ARCHERFIELD AIRPORT MASTER PLAN

TECHNICAL PAPER
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(Revision 2)

RUNWAY CAPACITY

An Investigation of Practical Capacity with Class D Airspace Procedures and the Proposed Runway Configuration

JULY 2010

CONTENTS

1. INTRODUCTION

The purpose of this report is to provide an estimate of practical capacity of Archerfield Airport for planning purposes.

The concept of capacity is only meaningful when considered in the context of demand – the rate at which aircraft arrivals and departures are presented to the runway, taxiway or apron systems. The runway system is usually the "bottleneck" which constrains the capacity of the airfield as it is here that air traffic transitions from/to a three-dimensional flow in airspace to/from a single file on the ground.

Practical capacity is defined in this report as the maximum number of aircraft the runway system can handle in the peak hour while operating to normal safety standards. In deriving an estimate of annual capacity, the study has assumed that the current hourly demand profile remains the same and will grow uniformly until the peak hour demand reaches the estimate of maximum throughput for the runway system.

An analytical method has been used to estimate hourly runway capacity with the projected traffic mix at capacity operations. The model accounts for the effects of the length of the common approach path, aircraft approach speeds and the minimum aircraft separation for arrivals and departures as specified for the application of Class D airspace procedures in a high capacity general aviation (GA) environment.

These parameters have been derived in discussions with Archerfield ATC and by reference to the *Notice of Proposed Change (NPC 172/04): Changes to General Aviation Aerodrome Procedures (GAAP), Class D procedures, and miscellaneous air traffic procedures* (CASA, February 2010).

2. AIRPORT INFRASTRUCTURE AND OPERATIONS

RUNWAYS, TAXIWAYS AND APRONS

Archerfield has two pairs of parallel runways – 10L/28R, 10R/28L and 04L/22R, 04R/22L. The Draft Master Plan proposes replacement of the existing natural surfaced 04/22 parallels with a pair of grassed or natural surfaced runways located on higher ground in the eastern sector of the site, aligned 010/190° Magnetic and designated as the 01/19 parallels. Runway 01L/19R is proposed as 1020 metres long and 18 metres wide, while runway 01R/19L is proposed as 900 metres long and 18 metres wide. The approach thresholds will be established at the runway ends.

Simultaneous and independent parallel runway operations by VFR aircraft are permitted under Class D airspace procedures subject to minimum runway separation criteria. The existing 10/28 parallel runway spacing of 165 metres means that these procedures may only be utilised by single and twin piston engine aircraft. To provide equivalent capacity, the proposed 01/19 parallels will be spaced at 150 metres, the minimum separation to permit simultaneous operation by these aircraft types.

Runway 10L/28R is the only runway available for jet - turboprop and turbofan - aircraft, and for IFR operations. For these aircraft to use the runway ATC must interrupt the normal traffic sequence and change temporarily from independent to dependent operations. In simple terms, the close-spaced parallels revert to a singe runway during the jet/turboprop or IFR operation.

Runway 10L/28R is sealed and is 1471m long and 30m wide. Runway 10R/28L is also sealed and is 1100m long and 30m wide. These runways are aligned to provide near optimal utilisation taking account of all hours wind conditions.

The secondary grassed runways are required to increase the usability of the airport for very light aircraft with limiting crosswind tolerance less than 13 knots.

The Draft Master Plan proposes an extension of runway 10L/28R by around 160 metres to the east – to an overall length of 1630 metres – while retaining the 28R threshold in its present location, a displacement of 212 metres. The runway will also be strengthened to allow operations as required by heavier aircraft, including possible niche airline services by Dash 8-Q400 and Embraer 170 aircraft.

The runways will be served by a taxiway network which provides access to the aprons and hangar facilities. Taxiway B, which becomes an "inboard" parallel to runway 10L/28R, will be upgraded to allow its use by all aircraft able to use the associated runway.

As the availability of suitable entry and exit taxiways will influence the runway system capacity, this study takes into account the location and number of taxiways for each runway. The taxiway concept depicted in the Draft Master Plan will be progressively fine tuned to ensure that the

final exit taxiway locations near as possible optimise the associated runway capacity. While additional exit taxiways may be considered for the 10/28 parallels this study adopts the current taxiways (A1-A5 and B1-B5) as the most likely locations. These are listed in Table 1.

RUNWAY	LENGTH	1	2	3	4
10L	1471	362 (B4)	754 (B3)	1037 (B2)	1431 (B1)
28R		434 (B2)	717 (B3)	1109 (B4)	1471 (B5)
10R	1100	308 (A4)	552 (A3)	789 (A2)	1100 (A1)
28L		311 (A2)	548 (A3)	792 (A4)	1100 (A5)

Table 1: Parallel Runways 10/28 Taxiway Designator and Distance (m) from Threshold

RUNWAY OPERATING MODE

Runway system and airport capacity is maximised when parallel runways are operated simultaneously with opposite direction (or contra-) circuits being utilised to best manage the mix of flying training activity with aircraft arrivals and departures. This mode of operation requires an air traffic control (ATC) presence. This study has assumed that ATC will provide a continuous 24 hour presence when Archerfield is operating at practical capacity.

Runways 10L and 10R are the principal directions with the reciprocal 28R and 28L runways being the second preference. The 01/19 parallels will be occasionally used by aircraft with low crosswind tolerance. The overall utilisation of each pair of parallel runways for VFR aircraft at is summarised in Tables 2 and 3.

RUNWAY UTILISATION (%)							
10L	28R	10R	28L	01L	19R	01R	19L
28.3%	18.8%	25.2%	16.8%	4.8%	1.0%	4.3%	0.8%

Table 2: Individual runway utilisation

RUNWAY DIRECTION UTILISATION (%)			
10L/10R	28R/28L	01R/01L	19R/19L
53.5%	35.6%	9.1%	1.8%

Table 3: Runway direction utilisation

As noted earlier, runway 10L/28R is the only runway available for jet – turboprop and turbofan – and IFR aircraft. The usability of each direction for these aircraft is 60% for runway 10L and 40% for runway 28R.

Since runways 10L/10R provide the dominant usability for both VFR and IFR operations their capacity to handle visual flight rules (VFR) and instrument flight rules (IFR) arrivals/departures together with circuit training will be the primary determinant of practical capacity.

The operational procedures adopted by ATC for processing VFR traffic at Archerfield prefer entry via recommended visual approach points (VAP) which have been established to facilitate arrivals from the north (via the TV Towers at Mt Cootha), west (Goodna), south (the Park Ridge Water Tower) and east (the Target retail complex at Springwood). Archerfield ATC has advised that these are utilised by inbound/outbound VFR traffic in the ratio approximately 20:40:40.

Depending on the runway direction(s) in use single and twin engine VFR arrivals

- from the north via Mt Cootha TV towers are assigned to runways 01L, 10L, 19R and 28R,
- from Goodna are assigned to runways 01L, 10L, 10R, 19R, 28L and 28R,
- from Park Ridge are assigned to runways 01R, 10L, 10R, 19L, 28L and 28R, and
- from Target are assigned to runways 01R, 10L, 10R, 19L and 28R.

Single and twin piston engine VFR departures

- to the north via Mt Cootha TV towers are assigned to runways 01L, 10L, 19R and 28R,
- to Goodna are assigned to runways 01L, 10L, 10R, 19R, 28L and 28R,
- to Park Ridge are assigned to runways 01R, 10L, 10R, 19L, 28L and 28R, and
- to Target are assigned to runway 01R, 10L, 19L and 28R.

All jet – turboprop and turbofan – and IFR arrivals and departures are assigned to runway 10L/28R.

Jet – turboprop and turbofan – circuits are also assigned to runway 10L/28R.

In the runway 10L/10R operating mode single and twin piston engine circuits are then assigned to runway 10L or 10R as required to achieve balanced capacity of each runway and maximum capacity of the runway system.

In practice this means that a greater number of circuits are flown from runway 10R at maximum capacity, while runway 10L is preferred for noise abatement considerations at other times.

CONTRA-CIRCUIT OPERATIONS

Given the dominance of fixed wing flying training and volume of demand in normal demand periods, ATC will establish a pattern of contra-rotating (or opposing) circuits using a separate tower frequency for each runway. Arriving and departing aircraft will be interspersed and sequenced as required between successive aircraft engaged in circuit training. When issued with a sequencing instruction, a pilot must follow the preceding aircraft.

ATC is required to apply minimum separation distances between aircraft pairs in a sequence of arrivals and departures based on wake turbulence considerations or physical separation standards designed to avoid the risk of collision between aircraft operated under the IFR.

Wake turbulence separation is applied on the basis of aircraft weight:

- Light, below 7,000kg,
- Medium, between 7,000 and 130,000kg, and
- Heavy, above 130,000kg.

In terms of the aircraft types forecast to operate at Archerfield, ATC will be required to apply 3 minutes separation time between RPT and any other aircraft operation.

ATC will also be required to provide a 3 nautical mile separation between an IFR aircraft and any other aircraft. In practice this satisfies the wake turbulence separation requirement.

For VFR operations at Archerfield, and particularly for circuit training, aircraft separation may be reduced, where ATC is able to confirm that the pilot of the following aircraft has the lead aircraft in sight and accepts responsibility for the reduced separation distances. In a continuous sequence of landing and departing aircraft this means that a departing aircraft will be cleared for take-off as the leading aircraft which has landed is vacating the runway, while the following aircraft is on final approach at 1 nautical mile (if VFR) or 3 nautical miles (if IFR) from the runway threshold.

3. METHODOLOGY

An analytical method has been used to estimate the runway system capacity for Archerfield Airport. Although analytical models are relatively simple to apply they have been shown to consistently produce results close to the capacities observed in practice.

Three scenarios may need to be considered and then combined in proportion to the observed or forecast demand to derive the overall capacity estimate. The three fundamental scenarios are:

- a sequence of arrivals – or an arrivals peak;
- a sequence of departures – or a departures peak; and/or
- mixed operations with alternating arrivals and departures.

The majority of aircraft movements at Archerfield currently occur between 7:00am and 7:00pm. Defined peaks occur from 9:00am-12:00pm and 1:00-3:00pm, with the 9:00-10:00am hourly demand being marginally the highest. In each case there are almost equal arrivals and departures. This daily demand and peak hour traffic pattern is assumed to continue until the airport is operating at practical capacity. This means that only the mixed operations scenario needs to be considered in determining practical capacity.

To determine runway capacity, the separation time between successive arrivals is calculated by adding runway occupancy time of the landing aircraft and the time on final approach of the following aircraft by reference to the aircraft approach speed category:

- large (L) typified by approach speeds around 130 knots, and
- small (S) typified by speed categories up to 100 knots.

Where the majority of the aircraft using the airport are speed category S this may be further subdivided as:

- S1, typified by approach speeds around 100 knots, and
- S2, typified by approach speeds around 70 knots.

L class aircraft include the Dash 8-Q400, Embraer 170, very light jets (VLJ) such as the Cessna Mustang and Eclipse 500, the Beech 300 Super King Air and Fairchild SA 226/227 Metro/Merlin. These aircraft are typically used in medium/low capacity RPT and other types of air work.

S1 class aircraft include the Beech 58 Baron, Cessna 208 Caravan, Cessna T303 Crusader, Cessna 310, Cirrus SR22, Piper PA-31 Chieftain, Piper PA-32 Lance, Piper PA-34 Seneca, and the Piper PA-39 Twin Comanche These twin or high performance single-engined aircraft are typically used in advanced and IFR training, and in charter and other types of air work.

S2 class aircraft include the American AA5 Traveller, Beech Bonanza, Beech 77 Skipper, Cessna 152, Cessna 172, Cessna 210, Jabiru J160, Jabiru J230, Partenavia P68, Piper PA-25 Pawnee, Piper PA-28 Arrow, Piper PA-28 Warrior/Cherokee, the Seabird SB7L and the Mooney M-20F.

These aircraft are primarily used in basic flying training and for private flying. A number of these aircraft may not be equipped for IFR operations.

As an example, the runway occupancy time of an S2 aircraft making a full stop landing is around 50 seconds, while a following S1 aircraft will complete the one nautical mile final approach in 36 seconds. This provides an 86 second separation between the two arriving aircraft. This reduces to around 66 seconds where the leading aircraft executes a touch and go manoeuvre. In periods of continuous demand a departing aircraft can be cleared by ATC to line up and take-off between the pair of arrivals.

This calculation, applied to successive arrival pairs, provides the highest estimate of peak hour capacity if a departure is assumed between each arrival pair. Any other combination of arrivals and departures will result in a lower estimate of hourly capacity.

RUNWAY 10L

Tables 4 and 5 detail the forecast mix of aircraft at practical capacity operations. The time separations for successive arrivals to runway 10L for these aircraft categories are shown in Tables 6 and 7.

The runway occupancy times are runway specific as they depend on the distance remaining to the nearest exit taxiway from the point where the pilot has decelerated the aircraft to normal taxiing speed.

AIRCRAFT APPROACH SPEED CATEGORY					
L		S1		S2	
IFR	VFR	IFR	VFR	IFR	VFR
10.1%	1.4%	5.6%	13.4%	8.5%	61.0%

TABLE 4: Percentage Mix of Aircraft Arrivals/Departures

AIRCRAFT APPROACH SPEED CATEGORY					
L		S1		S2	
IFR	VFR	IFR	VFR	IFR	VFR
--	0.3%	--	10.1%	--	89.6%

TABLE 5: Percentage Mix of Aircraft in Circuit Training

			TRAILING AIRCRAFT					
			L		S1		S2	
			IFR	VFR	IFR	VFR	IFR	VFR
LEADING AIRCRAFT	L	IFR	128	128	153	81	154	96
		VFR	128	128	153	81	154	96
	S1	IFR	139	139	164	92	210	107
		VFR	139	139	164	92	210	107
	S2	IFR	83	83	158	86	204	101
		VFR	83	83	158	86	204	101

TABLE 6: Time Separations for Successive Arrivals

			TRAILING AIRCRAFT					
			L		S1		S2	
			IFR	VFR	IFR	VFR	IFR	VFR
LEADING AIRCRAFT	L	IFR	--	--	--	--	--	--
		VFR	--	46	--	54	--	69
	S1	IFR	--	--	--	--	--	--
		VFR	--	55	--	63	--	78
	S2	IFR	--	--	--	--	--	--
		VFR	--	58	--	66	--	81

TABLE 7: Time Separations for Successive Circuits

The probability of any arrivals pair – say S1 IFR followed by L VFR – is established by multiplying their individual percentage in the overall aircraft mix – in this case, 5.6% x 1.4%, or 0.000784. The probability of each pairing multiplied by their separation time determines their contribution to the average separation time for all possible pairs in the aircraft mix.

In this way, the average separation time for a continuous arrivals sequence is determined as 110.46 seconds, which equates to 32.6 arrivals per hour.

In contrast, the average separation time for a sequence of successive circuits is 79.08 seconds, which equates to 45.5 landings per hour.

The weighted average separation time is calculated by reference to the percentage of arrivals and flying training circuits each hour – in this instance 40.8% and 59.2% - which gives a weighted separation of 91.88 seconds, or 39 arrivals/landings per hour.

Spreadsheets supporting these capacity calculations are included as Attachments 1-4 at the end of this Technical Paper.

RUNWAY 10R

The equivalent calculation for runway 10R derives 45 arrivals/landings per hour. This is calculated on the basis of fully independent parallel runway operations and needs to be reduced to account for IFR and VFR jet/turboprop traffic on runway 10L, which precludes simultaneous operations on the adjacent close-spaced parallel runway.

No traffic is permitted on runway 10R while IFR aircraft are on 3 nautical mile finals for runway 10L. This reduces effective usage of runway 10R to only 51 minutes in the peak hour, and reduces the capacity estimate to 38 arrivals/landings an hour.

A similar allowance for VFR jet/turboprop aircraft using runway 10L further reduces the capacity estimate to 36 arrivals/landings an hour.

Spreadsheets supporting the "uncorrected" capacity calculation are included as Attachments 5-8 at the end of this Technical Paper.

RUNWAYS 10L AND 10R

The average hourly capacity of the 10L and 10R parallel runway system is therefore assessed as 75 arrivals/landings an hour (39 + 36) for the assumed aircraft mix at practical capacity. Assuming a departure is sequenced between every arrival pair, the maximum hourly capacity is 150 movements an hour.

4. THE DAILY DEMAND PROFILE

An average of 389.9 daily fixed wing GA movements were recorded in the period from 1 March 2004 to 28 February 2009. Of these, 50.26 movements were recorded on average in the busy hour from 9-10am.

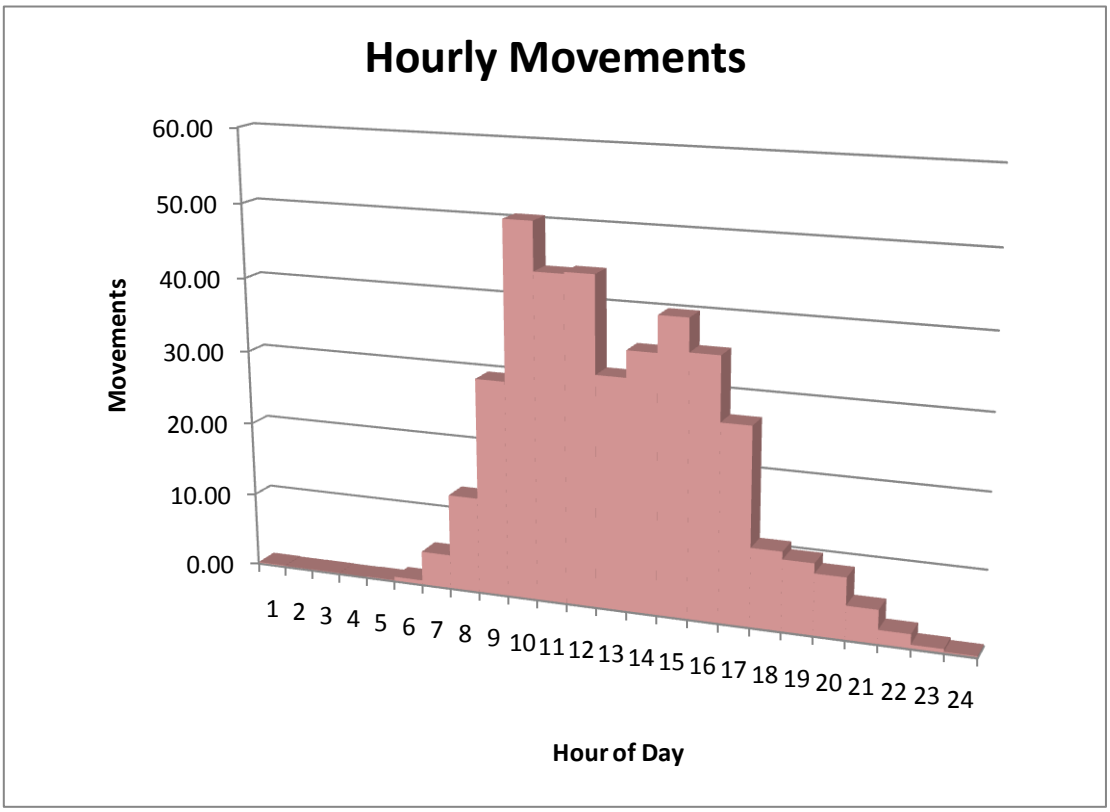

FIGURE: Average Daily Aircraft Movements
Source: Archerfield Airport Corporation Movements Data Base 1 August 2008 – 31 July 2009.

5. ANNUAL PRACTICAL CAPACITY

The estimate of annual capacity is derived by proportionally "scaling up" the current daily demand profile until the peak hour reaches the runway capacity, estimated as 150 movements and hour. This equates to an annual capacity estimate of 425,000 fixed wing movements.

6. SUMMARY OF FINDINGS

An estimate of practical annual capacity has been derived by reference to the runway 10L/10R mode of operations. While other runway operating modes may provide marginal increase or decrease in capacity these runways are the dominant mode of operation and are therefore the primary determinant of overall capacity.

As a consequence, the practical annual capacity of Archerfield Airport is estimated as 425,000 fixed wing operations when aircraft are processed with Class D airspace procedures.

7. ABBREVIATIONS & ACRONYMS

ATC	air traffic control
GA	general aviation
IFR	instrument flight rules
L	large
S	small
VAP	visual approach point
VFR	visual flight rules
VLJ	very light jet

ATTACHMENT 1

RUNWAY OCCUPANCY

Runway 10L
Lead Aircraft S2

1 Lead Aircraft in full stop landing

Approach Speed 70 knots							
V th	70			35			
V td	65		67.5				
V ba	55		60				
V ex	25		40				
					Time	Distance	
D1	Flare & Touchdown				7	250	
D2	Distance to Brake Application				10	309	Ab-initio/Student Pilot
D3	Braking & Deceleration						
	@ 2.1m/s		2.1		7	143	
				Total	24	702	
D4	Taxi to nearest exit Taxiway						
			1037		26	335	
				Total	50		
Final Approach							
VFR	1.0 NM	L		28	78		
		S1		36	86		
		S2		51	101		
Final Approach							
IFR	3.0 NM	L		83	83		
		S1		108	158		
		S2		154	204		

2 Lead Aircraft in Touch-and-go

					Time	Distance	
D1	Flare & Touchdown				7	250	
D2	Distance to Brake Application				10	309	Average Student Pilot
D3	Acceleration & Take-off						
	normal take-off roll			275	13		
	@	40					
	normal take-off distance			455			
	@	70		180	5		
	TGO take-off roll						
	55	to	70	15	3		
	Reaction Time				5		
			Total		30		
Final Approach							
VFR	1.0 NM	L		28	58		
		S1		36	66		
		S2		51	81		

ATTACHMENT 2

RUNWAY OCCUPANCY

Runway 10L
Lead Aircraft S1

1 Lead Aircraft in full stop landing

Approach Speed 100 knots							
V th	100			50			
V td	95		97.5				
V ba	85		90				
V ex	25		55				
					Time	Distance	
D1	Flare & Touchdown				5	250	
D2	Distance to Brake Application				10	463	Student Pilot
D3	Braking & Deceleration						
	@ 2.3m/s		2.3		13	359	
				Total	28	1072	
D4	Taxi to nearest exit Taxiway						
			1431		28	359	
				Total	56		
Final Approach							
VFR	1.0 NM	L		28	84		
		S1		36	92		
		S2		51	107		
Final Approach							
IFR	3.0 NM	L		83	139		
		S1		108	164		
		S2		154	210		

2 Lead Aircraft in Touch-and-go

					Time	Distance	
D1	Flare & Touchdown				5	250	
D2	Distance to Brake Application				10	463	Average Student Pilot
D3	Acceleration & Take-off						
	normal take-off roll			465	16		
	@	55					
	normal take-off distance			700			
	@	100		235	5		
	TGO take-off roll						
	85	to	100	15	2		
	Reaction Time				5		
			Total		27		
Final Approach							
VFR	1.0 NM	L		28	55		
		S1		36	63		
		S2		51	78		

ATTACHMENT 3

RUNWAY OCCUPANCY

Runway 10L
Lead Aircraft L

1 Lead Aircraft in full stop landing

Approach Speed 130 knots							
V th	130			65			
V td	125	127.5					
V ba	115	120					
V ex	25	70					
					Time	Distance	
D1	Flare & Touchdown				4	250	
D2	Distance to Brake Application				5	309	Experienced Pilot
D3	Braking & Deceleration						
	@ 2.5m/s	2.5			17	630	
			Total		26	1189	
D4	Taxi to nearest exit Taxiway						
		1431			19	242	
			Total		45		
Final Approach							
VFR	1.0 NM		L	28	73		
			S1	36	81		
			S2	51	96		
Final Approach							
IFR	3.0 NM		L	83	128		
			S1	108	153		
			S2	154	154		

2 Lead Aircraft in Touch-and-go

				Time	Distance	
D1	Flare & Touchdown			4	250	
D2	Distance to Brake Application			5	309	Experienced Pilot
D3	Acceleration & Take-off					
	normal take-off roll		1050	29		
	@ 70					
	normal take-off distance		1140			
	@ 130		90	1		
	TGO take-off roll					
	115 to	130	15	3		
	Reaction Time			5		
		Total		18		
Final Approach						
	1.0 NM	L	28	46		
		S1	36	54		
		S2	51	69		

ATTACHMENT 4

AIRCRAFT SEPARATION MATRIX

Runway 10L
Lead Aircraft in full stop landing

		Trailing Aircraft					
Lead Aircraft		L - VFR	S1 - VFR	S2 - VFR	L- IFR	S1 - IFR	S2 - IFR
L	VFR	73	81	96	128	153	154
S1	VFR	84	92	107	139	164	210
S2	VFR	78	86	101	83	158	204
L	IFR	73	81	96	128	153	154
S1	IFR	84	92	107	139	164	210
S2	IFR	78	86	101	83	158	204

		% In Mix		% Full Stop			
L	VFR	1.4%	0.014	0.0%	0.00%		
S1	VFR	13.4%	0.134	100.0%	13.40%		
S2	VFR	61.0%	0.610	100.0%	61.00%		
L	IFR	10.1%	0.101	100.0%	10.10%		
S1	IFR	5.6%	0.056	100.0%	5.60%		
S2	IFR	8.5%	0.085	100.0%	8.50%	98.60%	40.8%

		Trailing Aircraft						
Lead Aircraft		L - VFR	S1 - VFR	S2 - VFR	L- IFR	S1 - IFR	S2 - IFR	
L	VFR	0.00020	0.00188	0.00854	0.00141	0.00078	0.00119	
S1	VFR	0.00188	0.01796	0.08174	0.01353	0.00750	0.01139	
S2	VFR	0.00854	0.08174	0.37210	0.06161	0.03416	0.05185	
L	IFR	0.00141	0.01353	0.06161	0.01020	0.00566	0.00859	
S1	IFR	0.00078	0.00750	0.03416	0.00566	0.00314	0.00476	
S2	IFR	0.00119	0.01139	0.05185	0.00859	0.00476	0.00723	1.0000
		0.0146	0.1523	0.8198	0.1805	0.1193	0.1833	
		0.1579	1.6523	8.7462	1.8807	1.2300	2.3919	
		0.6661	7.0296	37.5821	5.1136	5.3973	10.5774	
		0.1029	1.0959	5.9146	1.3056	0.8660	1.3229	
		0.0655	0.6900	3.6551	0.7867	0.5150	0.9996	
		0.0928	0.9795	5.2369	0.7130	0.7521	1.4749	110.46

Lead Aircraft in touch-and-go

		Trailing Aircraft					
Lead Aircraft		L - VFR	S1 - VFR	S2 - VFR	L- IFR	S1 - IFR	S2 - IFR
L	VFR	46	54	69	0	0	0
S1	VFR	55	63	78	0	0	0
S2	VFR	58	66	81	0	0	0
L	IFR	0	0	0	0	0	0
S1	IFR	0	0	110	0	0	0
S2	IFR	0	0	113	0	0	0

		% In Mix		% Touch & Go			
L	VFR	0.3%	0.003	0%	0.0%		
S1	VFR	10.1%	0.101	100%	10.1%		
S2	VFR	89.6%	0.896	100%	89.6%		
L	IFR	0.0%	0.000	0%	0.0%		
S1	IFR	0.0%	0.000	0%	0.0%		
S2	IFR	0.0%	0.000	0%	0.0%	99.70%	59.2%

		Trailing Aircraft						
Lead Aircraft		L - VFR	S1 - VFR	S2 - VFR	L- IFR	S1 - IFR	S2 - IFR	
L	VFR	0.0000	0.0003	0.0027	0.0000	0.0000	0.0000	
S1	VFR	0.0003	0.0102	0.0905	0.0000	0.0000	0.0000	
S2	VFR	0.0027	0.0905	0.8028	0.0000	0.0000	0.0000	
L	IFR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
S1	IFR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
S2	IFR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0000	0.0162	0.1863	0.0000	0.0000	0.0000	
		0.0165	0.6426	7.0590	0.0000	0.0000	0.0000	
		0.1566	5.9730	65.0268	0.0000	0.0000	0.0000	
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	79.08
Weighted hourly contributions								
		0.0060	0.0621	0.3345	0.0736	0.0487	0.0748	
		0.0644	0.6741	3.5684	0.7673	0.5018	0.9759	
		0.2718	2.8681	15.3335	2.0863	2.2021	4.3156	
		0.0420	0.4471	2.4132	0.5327	0.3533	0.5397	
		0.0267	0.2815	1.4913	0.3210	0.2101	0.4078	
		0.0379	0.3996	2.1367	0.2909	0.3069	0.6018	
		0.0000	0.0096	0.1103	0.0000	0.0000	0.0000	
		0.0098	0.3804	4.1789	0.0000	0.0000	0.0000	
		0.0927	3.5360	38.4959	0.0000	0.0000	0.0000	
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	91.88

39 Arrivals/hour
23 TGO Departures/hour
16 Departures/hour
78 Movements/hour

ATTACHMENT 5

RUNWAY OCCUPANCY

Runway 10L
Lead Aircraft S2

1 Lead Aircraft in full stop landing

Approach Speed 70 knots							
V th	70			35			
V td	65		67.5				
V ba	55		60				
V ex	15		35				
					Time	Distance	
D1	Flare & Touchdown				7	250	
D2	Distance to Brake Application				10	309	Ab-initio/Student Pilot
D3	Braking & Deceleration						
	@ 2.1m/s		2.1		9	167	
				Total	26	726	
D4	Taxi to nearest exit Taxiway						
			789		8	63	
				Total	34		
Final Approach							
VFR	1.0 NM		L	28	62		
			S1	36	70		
			S2	51	85		
Final Approach							
IFR	3.0 NM		L	83	117		
			S1	108	142		
			S2	154	188		

2 Lead Aircraft in Touch-and-go

					Time	Distance	
D1	Flare & Touchdown				7	250	
D2	Distance to Brake Application				12	370	Average Student Pilot
D3	Acceleration & Take-off						
	normal take-off roll			275	15		
	@	35					
	normal take-off distance			455			
	@	70		180	5		
	TGO take-off roll						
	55	to	70	15	3		
	Reaction Time				5		
				Total	32		
Final Approach							
VFR	1.0 NM		L	28	60		
			S1	36	68		
			S2	51	83		

ATTACHMENT 6

RUNWAY OCCUPANCY

Runway 10L
Lead Aircraft S1

1 Lead Aircraft in full stop landing

Approach Speed 100 knots							
V th	100			50			
V td	95		97.5				
V ba	85		90				
V ex	15		50				
					Time	Distance	
D1	Flare & Touchdown				5	250	
D2	Distance to Brake Application				10	463	Student Pilot
D3	Braking & Deceleration						
	@ 2.3m/s		2.3		15	380	
				Total	30	1093	
D4	Taxi to nearest exit Taxiway						
			1100		1	7	
				Total	31		
Final Approach							
VFR	1.0 NM	L		28	59		
		S1		36	67		
		S2		51	82		
Final Approach							
IFR	3.0 NM	L		83	114		
		S1		108	139		
		S2		154	185		

2 Lead Aircraft in Touch-and-go

					Time	Distance	
D1	Flare & Touchdown				5	250	
D2	Distance to Brake Application				10	463	Average Student Pilot
D3	Acceleration & Take-off						
	normal take-off roll			465	18		
	@ 50						
	normal take-off distance			700			
	@ 100			235	5		
	TGO take-off roll						
	85	to	100	15	3		
	Reaction Time				5		
				Total	28		
Final Approach							
VFR	0.5 NM	L		14	42		
		S1		18	46		
		S2		26	54		

ATTACHMENT 7

RUNWAY OCCUPANCY

Runway 10L
Lead Aircraft L

1 Lead Aircraft in full stop landing

Not Applicable

2 Lead Aircraft in Touch-and-go

Not Applicable

ATTACHMENT 8

AIRCRAFT SEPARATION MATRIX

Runway 10L
Lead Aircraft in full stop landing

		Trailing Aircraft					
Lead Aircraft		L - VFR	S1 - VFR	S2 - VFR	L- IFR	S1 - IFR	S2 - IFR
L	VFR	0	0	0	0	0	0
S1	VFR	0	67	82	0	0	0
S2	VFR	0	70	85	0	0	0
L	IFR	0	0	0	0	0	0
S1	IFR	0	0	0	0	0	0
S2	IFR	0	0	0	0	0	0

		% In Mix		% Full Stop				
L	VFR	0.0%	0.000	0.0%	0.00%			
S1	VFR	18.1%	0.181	100.0%	18.10%			
S2	VFR	81.9%	0.819	100.0%	81.90%			
L	IFR	0.0%	0.000	100.0%	0.00%			
S1	IFR	0.0%	0.000	100.0%	0.00%			
S2	IFR	0.0%	0.000	100.0%	0.00%	100.00%		38.1%

		Trailing Aircraft						
Lead Aircraft		L - VFR	S1 - VFR	S2 - VFR	L- IFR	S1 - IFR	S2 - IFR	
L	VFR	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
S1	VFR	0.00000	0.03276	0.14824	0.00000	0.00000	0.00000	
S2	VFR	0.00000	0.14824	0.67076	0.00000	0.00000	0.00000	
L	IFR	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
S1	IFR	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
S2	IFR	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.0000
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0000	2.1949	12.1557	0.0000	0.0000	0.0000	
		0.0000	10.3768	57.0146	0.0000	0.0000	0.0000	
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	81.74

Lead Aircraft in touch-and-go

		Trailing Aircraft					
Lead Aircraft		L - VFR	S1 - VFR	S2 - VFR	L- IFR	S1 - IFR	S2 - IFR
L	VFR	0	0	0	0	0	0
S1	VFR	0	46	54	0	0	0
S2	VFR	0	68	83	0	0	0
L	IFR	0	0	0	0	0	0
S1	IFR	0	0	0	0	0	0
S2	IFR	0	0	0	0	0	0

		% In Mix		% Touch & Go				
L	VFR	0.0%	0.000	0%	0.0%			
S1	VFR	10.1%	0.101	100%	10.1%			
S2	VFR	89.9%	0.899	100%	89.9%			
L	IFR	0.0%	0.000	0%	0.0%			
S1	IFR	0.0%	0.000	0%	0.0%			
S2	IFR	0.0%	0.000	0%	0.0%	100.00%		61.9%

		Trailing Aircraft						
Lead Aircraft		L - VFR	S1 - VFR	S2 - VFR	L- IFR	S1 - IFR	S2 - IFR	
L	VFR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
S1	VFR	0.0000	0.0102	0.0908	0.0000	0.0000	0.0000	
S2	VFR	0.0000	0.0908	0.8082	0.0000	0.0000	0.0000	
L	IFR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
S1	IFR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
S2	IFR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0000	0.4692	4.9032	0.0000	0.0000	0.0000	
		0.0000	6.1744	67.0806	0.0000	0.0000	0.0000	
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	78.63

Weighted hourly contributions

	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	0.0000	0.8363	4.6313	0.0000	0.0000	0.0000	
	0.0000	3.9536	21.7226	0.0000	0.0000	0.0000	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	0.0000	0.2904	3.0351	0.0000	0.0000	0.0000	
	0.0000	3.8220	41.5229	0.0000	0.0000	0.0000	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	79.81

45 Arrivals/hour
28 TGO Departures/hour
17 Departures/hour
90 Movements/hour