FAA/NASA/Industry Airport Planning Workshop:
Airside Modeling and Simulation Solutions

Runway Safety Study
Phoenix Sky Harbor International Airport

September 12, 2006

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State of the Airfield Simulation Business: A Consultant Pontificates

5 Years Ago	Today
Large simulation projects	Smaller, more targeted projects
Large-scale improvements (new runways, major airspace projects)	Many incremental improvements / initiatives (new taxiways, operational initiatives)
Simulate iteratively with the design process	Simulate interactively with the design process
Limited sensitivity evaluation	Broader sensitivity evaluation
Simulate in the back room	Simulate in the client's office
Capacity and delay are principal evaluation metrics	Capacity and delay are still principal evaluation metrics, but there's so much more we can measure reliably

Industry Responses

- Develop faster, more interactive approach to doing simulation analyses
- Develop tools that speed input and output data preparation and simulation visualization
- Work even more closely with subject matter experts during the simulation process
- Expand set of evaluation metrics and output data to address client issues/interests

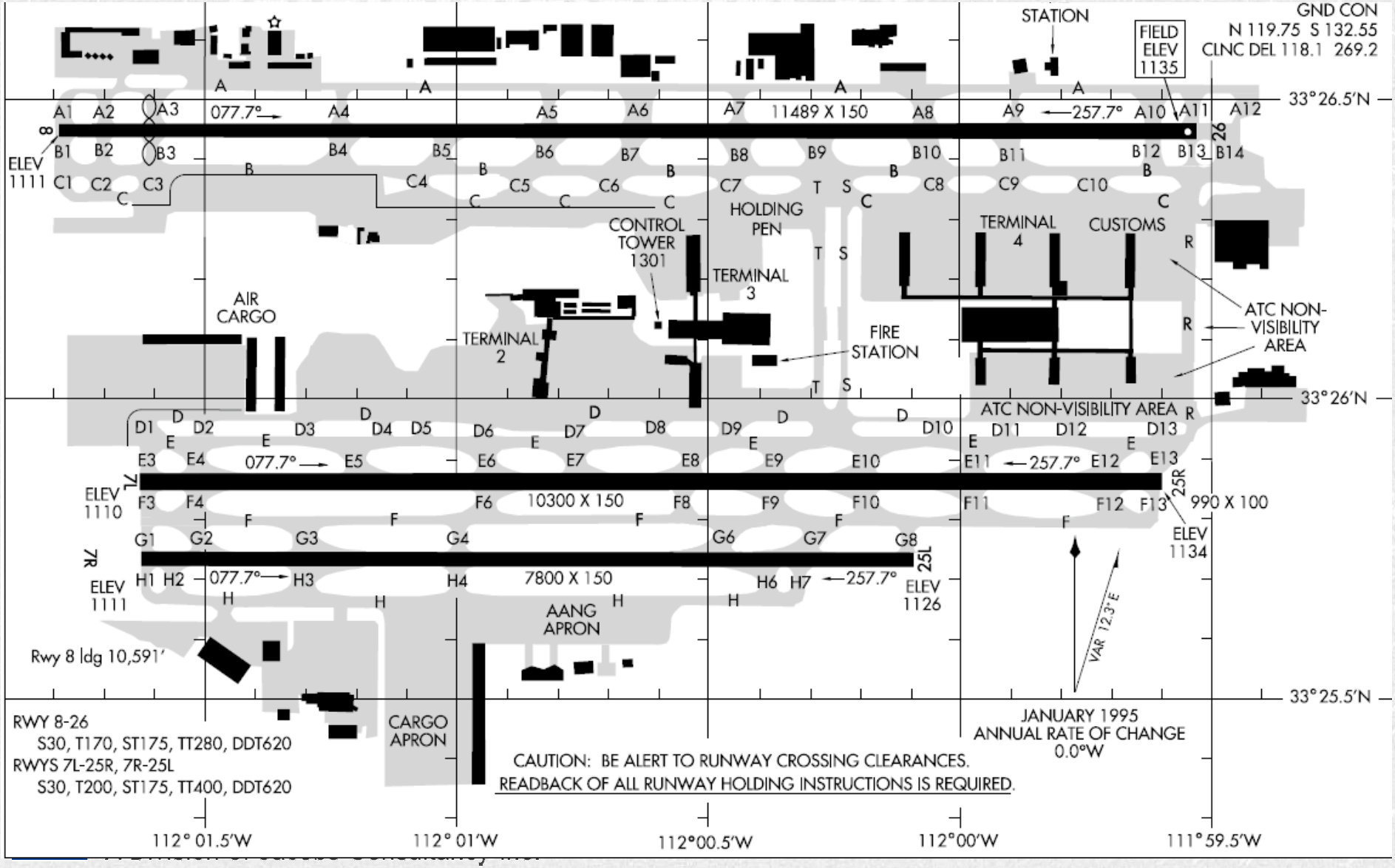
Recent LFA Airfield Simulation Experiences

- BOS—Targeted taxiway simulations to illustrate future operating concepts (3 weeks)
- BOS—Taxiway analyses to develop inputs for use in subsequent environmental modeling (12 weeks)
- JFK—Assessment of A380 taxiway improvements (2 weeks)
- Westchester, Teterboro, Islip—Development of detailed TAAM ground models (12 weeks)
- FLL—Evaluation of airfield development alternatives (8 weeks)
- PHX—Runway safety study

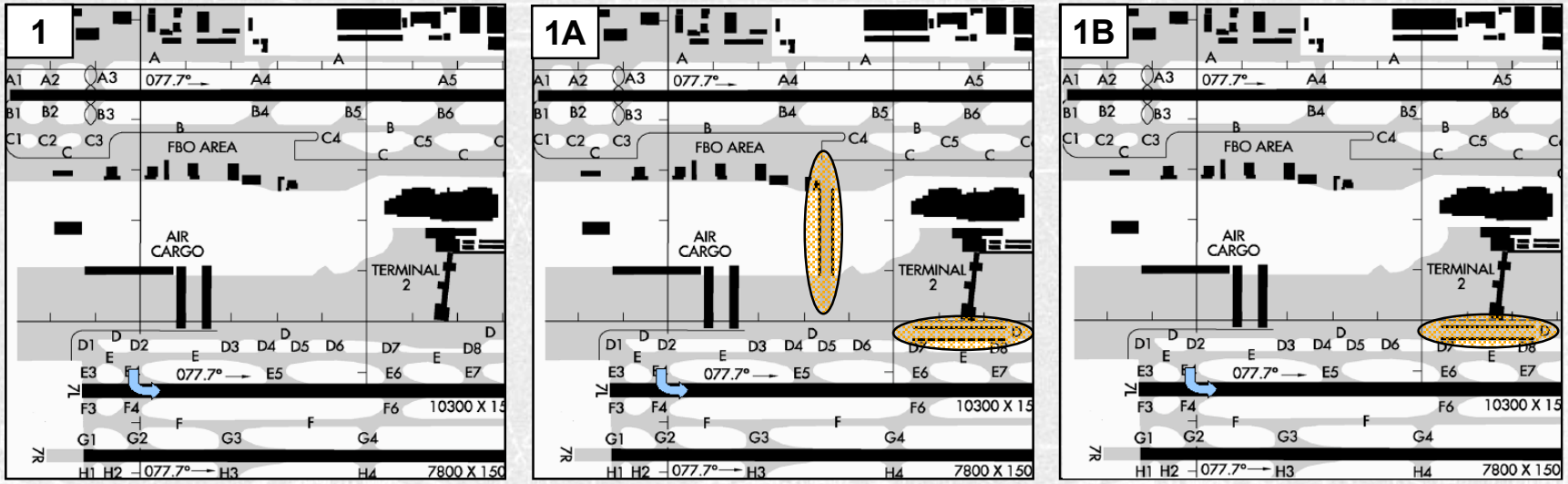
Phoenix Runway Safety Study

- TAAM used to evaluate effectiveness and efficiency of alternative runway crossing strategies and taxiway improvements
  - End around taxiways
  - Alternative taxiway use strategies
- Challenges included:
  - Need for rapid model development
  - Criticality of Air Traffic Organization validation
  - Development and use of non-traditional metrics
  - Need to model complex taxiway flows in congested terminal areas

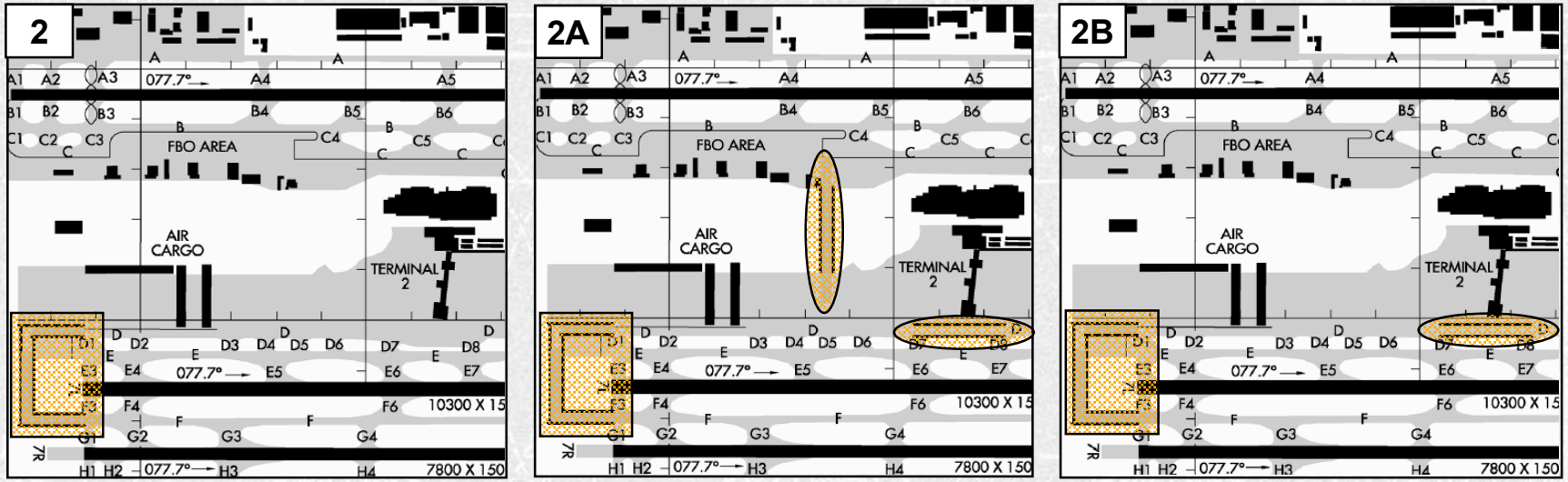
Airfield Overview



Alternative 1: Taxi Behind Intersection Departures



Alternative 2: West End Around Taxiway Variants



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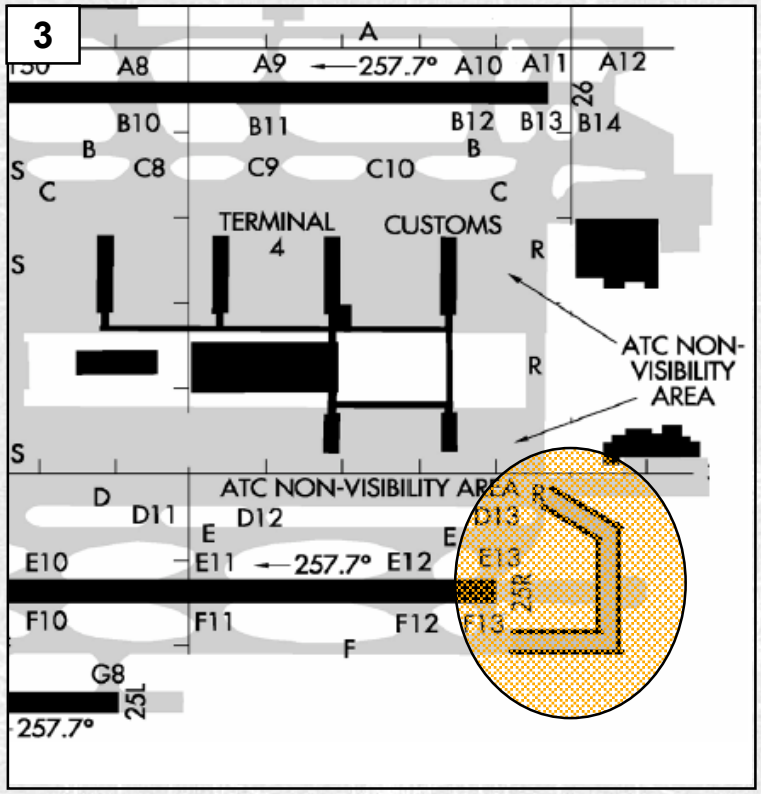
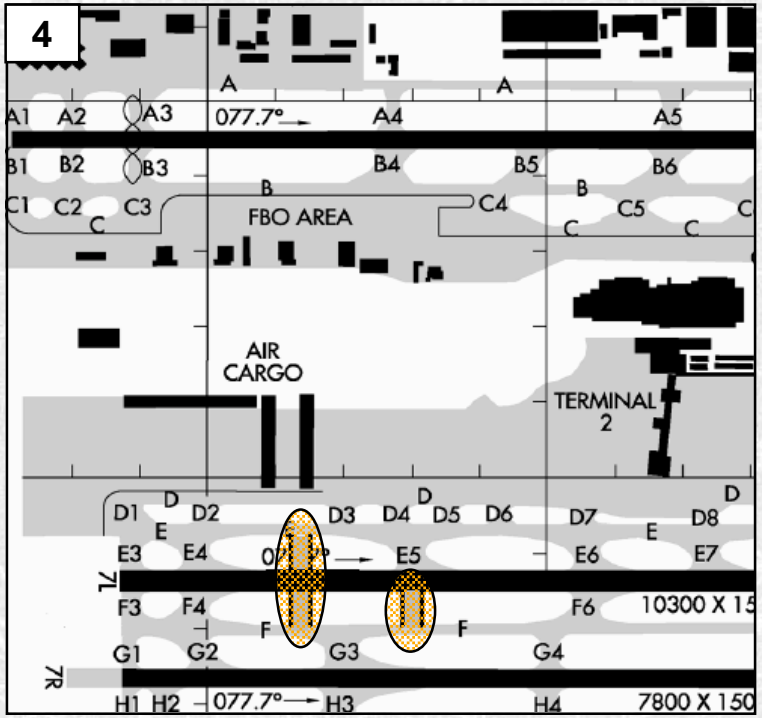
Alternative 3: East End Around Taxiway



Alternative 4: New Runway 7L/25R Cross Taxiways



- Objective: shift primary crossing points to less "critical" locations
- 2 new crossings added as shown
- Crossings used sequentially from east to west

Metrics Evaluated

RUNWAY CROSSINGS

- Volume by third of runway during operational day
- Estimated effect on future number of runway incursions

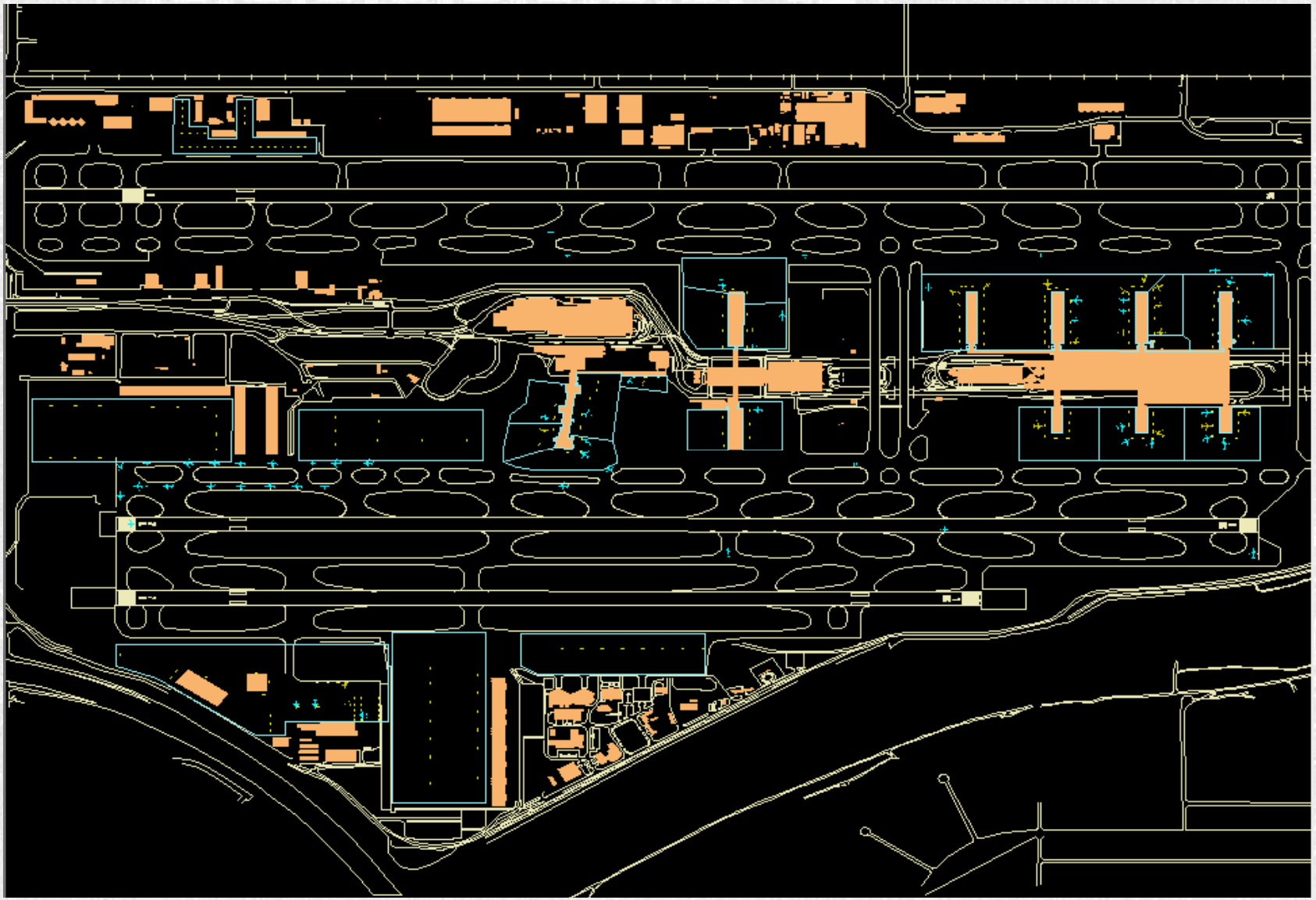
DELAY

- Taxiway delay: OUT to OFF delays for departures. ON to IN delays for arrivals
- Overall delay: Includes all ground delays and airborne delays

TAXI TIME

- Unimpeded taxi time: Unimpeded OUT to OFF time for departures. Unimpeded ON to IN time for arrivals
- Total taxi time: Unimpeded taxi times + taxiway delay

Now for the Obligatory Simulation Animation



Results: Runway 7L/25R Crossings

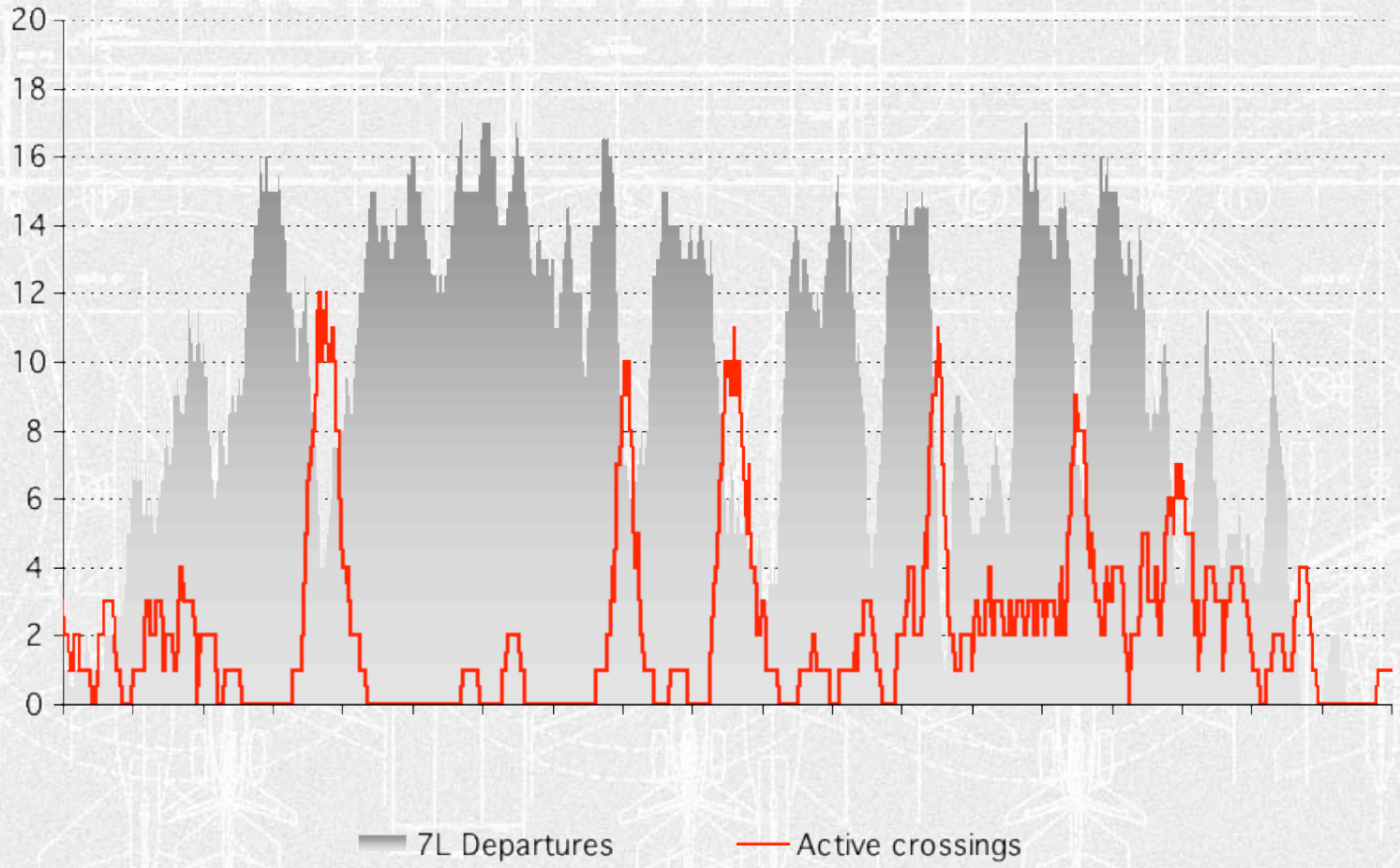
EAST FLOW (7L, 8 | 7R)

Scenario	1st third (1)	2nd third (2)	3rd third (3)	"Taxi under" (4)	"Taxi behind" (5)
Base	66	126	210	-	-
1	29	57	69	-	248
1A	62	54	62	-	225
1B	58	57	62	-	227
2	33	67	71	-	232
2A	59	51	69	-	224
2B	59	51	73	-	220
3	65	53	57	227	-
4	*	*	*	*	*

(1) Crossings on taxiways F3, F4, F6 and new taxiways F4E & F5 in Alternative 4
(2) Crossings on taxiways F8, F9, F10
(3) Crossings on taxiways F11, F12, F13
(4) Crossings on east end-around taxiway
(5) Crossings on west end-around taxiway and F3 in Alternatives 1, 1A & 1B
* Same as Baseline

Preliminary Results: Runway 7L/25R Crossings

EAST FLOW (7L, 8 | 7R)

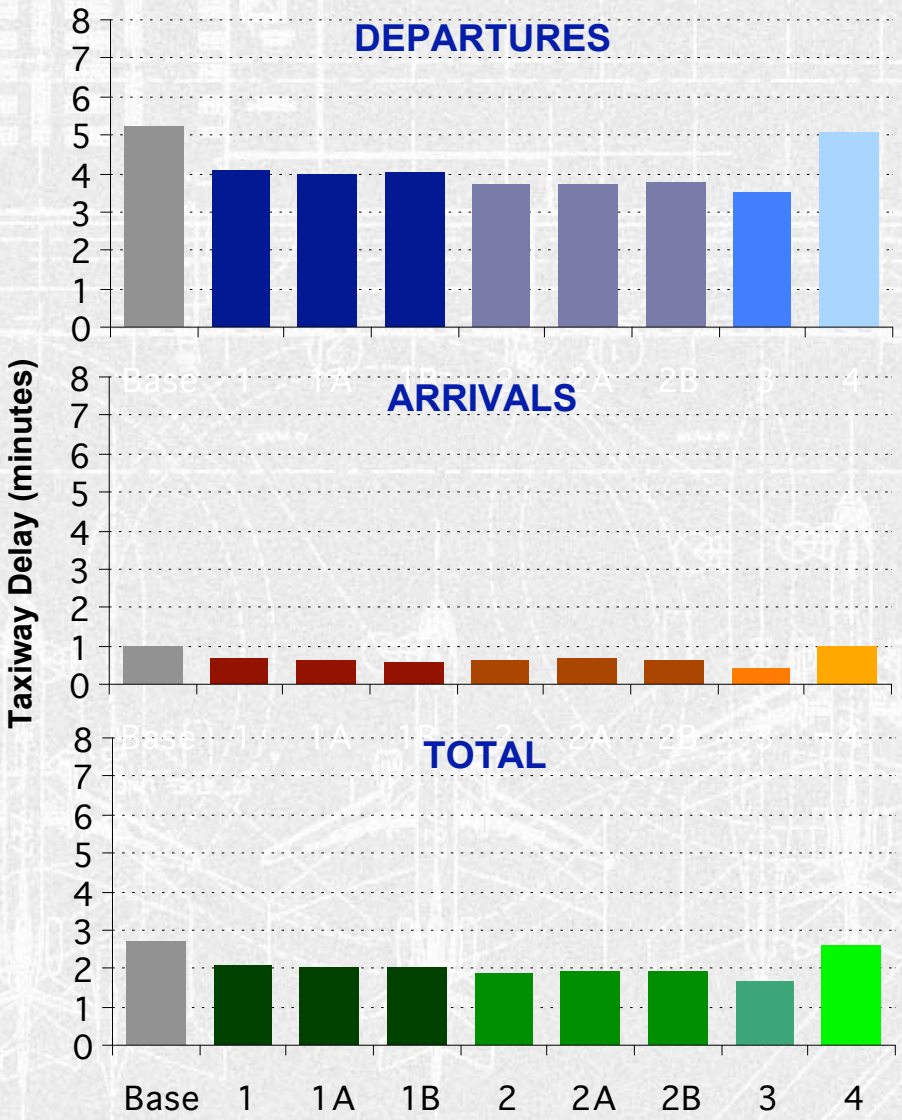


Preliminary Results: Taxiway Delay

COMPOSITE DESIGN DAY*

TAXIWAY DELAY (MINUTES)			
Scenario	Departures	Arrivals	Total
Base	5.19	1.00	2.68
1	4.08	0.65	2.09
1A	4.00	0.60	2.02
1B	4.02	0.57	2.02
2	3.72	0.64	1.88
2A	3.72	0.66	1.88
2B	3.78	0.64	1.90
3	3.52	0.41	1.66
4	5.04	0.97	2.60

* 57% west flow, 43% east flow per ASPM data

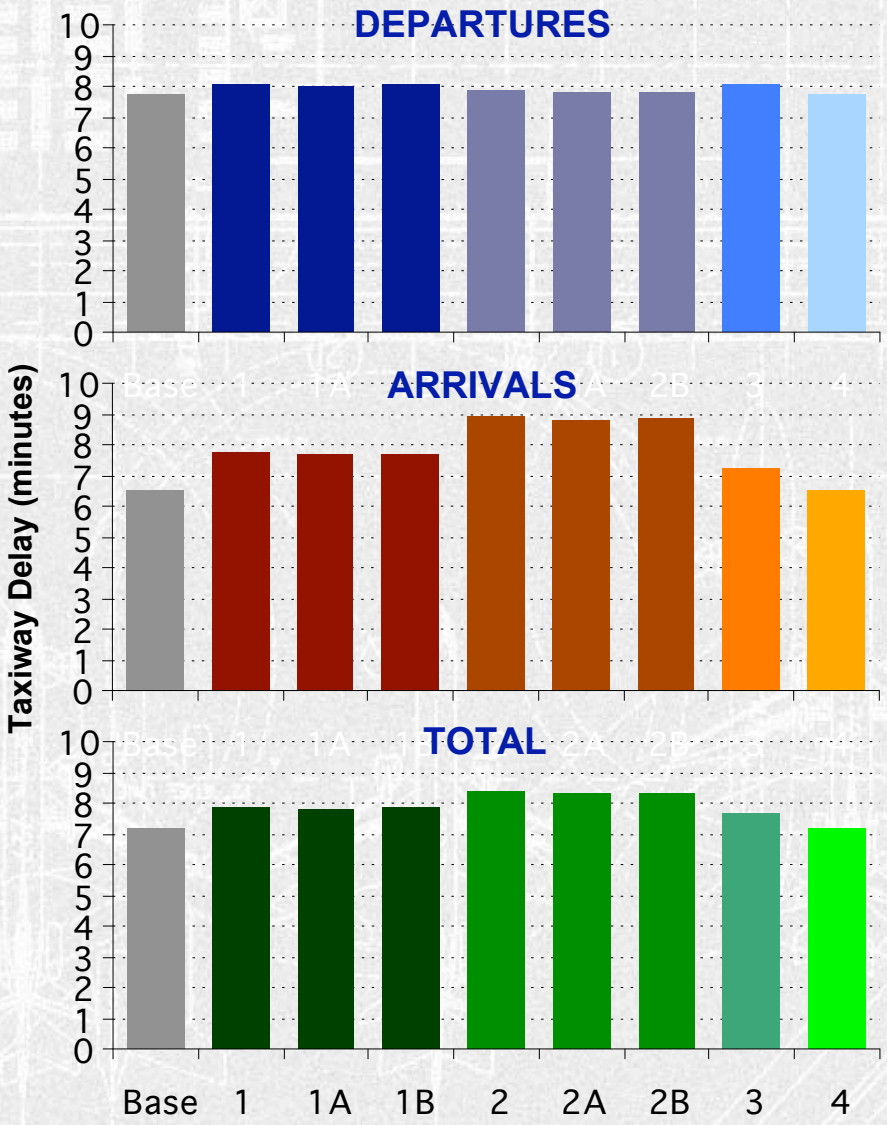


Preliminary Results: Unimpeded Taxi Time

COMPOSITE DESIGN DAY*

UNIMPEDED TAXI TIME (MINUTES)			
Scenario	**Departures**	**Arrivals**	**Total**
Base	**7.76**	**6.52**	**7.14**
1	**8.05**	**7.75**	**7.90**
1A	**8.00**	**7.66**	**7.83**
1B	**8.04**	**7.66**	**7.85**
2	**7.85**	**8.88**	**8.36**
2A	**7.81**	**8.79**	**8.30**
2B	**7.83**	**8.82**	**8.32**
3	**8.08**	**7.22**	**7.65**
4	**7.77**	**6.52**	**7.15**

* 57% west flow, 43% east flow per ASPM data



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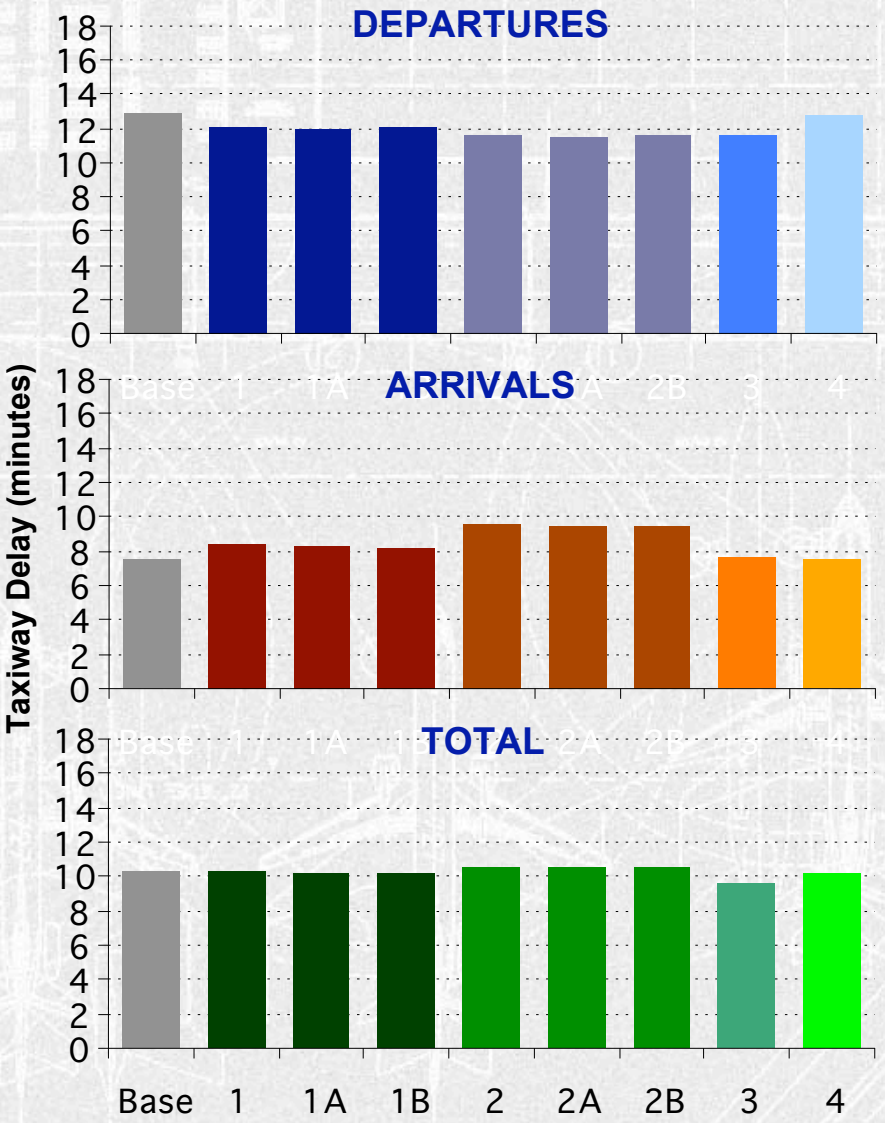
Preliminary Results: Total Taxi Time

COMPOSITE DESIGN DAY*

TOTAL TAXI TIME (MINUTES)			
Scenario	**Departures**	**Arrivals**	**Total**
Base	**12.95**	**7.52**	**10.24**
1	**12.13**	**8.40**	**10.26**
1A	**12.00**	**8.27**	**10.13**
1B	**12.05**	**8.24**	**10.15**
2	**11.56**	**9.52**	**10.54**
2A	**11.53**	**9.45**	**10.49**
2B	**11.61**	**9.46**	**10.53**
3	**11.60**	**7.64**	**9.62**
4	**12.82**	**7.49**	**10.15**

* 57% west flow, 43% east flow per ASPM data



Findings

- All alternatives substantially reduced crossings in the first and second thirds of Runway 7L/25R
- With one exception, all alternatives improve overall airfield operational efficiency
- While unimpeded taxiing times increase with most alternatives, these increases are generally offset by reductions in runway crossing and departure queuing delay

Safety and efficiency aren't necessarily mutually exclusive

Other Fun Facts

- Simulation work was performed in about three months, including coordination with Phoenix Tower representatives
- Much simulation work was accomplished in real time working with Tower staff
- Visual simulation environment was extremely important to accurate ground movement modeling

QUESTIONS?