Organización de Aviación Civil Internacional
Grupo Regional de Planificación y Ejecución CAR/SAM (GREPECAS)
Séptima Reunión del Subgrupo GREPECAS de Aeródromos y Ayudas Terrestres/Planificación Operacional de los Aeródromos (AGA/AOP/SG/7)
Buenos Aires, Argentina, 9 al 13 de noviembre de 2009

Cuestión 4 del Orden del Día: **Revisión de las Actividades de los Grupos de Tarea, CARSAMPAF y ALACPA**

4.2 Informe del Grupo de Tarea sobre Demanda/Capacidad en los Aeropuertos

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ESTUDIOS DE DEMANDA Y CAPACIDAD

(Nota informativa presentada por Brasil)

RESUMEN

Esta nota informativa presenta algunos comentarios relacionados a los estudios y practicas desarrolladas en base a la de experiencia Brasileña en la determinación de demanda y capacidad de las operaciones de aeródromos. La misma nota fue presentada en la Reunión SAM/IG/4, Lima, Perú del 19 al 23 de octubre de 2009.

Un ejemplo de esta metodología, ha sido incluida en el calculo de capacidad para el aeropuerto internacional Salgado Filho, Porto Alegre

Referencias:

- Doc. 8168 – PANS OPS Vol. II- ICAO
- Anexo 14 – AERODROMOS- Vol. I - ICAO

Objetivos estratégicos de la OACI:

1. Introducción

1.1 Debido al incremento de las operaciones aéreas alrededor del mundo y, específicamente en algunos aeropuertos brasileros, Brasil viene aplicando un programa de demanda y capacidad en sus principales aeropuertos.

1.2 Ese programa fue desarrollado por el Centro de Gestiones de Navegación Aérea (CGNA) y su aplicación ha sido presentada a través de seminarios para algunos Estados de la Región, incluyendo talleres prácticos para el mejor aprendizaje.

1.3 Estos procedimientos cubren todas las variables involucradas en los aspectos referentes a demanda/capacidad en los aeropuertos aplicando parámetros, que sean adecuados para ser empleados a los padrones y procedimientos en los cálculos de las capacidades para cada pista de aterrizaje.

1.4 Para permitir el desarrollo de los estudios son necesarios recolectar los siguientes datos:

a) Factores de Planeamiento;

Son utilizados para simplificar los modelos matemáticos o los aspectos operacionales que puedan tener correlación en la determinación de las capacidades de las pista.

Generalmente estos factores tienen que ver con las condiciones en el orden de secuencia de aeronaves; la capacitación del personal envuelto en la operaciones; la fiabilidad y “performance” de los equipos de comunicación y de las radios ayudas.

b) Factores relativos a las operaciones de aterrizajes y despegues tales como:

- Tiempo de ocupación de la pista;
- Composición de aeronaves;
- Índices de utilización de cabeceras;
- Longitud del segmento de aproximación final:
- Patrón en los mínimos de separación entre aeronaves en aproximación;
- Configuración adecuada entre pistas de aterrizaje y de rodaje; y,
- Adecuación de la pista utilizada en la aproximación final.

1.5 Entonces, con esos parámetros, el CGNA de Brasil desarrollo un modelo matemático para el cálculo teórico de 14 “steps” para obtener la capacidad de la pista del aeropuerto de Porto Alegre, basado en las “performances” de las aeronaves, en conformidad con la clasificación contenida en Doc. 8168 – PANS OPS.

1.6 Ese modelo podrá ser presentado a los Estados de la Región CAR/SAM, de acuerdo a las características locales y de ser ese el caso, considerarlo como “standard” para ser utilizado como solución inmediata hasta que la OACI publique un manual al respecto.

1.7 Se ofrece, incluso para suministrar un taller sobre el tema, sea en la Oficina Regional de Lima o de México acuerdo a la disponibilidad de OACI, en fecha a ser coordinada.

2. Discusión

2.1 Considerar la experiencia presentada por Brasil como solución de los problemas de saturación de llegadas y salidas en el trafico aéreo domestico e internacional. De acuerdo a los motivos expuestos que podrían llevar a adoptar el método presentado y/o discutir su adopción, se podría crear un Grupo de Tarea para considerar la validez de la propuesta brasilera en términos de circulación aérea que cumplen con los Métodos y Normas Recomendadas por la OACI.

2.2 Se adjunta a la NI los estudios desarrollados para atender la demanda y capacidad del aeropuerto SBPA, ubicado al sur de Brasil, como ejemplo.

3. **Acción sugerida**

3.1 Se invita a la Reunión:

a) Considerar la presentación de la NI para discusión por el Grupo de Tarea de Estudios de Demanda y Capacidad;

b) De ser el caso, coordinar talleres de trabajo en la Regiones CAR y SAM, de ser el caso.

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APÉNDICE A

RUNWAY CAPACITY CALCULATION - PORTO ALEGRE AIRPORT

(Presented by Brazil to the SAM/IG/4 Meeting)

Abstract

This paper aims to submit to ICAO, an example of runaway capacity calculation in Porto Alegre Airport with the methodology adopted by Brazil.

Reference:

- Doc 8168 – ICAO – Aircraft Operations.

1 Introduction

1.1 The runway capacity saturation for arrivals and departures have is a big problem for domestic and international airports. In order to maintain the air traffic flow near the optimal conditions, avoiding possible overflow in the system, the Brazilian Air Navigation Management Center (CGNA) applies standard proceedures for runway capacity calculations. These procedures help to cope with the variation in the demand/capacity at the airports, giving parameters which support recommendations to the airports of interest in advance and to keep the overall operation in harmony.

1.2 In the following sessions, the procedures used in the calculation of the Porto Alegre Airport runaway capacity will be presented.

2 Analysis

2.1 To determine the capacity of a runway or a set of runways, the following factors are considered:

2.1.1 Planning Factors

The planning factors are elements used to simplify the mathematical models, or the operational aspects, which influence the determination of the runway capacity. The most common are:

a) Optimal conditions for aircraft sequencing and air traffic coordination;

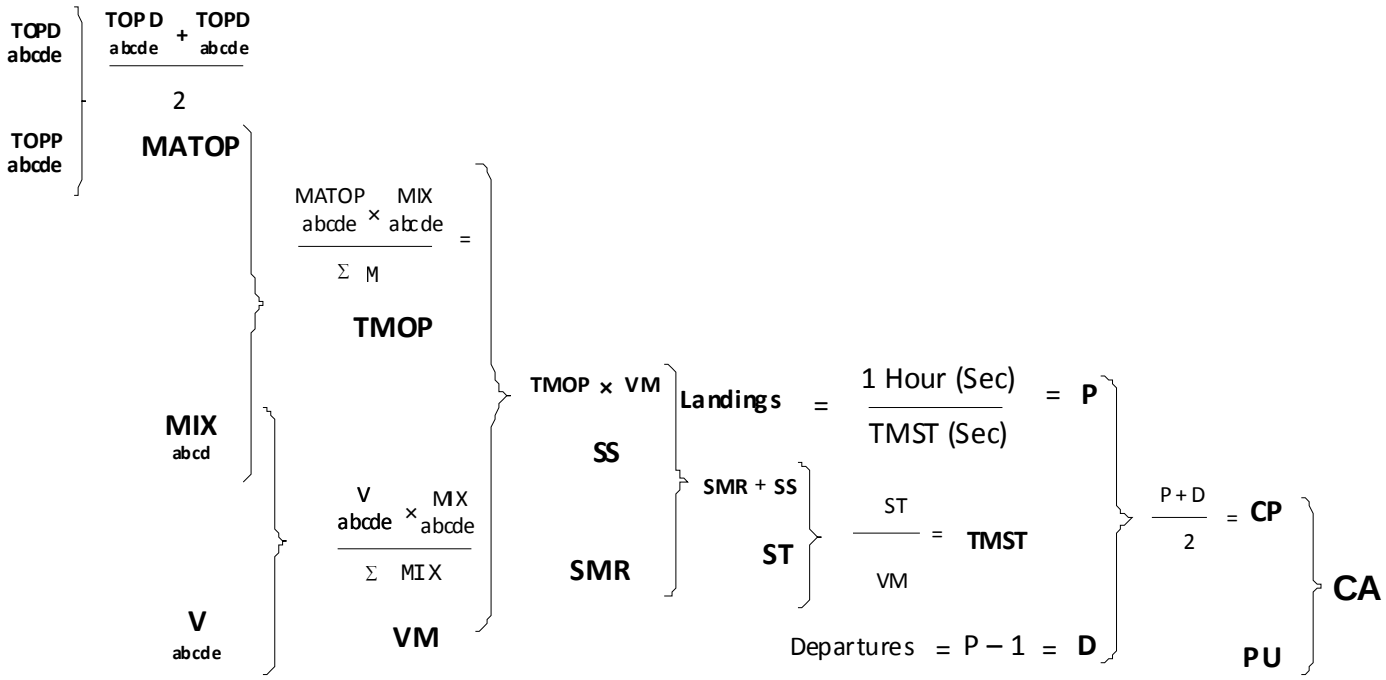
b) All operational teams are considered with the same capacity and same operational performance; and

c) All radio-navigation and visual-aid are considered, technically and operationally, unrestricted, and all communication equipment (VHF/telephony) are considered operational.

2.1.2 Takeoff and Landing Operations Factors

a) Average runway occupancy time;
b) Aircraft Mix ;
c) Thresholds percentage of use;
d) Final approach segment length;
e) Standardized minimum separation between the aircrafts for landing;
f) Runways and taxiways configuration, and
g) Final approach speed.

2.2 The mathematical model (Fig. 1) for calculating the theoretical runway capacity used by CGNA is used in the following 14 steps for obtaining the runaway capacity of Porto Alegre Airport. In some of the steps, the aircraft classification (A through E) is used according to the Doc 8168 (Table III-1-2).



$$CA = \frac{PUA \times CTPA + PUB \times CTPB + \ldots\ldots PUN \times CTPN}{PUA + PUB \ldots\ldots PUN}$$

Fig. 1 Mathematical model for the theoretical runway capacity

STEP 1
COLLECTION OF DATA FROM THE AIRPORT:

1º) The runway occupation time at takeoff (TOPD): time taken by the aircraft during the takeoff operation. It is measured from the moment when the aircraft leaves the "hold short of" position until the it flyies over the opposite threshold.

SBPA			
RWY 11		RWY 29	
CAT	**TOPD (s)**	**CAT**	**TOPD (s)**
A	93	A	76
B	90	B	93
C	97	C	117
D	0	D	0
E	0	E	0

2º) The runway occupation time at landing (TOPP): time taken from the point at which the aircraft crosses the threshold of the runway during the landing operation until it leaves the runway.

SBPA			
RWY 11L		RWY 29R	
CAT	**TOP**	**CAT**	**TOP**
A	67	A	74
B	60	B	66
C	54	C	61
D	0	D	0
E	0	E	0

3º) Flight time from the outer marker (or FAF) to the threshold of the runway (T): time taken by the aircraft during the final approach segment (SAF), from the moment when the aircraft crosses over the outer marker (or FAF) until it crosses the threshold of the runway or, in the absence of an outer marker, when it starts the final approach segment until it crosses the threshold of the runway. The aircraft category is considered in the time mesurement process.

SBPA				
RWY 11 - SAF: 5 NM			**RWY 29 - SAF: 10 NM**	
CAT	**T (s)**		**CAT**	**T (s)**
A	150		**A**	263
B	140		**B**	208
C	134		**C**	226
D	0		**D**	0
E	0		**E**	0

Remark: The times previously described are classified by the aircraft category and are taken in the control tower of the airport. These times are recorded on special forms (Annexes 1 and 2, respectively). It is important to point out that during the time mesurement, must be observed the "Modus Operandi" of the ATC Organs at the airport.

STEP 2
AVERAGE RUNWAY OCCUPANCY TIME (MATOP)

Average runway occupancy time will be calculated for each runway threshold, due to the fact that each runway has its own configuration. This leads to different average time of runway occupancy for each threshold.

After taking the runway occupancy time, the arithmetic average of the runway occupancy time (MATOP) is calculated separatelly by aircraft category, as follows:

$$\textbf{MATOPA} = \frac{\textbf{TOPDA+TOPPA}}{\textbf{2}}$$

$$\textbf{MATOPB} = \frac{\textbf{TOPDB+TOPPB}}{\textbf{2}}$$

$$\textbf{MATOPC} = \frac{\textbf{TOPDC+TOPPC}}{\textbf{2}}$$

$$\textbf{MATOPD} = \frac{\textbf{TOPDD+TOPPD}}{\textbf{2}}$$

$$\textbf{MATOPE} = \frac{\textbf{TOPDE+TOPPE}}{\textbf{2}}$$

SBPA

RWY 11		RWY 29	
CAT	**MATOP (S)**	**CAT**	**MATOP (S)**
A	80	A	75
B	75	B	80
C	76	C	89
D	0	D	0
E	0	D	0

STEP 3
AIRCRAFT MIX (MIX)

Aircraft Mix is the fleet configuration operating at the studied airport. According to Doc 8168, the aircraft are classified into five categories, depending on the runway threshold crossing speed, which must be 130% of the value of the stall speed with the landing configuration (full flaps, gear down). Therefore, the aircraft are classified as follows:

- CAT "A" speed less than 90 kt
- CAT "B" Speed between 91/120kt
- CAT "C" Speed between 121/140kt
- CAT "D" speed between 141/165kt
- CAT "E" Speed between 166/210kt

The percentage by aircraft category (Mix) will be calculated from the total daily movement. To obtain this number, the data sample should be taken in the period of at least one week. The choosen week should contain the selected day to collect the data for calculating the runway occupation time.

The table below shows an example of aircraft mix calculation:

SBPA	
CAT	***Mix***
A	15,75%
B	12,39%
C	68,94%
D	2,93%
E	0,00
TOTAL	**100 %**

STEP 4
WEIGHTED AVERAGE TIME OF RUNWAY OCCUPATION (TMOP)

It is the weighted average time of the MATOP by aircraft category, taking into account the mix of aircrafts.The average time shall be calculated for each threshold in the airport, due to different taxiway configurations for each threshold in use.

$$\mathbf{TMOP} = \frac{\mathbf{MIX_A \times MATOPA + MIX_B \times MATOPB + MIX_C \times MATOPC + MIX_D \times MATOPD + MIX_E\ MATOPE}}{\mathbf{\sum MIX}}$$

SBPA - RWY 11			
CAT	**MIX**		**MATOP (s)**
A	15,75%		80
B	12,39%		75
C	68,94%		76
D	2,93%		0
E	0		0
TOTAL	100%		
TMOP = 73,7214 s			

SBPA - RWY 29

CAT	MIX		MATOP (s)
A	15,75%		76
B	12,39%		93
C	68,94%		117
D	2,93%		0
E	0		0
TOTAL	100%		
TMOP = 104,1525 s			

STEP 5
FINAL APPROACH SPEED(VA)

It is the speed needed to go through the final approach segment (**SAF**) for landing. This spead comes from the division of the approach segment length by the flight time (**T**) from the outer marker (or FAF) until the runway threshold. It is calculated for each aircraft category.

$$VA_A = \frac{SAF}{T_A}$$

$$VA_B = \frac{SAF}{T_B}$$

$$VA_C = \frac{SAF}{T_C}$$

$$VA_D = \frac{SAF}{T_D}$$

$$VA_E = \frac{SAF}{T_E}$$

SBPA - RWY 11

SAF: 5 NM

CAT		VA (Kt)	VA (NM/min)	VA (NM/s)
A		120,000	2,000000	0,033333
B		128,571	2,142857	0,035714
C		134,328	2,238806	0,037313
D		0	0	0
E		0	0	0

SBPA - RWY 29

SAF: 10 NM

CAT		VA (Kt)	VA (NM/min)	VA (NM/s)
A		136,9	2,281369	0,038023
B		173,1	2,884615	0,048077
C		159,3	2,654867	0,044248
D		0	0	0
E		0	0	0

STEP 6
AVERAGE SPEED IN THE FINAL APPROACH (VM):

Weighted average of the final approach speeds, taking into account the aircraft mix.

$$VM = \frac{MIX_A \, xVA_A + MIX_B \, xVA_B + MIX_C \, xVA_C + MIX_D \, xVA_D + MIX_E \, xVA_E}{\sum MIX}$$

SBPA - RWY 11				
CAT	**VA (NM/seg)**		CAT	MIX
A	0,033333		A	15,75%
B	0,035714		B	12,39%
C	0,037313		C	68,94%
D	0		D	2,93%
E	0		E	0
VM = 0,0354 NM/seg				

SBPA - RWY 29				
CAT	**V.NM/seg**		CAT	MIX
A	0,038023		A	15,75%
B	0,048077		B	12,39%
C	0,044248		C	68,94%
D	0		D	2,93%
E	0		E	0
VM = 0,0424 NM/s				

STEP 7

DETERMINATION OF SAFE SEPARATION (SS):

The study considers the occurrence of one takeoff between two consecutive landings, but without affecting the regulatory minimum separation between aircrafts on approach (SMR), which is established at ICA 100-12 in the case of Brazil. Therefore, it is necessary to calculate a safe distance (SS) to be added to the SMR, in order to allow the take off of an aircraft, after the landing of the first approaching aircraft, without compromising the SMR to the second approaching one. This SS comes from the multiplication of VM to the TMOP.

SS = VM x TMOP

RWY 11	RWY 29
SS = 0,0354NM/s x 73,7214s **SS = 2,60NM**	**SS = 0,0424NM/s x 104,1525s** **SS = 4,41NM**

STEP 8
DETERMINATION OF TOTAL SEPARATION BETWEEN TWO CONSECUTIVES LANDINGS (ST):

The total separation comes from the summation of the SS with the SMR, as follows:

ST = SMR + SS

RWY 11	RWY 29
ST = 5NM + 2,60NM **ST = 7,60NM**	**ST = 5NM + 4,41NM** **ST = 9,41NM**

There are cases where the SS can be disregarded. Usually this can happen at the airports that have two or more runways, improoving the dynamism of the operation and enabling an aircraft to line up and wait on a runway during the landing of other aircraft on another runway.

STEP 9
DETERMINATION OF WEIGHTED AVERAGE TIME BETWEEN TWO CONSECUTIVES LANDINGS (TMST):

The weighted average time (TMST) used for the total separation between two consecutive landings is obtained from the ST divided by the VM, as follows:

TMST = ST/VM

RWY 11	RWY 29
TMST = 8NM/ 0,0354NM/s **TMST = 225,98s**	**TMST = 10NM / 0,0424NM/s** **TMST = 235,84s**

STEP 10
DETERMINATION OF THE NUMBER OF LANDING AIRCRAFT IN ONE HOUR (P):

The possible number of landings with the proposed separation within a time interval of one hour is obtained dividing the interval of one hour by the weighted average time (TMST) used for the total separation (ST) between two consecutive landings, as follows:

P = 1Hora(s)/TMST(s)

RWY 11	RWY 29
P = 3600s / 226s **P = 16**	**P = 3600s / 236s** **P = 15**

STEP 11
DETERMINATION OF THE NUMBER OF DEPARTURE IN ONE HOUR (D):

Applying the calculated total separation it is possible to have one departure between two consecutive landings. Decreasing one aircraft of the total number of landings, we get the possible number of departure in the interval of one hour.

D = P-1

RWY 11	RWY 29
D = 16 – 1 **D = 15**	**D = 15 - 1** **P = 14**

STEP 12
DETERMINATION OF THE RUNWAY CAPACITY (CP):

The runway capacity comes from the summation of the number of landings with the number of takeoffs, as folows:

CP = P+D

RWY 11	RWY 29
CP = 16 + 15 **CP = 31 Mov/h**	**CP = 15 + 14** **CP = 29 Mov/h**

STEP 13
RUNWAY USAGE PERCENTAGE (PU):

The runaway usage percentage (PU) is calculated from the total monthly movement, obtained from a one year data sample.

In order to achieve the required precision in the calculations, the last twelve months data of the control tower management systems are analysed to measure the usage percentage of each runway of the airport.

The tables below show an example the runaway usage percentage calculation:

SBPA	
RUNWAY	**% RUNWAY USAGE**
11	**72,78 %**
29	**27,22 %**
TOTAL	**100 %**

STEP 14
CAPACITY OF A RUNWAY SET

The runway capacity of a runway set is the full sustainable capacity, in the operational point of view, considering the runway usage percentage of each runway. The runway set capacity is the weighted average of each runway capacity, considering the respective runway usage percentage, as follows:

$$CA = \frac{PU_1 x CP_1 + PU_2 x CP_2 + \ldots\ldots PU_N x CP_N}{PU_1 + PU_2 \ldots\ldots PU_N}$$

$$CA = \frac{72{,}78 \times 31 + 27{,}22 \times 29}{72{,}78 + 27{,}22}$$

$$CA = 30 \text{ Mov/h}$$

2.2 Declared Runway Capacity

The declared runway, or runway set, capacity can be choosen between 80% and 100% of the theoretical runway capacity calculated above.

It is recommended to use values closed to 80% of the theoretical runway capacity to reduce the possibility of delays during the operation when some external factor, like weather, operational delays of the companies, etc., interferes in the normal airport operation. When the declared runway capacity value is closed to 100%, it becomes difficult to recover delays caused by external factors.

The declared runaway set capacity for SBPA is 28 moviments/hour (93% of the CA).

3 Action suggested

3.1 The meeting is invited to:

a) Analyze the information presented in the Working Paper.

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APPENDIX A

TEMPO DE OCUPAÇAO DE PISTA (DEP) - SBPA-11										
MATRÍCULA ACFT	Tipo ACFT	CAT ACFT	EST ACFT	Tempo (Seg)				TWY ingres	Vento (kt)	OBS.
				ingresso	Parada	corrida	Total			
PTRHR	P28A	A	L	52	0	61	113	A		
GEIV27	E110	B	L	39	0	44	83	A		
GOL1955	B733	C	M	51	0	41	92	J		
GOL2105	B738	C	M	57	0	43	100	J		
ONE6185	F100	C	M	60	0	43	103	J		
GOL2107	B733	C	M	55	0	45	100	J		
TAM3158	A319	C	M	64	0	48	112	J		
PTORB	BE20	B	L	45	0	65	110	J		
NHG4518	L410	B	L	46	0	55	101	J		
TAM3060	A320	C	M	43	0	47	90	J		
TAM3162	A320	C	M	43	0	49	92	J		
TAM3418	A320	C	M	46	0	43	89	J		
TAM3422	A320	C	M	59	0	41	100	J		
PTRHR	P28A	A	L	40	0	62	102	A		
NHG4506	L410	B	L	44	0	54	98	J		
GOL1696	B738	C	M	45	0	43	88	J		
GOL2109	B737	C	M	56	0	45	101	J		
AZU4062	E195	C	M	55	0	44	99	J		
ONE6385	F100	C	M	55	0	48	103	J		
TAM3072	A320	C	M	48	0	48	96	J		
TAM8021	A320	C	M	45	0	52	97	J		
GOL8615	B738	C	M	72	0	44	116	J		
GOL2103	B738	C	M	65	0	41	106	J		
TAM3416	A320	C	M	60	0	43	103	J		
PTNOV	P28R	A	L	30	0	60	90	A		
TAM3058	A320	C	M	51	0	40	91	J		
NHG4502	L410	B	L	35	0	48	83	J		
AZU4064	E190	C	M	59	0	48	107	J		
GOL1945	B738	C	M	47	0	45	92	J		
PTRHR	P28A	A	L	39	0	60	99	A		
WEB6721	B733	C	M	36	0	47	83	J		
NHG4510	L410	B	L	35	0	46	81	J		
TAM3502	A320	C	M	38	0	39	77	J		
PRMLA	LJ35	C	M	56	0	38	94	J		
GOL1953	B738	C	M	46	0	46	92	J		
NHG4504	L410	B	L	41	0	50	91	J		
GOL1948	B733	C	M	44	0	49	93	J		
TAM3422	A320	C	M	54	0	44	98	J		
TAM3418	A320	C	M	53	0	45	98	A		
ONE6385	F100	C	M	62	0	41	103	A		
NHG4506	L410	B	L	35	0	50	85	J		

TEMPO DE OCUPAÇAO DE PISTA (DEP) - SBPA-11										
MATRÍCULA ACFT	Tipo ACFT	CAT ACFT	EST ACFT	Tempo (Seg)				TWY ingres	Vento (kt)	OBS.
				ingresso	Parada	corrida	Total			
PTNCL	P28R	A	L			52	52	G		
GOL1696	B738	C	M	40	0	44	84	J		
PTLKY	PA31	A	L	44	0	53	97	J		
PROEC	BE40	B	M	45	0	38	83	J		
FAB2582	E135	B	M	59	0	42	101	J		
TAM3832	A320	C	M	37	0	41	78	J		
TAM3836	A320	C	M	57	0	45	102	J		
WEB6740	B733	C	M	54	0	44	98	A		
AZU4060	E195	C	M	55	0	47	102	A		
GOL7487	B738	C	M	76	0	46	122	A		
GOL1725	B738	C	M	56	0	46	102	J		
GOL1993	B737	C	M	81	0	47	128	J		
GOL7469	B737	C	M	64	0	44	108	A		
PTVOB	PA34	A	L	33	0	55	88	G		
GOL1241	B738	C	M	35	0	43	78	J		
TAM3848	A320	C	M	59	0	47	106	J		
GOL1836	B738	C	M	67	0	44	111	J		
TAM3452	A320	C	M	56	0	42	98	J		
GOL2103	B733	C	M	54	0	44	98	A		
GOL8615	B738	C	M	54	0	45	99	A		
TAM3416	A320	C	M	48	0	42	90	J		
TAM3058	A320	C	M	42	0	45	87	J		
AZU4064	E195	C	M	52	0	46	98	A		
GUAPO16	PA34	A	L	33	0	55	88	G		
NHG4502	L410	B	L	37	0	48	85	J		
GOL1945	B738	C	M	60	0	39	99	J		
PTWQP	C152	A	L	32	0	70	102	A		
NHG4510	L410	B	L	38	0	46	84	J		
TAM3502	A321	C	M	59	0	42	101	J		
WEB6721	B733	C	M	54	0	37	91	J		
GOL1948	B737	C	M	45	0	44	89	J		
GOL1953	B738	C	M	44	0	43	87	J		
NHG4504	L410	B	L	36	0	52	88	J		
PTRHR	P28A	A	L	40	0	59	99	A		
TAM3832	A320	C	M			76	76	J		
LVZRL	BA32	B	L	44	0	44	88	J		

TEMPO DE OCUPAÇAO DE PISTA (DEP) - SBPA-29										
MATRÍCULA ACFT	Tipo ACFT	CAT ACFT	EST ACFT	T empo (Seg)				TWY ingres	Vento (kt)	OBS.
				ingresso	Parada	corrida	Total			

FAB01	B732	C	M	73	0	43	116	E		
TAM8020	A320	C	M	89	0	40	129	E		
AZU4070	E195	C	M	75	0	39	114	E		
TAM3052	A320	C	M	90	0	33	123	E		
PREPZ	SR22	A	L	35	0	35	70	E		
GOL1243	B732	C	M	89	0	40	129	E		
FAB2526	E145	B	M	88	0	38	126	E		
PTVAP	PAT4	A	L	24	0	38	62	E		
TAM3088	A320	C	M	76	0	33	109	E		
PRANP	C56X	B	M	57	0	34	91	E		
TAM3294	A320	C	M	93	0	39	132	E		
GUAPO 07	BE35	A	L	26	0	47	73	E		
GOL1829	B738	C	M	68	0	40	108	E		
PTRHR	PA28A	A	L	25	0	50	75	F		
GOL1955	B738	C	M	71	0	40	111	F		
GOL7488	B738	C	M	79	0	40	119	E		
ONE6185	F100	C	M	77	0	40	117	E		
GOL2105	B738	C	M	69	0	44	113	E		
GOL1829	B738	C	M	77	15	40	132	E		
GOL2107	B737	C	M	84	0	43	127	E		
NHG4518	L410	B	L	28	0	41	69	E		
TAM3858	A320	C	M	74	0	39	113	E		
ONE6185	F100	C	M	80	0	41	121	E		
TAM3060	A320	C	M	86	0	39	125	E		
GOL1955	B738	C	M	90	0	35	125	E		
TAM3418	A320	C	M	68	0	37	105	E		
TAM3422	A320	C	M	67	0	37	104	E		
GUAPO 07	BE35	A	L	35	0	51	86	E		
NHG4506	L410	B	L	25	0	41	66	E		
ONE6385	F100	C	M	62	0	36	98	E		
PTRHO	P28A	A	L	44	0	50	94	E		
GOL1696	B738	C	M	65	0	40	105	E		
PPEVG	C510	B	L	55	0	40	95	E		
PTWQP	C152	A	L			90	90	F		
AZU4062	E195	C	M	82	0	37	119	E		
TAM3072	A320	C	M	77	0	44	121	E		
GOL2109	B738	C	M	62	0	41	103	E		
PRJES	PA34	A	L			73	73	E		
GOL2105	B738	C	M	74	0	40	114	E		
ONE6185	F100	C	M	73	0	36	109	E		

TEMPO DE OCUPAÇAO DE PISTA (DEP) - SBPA-29										
MATRÍCULA ACFT	**Tipo ACFT**	**CAT ACFT**	**EST ACFT**	**Tempo (Seg)**				**TWY ingres**	**Vento (kt)**	**OBS.**
				ingresso	**Parada**	**corrida**	**Total**			

GOL2107	B738	C	M	68	0	36	104	E		
PTRHR	P28A	A	L			63	63	F		
TAM3858	A320	C	M	103	0	36	139	E		
GOL1955	B738	C	M	71	0	36	107	E		
TAM3060	A320	C	M	87	0	36	123	E		
NHG4518	L410	B	L	65	0	46	111	E		
TAM3162	A320	C	M	105	0	39	144	E		

APPENDIX B

TEMPO DE OCUPAÇAO DE PISTA (ARR) - SBPA-11							
MATRÍCULA	**Tipo**	**CAT**	**EST**	**Tempo (Seg)**	**TWY**	**Vento (Kt)**	**OBS.**
GOL2102	B737	C	M	53	F		
ONE6184	F100	C	M	46	F		

TAM3293	A320	C	M	54	F		
AZU4061	E195	C	M	52	F		
TAM8021	A320	C	M	65	F		
TAM3055	A320	C	M	62	F		
GOL7849	B737	C	M	65	F		
WEB6741	B737	C	M	48	F		
GOL1862	B737	C	M	50	F		
TAM3863	A320	C	M	52	F		
PTORB	BE20	B	L	60	F		
AZU4063	E190	C	M	59	E		
GOL1944	B737	C	M	49	F		
WEB6700	B737	C	M	46	F		
PRMLA	LR35	C	M	48	F		
GOL1952	B737	C	M	44	F		
PTWKQ	C550	B	L	60	F		
GOL1242	B737	C	M	46	F		
PPCRS	C525	B	L	59	F		
TAM8020	A320	C	M	46	F		
GOL1695	B737	C	M	61	E		
TAM3097	A320	C	M	60	E		
PTRHR	PA28	A	L	61	F		
TAM3053	A320	C	M	64	E		
GOL1244	B737	C	M	52	F		
PTRHR	P28	A	L	65	F		
PTVEQ	PA34	A	L	60	F		
TAM3293	A320	C	M	59	F		
GEIV27	E110	B	L	62	E		
AZUL4061	E190	C	M	47	F		
TAM8021	A320	C	M	56	E		
PREPT	PA34	A	L	69	E		
NHG405	L410	B	L	60	F		
TAM3061	A320	C	M	49	F		
PRANP	C560	B	M	60	F		
PTRHR	P28A	A	L	80	F		
GOL1743	B738	C	M	45	F		
GOL1240	B738	C	M	51	F		
TAM3847	A320	C	M	63	F		
TAM3451	A320	C	M	55	F		
NHG4500	L410	B	L	61	F		

TEMPO DE OCUPAÇAO DE PISTA (ARR) - SBPA-11							
MATRÍCULA	**Tipo**	**CAT**	**EST**	**T empo (Seg)**	**TWY**	**Vento (Kt)**	**OBS.**
VRN8615	B737	C	M	64	E		
TAM3413	A320	C	M	53	F		
TAM3059	A320	C	M	53	F		

VLO9868	B727	C	M	54	F		
TAM3501	A320	C	M	60	F		
GOL1944	B738	C	M	62	F		
WEB6700	B737	C	M	50	F		
TAM3415	A320	C	M	55	F		
TAM3053	A320	C	M	56	F		
AZU4069	E195	C	M	66	E		

TEMPO DE OCUPAÇAO DE PISTA (ARR) - SBPA 29							
MATRÍCULA	**Tipo**	**CAT**	**EST**	**T empo (Seg)**	**TWY**	**Vento (Kt)**	**OBS.**
NHG4503	L410	B	L	73	C		
PTRRQ	PA32	A	L	80	J		
GOL7488	B737	C	M	50	C		
ONE6384	F100	C	M	55	C		
GOL1954	B737	C	M	68	C		
TAM3419	A320	C	M	50	C		
GOL1280	B737	C	M	60	C		
TAM3161	A320	C	M	55	C		
TAM3859	A320	C	M	74	C		
TAM3859	A320	C	M	63	C		
TAM3419	A320	C	M	75	A		
GOL1954	B737	C	M	65	C		
TAM3161	A320	C	M	68	C		
GEIV38	E110	B	L	96	G		
NHG4505	L410	B	L	53	C		
TAM3423	A320	C	M	87	C		
ONE6184	F100	C	M	59	C		
PPGVG	C510	B	L	53	C		
PTJGJ	PA34	A	L	80	C		
PTRXI	PAT2L	A	L	62	C		
GOL1202	B737	C	M	55	C		
TAM8021	A320	C	M	45	C		
FAB2012	E120	B	M	55	C		
TAM3055	A320	C	M	52	C		
GOL7489	B737	C	M	65	C		
TAM3423	A320	C	M	52	C		
ONE6184	F100	C	M	76	A		

APPENDIX C

TEMPO DE VOO ENTRE O OM E A THR - SBPA-11					
MATRÍCULA	**TIPO**	**CAT**	**EST**	**Tempo (seg)**	**OBS.**
PTRHR	P28AL	A	L	160	
PTVGQ	PA34	A	L	159	
GEIV27	E110	B	L	161	
PRGPT	PA34	A	L	133	
NHG405	L410	B	L	162	

PRANP	C560	B	M	131	
GOL2102	B738	C	M	164	
ONE6184	F100	C	M	128	
TAM3293	A320	C	M	125	
AZUL4061	E195	C	M	130	
TAM8021	A320	C	M	152	
TAM3055	A320	C	M	149	
GOL7849	B738	C	M	140	
WEB6741	B738	C	M	121	
GOL1862	B738	C	M	145	
TAM3863	A320	C	M	151	
FAB2526	E145	B	M	132	
AZUL4063	E190	C	M	136	
GOL1944	B738	C	M	116	
WEB6700	B738	C	M	115	
PRMLA	LR35	C	M	121	
GOL1952	B738	C	M	127	
PTWKQ	C550	B	L	132	
GOL1242	B738	C	M	127	
PPCRS	C525	B	L	123	
TAM8020	A320	C	M	137	
GOL1695	B738	C	M	120	
AZUL4069	E195	C	M	125	
TAM3097	A320	C	M	130	
TAM3053	A320	C	M	127	
GOL1244	B738	C	M	129	
TAM3847	A320	C	M	154	
TAM3451	A320	C	M	142	
GOL1833	B738	C	M	144	
VRN8615	B738	C	M	134	
TAM3413	A320	C	M	148	
TAM3059	A320	C	M	140	
VLO9868	B722	C	M	133	
TAM3501	A320	C	M	129	
AZU4063	E195	C	M	124	
GOL1944	B737	C	M	137	

TEMPO DE VOO ENTRE O OM E A THR - SBPA-11					
MATRÍCULA	**TIPO**	**CAT**	**EST**	**Tempo (seg)**	**OBS.**
WEB6700	B737	C	M	146	
GOL1952	B737	C	M	127	
GOL1242	B737	C	M	138	
TAM3415	A320	C	M	133	
TAM3053	A320	C	M	128	
AZU4069	E195	C	M	140	

TAM8020	A320	C	M	129	
GOL1695	B737	C	M	132	

TEMPO DE VOO ENTRE O OM E A THR - SBPA-29					
MATRÍCULA	**TIPO**	**CAT**	**EST**	**Tempo (seg)**	OBS.
TAM3859	A320	C	M	262	
TAM3419	A320	C	M	219	
TAM3161	A320	C	M	222	
GOL1954	B738	C	M	194	
GEIV38	E110	B	L	239	
NHG4505	L410	B	L	117	
TAM3423	A320	C	M	231	
ONE6184	F100	C	M	224	
PPEVG	C510	B	M	219	
PTJES	PA34	A	L	225	
PTRXI	PAT2L	A	L	240	
PTLVA	PA34	A	L	325	
GOL2102	B738	C	M	256	
TAM3293	A320	C	M	241	
AZU4061	E195	C	M	233	
TAM8021	A320	C	M	210	
FAB2012	E120	B	M	226	
TAM3055	A320	C	M	225	
GOL7489	B738	C	M	215	
TAM3423	A320	C	M	235	
ONE6184	F100	C	M	225	
TAM3061	A320	C	M	220	
PRWTR	G200	C	M	200	
GOL1959	B738	C	M	218	
NHG4503	L410	B	L	243	
GOL7488	B738	C	M	211	
ONE6384	F100	C	M	238	

TEMPO DE VOO ENTRE O OM E A THR - SBPA-29					
MATRÍCULA	**TIPO**	**CAT**	**EST**	**Tempo (seg)**	OBS.
GOL1954	B738	C	M	236	
TAM3419	A320	C	M	232	
GOL1280	B738	C	M	252	
TAM3161	A320	C	M	223	
TAM3859	A320	C	M	213	

APPENDIX D

ABBREVIATIONS

ARR	Arrival
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
CAT	Category
CFP	Actual Runway Capacity
CTP	Hypothetical Runway Capacity
CT	Time Counting
CGNA	Air Navigation Management Center
DEP	Departure
FAA	Federal Aviation Administration
IEPV	Brazilian Aeronautical Forms
OM	Outer Marker
FAF	Final Approach Fix
FPL	Filed Flight Plan
IMC	Instrument Meteorological Conditions
RWY	Runway
SAS	Situation Analysis System
SEP REQ	Required Separation
SGTC	Control Tower Management System
TARIS	Terminal of radar presentation with synthetic image
TG	Touch-and-Go
TOP	Runway Occupancy Time
THR	Threshold
TPH	Typical Peak Hour

APPENDIX E

DEFINITIONS

a) ACTUAL RUNWAY CAPACITY

The possible maximum number of operations during sixty minutes, taking into account the runway occupancy time. ***(t_{op}).***

b) HYPOTHETICAL RUNWAY CAPACITY

The runway capacity calculated during sixty minutes, taking into account the average time of runway occupancy and the legislation concerning aircraft separation, including the specific rules and procedures adopted to the local operations.

c) AEROPLANE CATEGORY

Classification of aeroplanes subdivided into five groups (a, b, c, d, e), defined according to the indicated airspeed at threshold which must be equal to 130 per cent of the stall speed, with a landing configuration (full flaps, gear down).

d) AIRCRAFT MIX

Percent distribution of the aircraft fleet in operation in the analyzed airport, according to the aeroplane category.

e) PERCENTAGE BY AEROPLANE CATEGORY

Calculated index considering the total daily aircraft movement, reported in the IEPV 100-34 form (Aircraft Movement in Aerodromes) or collected from the Control Tower Management Systems. This index is equal to the percent mean of one year sample, based on weekdays (except Saturdays, Sundays and holidays).

f) PERCENTAGE OF RUNWAY UTILIZATION AT AN AERODROME

Calculated index considering the total daily aircraft movement. This index is equal to the percent mean of one year sample in order to approve the confidence on the data.

g) SATURATION

Situation on which the air traffic demand is higher than the airport capacity or than a certain control sector.

h) RUNWAY OCCUPANCY TIME FOR DEPARTING AIRCRAFT

Runway occupancy time for departing aircraft based on the moment that the aircraft leaves the holding point until the moment it crosses the opposite threshold.

i) RUNWAY OCCUPANCY TIME FOR ARRIVING AIRCRAFT

Runway occupancy time for arriving aircraft based on the moment that the aircraft crosses the threshold until the moment it vacates the runway.

j) AVERAGE RUNWAY OCCUPANCY TIME TAKING INTO ACCOUNT EACH AEROPLANE CATEGORY

Arithmetic mean, considering each aeroplane category, between the runway occupancy time for departing aircraft and the runway occupancy time for arriving aircraft.