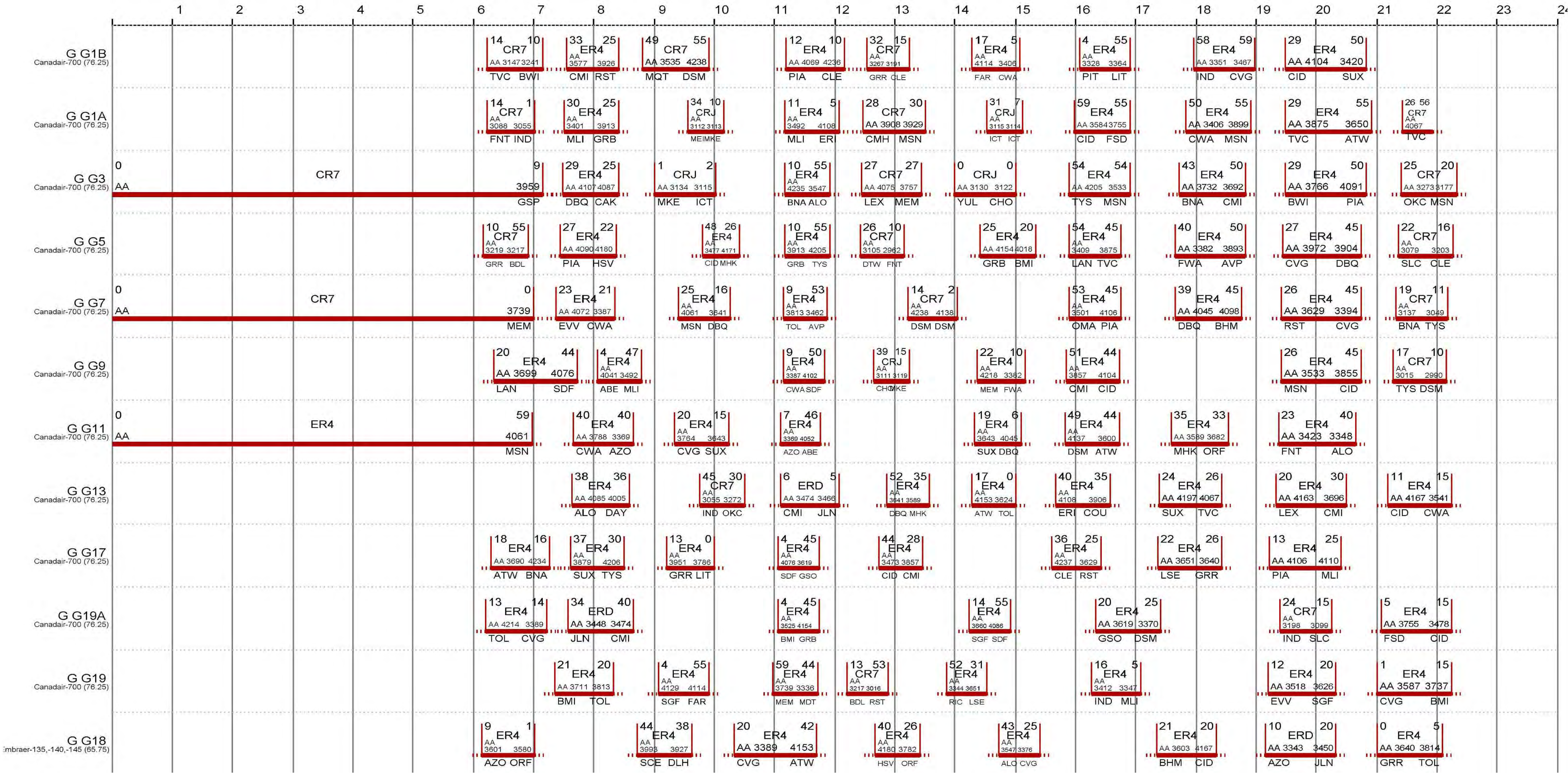
Ramp Charts

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (9) Plotted: Nov 4, 2020, 08:45PM

Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (10 OF 19)

Ramp Charts

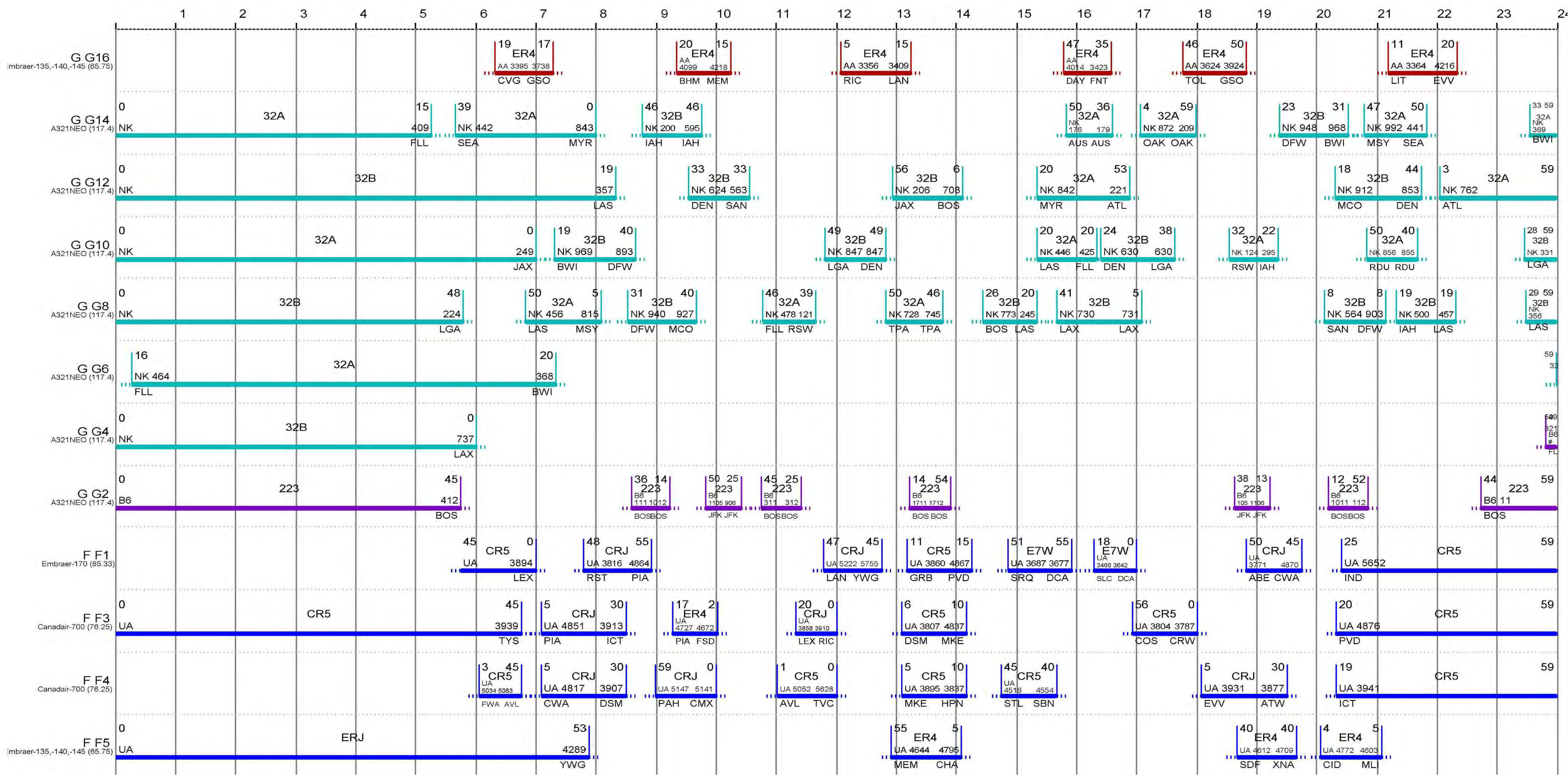
Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (10) Plotted: Nov 4, 2020, 08:45PM

Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

CDA CHICAGO DEPARTMENT OF AVIATION

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

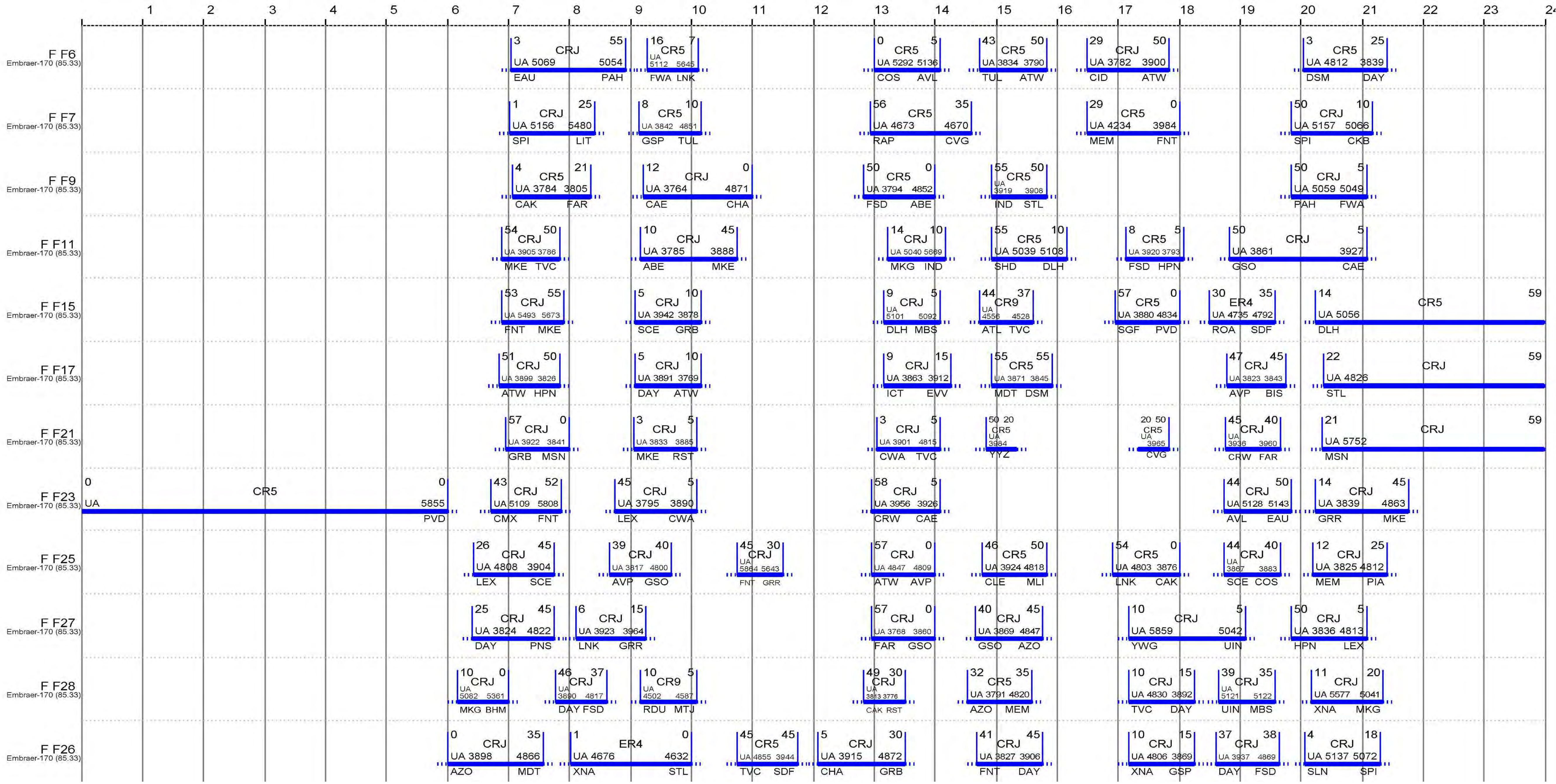
EXHIBIT 1-4 (11 OF 19)

Ramp Charts

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (11) Plotted: Nov 4, 2020, 08:45PM

CDA CHICAGO DEPARTMENT OF AVIATION

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (12 OF 19)

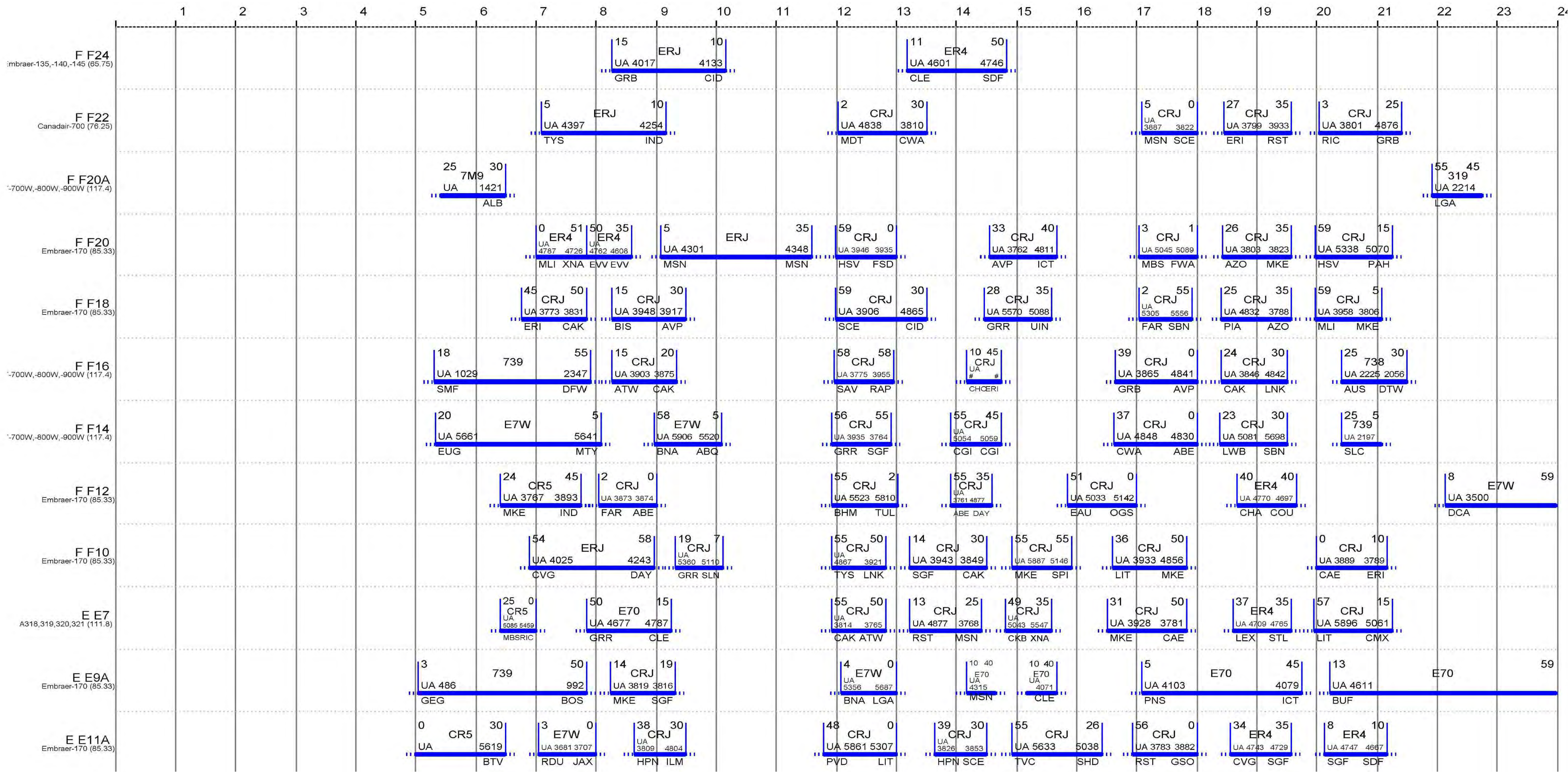
Ramp Charts

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (12) Plotted: Nov 4, 2020, 08:45PM

Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (13 OF 19)

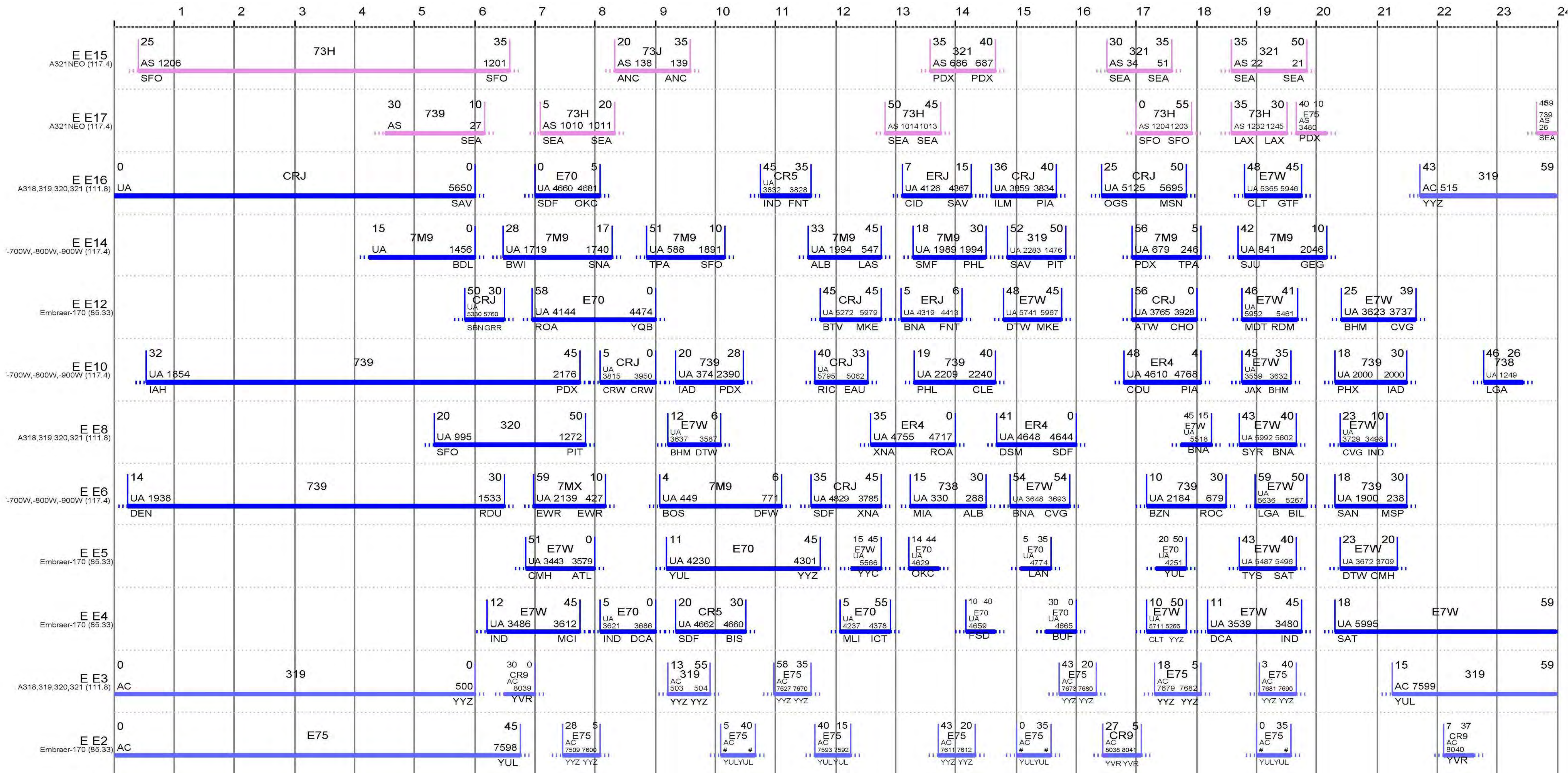
Ramp Charts

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (13) Plotted: Nov 4, 2020, 08:46PM

Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (14 OF 19)

Ramp Charts

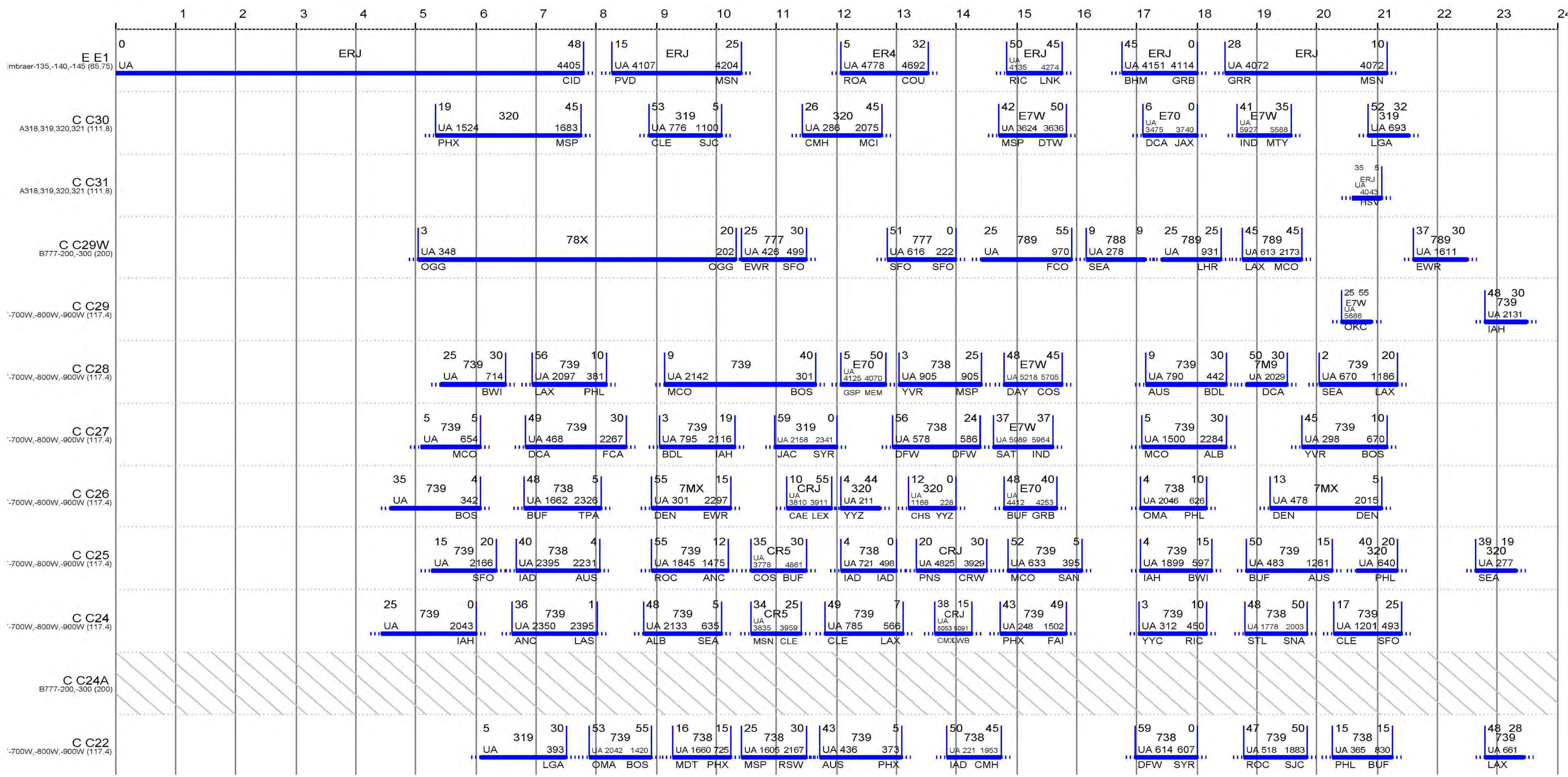
Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (14) Plotted: Nov 4, 2020, 08:46PM

Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

CDA CHICAGO DEPARTMENT OF AVIATION

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (15 OF 19)

Ramp Charts

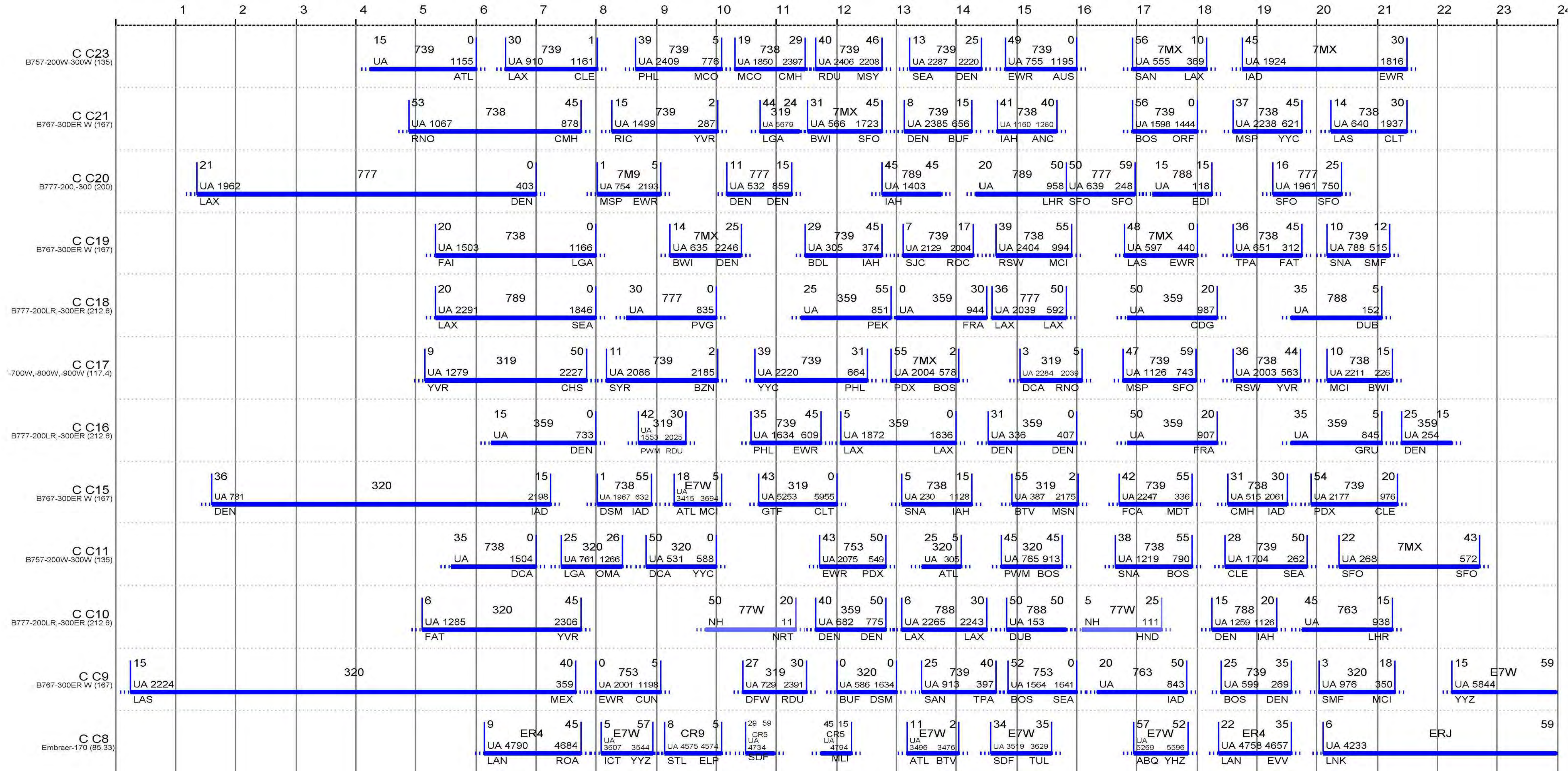
Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (15) Plotted: Nov 4, 2020, 08:46PM

Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

CDA CHICAGO DEPARTMENT OF AVIATION

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (16 OF 19)

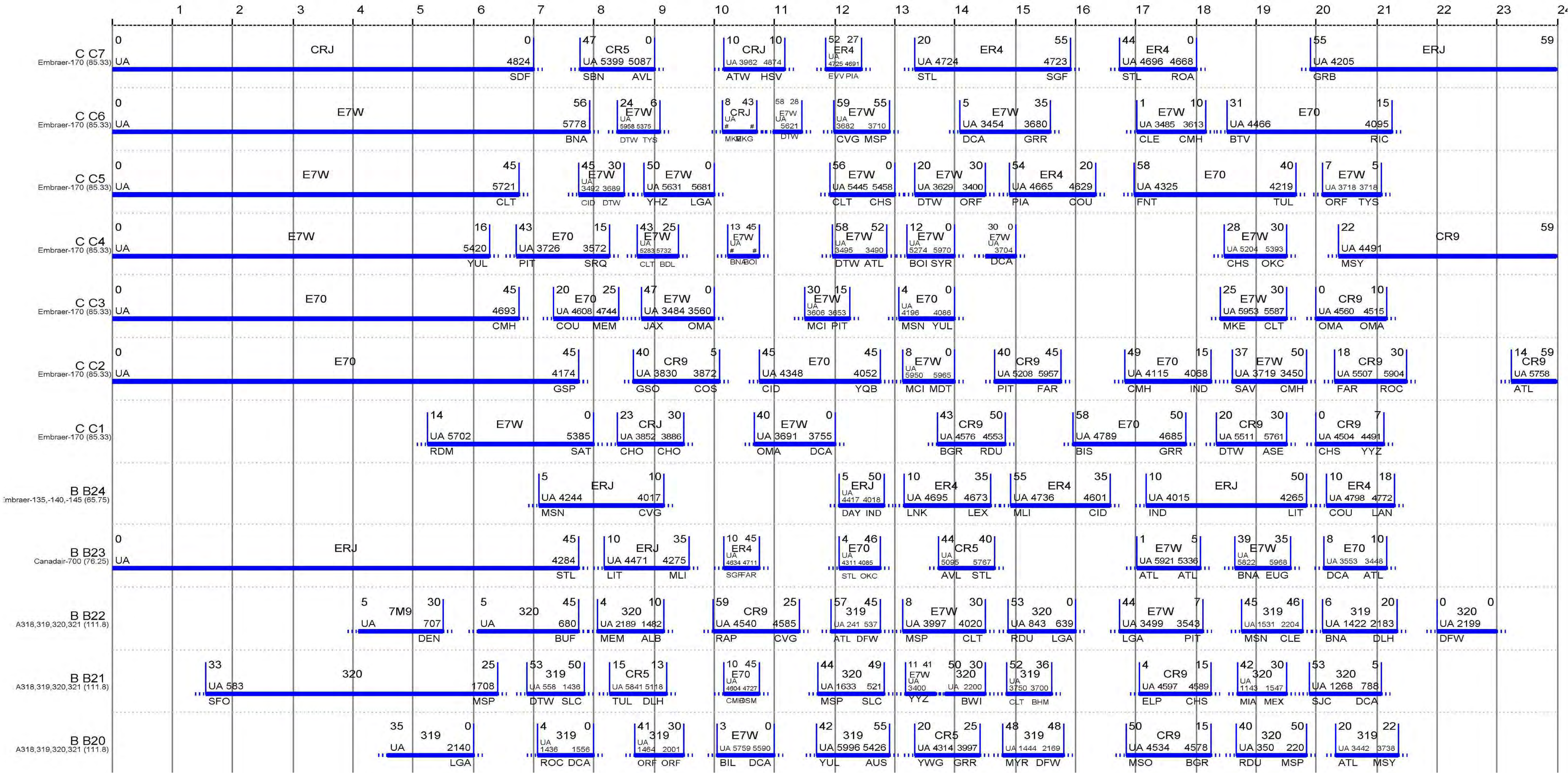
Ramp Charts

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (16) Plotted: Nov 4, 2020, 08:46PM

Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

NOVEMBER 2020



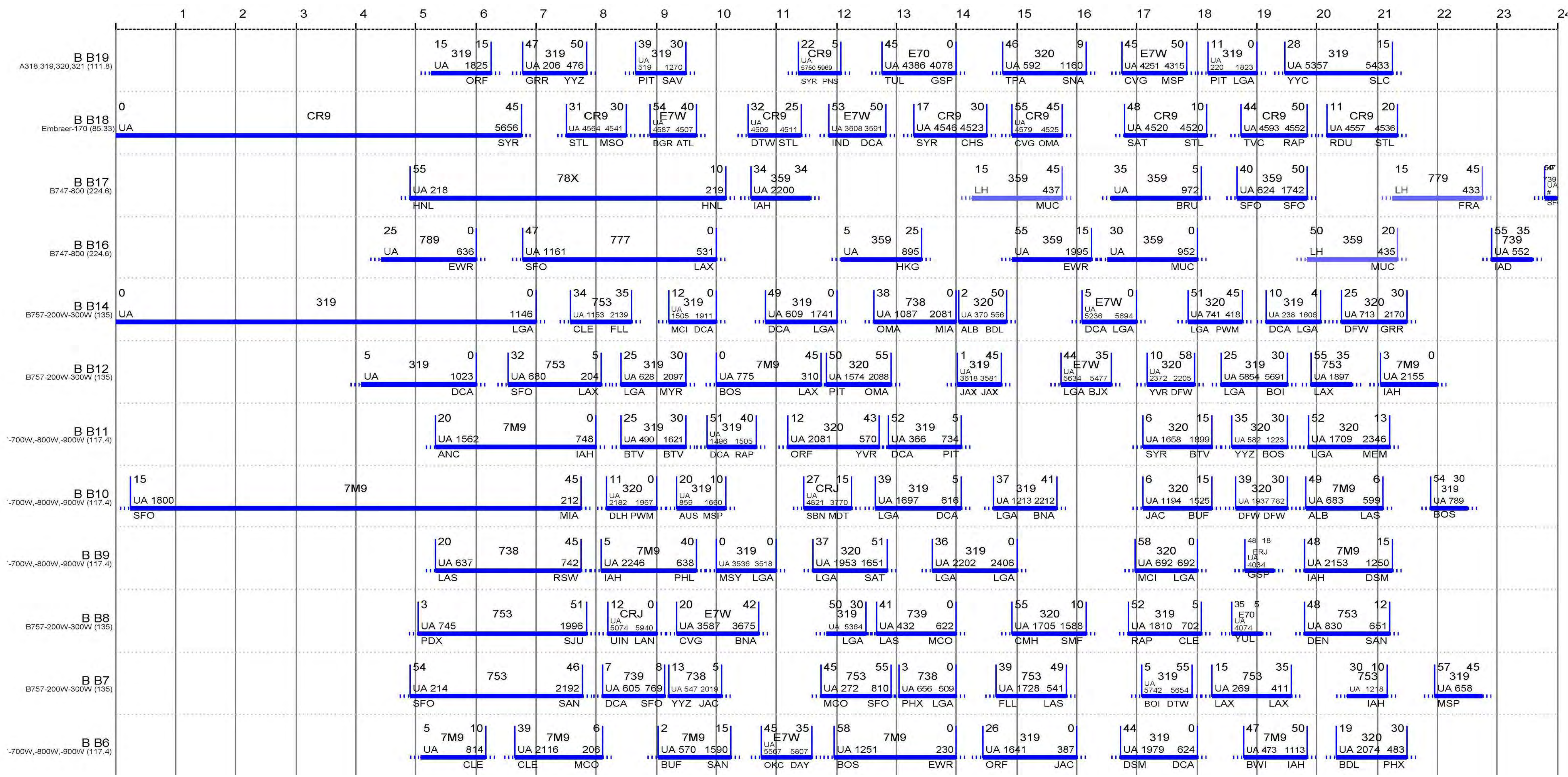
SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (17 OF 19)

Ramp Charts

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (17) Plotted: Nov 4, 2020, 08:46PM

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

EXHIBIT 1-4 (18 OF 19)

Ramp Charts

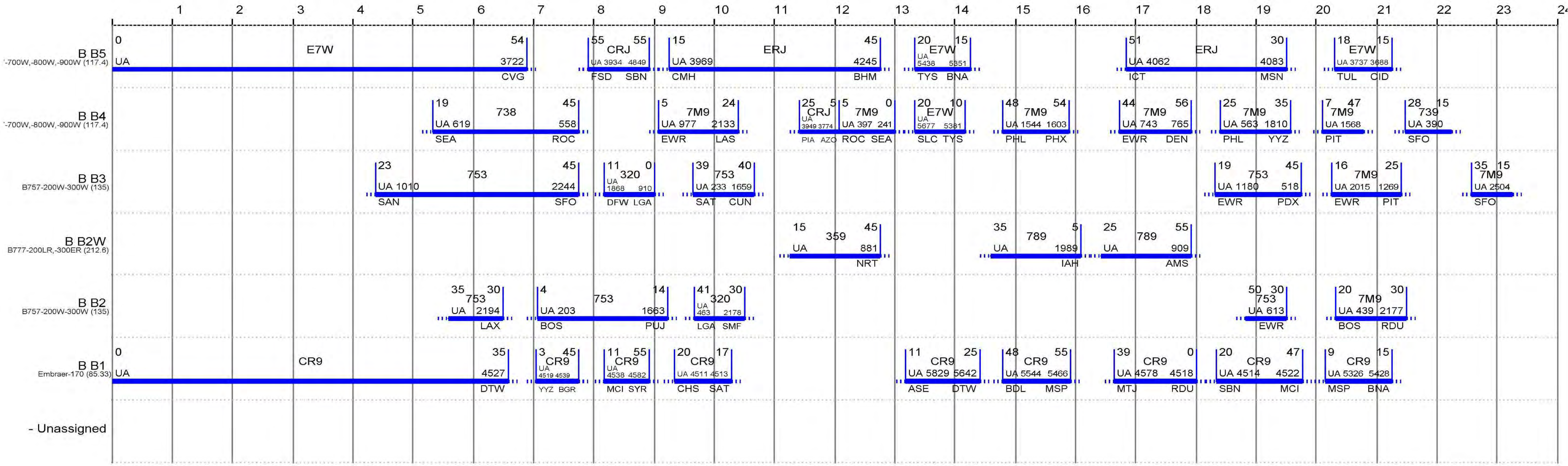
Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (18) Plotted: Nov 4, 2020, 08:46PM

Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim

CDA CHICAGO DEPARTMENT OF AVIATION

NOVEMBER 2020



SOURCE: Ricondo & Associates, Inc., December 2019.

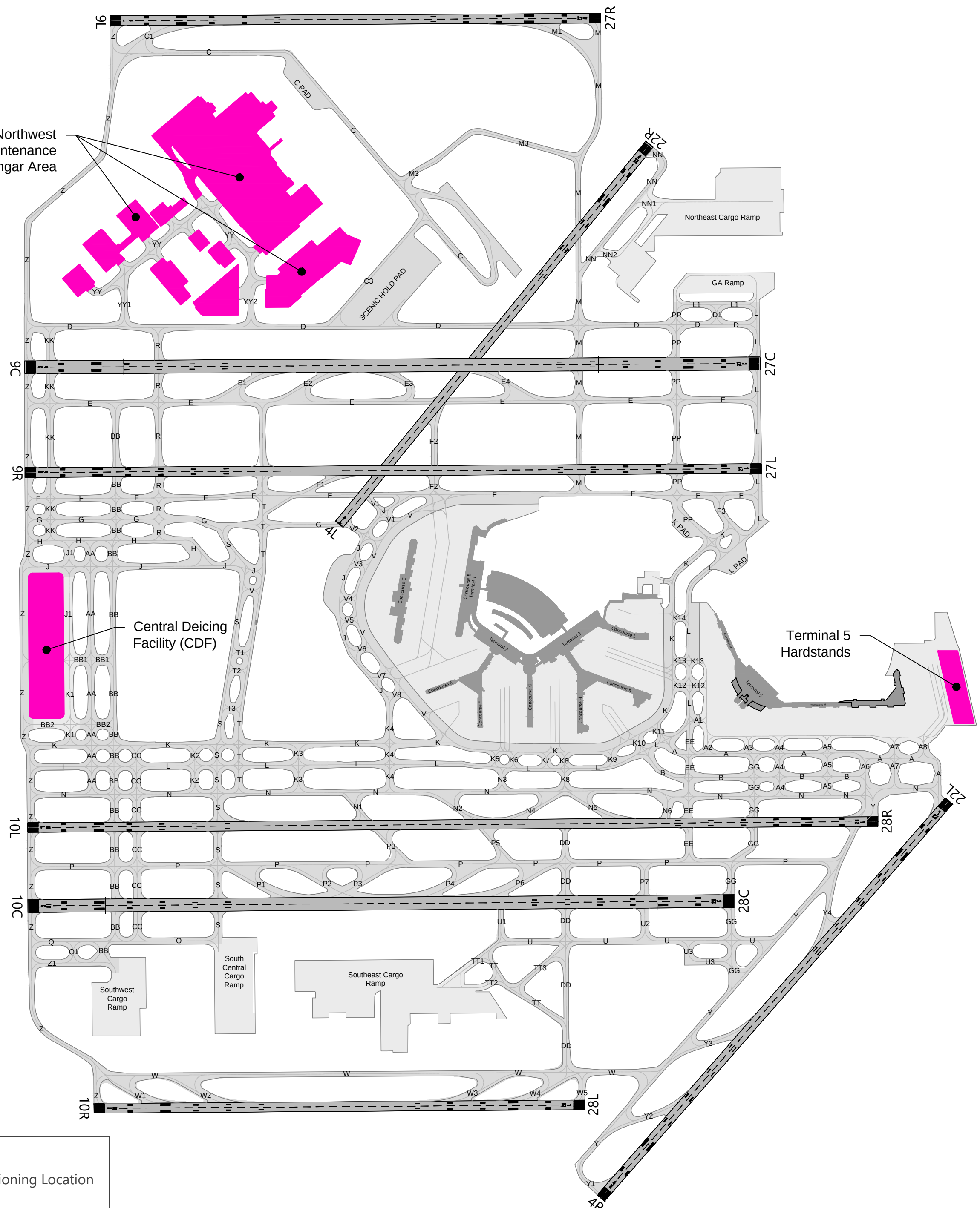
EXHIBIT 1-4 (19 OF 19)

Ramp Charts

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\05-Gating\AutoCAD\TAP EA - Ramp Charts - NP Interim_20200921.dwgLayout: Ramp Charts (19) Plotted: Nov 4, 2020, 08:47PM

Terminal Area Plan and Air Traffic Procedures EA

Simulation Data Package - No Project Interim



LEGEND

Remote Positioning Location

NOTE

GA - General Aviation

SOURCES: Ricondo & Associates, Inc., *O'Hare International Airport Draft Future Airport Layout Plan*, May 2019; Ricondo & Associates, Inc., *List of Proposed and Baseline Projects*, October 2019; Ricondo & Associates, Inc., June 2019.

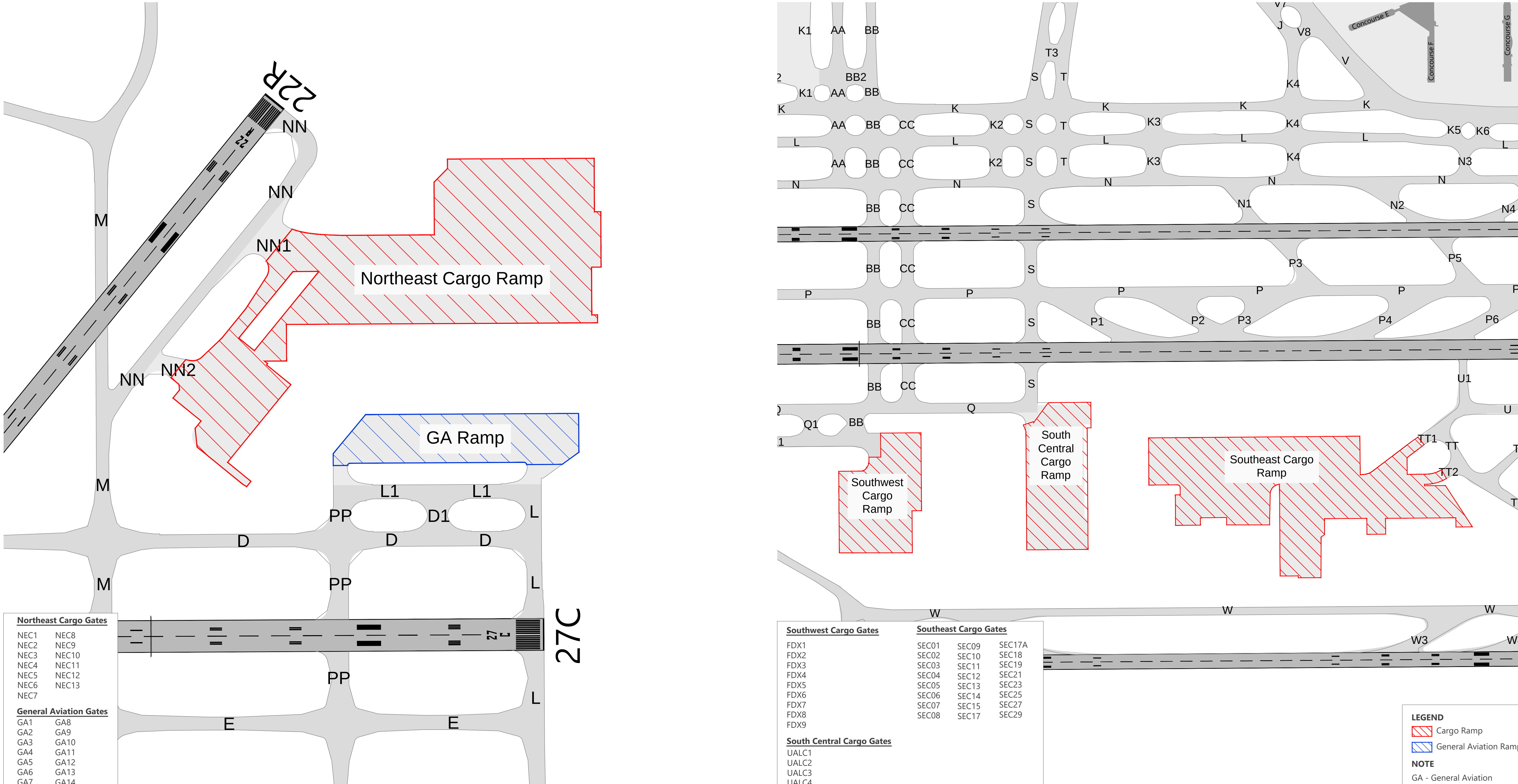
EXHIBIT 1-5

NORTH

0 2,500 ft.

Repositioning Remote Locations

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\02-Airfield\AutoCAD\TAP EA - Repositioning Remote Locations.dwgLayout: No Project - Interim Plotted: Oct 30, 2020, 04:17PM



SOURCES: Ricondo & Associates, Inc., *O'Hare International Airport Draft Future Airport Layout Plan*, May 2019; Ricondo & Associates, Inc., *List of Proposed and Baseline Projects*, October 2019; Ricondo & Associates, Inc., August 2020.

EXHIBIT 1-6

NORTH 0 Not To Scale

General Aviation and Cargo Parking Areas

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\02-Airfield\AutoCAD\TAP EA - GA and Cargo Parking Areas.dwgLayout: No Project - Interim Plotted: Oct 30, 2020, 04:21PM

1.6 Arrival Fixes by Departure Airport

Arrival fixes were assigned based on the location of the departure airport. **Exhibits 1-7** and **1-8** depict the arrival fix assignments for West Flow and East Flow, respectively.

1.7 Taxi Speeds

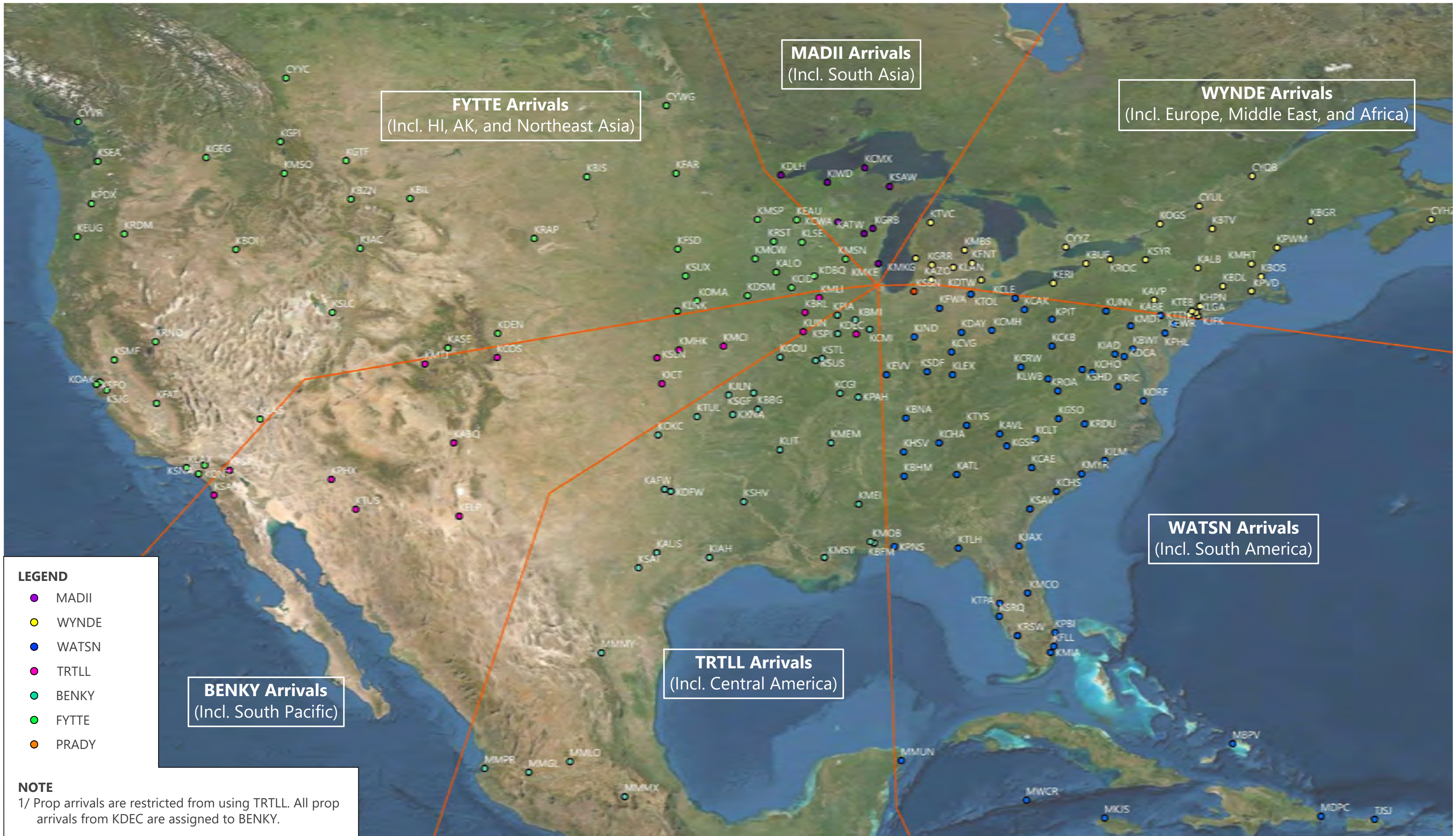
Taxi speeds were established for taxiways and aprons. **Exhibits 1-9** and **1-10** depict the taxi speeds for West Flow and East Flow, respectively.

1.8 Intersection Departure Procedures

Departures utilizing Runways 9R-27L and 10L-28R are encouraged to use intersection departure procedures whenever possible so that arrivals from the outboard runways (Runways 9L-27R, 9C-27C, 10C-28C, and 10R-28L) can taxi behind departing aircraft, reducing delay incurred by both arriving and departing aircraft. However, some departures cannot use intersection departure procedures due to runway length requirements. A subset of widebody[7] operations that is representative of the characteristics of the operations that typically utilize the full length of the departure runway was restricted from using intersection departure procedures. This subset was defined based on the airline and the great circle distance[8] from O'Hare to the destination airport. **Tables 1-2** and **1-3** detail the air carrier operations and cargo operations, respectively, that were in the DDFS and restricted from using intersection departures.

[7] This refers to aircraft with a fuselage wide enough to accommodate two passenger aisles.

[8] This is the shortest distance between two points on the surface of a sphere, measured along the surface of the sphere.



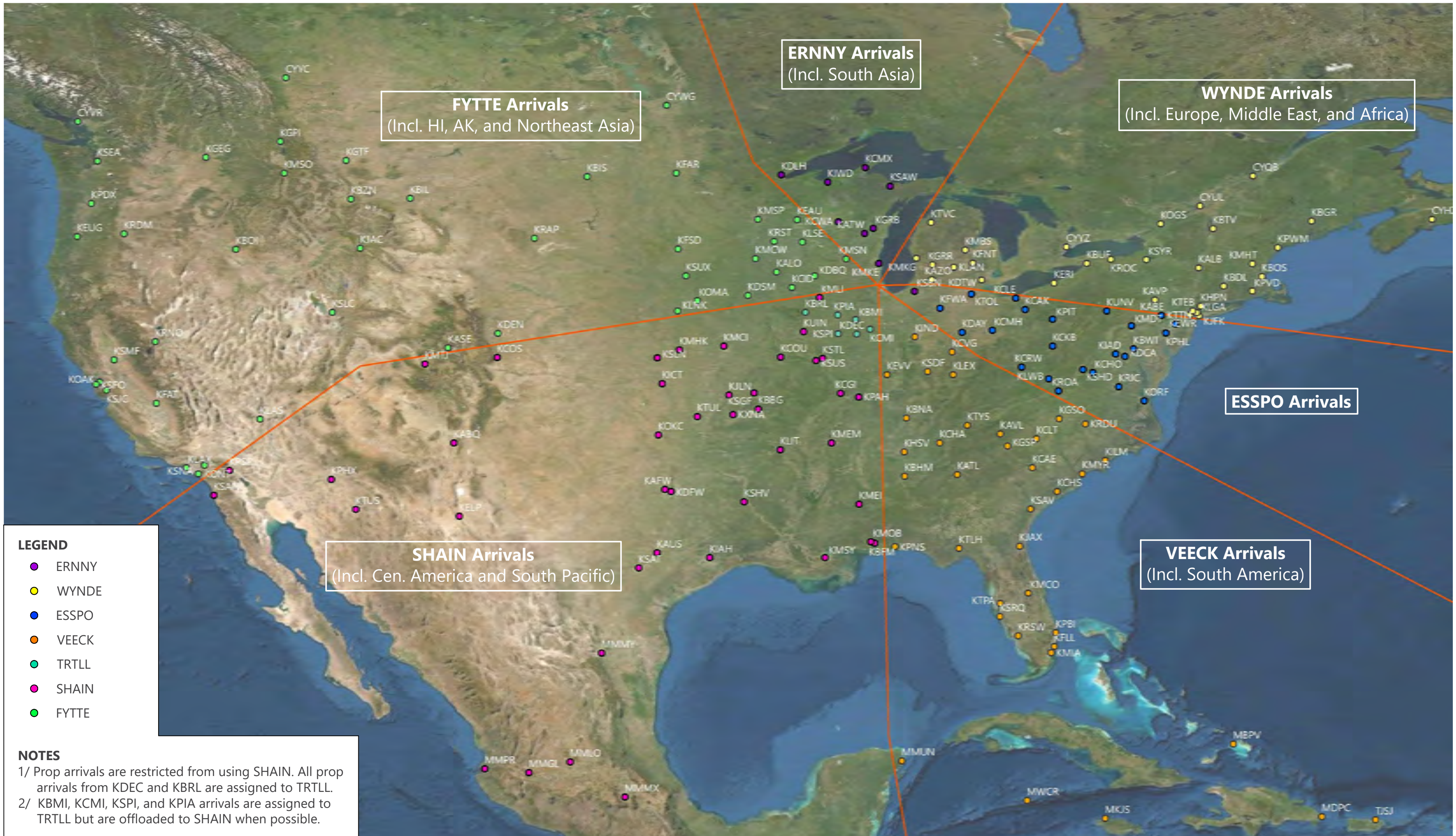
SOURCE: Terminal Area Plan and Air Traffic Procedures Environmental Assessment Air Traffic Workgroup, August 2019.

EXHIBIT 1-7

NORTH 0 Not To Scale

Arrival Fixes by Departure Airport West Flow

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\04-Airspace\AutoCAD\KORD TAP EA - Arrival Fixes by Departure Airport.dwgLayout: NPInterim_West Plotted: Oct 30, 2020, 04:24PM



SOURCE: Terminal Area Plan and Air Traffic Procedures Environmental Assessment Air Traffic Workgroup, August 2019.

EXHIBIT 1-8

NORTH 0 Not To Scale

Arrival Fixes by Departure Airport East Flow

Drawing: P:\Simulation\KORD_TAP_EA\Assumptions\04-Airspace\AutoCAD\KORD TAP EA - Arrival Fixes by Departure Airport.dwgLayout: NPInterim_East Plotted: Oct 30, 2020, 04:24PM