

CDTI Capacity/Efficiency Benefits Analysis for Selected Applications: Preliminary Results



Jim Cieplak

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MITRE

Scope

- 0 **Analyzed some ADS-B/CDTI potential applications that have capacity/efficiency benefits**
 - **Enhanced Visual Approaches**
 - **Paired Approaches in IMC**
- 0 **NAS operations, procedures, and system development may increase or decrease CDTI benefits (e.g., new airport procedures and runways, system improvements such as RVSM)**
- 0 **Preliminary analysis - assumptions and results have not been validated**

Some Potential Terminal Capacity/Efficiency Enhancing CDTI Concepts

0 VMC/MVMC

- * - **VAPE-1: Simultaneous parallel visual approaches conducted reliably to published approach minima (mva+500) without decreasing capacity**
 - = a) **More efficient visual acquisition using CDTI and/or continued approach during temporary loss of visual acquisition**
 - = b) **Structured offset final approach paths or glide slope intercept altitudes to foster achieving visual separation**
- **VAPE-2: Simultaneous parallel visual approaches conducted reliably to lower approach minima (e.g., 1500/3)**
 - = **Same as VAPE-1b**
- * - **VAPE-S: Increase in single runway approach/departure capacity in MVMC**
 - = **Same as VAPE-1a**

Some Potential Terminal Capacity/Efficiency Enhancing CDTI Concepts (cont.)

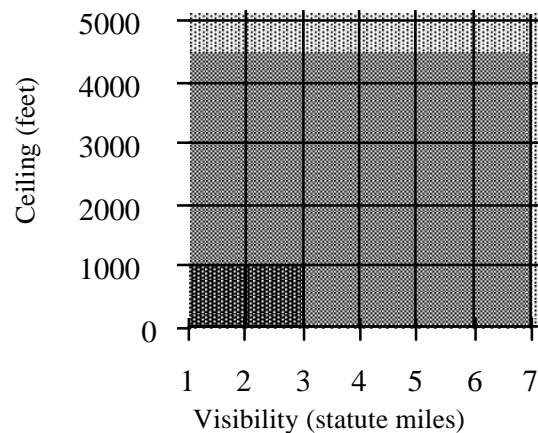
0 IMC

- *- Paired dependent approaches to closely spaced parallel runways (e.g., down to 750 ft runway spacing ?)
 - = Separation established procedurally with pilot monitoring stagger distance until reaching outer marker
- Simultaneous independent approaches to closely spaced parallel runways (e.g., down to 1700 ft runway spacing ?)
 - = Cockpit based blunder detection logic and escape maneuvering

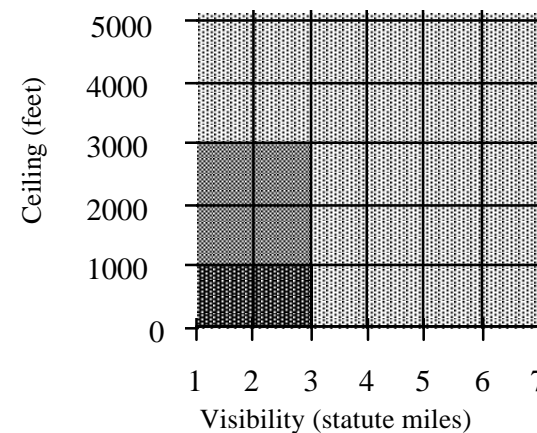
VAPE-1 Example: ATL - Dual Runways





- 0 **VAPE-1: Current visual approach operations can be reliably conducted to published approach minima without decreasing capacity (i.e., continue VMC capacity into MVMC conditions)**

VMC / MVMC / IMC Operations



VAPE-1 Operations

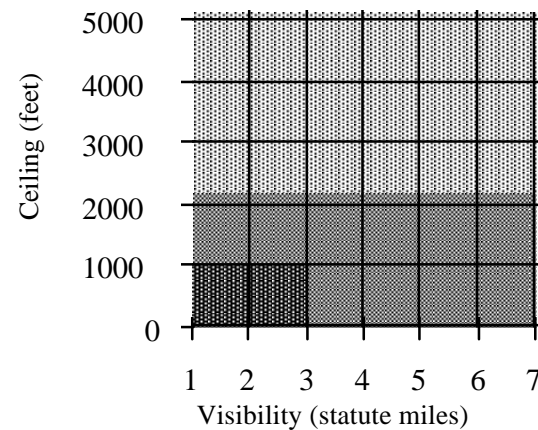


-  **VMC Operations: 85 arr/90 depart**
-  **MVMC Operations: 80 arr/85 depart**
-  **VAPE-1: 85 arr/90 depart**
-  **IMC Operations: 65 arr/75 depart**

VAPE-S Example: EWR - Single Runway

- 0 **VAPE-S: Increase single runway approach/departure capacity in MVMC conditions**

VMC / MVMC / IMC Operations



VMC Operations: 50 arr/48 depart

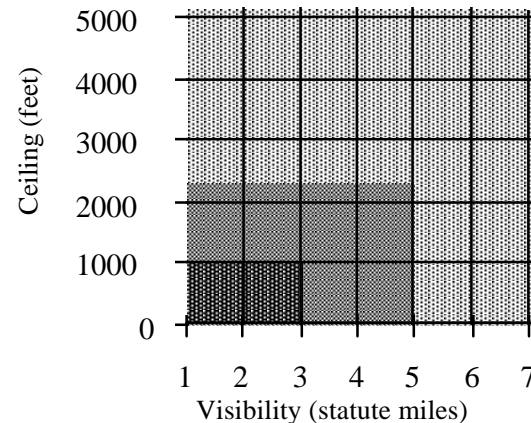
MVMC Operations Current: 37 arr/28 depart
VAPE-S: 40 arr/31 depart

IMC Operations: 36 arr/27 depart

Paired Approach Example: SFO

- 0 Paired Approach: Maintain dual runway approach capability to airports with closely spaced runways during low ceiling and visibility weather conditions (e.g., Cat I conditions)

VMC / MVMC / IMC Operations



VMC Operations: 52 arr/53 depart

MVMC Operations Current: 35 arr/48 depart
Paired Approach: 40-45 arr/48 depart

IMC Operations Current: 35 arr/42 depart
Paired Approach: 40-45 arr/42 depart

Terminal CDTI Analysis: Overview

- 0 **CAASD's Detailed Policy Assessment Tool (DPAT) used to gain insight into quantifiable capacity vs. delay benefits**
 - **Offshoot of FAA's National Airspace System Performance Analysis Capability (NASPAC)**
- 0 **Ceiling and visibility conditions analyzed to estimate useful percentage time period for procedures**
- 0 **Analyzed ATL, DFW, EWR, JFK, SEA, SFO, and STL as sample airports**
 - **Chosen due to preliminary operational discussions with airport representatives**
- 0 **Assumptions (per airport)**
 - **Capacity increase (through discussion with airports)**
 - **Ceiling and visibility requirements**
 - **Duration of weather (ceiling and visibility) conditions**

Terminal CDTI Analysis: DPAT and Weather Analysis

0 DPAT Analysis: 1 day of traffic analyzed

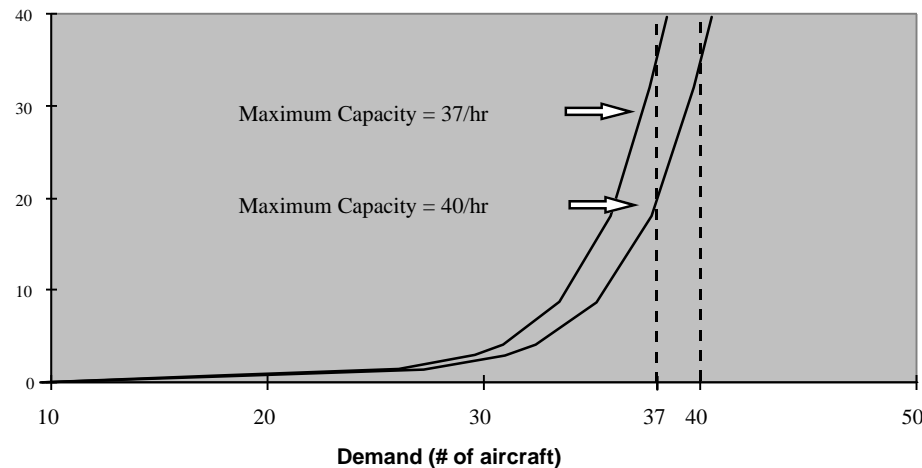
- Capacity demand estimated from OAG data (Friday May 6, 1993) + general aviation stochastic model
- 3 capacity/weather scenarios analyzed
 - = MVMC capacity entire day (i.e., CDTI procedures applicable entire day)
 - = VMC capacity entire day except for 2 hours MVMC capacity (1pm-3pm and 5pm-7pm local) (i.e., CDTI procedures applicable 2 hours)
 - = IMC capacity entire day except for 2 hours MVMC capacity (1pm-3pm and 5pm-7pm local) (i.e., CDTI procedures applicable 2 hours)

0 Weather Analysis

- 4 months of weather data (Jan, Apr, Jul, Sep 1991)
- % of time in specific ceiling and visibility conditions

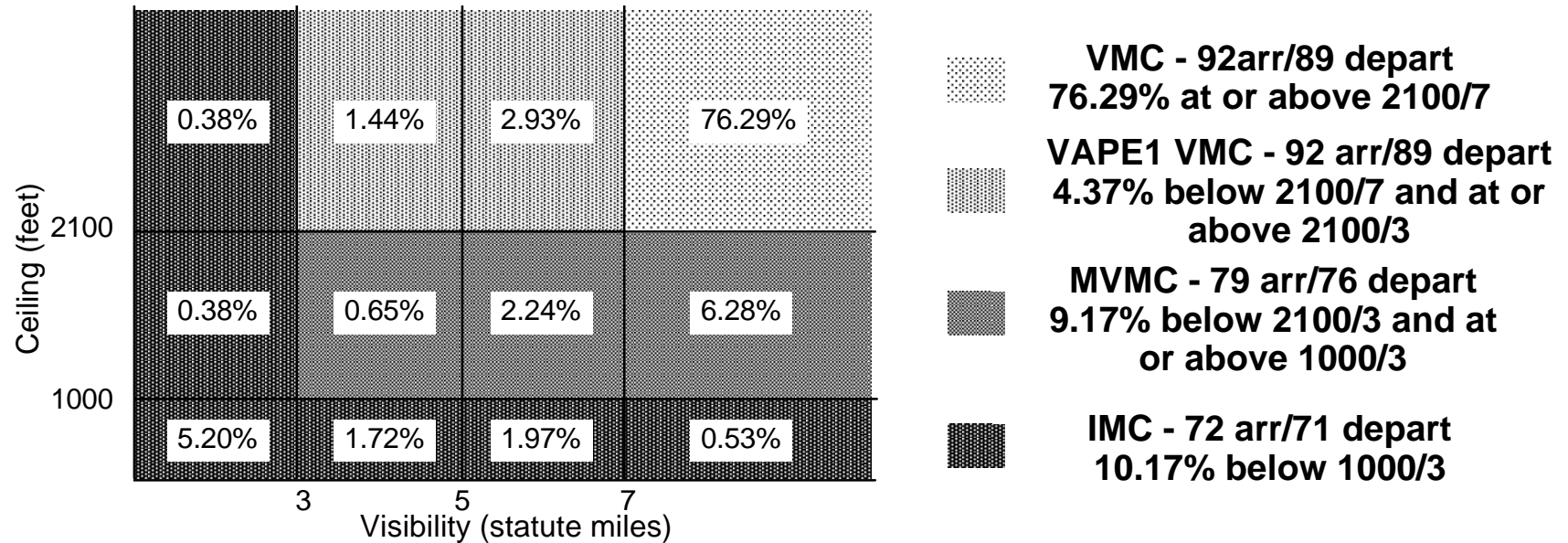
Effects of Delay

- 0 **Total aircraft delay (a/c min) can be more than elapsed time**
 - 2 aircraft holding over a 10 min period = 20 a/c min of delay
- 0 **Duration of delay - how long it takes to return the system to normal operations (i.e., absorb delay impact)**
- 0 **Delay curve - as demand reaches capacity, delay becomes unbounded (i.e., you can't land aircraft above max capacity)**



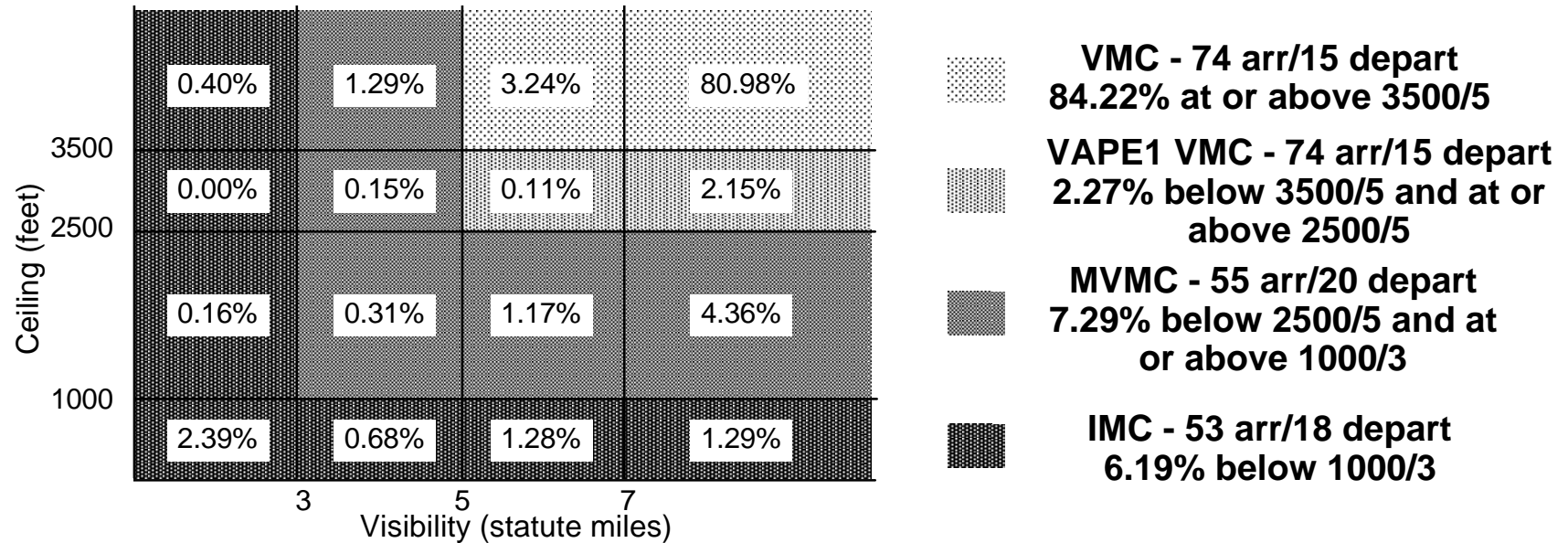
- 0 **Other factors in NAS not modeled by DPAT, such as flight cancellations or miles in-trail restrictions, may reduce delay**

DFW - VAPE-1 Analysis



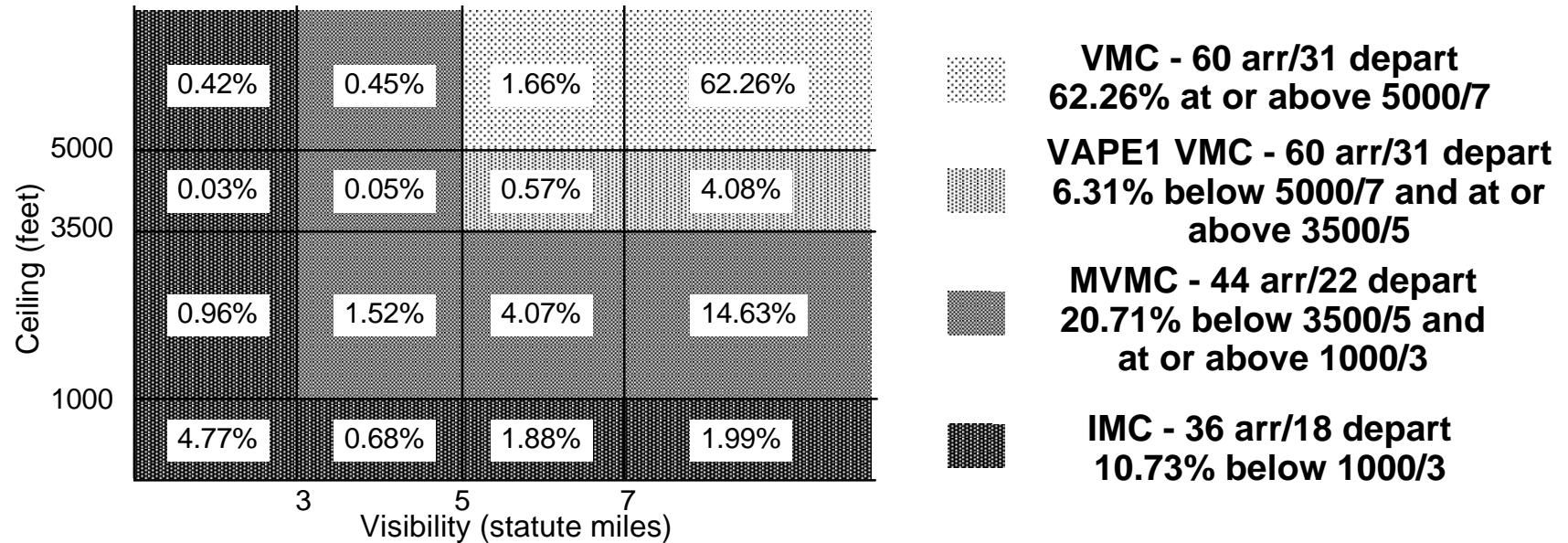
	Current MVMC Delay per day (a/c min)	CDTI VAPE1 VMC Delay per day (a/c min)	Delay Saved per day (a/c min)
24hr MVMC	2517.6	1341.3	1176.3
VMC to 2hr MVMC (1pm-3pm local)	1835.7	1339.0	496.7
VMC to 2hr MVMC (5pm-7pm local)	1611.1	1339.6	271.5
IMC to 2hr MVMC (1pm-3pm local)	3654.1	3397.9	256.2
IMC to 2hr MVMC (5pm-7pm local)	3846.4	3685.7	160.7

JFK - VAPE-1 Analysis



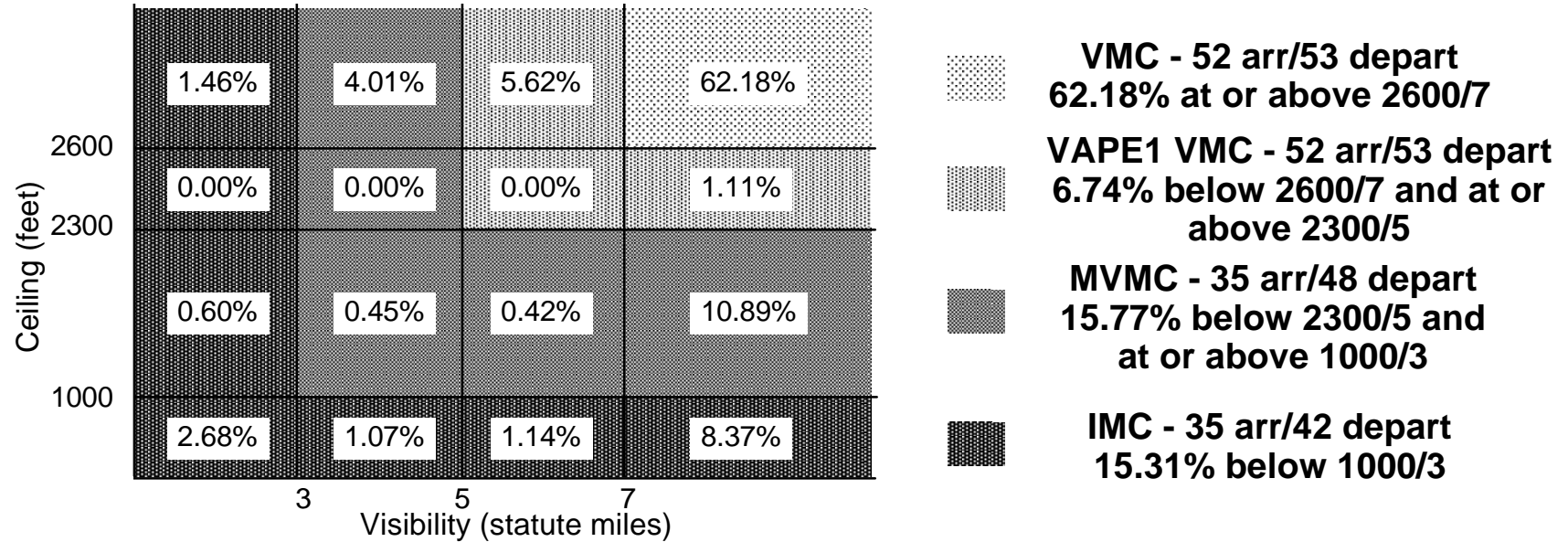
	Current MVMC Delay per day (a/c min)	CDTI VAPE1 VMC Delay per day (a/c min)	Delay Saved per day (a/c min)
24hr MVMC	2269.3	663.1	1606.2
VMC to 2hr MVMC (1pm-3pm local)	1744.9	757.2	987.7
VMC to 2hr MVMC (5pm-7pm local)	* effect of departures needs to be investigated		
IMC to 2hr MVMC (1pm-3pm local)	2278.1	841.0	1437.1
IMC to 2hr MVMC (5pm-7pm local)	* effect of departures needs to be investigated		

SEA - VAPE-1 Analysis



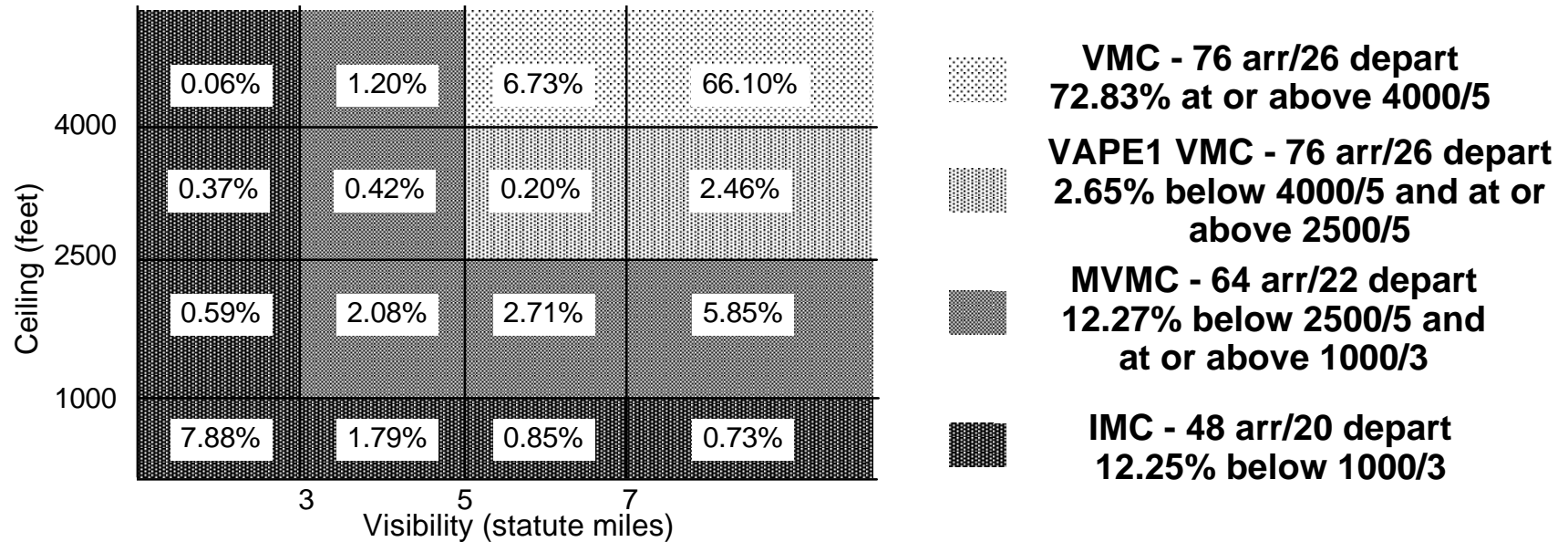
	Current MVMC Delay per day (a/c min)	CDTI VAPE1 VMC Delay per day (a/c min)	Delay Saved per day (a/c min)
24hr MVMC	939.1	328.9	610.2
VMC to 2hr MVMC (1pm-3pm local)	348.1	310.4	37.7
VMC to 2hr MVMC (5pm-7pm local)	534.9	314.7	220.2
IMC to 2hr MVMC (1pm-3pm local)	2605.7	2498.9	106.8
IMC to 2hr MVMC (5pm-7pm local)	1677.4	1391.6	285.8

SFO - VAPE-1 Analysis



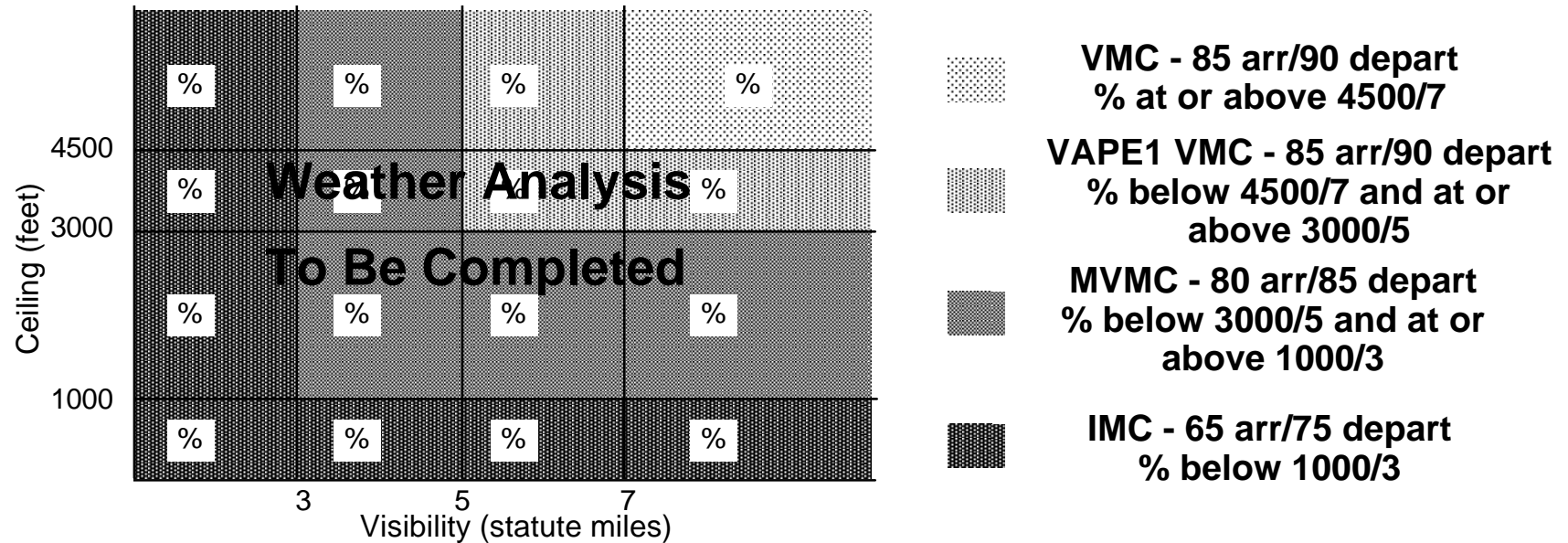
	Current MVMC Delay per day (a/c min)	CDTI VAPE1 VMC Delay per day (a/c min)	Delay Saved per day (a/c min)
24hr MVMC	14814.3	1247.0	13567.3
VMC to 2hr MVMC (1pm-3pm local)	1640.3	1171.5	468.8
VMC to 2hr MVMC (5pm-7pm local)	2107.8	1172.1	935.7
IMC to 2hr MVMC (1pm-3pm local)	14261.3	13412.4	848.9
IMC to 2hr MVMC (5pm-7pm local)	14227.6	8808.8	5418.8

STL - VAPE-1 Analysis



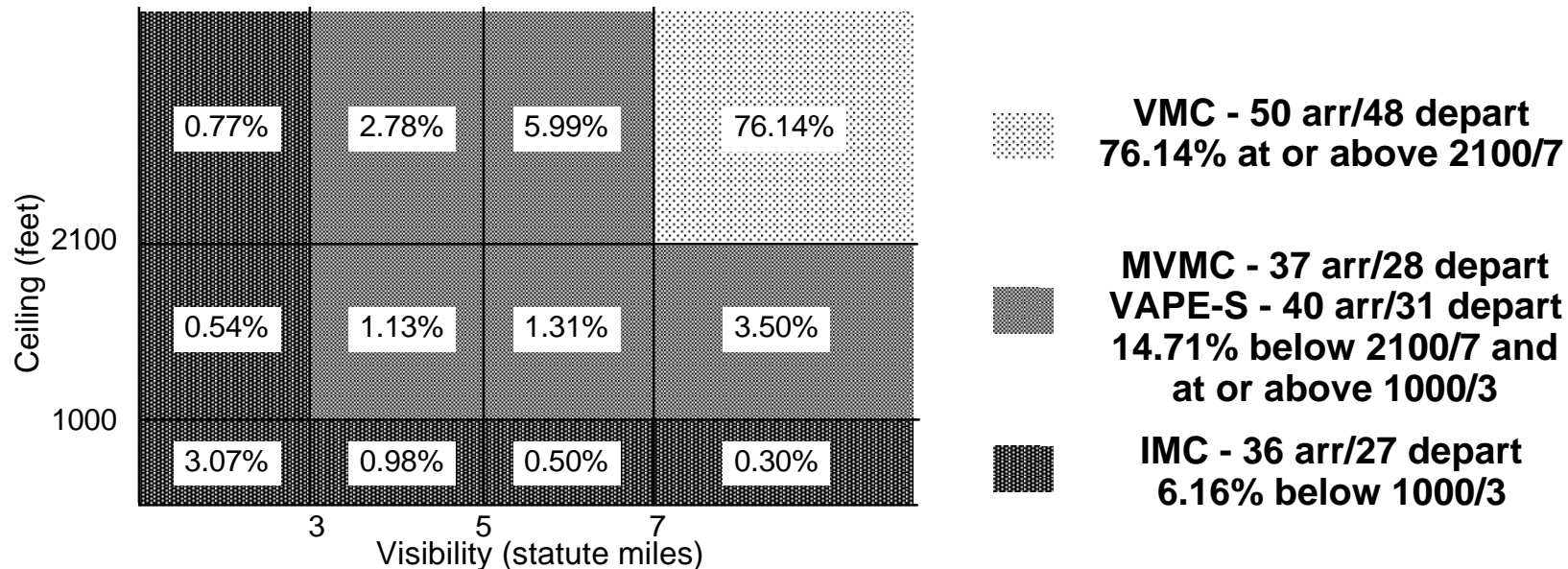
	Current MVMC Delay per day (a/c min)	CDTI VAPE1 VMC Delay per day (a/c min)	Delay Saved per day (a/c min)
24hr MVMC	1923.8	712.8	1211
VMC to 2hr MVMC (1pm-3pm local)	745.4	666.9	78.5
VMC to 2hr MVMC (5pm-7pm local)	870.0	681.5	188.5
IMC to 2hr MVMC (1pm-3pm local)	5481.9	5058.2	423.7
IMC to 2hr MVMC (5pm-7pm local)	4867.1	4507.1	360.0

ATL - VAPE-1 Analysis



	Current MVMC Delay per day (a/c min)	CDTI VAPE1 VMC Delay per day (a/c min)	Delay Saved per day (a/c min)
24hr MVMC	1922.4	1414.7	507.7
VMC to 2hr MVMC (1pm-3pm local)	1633.8	1480.8	153
VMC to 2hr MVMC (5pm-7pm local)	1578.4	1449.2	129.2
IMC to 2hr MVMC (1pm-3pm local)	4275.8	4172	103.8
IMC to 2hr MVMC (5pm-7pm local)	4535.9	4350.4	185.5

EWR - VAPE-S Analysis

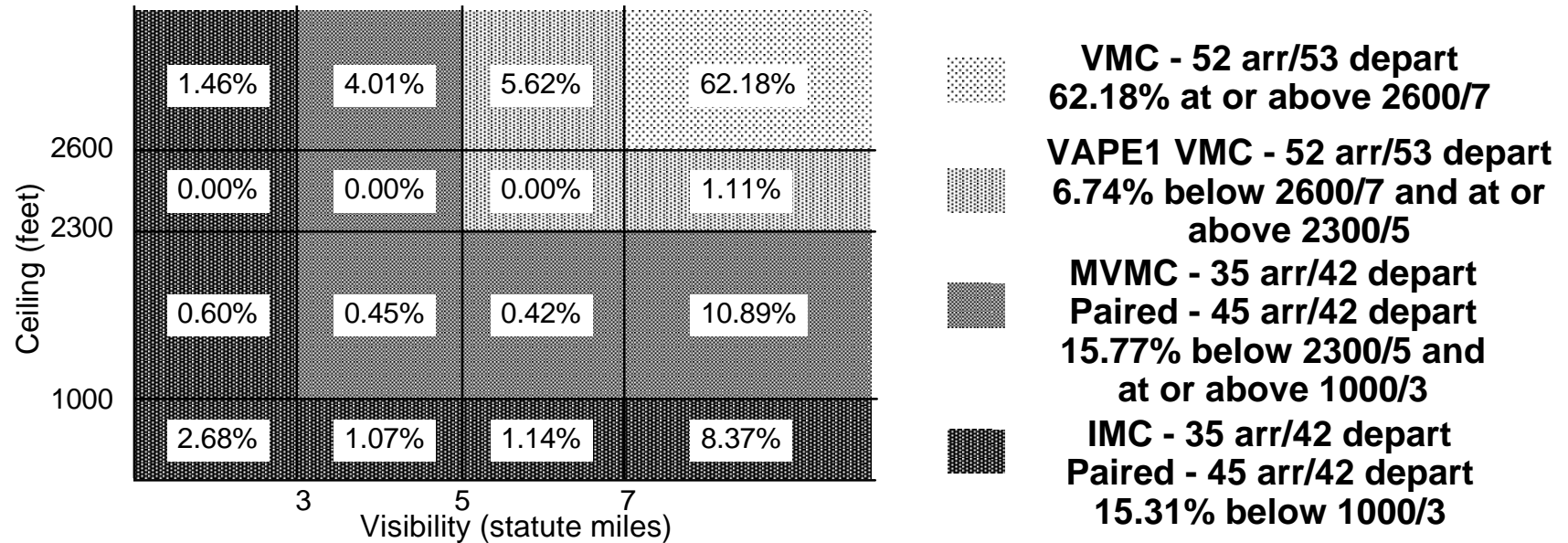


	Current MVMC Delay per day (a/c min)	CDTI VAPE1 VMC Delay per day (a/c min)	Delay Saved per day (a/c min)
24hr MVMC	23902.1	13389.7	10512.4
VMC to 2hr MVMC (1pm-3pm local)	3790.9	3213.6	577.3
VMC to 2hr MVMC (5pm-7pm local)	4589.3	3844.5	744.8
IMC to 2hr MVMC (1pm-3pm local)	28757.1	26315.5	2441.6
IMC to 2hr MVMC (5pm-7pm local)	28847.2	27178.3	1668.9

IMC CDTI Paired Approaches

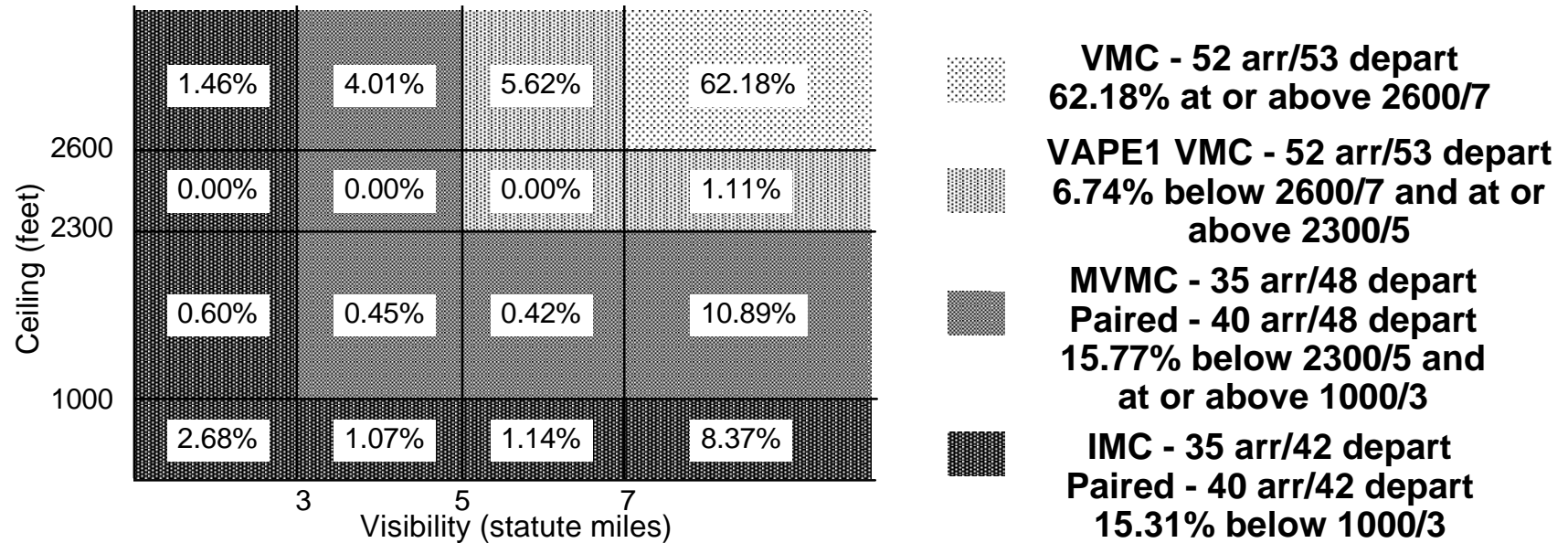
- 0 **Concept - maintain dual runway approach capability to airports with closely spaced runways during low ceiling and visibility weather conditions (e.g., Cat I conditions)**
 - **Separation assured by electronic means (aircraft to aircraft), not visual contact**
- 0 **Procedural constraints are not yet defined, but capacity was estimated between 40 and 45 arrivals/hr using a modified version of the FAA's Airfield Capacity Model (FAA Office of System Capacity and Requirements) and given a minimum 0.25 nmi stagger between aircraft pairs**

SFO - Paired Approach (45 arr) Analysis



	Current MVMC/IMC Delay per day (a/c min)	CDTI Paired MVMC/IMC Delay per day (a/c min)	Delay Saved per day (a/c min)
24hr MVMC/IMC	13932.5	2273.2	11659.3
VMC to 2hr MVMC/IMC (1pm-3pm local)	1603.4	1295.3	308.1
VMC to 2hr MVMC/IMC (5pm-7pm local)	2165.9	1289.8	876.1
IMC to 2hr MVMC/IMC (1pm-3pm local)	14415.1	13699.1	716.0
IMC to 2hr MVMC/IMC (5pm-7pm local)	14403.3	9447.3	4956.0

SFO - Paired Approach (40 arr) Analysis



	Current MVMC/IMC Delay per day (a/c min)	CDTI Paired MVMC/IMC Delay per day (a/c min)	Delay Saved per day (a/c min)
24hr MVMC/IMC	13932.5	5103.7	8828.8
VMC to 2hr MVMC/IMC (1pm-3pm local)	1603.4	1430.5	172.9
VMC to 2hr MVMC/IMC (5pm-7pm local)	2165.9	1602.3	563.6
IMC to 2hr MVMC/IMC (1pm-3pm local)	14415.1	13884.3	530.8
IMC to 2hr MVMC/IMC (5pm-7pm local)	14403.3	11759.6	2643.7

Potential CDTI IMC Airports - Top 25 in Delays*

	Main Runway Pairs Separation (ft)**	Current IMC Approaches	Potential IMC Approaches
Newark (EWR)	948	ILS	
Chicago O'Hare (ORD)	5426, 6498, 9850	simo ILSs	
Boston Logan (BOS)	1495, 1500	ILS	
New York LaGuardia (LGA)		ILS	
Denver Stapleton (DEN)	6000, 4286	simo ILSs	
New York Kennedy (JFK)	3000, 6700	simo ILSs	PRM
Dallas-Fort Worth (DFW)	7578, 8800, 6400	simo ILSs	
San Francisco (SFO)	748, 751	ILS	
Atlanta (ATL)	5405, 6450, 4400, 5458	simo ILSs	PRM? (new runway)
St. Louis (STL)	1300	simo ILS/LDA	PRM
Philadelphia (PHL)	1401	ILS	PRM? (new runway)
Miami (MIA)	5116	simo ILSs	
Washington National (DCA)		ILS	
Los Angeles (LAX)	5990, 5243, 5289, 4542	simo ILSs	
Detroit (DTW)	3791, 5786, 1995, ?	simo ILSs	
Houston (IAH)	5774, 998	simo ILSs	
Minneapolis-St. Paul (MSP)	3380	ILS	PRM
Washington Dulles (IAD)	6700	simo ILSs	
Pittsburg (PIT)	5475, 4304, 1198	simo ILSs	PRM? (new runway)
Seattle-Tacoma (SEA)	797	ILS	
Cincinnati International (CVG)	6243	simo ILSs	
Orlando International (MCO)	1496, 8428, 9924	simo ILSs	
Baltimore-Washington (BWI)	4673	simo ILSs?	
San Diego International (SAN)		ILS	
Salt Lake City (SLC)	4101, 2976	ILS	

* 1994 Aviation Capacity Enhancement Plan

** 1993 Top 100 Airports Fact Book - FAA Office of System Capacity and Requirements

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