Los Angeles International Airport
Runway Incursion Studies

Phase II Alternatives Simulation

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FFC-LAX-R002

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Executive Summary

The Phase II study evaluated several candidate changes to airport geometry and/or operations which potentially could reduce the possibility of runway incursions. The objective was to assess the impact of each candidate change on airport surface traffic congestion and overall capacity. Tested conditions concentrated on redistributing surface traffic away from the congested South Complex "hot spots" associated with runway incursion events, by reducing runway crossings, and improving the manageability of the surface traffic.

Baseline data, gathered in Phase I, was used for comparison with the statistical data on airport operations and voice communications generated by the alternatives studied in Phase II. These comparisons pointed out the strengths and weaknesses of the different alternatives as measured by airport efficiency, capacity, traffic flow, and controller workload.

The following summarizes the findings of the six different alternatives run during Phase II:

Alternative 1, "Current Plan: Swapped Runways," scheduled most arrivals onto the inboard runways (24L and 25R) and departing flights primarily used the outboard runways to reduce the need for runway crossings. This alternative reduced runway crossings, but resulted in taxiway congestion. It could contribute to runway incursions of a different type in which landing aircraft are forced to occupy the runway longer due to traffic congestion in the exit area.

Alternative 2, "Current Plan: Two South Locals," used two local controllers on the south side, one controlling runway 25L and one controlling runway 25R. This scenario created workload and coordination problems between the local controllers, and was regarded as unsafe.

Alternative 3, "B-16: AA, One Way," included an extension to B16 which was to be used by all arrivals on the south to avoid crossing Runway 25R. This alternative created traffic management problems on the north side because of the rules used governing taxi routes for south arrivals going to north side gates.

Alternative 3a, "B-16: Bridge Open," included the B16 extension but allowed more flexibility in the taxi routes used by arrivals on the south runways when going to gates on the north side of the airport. This alternative had many positive results in the subjective and statistical data.

Alternative 4, "B-16: ATC Discretion," included the B16 extension, but allowed some arrivals to cross the inboard Runway 25R as is currently done if the crossing could be made without a hold short instruction. Flexible routing of south runway arrivals taxiing to north gates was allowed. This alternative showed some positive potential in the subjective and statistical data.

Alternative 5, "B-16: With 2 Locals," included the B16 extension with flexible routing for arrivals on the south runways taxiing to gates on the North. This scenario also included the addition of a second local controller on the south, each local controlling one runway. This alternative also had many positive results as documented in the subjective and statistical data.

The B-16 extension under the rules of Alternatives 3a and 5 scored most favorably as illustrated in Figure 1 below.

The following diagram combines **Controller Subjective Ratings vs. Departure Rate,** one of the important indicators of the efficiency of the alternatives. The vertical axis shows the controllers' combined subjective ratings for each alternative. The horizontal axis shows the average departure rate per hour during a departure rush. The results were similar for the arrival rush.

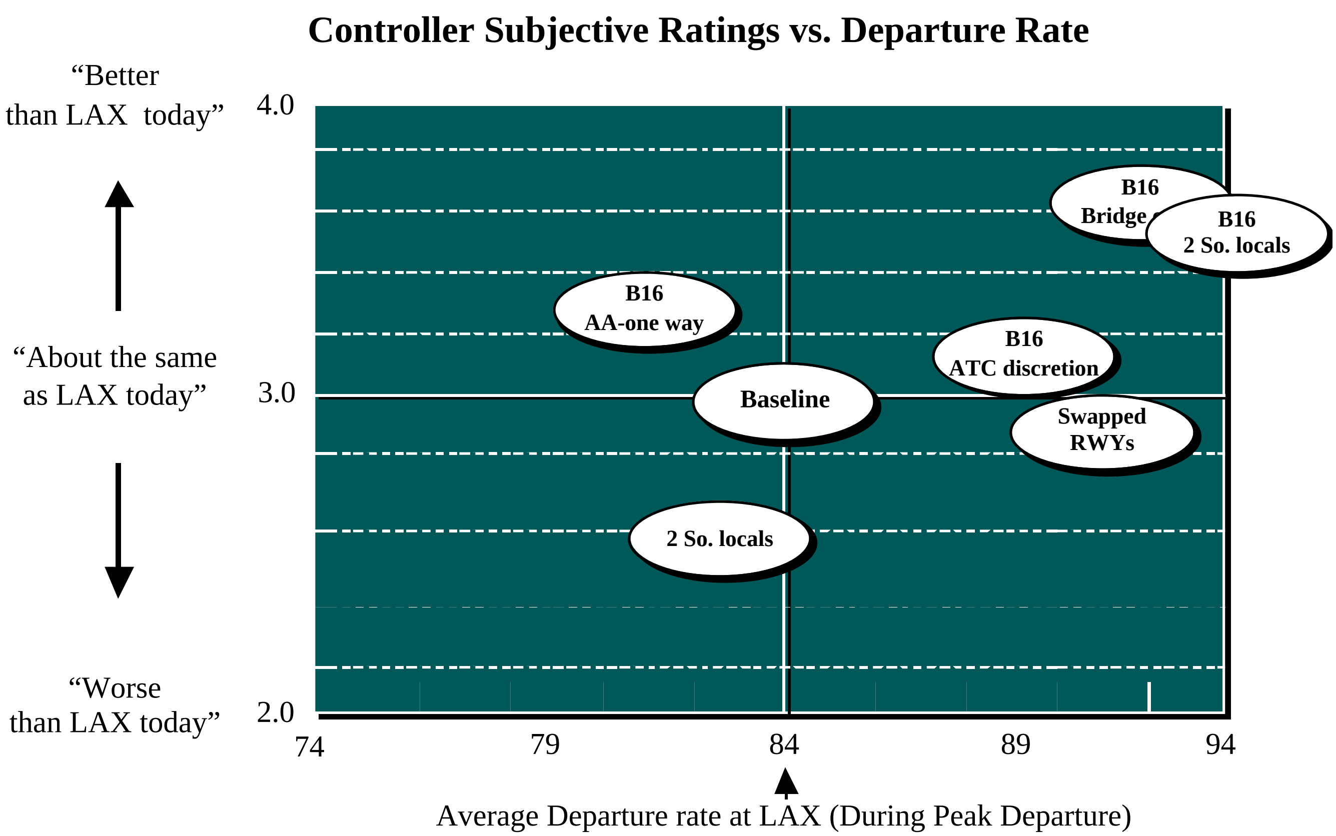


Figure 1: Controller Subjective Ratings during Peak Departure Scenarios

Critical Issues of Alternatives

The table below presents the data from the controllers' responses to Question 8[1].

> **Controllers evaluated six operational criteria. They could select up to three to indicate the most challenging aspects of each alternative.**
>
> **Table 1 shows** the Frequency of Occurrence **for each Alternative. This indicates how frequently this operational aspect was marked as *critical* across all positions.**
>
> .

	Swapped Runways	Two So. Locals	B-16: AA One Way	B-16: Bridge Oopen	B-16: ATC Discretion	B-16: Two Locals
Communication	0.17	0.08	0.00	**0.31**	0.04	**0.38**
Coordination	0.13	**0.50**	0.13	0.19	0.29	0.06
Traffic Complexity	**0.39**	0.25	**0.35**	0.19	0.21	0.19
Workload	**0.35**	0.25	0.13	0.25	**0.38**	0.25
Safety	0.26	**0.33**	**0.38**	0.06	0.13	0.13
Manageability	0.22	**0.67**	0.13	0.25	0.13	0.06

Table 1: Critical Issues of the Alternatives

Non-critical issues (Frequency of Occurrence less than 0.3)

Critical issues (Frequency of Occurrence more than 0.3)

The red cells represent the criteria with Frequency of Occurrence greater than 0.3 and categorized as the most critical for the given alternative.

[1] Question 8: "The most critical problems(s) in this scenario was/were: (circle up to three choices)"

Key Results

Safety, Efficiency, and Workload

The following figure represents LAX controllers' subjective ratings of a potential for runway incursion.

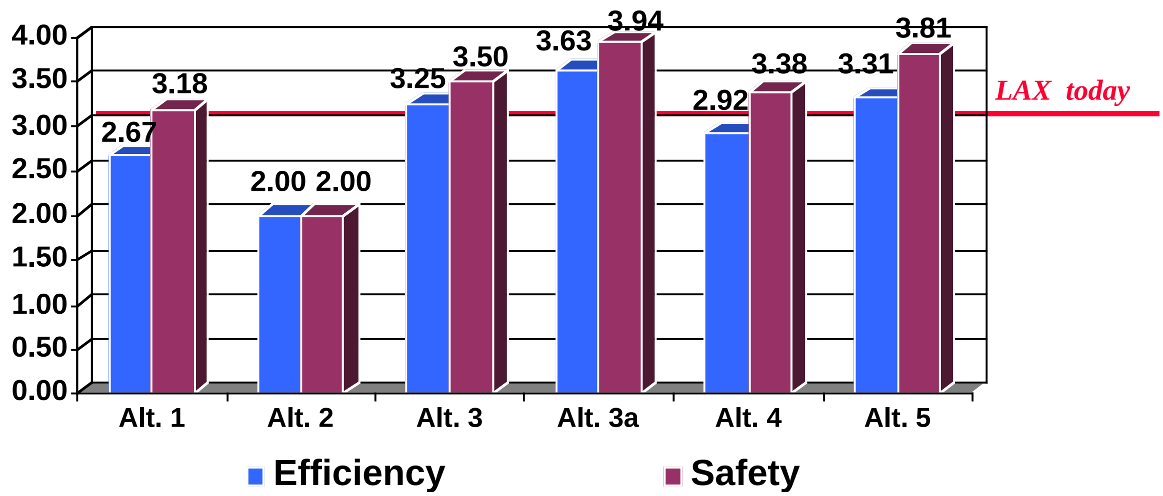


Figure 2: LAX ATC Rankings of Airport Alternative Configurations

- The following list shows the relative rankings of the potential for runway incursion:

B-16: Bridge Open (Alt. 3a) ← **Least potential for a runway incursion**

B-16: With Two Locals (Alt. 5)

B-16: AA, One Way (Alt. 3)

B-16: ATC Discretion (Alt. 4)

Current Plan: Swapped Runways (Alt. 1)

Current Plan: Two South Locals (Alt. 2) ← **Most potential for a runway incursion and below level of current LAX operations**

These results indicate that LAX controllers' opinion of the B-16 extension depends somewhat upon the associated procedures. Alternative 3, B-16: AA, One Way, created a negative side effect of congesting Taxiway E on the north side of the airport. This effect was not present in any other test of the B-16 extension.

Significantly, both alternatives that included no change to the current airport geometry ranked relatively low for safety.

- In terms of efficiency ratings, LAX controllers ranked the LAX test layouts in the following order:

B-16: Bridge Open (Alt. 3a)	**← #1 in overall ease of traffic management and efficiency**
B-16: With 2 Locals (Alt. 5**)**	
B-16: AA, One Way (Alt. 3)	
B-16: ATC Discretion (Alt. 4)	
Current Plan: Swapped Runways (Alt. 1)	
Current Plan: Two South Locals (Alt. 2)	**← Ranked last and below level of current LAX operations**

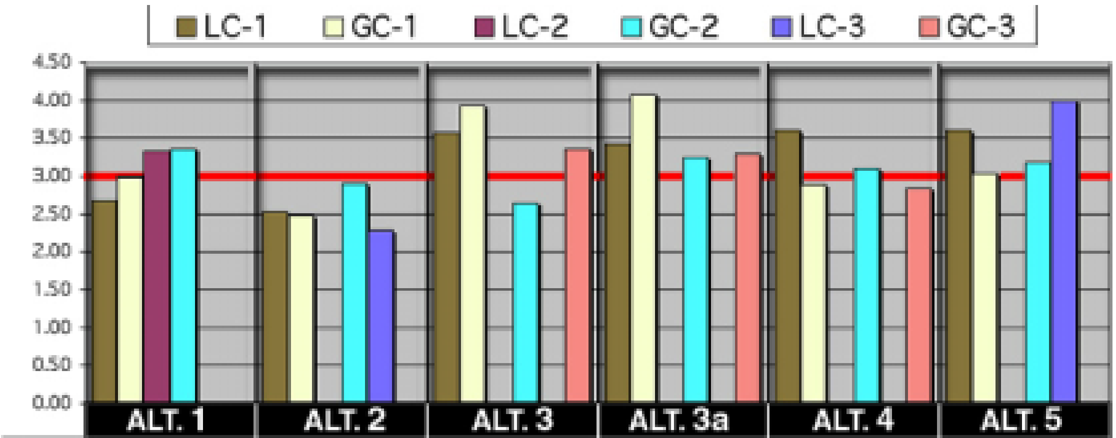
- Workload ratings were based on the combined judgements of the level of coordination, amount of communication, traffic complexity and manageability. The local controller position is primarily responsible for ensuring runway safety[2] on the airfield. It is interesting to note that the LAX local controllers participating in the NASA study judged the B-16 extension alternatives "easier to manage" than either Alternative 1 (Current Plan: Swapped Runways) or Alternative 2 (Current Plan: Two South Locals).

  Local controllers judged Alternative 5 **"B-16: With Two Locals**" **as less workload** than the alternatives.

Controllers at all positions judged Alternative 5 as less prone to a runway incursion. (See 4.6.1, Question 5.)

Figure 3 shows the combined subjective ratings for all survey questions by position for each alternative. With each alternative, positions varied. Controllers favored some alternatives more than others, depending on the position worked.

[2] This represents the expert opinion of NATCA Safety Representative at LAX.



	ALT. 1	ALT. 2	ALT. 3	ALT. 3a	ALT. 4	ALT. 5
LC-1	2.67	2.52	3.57	3.43	3.61	3.61
GC-1	2.98	2.48	3.93	4.07	2.89	3.04
LC-2	3.32					
GC-2	3.36	2.90	2.64	3.25	3.09	3.18
LC-3		2.29				4.00
GC-3			3.36	3.29	2.84	

Figure 3: Mean Ratings for Each Alternative by Tower Position (Controller Surveys)

Airport Operational Performance

Quantitative data for the South Complex indicate that inbound taxi times with a B-16 extension increased by four to six minutes over Baseline taxi times. Outbound taxi times decreased by one to four minutes over Baseline taxi times.

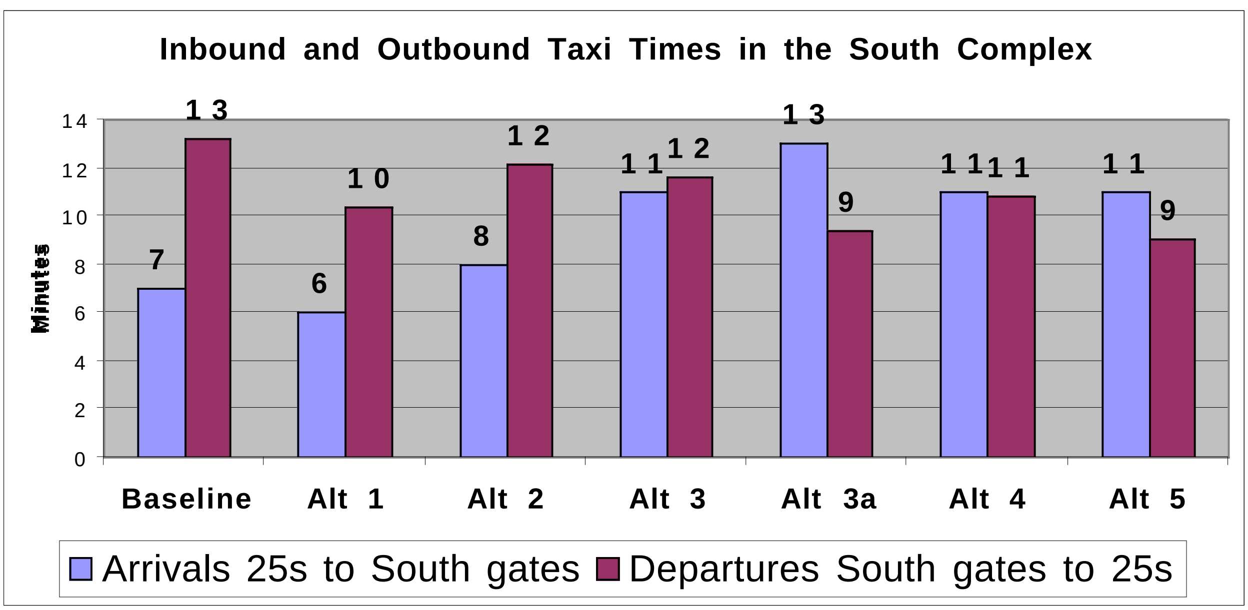


Figure 4: Inbound and Outbound Taxi Times in the South Complex

The average departure rate ***improved*** for all B-16 extension alternatives under both peak arrival and a peak departure rushes.

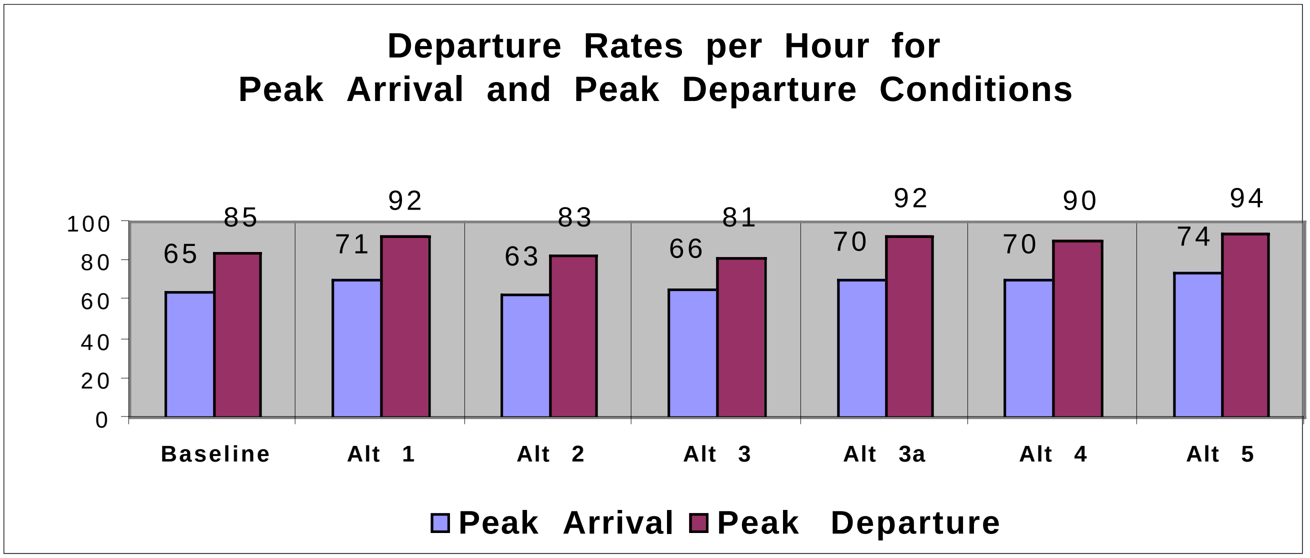


Figure 5: Departure Rates for Peak Arrival and Peak Departure Conditions

Conclusions

- The three most favored alternatives for reducing the potential for a runway incursion were:

  B-16: Bridge Open (Alt. 3a)

  B-16: With Two Locals (Alt. 5)

  B-16: AA, One Way (Alt. 3)

- All alternatives which include the B-16 Extension were regarded as more easily managed than the alternatives which included no modification to the airport geometry.

- Alternative 1 (Current Plan: Swapping Runways), while offering improved arrival taxi times and requiring less coordination by controllers, was not judged as safe as other alternatives. It was also regarded as having about the same potential for runway incursions as the current mode of operations.

- Alternative 2 (Current Plan: Two South Locals), resulted in a lower departure rate and was judged by controllers as having a higher potential for a runway incursion than the current operations, mostly because of the increased coordination required between the local controllers on the south side.

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Caveats

Due to inherent limitations of virtual reality, decisions should not be based solely on results obtained in FutureFlight Central. This study does not address engineering feasibility nor adherence to regulatory requirements. NASA shall not be liable for direct, indirect, or consequential damage or injury arising from decisions made based on this data.

This study focuses on airfield and procedural changes at LAX that may reduce the potential for runway incursion. For this reason, we omitted non-movement area operations, such as ground vehicle traffic and ramp control. Although we include overall capacity data in this report, it is not a precise quantitative assessment of the capacity impact of any airport changes.

Acknowledgements

The simulation of LAX in FutureFlight Central, was the first attempt ever to model a major hub airport with controllers and pilots interacting in real time. NASA would like to thank Los Angeles World Airports (LAWA), the FAA Runway Safety Office, and United Airlines for allowing FFC engineers to learn from the challenge of modeling LAX.

NASA would like to extend their gratitude to all the parties who made major contributions to the success of this project. In addition to the Space Act Agreement Participants, Los Angeles World Airports and United Airlines, NASA wishes to thank the Federal Aviation Administration National Runway Safety Directorate. Special recognition also goes to the following individuals: Boris Rabin who was the NASA/FFC LAX Project Manager; Elliot Brann, ATC Specialist from LAX tower; Tony Marshall and Stephen Steiner, United Airlines pilots; and Alaska Airlines, Southwest Airlines, and American Airlines ramp controllers who assisted the pseudo-pilots in simulating realistic ramp movements.

1. Introduction

Phase II of the LAX Runway Incursion Studies, conducted at NASA FutureFlight Central, had as its purpose the testing of new alternatives at Los Angeles International Airport. Specifically, FutureFlight Central was to evaluate "…air traffic control techniques, pilot procedures, airfield pavement geometry, and traffic management solutions to help eliminate runway incursions at LAX."

In Phase I, FutureFlight Central performed a validation analysis that determined that its simulation of LAX was sufficiently representative of LAX operations so that FFC could proceed with Phase II. (For the complete report, please see *Los Angeles International Airport Runway Incursion Studies: Phase I Baseline Simulation.)*

In Phase II, FFC only simulated VFR (Visual Flight Rules) conditions due to the inherent constraints of the IFR (Instrument Flight Rules) operation procedures for the proposed alternatives (with the one exception of Alternative 2: Adding a Second Local Controller to South-Side Operations, briefly tested under IFR conditions.) Under IFR conditions, restrictions are imposed on the airport due to the present location of equipment for instrument approaches.

This report presents the results of Phase II, in which new alternatives were compared objectively against data collected during Phase I and subjectively by the controllers and observers on the workload, efficiency, and safety criteria. To ensure a valid comparison of the data between Phase I and Phase II, the alternative scenarios used the same arrival and departure rates as well as the same mix of aircraft fleet as the baseline scenarios.

1.1 Background

- In October 2000, NASA Ames Research Center, Los Angeles World Airports and United Airlines signed an agreement "for the purpose of evaluating air traffic control techniques, pilot procedures, airfield pavement geometry and traffic management solutions to help eliminate runway incursions at LAX".[3]

- Despite considerable investment by LAX in surface markings, procedures, and training for mitigating runway incursion, the potential for incursion remains high: from January 2001 to date, five incursions occurred, a rate that exceeds the record for the corresponding period in year 2000.

- The objective of the Phase II study was to evaluate several candidate changes to airport geometry and/or operations which potentially could reduce airport surface traffic congestion and reduce the possibility of runway incursions without negatively impacting airport safety or capacity. Tested conditions concentrated on redistributing surface traffic away from the

[3] Reimbursable Space Act Agreement Between NASA Ames Research Center, Los Angeles World Airports and United Airlines: Runway Incursion Studies- Phases 1-2, Version 3.0, October 2, 2000.

congested south side "focal area" associated with runway incursion events, reducing the need for runway crossings, and/or improving the manageability of the surface traffic.

1.2 Review of Highlights from the Phase 1 Study

This report is preceded by a Phase I study entitled, "Runway Incursion Studies: Phase 1 Baseline Simulation".[4] In this previous study, NASA Ames established that NASA FutureFlight Central was capable of simulating LAX tower operations and surface movement with sufficient realism. Highlights from this earlier study include the following:

- The NASA simulation successfully tasked LAX controllers with the highest sustained traffic arrival and departure rates experienced at LAX.[5]
- LAX ATCs rated both their simulation workload and the realism of the simulation as "about the same as LAX."
- In terms of airport operational behavior, outbound taxi times measured with NASA FutureFlight's version of LAX were accurate within 1-2 minutes of corresponding taxi times at the real LAX.[6]
- FFC controller/pilot voice communications closely modeled recordings from the LAX tower.

1.3 Overview of Phase II

The study evaluated different "alternatives" to current LAX airport operations. The alternatives were selected as offering either a change to the airport geometry, ATC procedures and/or ATC resources.

1.3.1 Original Alternatives Deferred

At the completion of Phase I, representatives of the industry team reviewed the alternatives of the Space Act Agreement[7] for appropriateness, efficacy and possible deferral to a proposed Phase III or subsequent simulation sessions. Two alternatives were deferred and one was modified from those originally proposed in the Space Act Agreement for the following reasons:

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[4] "Los Angeles International Airport, Runway Incursion Studies: Phase 1 Baseline Simulation" published as FFC-LAX-R001 on May 9, 2001.
[5] Arrival and departure rates were based on flight schedules measured at LAX in June 2000.
[6] These measurements were made for aircraft originating in the North and South Complex gates, representing 82% of aircraft in the simulation.
[7] Modification to Reimbursable Space Act Agreement Between NASA Ames Research Center and Los Angeles World Airports and United Airlines for Runway Incursion Studies - Phases 1-2, SAA2-400549.

- Current Plan: Restrict 25L Exits. "Restrict aircraft that normally hold at Taxiways K, M, and J (turbo-props only) to exit runway 25L further down the runway." This alternative was deferred because it would be impractical to consistently stop a transport turbofan aircraft from exiting at the above-mentioned taxiways without a barrier that would also restrict turboprop aircraft.

- Current Plan: 1000 foot Threshold on 25L. "Impose a 1000 foot landing threshold on runway 25L to force aircraft to exit further down the runway." The assumption of this alternative is predicated on all the aircraft decelerating at the same rate. In actuality, the pilot can vary his deceleration rate. This action cannot be duplicated accurately in the simulator, thus leading to inconclusive results. Inter-linking the FFC simulator with the NASA Ames aircraft flight simulators could better emulate this braking behavior. This option was deferred to a later date.

- B-16 Taxi Extension, three variations "Restrict aircraft landing on 25L, especially those without gate assignments, to exit runway south and proceed via taxiway A to each of the following:

    4a. Taxiway U which exists today
    4b. Proposed FAA-designed extension of Taxiway B16
    4c. Proposed airport-designed extension of Taxiway B16

  The original re-configuration of the B-16 Extension was contingent upon using the Declared Distance procedure as outlined in a draft FAA Advisory Circular. Pilot and airline feedback indicated that this procedure raised safety concerns and they would not support it. This alternative was modified as described in the next section.

1.3.2 Alternatives Tested

- Alternative 1: Swapping Inboard and Outboard Operations
- Alternative 2: Adding a Second Local Controller to South Side Operations
- Alternative 3: Utilizing a Proposed B-16 Extension with AA, One Way
- Alternative 3a: Utilizing a Proposed B-16 Extension with the Bridge Route Open
- Alternative 4: Utilizing a Proposed B-16 Extension with Controller Discretion
- Alternative 5: Utilizing a Proposed B-16 Extension with Two Locals on South Side Operations

2. Description of Alternatives

Alternative #1: Swapping Inboard and Outboard Operations
The majority of the aircraft arrives on the inboard runways and departs on the outboard runways. Some landings occur on the outboards, and some departures occur on the inboards, depending on traffic demands. (See Figure 6.)

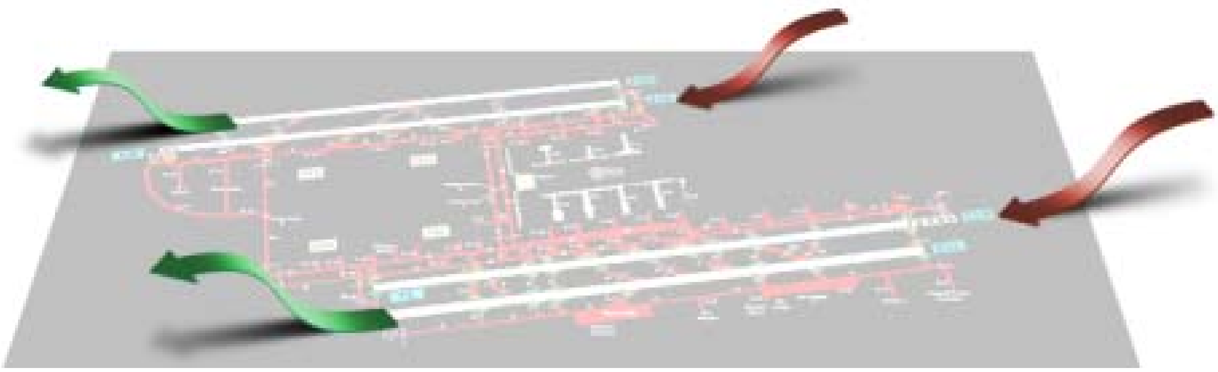

Figure 6: Alternative 1 Operations

Alternative #2: Adding a Second Local Controller to South-Side Operations
Runway 25R is under control of LC-1; Runway 25L is under control of the LC-3. The LC-3 coordinates crossing of the inboard runway with LC-1 internally and gives clearance to pilots. This eliminates the need for pilots to change frequency from LC-3 to LC-1.

After the first week of Phase II, participants from FAA, LAWA and UAL requested that NASA Stop further testing of Alternative 2 because controllers and observers noted that adding a second local on the south side under current procedures significantly increased coordination between controllers without reducing the possibility of an incursion.

Alternative #3: Utilizing a Proposed B-16 Extension with AA, One Way

All aircraft arriving on 25L turn left onto Taxiway A. (See Figure 7 below.) Aircraft stay on the local frequency until crossing 25L on Taxiway U, at which time they contact GC-3 on 120.35. A B-16 extension eliminates aircraft crossing 25R. All aircraft bound for the North Complex taxi via Taxiway AA, and contact GC-2 at Checkpoint 3. Aircraft bound for the South Complex turn onto Taxiway B, and are directed to monitor GC-1, who contacts the aircraft as it approaches Taxiway S. All 24L/R arrivals bound for the South Complex taxi via the South Route. The Bridge route, i.e., Taxiway AA south direction, is not available.

After the first week of Phase II, participants from FAA, LAWA and UAL requested that NASA stop further testing of Alternative 3 because controllers and observers noted that closing the Bridge Route and sending all south arrivals to the north gates via AA made Taxiway E overly congested and could potentially lead to a gridlock.

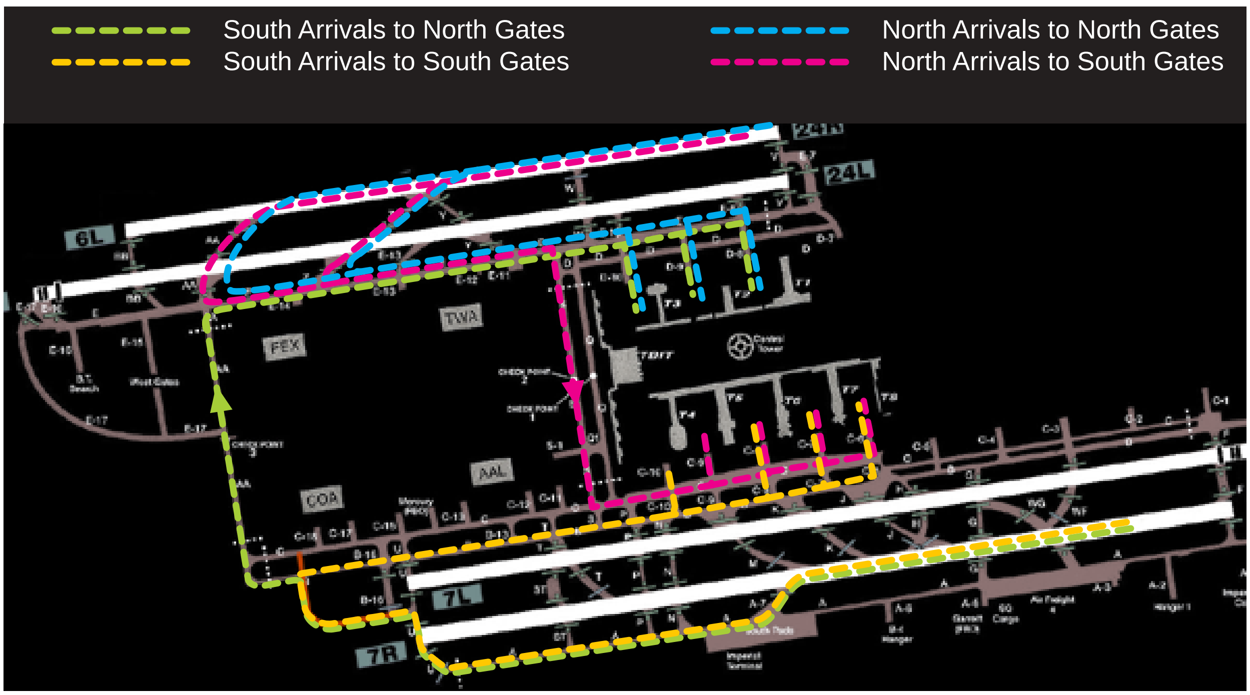

Figure 7: Alternative 3 Operations

Alternative #3a: Utilizing a Proposed B-16 Extension with the Bridge Route Open

All aircraft arriving on 25L turn left onto the Alfa taxiway. Aircraft stay on the local frequency until crossing 25L on Uniform, at which time they contact GC-3 on 120.35. For aircraft bound for the North Complex taxiing on the B-16 extension, GC-3 has the option of the West Route (AA) or the North Route (Q). Aircraft bound for the South Complex turn onto B, and are directed to monitor GC-1, who contacts the aircraft as it approaches S. The Bridge Route is open. (See Figure 8 below.)

Alternative 3a is a requested modification of Alternative 3, in an attempt to improve traffic flow and workload distribution between the GC-1 and GC-3 controllers.

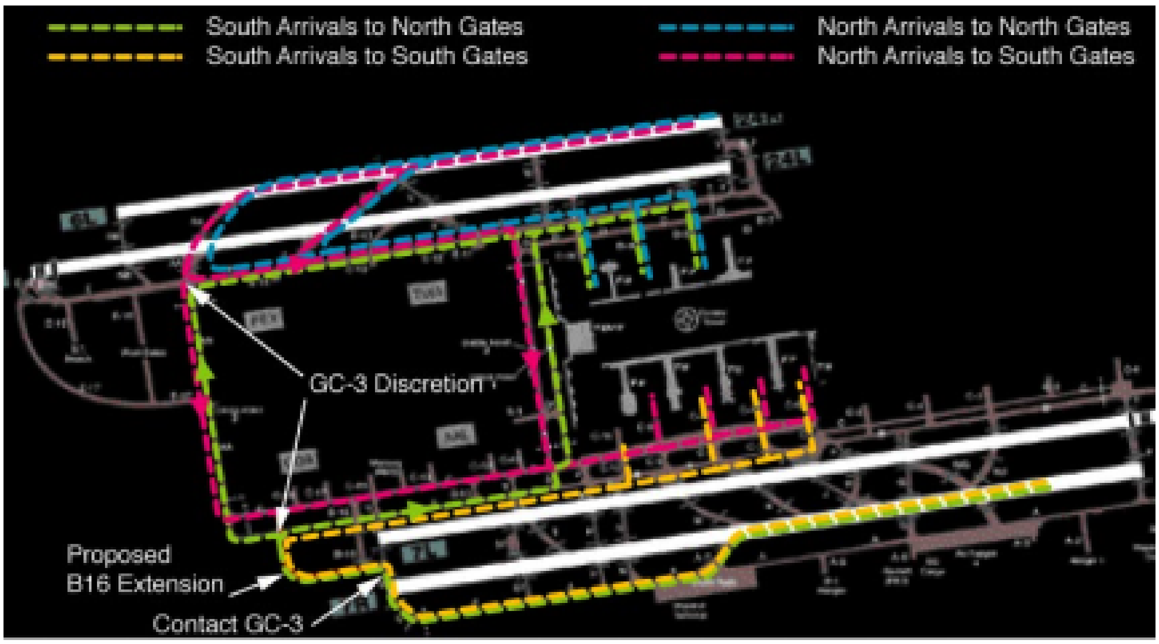

Figure 8: Alternative 3a Operations

Alternative #4: Utilizing a Proposed B-16 Extension with Controller Discretion

The B-16 extension is used, but the controller has discretion over its use. For arrivals on 25L, if the controller can issue an instruction to cross 25R without having to issue a hold-short command, he may exit the aircraft to the north (J, K, etc.). If the controller anticipates having to issue a hold-short command, he will exit the aircraft left onto Taxiway A. (See Figure 9 below, *Alternative 4 Operations*.) Taxiway AA is controlled by GC-2, and the Bridge route is available. For aircraft bound for the North Complex taxiing on the B-16 extension, GC-3 has the option of the West Route (AA) or the North Route (Taxiway Q). Traffic sent along the West Route must hold short of AA and contact GC-2. Traffic along Taxiway B monitors GC-1, who contacts the aircraft as it approaches Taxiway S.

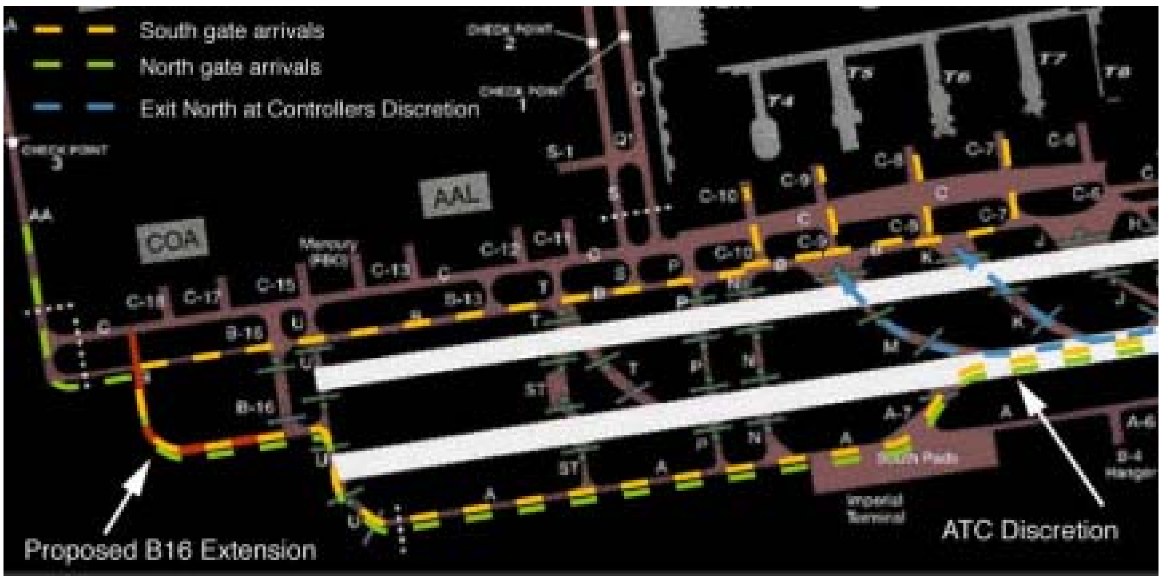

Figure 9: Alternative 4 Operations

Alternative #5: Utilizing a Proposed B-16 Extension with Two Locals on South Side Operations

Utilizing the proposed B16 extension under the rules[8] of Alternative 3a, LC-1 controls Runway 25R and LC-3 controls 25L. For the aircraft bound for the North Complex and taxiing on the B-16 extension, GC-1 has the option of the West Route (Taxiway AA) or the North Route (Taxiway Q). The Bridge Route is open.

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[8] Alternative 3a Rules: All aircraft arriving on 25L turn left onto the Alfa taxiway. Aircraft stay on the local frequency until crossing 25L on Uniform, at which time they contact GC-3 on 120.35. For aircraft bound for the North Complex taxiing on the B-16 extension, GC-3 has the option of the West Route (AA) or the North Route (Q). Aircraft bound for the South Complex turn onto B, and are directed to monitor GC-1, who contacts the aircraft as it approaches S. The Bridge Route is open.

3. Research Methodology

This section discusses three topics: Experimental Design, FFC Mockup of the LAX Tower, and Test Data Collected.

3.1 Experimental Design

Similar to the Phase I simulation, the approach for Phase II was to present a realistic environment for the controllers, such that they operate in the FFC tower the way they would in the LAX tower. The results of the Baseline simulation indicate that a sufficient level of workload realism was achieved. All parties agreed not to simulate the following actual operations: ramp control, ground vehicle traffic, and maintenance. Participants felt that, although this reduced the complexity of the airport simulation, the study should focus on runway safety and operations only.

Both the north and south sides of LAX were simulated, with a complement of 22 airlines and an aircraft mix representative of LAX in the summer of 2000, for which NASA obtained actual LAX operational statistics.

All alternatives were tested under two traffic conditions:

> Peak Arrivals - The scenario included 92 programmed arrivals and a total of 78 departures originating either in the departure queue, at the gate, at alleyway, or in transit.
>
> Peak Departures - The scenario included 62 programmed arrivals and a total of 107 departures originating either in the departure queue, at the gate, at the alleyway, or in transit.

Two groups of four LAX controllers each worked several 45 minute sessions over a three-day period, for a total of six simulation days. Controllers were rotated by tower position to ensure that there was no response bias produced by over-familiarity with the scenario, fatigue, boredom, or particular expertise in a position by any individual. Controllers were instructed to direct air and ground traffic just as they would at LAX.

ATIS “Alfa” information was used in both scenarios: “Los Angeles Airport Information ALFA, 0955 Zulu observation; wind calm; visibility 7; scattered clouds at 150 thousand; temperature 24; dewpoint 11; altimeter 2992. Simultaneous ILS approaches are in progress, runways 24 right, 25 left. Visual approaches to all runways are in use. Simultaneous instrument departure procedures are in use, runways 24 and 25. Read back all hold short instructions. Advise you have information ALFA.”

Pilots were given the following departure heading information. “Runway 24L/R – Props: 270 degrees, Jets: 250 degrees; Runway 25L/R – Props: 200 degrees, Jets: (LOOP) 235 degrees, (LAXX) 220 degrees; Both Props and Jets turn at the SHORELINE or SMO 160R. Go-around or Missed Approach: Runway 24 L/R – 250 heading/climb to 2000, Runway 25 L/R – 235 heading/climb to 2000."

3.2 Facility Mockup of the LAX Tower

FutureFlight Central duplicated the LAX tower layout, work positions, and its out-of-the-window view as closely as possible. FFC personnel visited the LAX tower on numerous occasions to obtain video and still imagery, to observe normal operational procedures, to interview the staff, and to document the location of all displays and controls. In addition to the four tower positions used during Phase 1, two more were configured for Phase II: GC-3 (alternatives 3, 3a and 4) and LC-3 (alternatives 2 and 5). The following is a drawing of the FFC tower cab showing the positions of the controller stations.

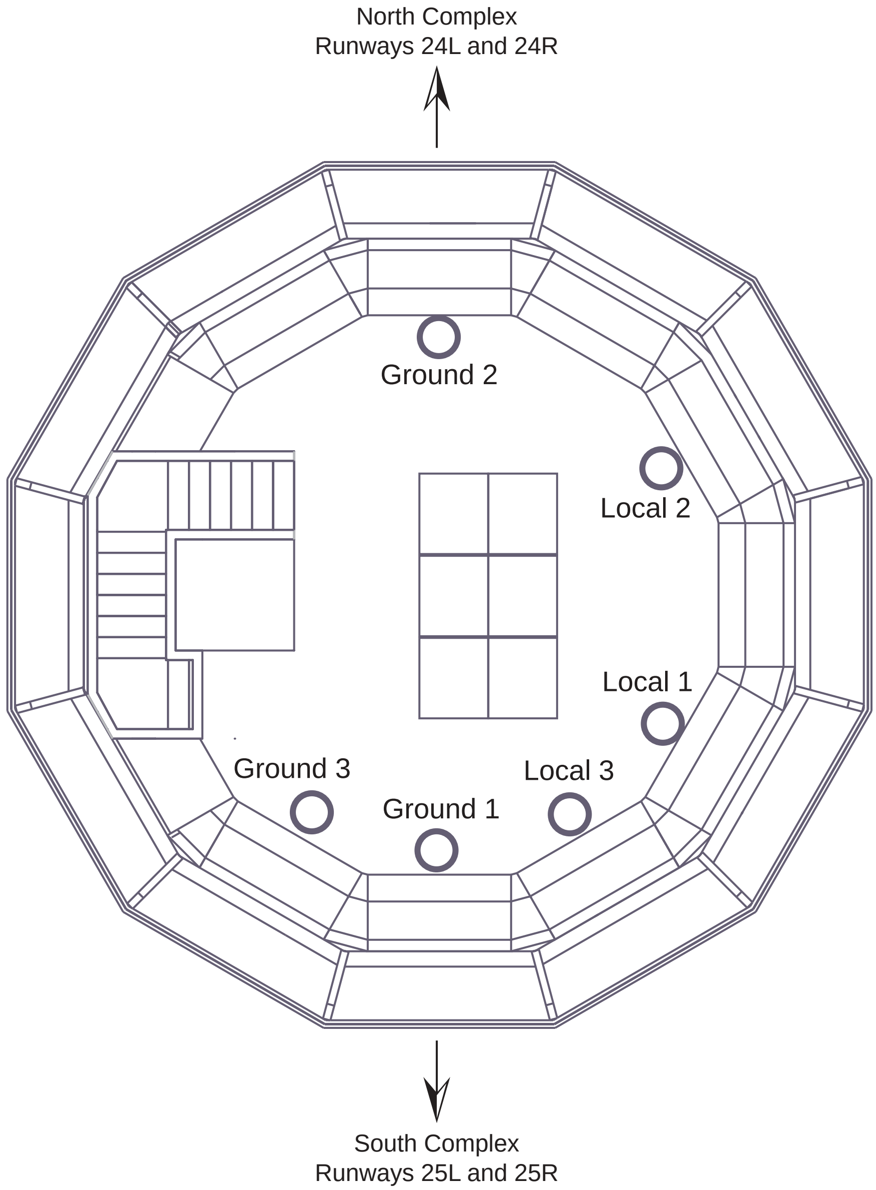

Figure 10: FFC Tower Positions Layout Diagram

Information displays in the FFC tower cab were physically configured as closely as possible to their counterpart displays in the LAX tower. DBRITE displays were not used in the simulation. FFC provided equivalent ASR-9 radar display information on the console.

Twenty-three people were needed for every data collection run. They included:

17 pseudo-pilots
1 test engineer
5 controllers (except Alternative 1, 4 controllers)
2 pseudo-pilot room coordinators

3.3 Test Data Collected

Similar to Phase I, three types of test data were collected during this study:

Controller subjective measures
Airport operations statistical data
Controller voice communications data

Together, the above measures enable an evaluation of the efficiency and safety of the proposed operations.

3.3.1 Controller Subjective Measures

Each controller completed a survey immediately following each run of a scenario. The primary objective of these surveys was to assess the viability of the alternatives.

Within the statistical margin of error that is inherent in such human experimentation, the data represent reliable comparisons among the test variables. Because each controller was randomly reassigned to a different work position during each scenario, their individual differences (response biases, fatigue-related effects, etc.) should have distributed approximately randomly over all of their ratings and not add bias to any single test condition.

The Survey forms filled out by the controllers contained eight questions. (See Appendix A.) Questions 1 through 7 were designed to elicit the subjective opinions of controllers with respect to:

- communication
- coordination
- overall efficiency
- potential for runway incursion
- traffic complexity
- manageability of the traffic flow

The answers to questions 1 through 7 provide mean rating data on the scale from 1 to 5 where value 3 represents "about the same" as current LAX operations. Depending on the parameter measured, a rating of 5 means “better than LAX today” and a rating of 1 means “worse than LAX today.”

For each question, FFC staff calculated the mean rating and standard deviation by controller position.

Question 8 presented six operational criteria. Controllers could select up to three to indicate the most challenging aspects of each alternative. Every time a controller selected a criterion, it was counted as an 'occurrence.' The total number of occurrences for each criterion was divided by the total number of forms filled out for any particular alternative. The resulting value, Frequency of

Occurrence, indicates how frequently this operational criterion was marked as *critical* across all positions.

Since in many cases a Frequency of Occurrence less than 0.3 can be inconclusive, we only list as *critical* those criteria with a Frequency of Occurrence value of more than 0.3.

3.3.2 Airport Operations Data

During all six days of Phase II, FFC collected airport operations data in order to compare the Baseline with the alternative scenarios. Collected data enabled calculations of:

For Departures:
Average departure rates
Average outbound taxi times by route

For Arrivals:
Average arrival rates
Average inbound taxi times by route

3.3.3 Controller Voice Communications Recordings

FFC created digital audio recordings of each simulation run. Voice data was recorded separately from each controller station on the south side. At each position, the controller's microphone provided an input signal to one channel and the pilot's transmissions received through the headphones were recorded on another channel. Alternative scenarios required two to three controllers on the south side. Thus four to six channels were recorded, two channels per each controller position. In addition the ambient sound in the tower was recorded on a separate channel. This capability allowed assessment of the controller workload through analysis of their inter-position communication.

Since the test runs during Phase II were 45 minutes long, the voice data recorded from those runs was extrapolated to one hour to make it comparable with the Baseline data, which was hourly. In the *Data Results* section for each Alternative, “Number of transmissions per hour" at GC-1 and LC-1 positions are compared.

4. Simulation Results

The results are presented for each of six tested alternatives. Data Analysis of each alternative consists of the following:

Results of Controller Surveys
Comparison of Statistical Airport Operations Data for Alternative vs. Baseline
Comparison of Controller Voice Communications Data for Alternative vs. Baseline

4.1 Data Results for Alternative 1, Swapped Runways

Alternative 1 was tested under following rules:

Aircraft will arrive on the inboard runways and depart on the outboard runways. Some landings will occur on the outboards, and some departures will occur on the inboards, depending on traffic demands.

Six runs were performed on this alternative over the two weeks of the Phase II simulation. LC-1 and GC-1 control the south side and LC-2 and GC-2 control the north side of the airport.

4.1.1 Results of Controller Surveys for Alternative 1

<u>Question 1</u>: The amount of coordination required with the controllers on my side of the airport was: (1 represents 'Much more,' 5 - 'Much less')

Same Side Coordination	LC-1	GC-1	LC-2	GC-2
Mean Rating	**2.67**	**3.00**	**3.80**	**3.50**
Standard Deviation	0.75	1.00	0.75	0.76

The data from this table shows that, in comparison with current LAX operations, Alternative 1 required more coordination on the south side and less on the north side of the tower.

<u>Question 2:</u> The amount of coordination required with the controllers on other side of the airport was: (1 represents 'Much more,' 5 - 'Much less')

Cross-Cab Coordination	LC-1	GC-1	LC-2	GC-2
Mean Rating	**4.00**	**3.50**	**4.20**	**3.33**
Standard Deviation	0.82	0.76	0.75	0.75

The data from this table shows that, in comparison with current LAX operations, Alternative 1 required less coordination between Ground Controllers and significantly less coordination between Local Controllers.

Question 3: The amount of communication with the pilots was: (1 represents 'Much more,' 5 - 'Much less')

Communication	LC-1	GC-1	LC-2	GC-2
Mean Rating	**2.50**	**2.67**	**3.00**	**3.17**
Standard Deviation	0.50	1.11	1.10	0.90

In comparison with current operations, Alternative 1 required more communication with the pilots on the south side and slightly less on the north side.

Question 4: The overall efficiency of this operation was: (1 represents 'Much less efficient,' 5 - 'Much more efficient')

Efficiency	LC-1	GC-1	LC-2	GC-2
Mean Rating	**2.00**	**2.67**	**3.00**	**3.00**
Standard Deviation	1.00	1.11	0.89	1.00

Subjective data from this question indicates that Alternative 1 appears to be less efficient for controllers on the south side and about the same as current operations for controllers on the north side.

Question 5: In your estimation, relative to current LAX operations, the potential for a runway incursion on this run was: (1 represents 'Much more,' 5 - 'Much less')

Safety	LC-1	GC-1	LC-2	GC-2
Mean Rating	**2.83**	**3.17**	**3.40**	**3.33**
Standard Deviation	0.69	1.34	0.49	1.11

The data from this table indicates that in comparison with current operations the potential for a runway incursion was about the same on the south side and less on the north side.

Question 6: The level of traffic complexity in your control area was: (1 - 'Much higher,' 5 - 'Much lower')

Complexity	LC-1	GC-1	LC-2	GC-2
Mean Rating	**2.17**	**3.00**	**2.80**	**3.50**
Standard Deviation	0.69	1.15	1.47	0.50

In comparison with current LAX operations, Alternative 1 presented a higher level of traffic complexity for Local Controllers and a lower level of complexity for Ground Controllers.

Question 7: How would you rate the ability to manage the traffic flow under this scenario: (1– ‘impossible to manage,’ 5 – ‘easier than under current operations’)?

Manageability	LC-1	GC-1	LC-2	GC-2
Mean Rating	**2.50**	**2.83**	**2.80**	**3.67**
Standard Deviation	0.50	1.21	0.98	0.94

The data from this table indicates that controllers on positions LC-1, GC-1 and LC-2 consider traffic flow to be more difficult to manage under Alternative 1 than under current operations mode. From GC-2 position it was easier.

The following diagram shows the overall mean rating of questions 1 through 7 for Alternative 1 in each tower position controlled by LAX controllers. The red line represents a rating of 'About the same' as current LAX operations.

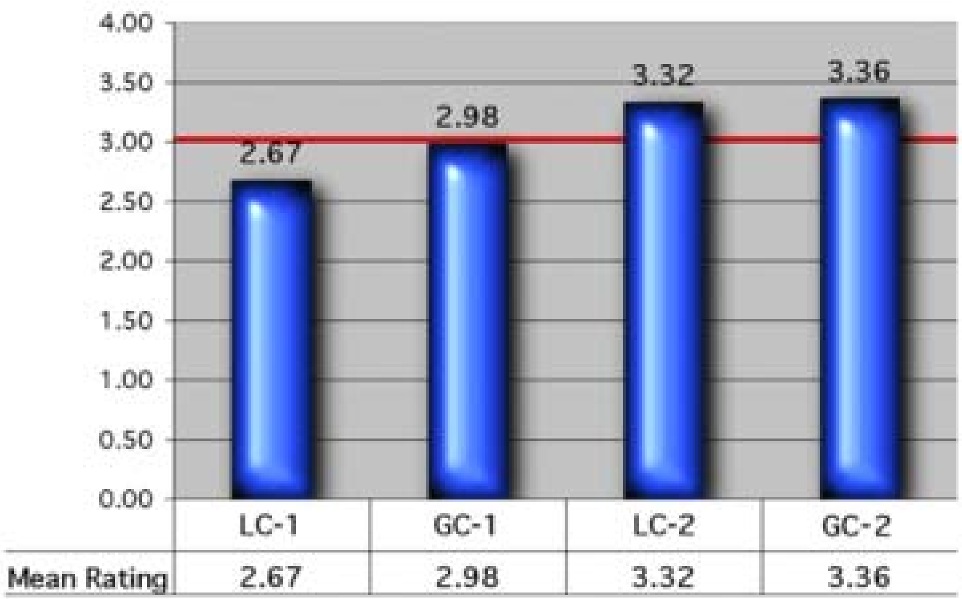

Figure 11: Alternative 1, Swapped Runways, Mean Rating for Questions 1-7

Key Controller Comments:

GC-1: *"When landing rwy 25R, ground has to protect the highspeed exits for every arrival. Local does not have the time to work around them. This increases the complexity".*

LC-1: *"This scenario would decrease the efficiency of LAX. The departure rate would be half of today's ops. It also creates gridlock for GC-1."*

GC-2: *"Taxi to 24 right, hold short of 24 left creates a workload issue along with increases potential for wake turbulence."*

LC-2: *"Landing RY24L and departing RY24R makes it more difficult for the controller.*

Question 8: The most critical problem(s) in this scenario was/were: (circle up to three choices)

Most Critical Problems	Number of Occurrences per position				Total number of Occurrences	Frequency of Occurrence
	L-1	G-1	L-2	G-2		
Communication	0	0	0	4	4	**0.17**
Coordination	2	1	0	0	3	**0.13**
Traffic Complexity	4	3	2	0	9	**0.39**
Workload	1	4	3	0	8	**0.35**
Safety	3	1	2	0	6	**0.26**
Manageability	0	2	2	1	5	**0.22**

Table 2: Alternative 1, Swapped Runways, Most Critical Problems

The data from this table demonstrate that the most critical aspects of the Alternative 1 operations were:

At LC-1 position: Coordination, Traffic Complexity, Safety

At GC-1 position: Traffic Complexity, Workload, Manageability

At LC-2 position: Traffic Complexity, Workload, Safety, Manageability

At GC-2 position: Communication

Criteria that was mentioned the most as critical for Alternative 1

- **Traffic Complexity** - Frequency of Occurrence = **0.39**
- **Workload** - Frequency of Occurrence = **0.35**

4.1.2. Statistical Airport Operations Data for Alternative 1

Average Arrival Taxi Time Data

The following table presents the calculated average arrival taxi times from the Alternative 1 simulation for pre-selected airport terminal locations. “North” refers to the gates at terminals T1 - T3 and gates 119-123 at the Tom Bradley International Terminal. “South” refers to the terminals T4 - T8 and gates 101-106 at the Tom Bradley International Terminal. The taxi time begins at the touch-down point and ends at the gate.

		Alternative 1	
		Arrivals	
From	To	Taxi Time (min.)	Std Dev (min.)
24s	North	6	1.8
24s	South	13	3.8
25s	South	6	2.4
25s	North	8	2.5
25s	C-Nest	4	0.6
24s	Q-Nest	7	1.9
25s	Box	3	1.4
24s	Box	10	2.9

Table 3: Alternative 1, Swapped Runways, Arrival Taxi Times

Figure 12 shows that Alternative 1 achieved a 14% reduction in taxi times, compared to the Baseline scenarios, on arrivals from the 25s to south gates, a 33% reduction from the 25s to the north gates, a 13 % reduction from the 24s to the south gates, and a 33% reduction from the 24s to north gates. These reductions were achieved mainly because landing on the inboard runways allowed direct exit from the runway without issuing a 'hold short' command, and there were shorter taxi distances to the gates.

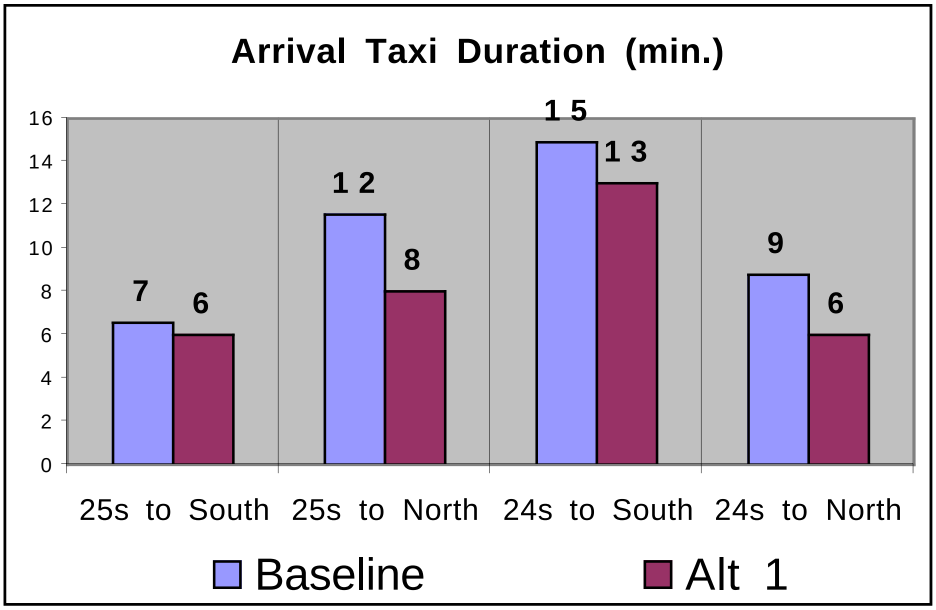

Figure 12: Alternative 1, Swapped Runways, Arrival Taxi Duration

Average Departure Taxi Time Data

This table shows the computed departure taxi times from pre-selected terminal locations (North, South, Nest, and Box) to the runways. "North" refers to the gates in the terminal area T1 - T3 and "South" refers to the terminal area T4 - T8. The taxi time is the elapsed time between the alleyway "SPOTS" and the beginning of the takeoff roll. For aircraft that push directly onto the taxiway, the time is calculated from the start of the forward taxi movement. They do not include any takeoff roll time.

		Alternative 1 Departures	
From	To	Taxi Time (min.)	Std Dev (min.)
North	24s	6	2.6
North	25s	16	2.0
South	25s	10	2.4
South	24s	12	3.8
Q-Nest	24s	10	0.8
Box	25s	11	2.1
Box	24s	11	2.7

Table 4: Alternative 1, Swapped Runways, Departure Taxi Times

Figure 13 indicates that Alternative 1 in comparison with the Baseline scenarios resulted in a possible reduction in departure taxi times.

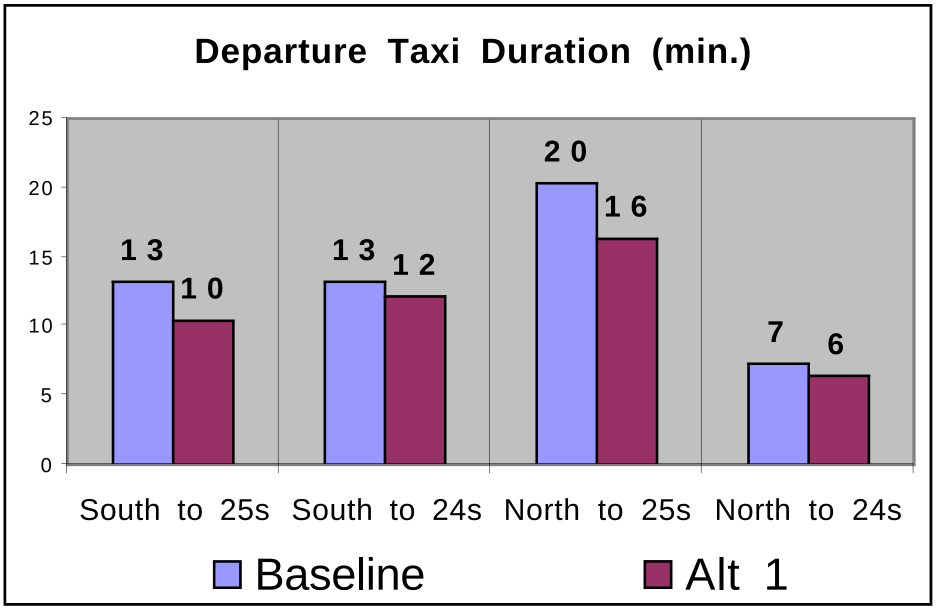

Figure 13: Alternative 1, Swapped Runways, Departure Taxi Duration

Running Average Departure Rate Data

Departure rate data was computed separately for peak arrival and peak departure scenarios. Figure 14 compares Alternative 1 and Baseline departure rates.

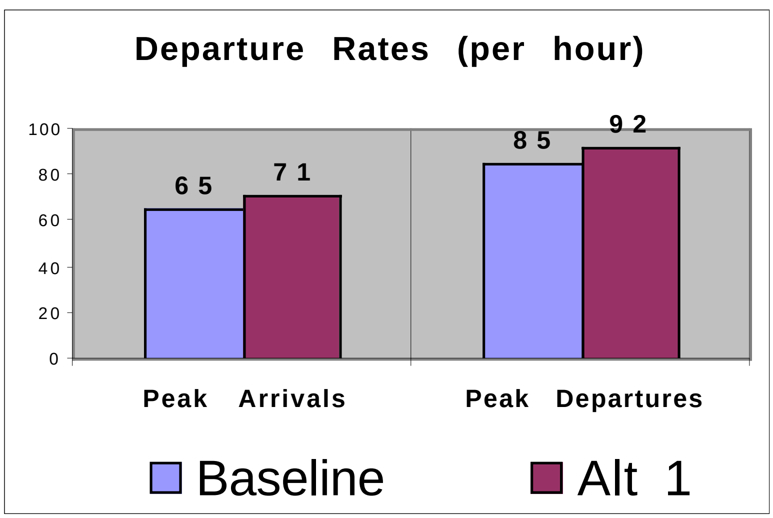

Figure 14: Alternative 1, Swapped Runways, Departure Rates

Figure 14 indicates that Alternative 1 departure rates were higher by 9% on both peak arrival and peak departure scenarios relative to the Baseline operations. This is consistent with data on departure taxi times.

4.1.3 Controller Voice Communication Data for Alternative 1

The following is a comparison of the voice data recorded during the Alternative 1 and Baseline scenarios. Primary parameters for comparison are 'Air Time Distribution' and the 'Number of transmissions per hour'.

Figure 15 shows that the communication time between the GC-1 controller and pilots increased by 8% during Alternative 1.

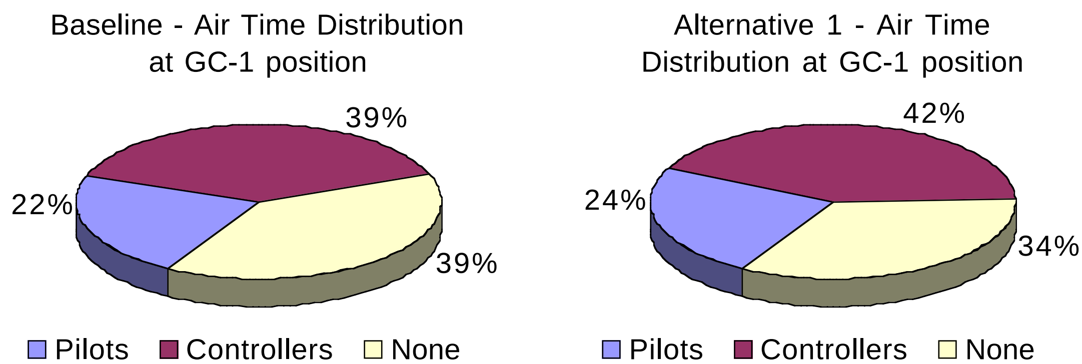

Figure 15: Alternative 1, Swapped Runways, Air Time Distribution, GC-1 Position

Figure 16 provides a comparison of Air Time Distribution at the LC-1 position between Alternative 1 and the Baseline scenarios.

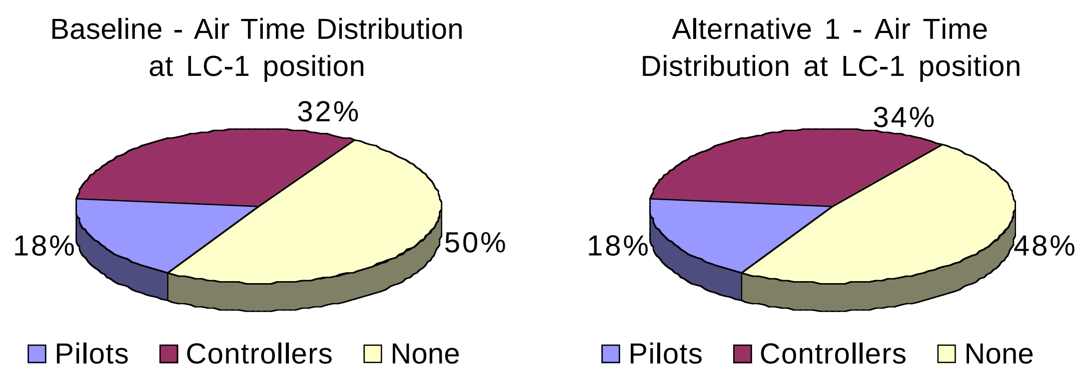

Figure 16: Alternative 1, Swapped Runways, Air Time Distribution, LC-1 Position

In comparison with Baseline scenarios, Figure 18 shows an increase in the number of transmissions at the GC-1 position for Alternative 1.

The number of transmissions was also higher at the LC-1 position, which indicates the amount of communication required at this position for Alternative 1 (i.e. swapped inboard/outboard operations) was increased compared to the Baseline scenarios. (See Figure 18.)

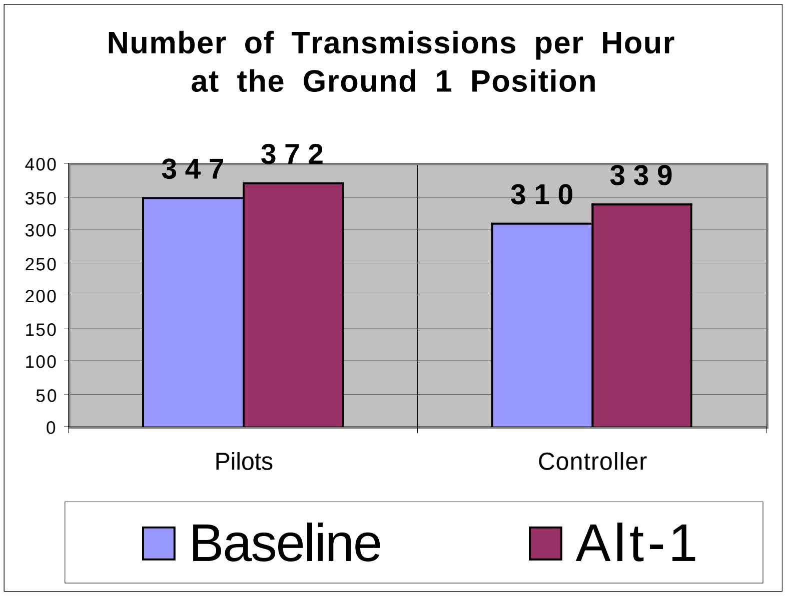

Figure 17: Alternative 1, Swapped Runways, Voice Transmissions, GC-1 Position

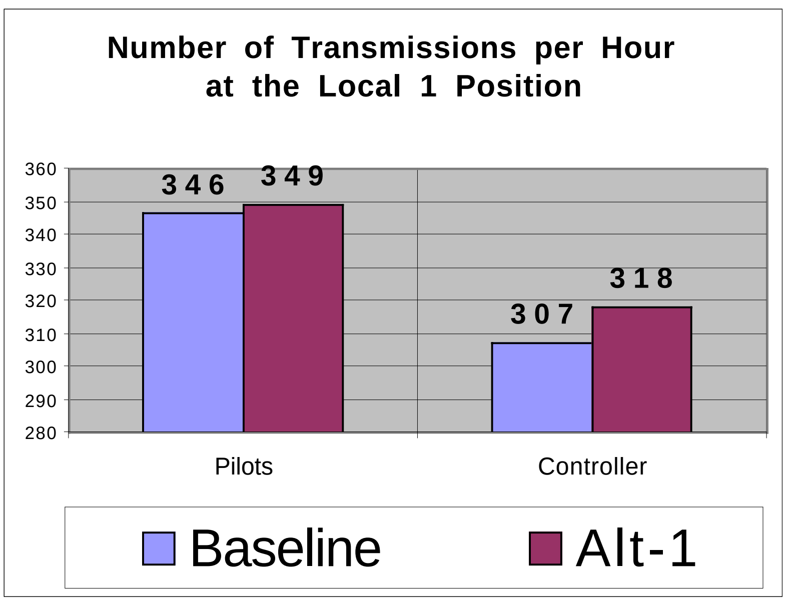

Figure 18: Alternative 1, Swapped Runways, Voice Transmissions, LC-1 Position

This data supports the results from the subjective data analysis (See Section 4.1.1, Question 3). The mean ratings for the communication criteria and comments provided by the controllers confirm the **increased amount of communication needed in the Alternative 1 scenarios.**

4.2 Data Results for Alternative 2, Two South Locals

Alternative 2: was tested under following rules:

Runway 25R is under the control of LC-1. Runway 25L is under the control of LC-3. LC-3 coordinates the crossing of the inboard runway with LC-1 internally and gives clearance to pilots.

Three runs of this Alternative were performed during first week of Phase II, one each in peak arrival, peak departure , and instrument flight rules (IFR) conditions. LC-1, LC-3, and GC-1 control the south side; LC-2 and GC-2 control the north side of the airport. FFC provided the controller for the LC-2 position.

4.2.1 Results of Controller Surveys for Alternative 2, Two South Locals

Question 1: The amount of coordination required with the controllers on my side of the airport was: (1 represents ‘Much more,’ 5 – ‘Much less’)

Same-side Coordination	LC-1	GC-1	GC-2	LC-3
Mean Rating	**1.33**	**2.33**	**3.00**	**1.00**
Standard Deviation	0.47	0.47	0.00	0.00

This table shows that in comparison with current LAX operations Alternative 2 required 'Much more' coordination on the south side, especially between LC-1 and LC-3.

Question 2: The amount of coordination required with the controllers on other side of the airport was: (1 represents ‘Much more,’ 5 – ‘Much less’)

Cross-cab Coordination	LC-1	GC-1	GC-2	LC-3
Mean Rating	**4.67**	**3.00**	**4.00**	**3.67**
Standard Deviation	0.47	0.00	0.82	0.94

This table shows that compared to current LAX operations Alternative 2 required 'Less' coordination between Controllers on the opposite sides of the airport.

Question 3: The amount of communication with the pilots was: (1 represents ‘Much more,’ 5 – ‘Much less’)

Communication	LC-1	GC-1	GC-2	LC-3
Mean Rating	**3.00**	**2.33**	**3.00**	**3.00**
Standard Deviation	0.00	0.94	0.00	0.00

Alternative 2 required 'About the same' amount of communication with the pilots as current LAX operations.

Question 4: The overall efficiency of this operation was (1 represents ‘Much less efficient, 5 – ‘Much more efficient’)

Efficiency	LC-1	GC-1	GC-2	LC-3
Mean Rating	**2.00**	**2.33**	**2.33**	**1.33**
Standard Deviation	0.82	0.47	0.94	0.47

Alternative 2 was rated as 'Less efficient' than current operations at LAX and 'Much less efficient' from the position of LC-3 (controlling 25L).

Question 5: In your estimation, relative to current LAX operations, the potential for a runway incursion on this run was: (1 represents ‘Much more;’ 5 – ‘Much less’)

Safety	LC-1	GC-1	GC-2	LC-3
Mean Rating	**1.67**	**2.33**	**2.67**	**1.33**
Standard Deviation	0.47	0.47	0.47	0.47

This table indicates that local controllers on the south side consider the potential for a runway incursion 'Much more' than under current operations. Additionally, ground controllers rated the potential for runway incursions for Alternative 2 'More' than for current LAX operations.

Question 6: Level of traffic complexity in your control area was: (1 represents ‘Much higher ; 5 – ‘Much lower’)

Complexity	LC-1	GC-1	GC-2	LC-3
Mean Rating	**2.67**	**2.67**	**2.67**	**3.00**
Standard Deviation	0.94	0.47	0.47	1.41

Compared with the current LAX operations, Alternative 2 presents a 'Higher' level of traffic complexity.

Question 7: How would you rate your ability to manage the traffic flow under this scenario: (1– 'impossible to manage,' 5 – 'easier than under current operations')?

Manageablility	LC-1	GC-1	GC-2	LC-3
Mean Rating	**2.33**	**2.33**	**2.67**	**2.67**
Standard Deviation	0.47	0.47	0.47	0.94

Compared to current operations, all controllers considered traffic flow to be 'More difficult' to manage under Alternative 2.

Figure 19 shows the overall mean rating of questions 1 through 7 in each tower position. The horizontal red line represents a rating of 'About the same' as current LAX operations.

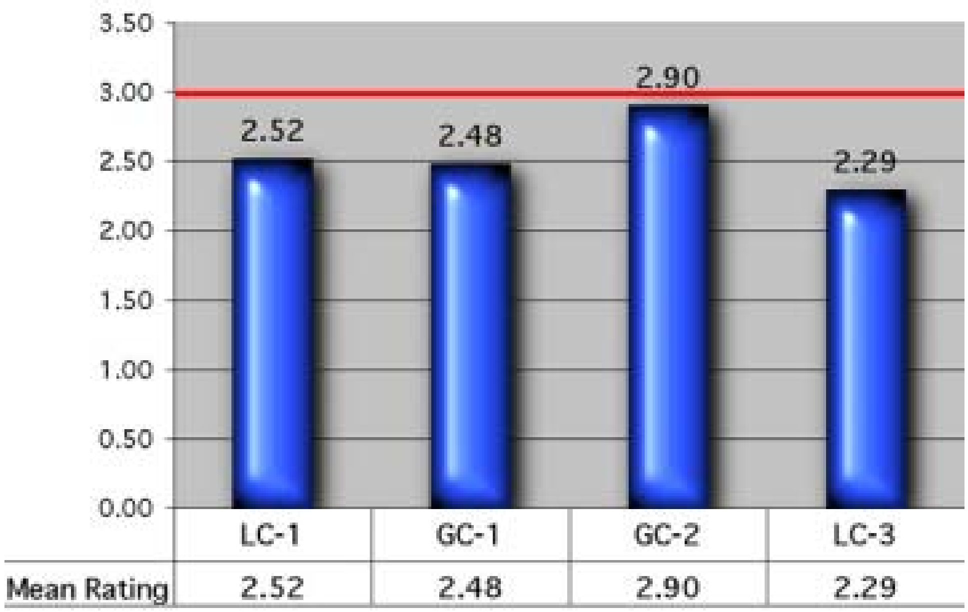

Figure 19: Alternative 2, Two South Locals, Mean Rating for Questions 1 - 7

Figure 19 indicates that Alternative 2 presents a more difficult environment to operate than the current LAX operation.

Key Controller Comments:

GC-1: *"Had to coordinate with two people instead of one. LC3 did not know if he was crossing at times."*

LC-1: *"Efficiency reduced due to the two plans – i.e. LC1 traffic & LC3 traffic – and the need to coordinate."*

LC-3: *"Efficiency was compromised due to excessive coordination and trying to fit RWY crossings with LC1 & GC1 traffic."*
"Much more [safe] but based on excessive coordination & the possibility of misunderstanding the potential for pilots was the same."
" More of a chance for missed communication between controllers."

Question 8: The most critical problem(s) in this scenario was/were: (circle up to three choices)

Most Critical Problems	L - 1	G - 1	L - 2	G - 2	L - 3	Total number of Occurrences	Frequency of Occurrence
Communication	0	1	0	0	0	1	**0.08**
Coordination	2	1	0	0	3	6	**0.50**
Traffic Complexity	1	2	0	0	0	3	**0.25**
Workload	1	1	1	0	0	3	**0.25**
Safety	2	0	0	0	2	4	**0.33**
Manageability	1	2	2	1	2	8	**0.67**

Table 5: Alternative 2, Two South Locals, Most Critical Problems

The data from this table demonstrate that the most critical aspects of the Alternative 2 operations were:

At LC-1 position: Coordination, Safety

At GC-1 position: Traffic Complexity, Manageability

At GC-2 position: Manageability

At LC-3 position: Coordination, Safety, and Manageability

Criteria that was mentioned the most as critical for Alternative 2:

- **Coordination** - Frequency of Occurrence = **0.50**
- **Safety** - Frequency of Occurrence = **0.33**
- **Manageability** - Frequency of Occurrence = **0.67**

4.2.2. Statistical Airport Operations Data for Alternative 2

Average Arrival Taxi Time Data

The following table presents the calculated average arrival taxi times from the Alternative 2 simulation for pre-selected airport terminal locations. "North" refers to the gates at terminals T1 - T3 and gates 119-123 at the Tom Bradley International Terminal (TBIT). "South" refers to the terminals T4 - T8 and gates 101-106 at the Tom Bradley International Terminal (TBIT). The taxi time begins at the touch-down point and ends at the gate.

		Alternative 2	
		Arrivals	
From	To	Taxi Time (min.)	Std Dev (min.)
North	North	10	2.8
North	South	14	2.5
South	South	8	3.3
South	North	12	3.6
South	C-Nest	4	0.8
North	Q-Nest	3	
South	Box	5	2.0
North	Box	12	2.5
Q-Nest	North		
South	Box		
North	Box		

Table 6: Alternative 2, Two South Locals, Arrival Taxi Times

The comparison chart in the Figure 20 demonstrates that taxi tames on arrivals in the Alternative 2 scenarios were about the same as in the Baseline scenarios.

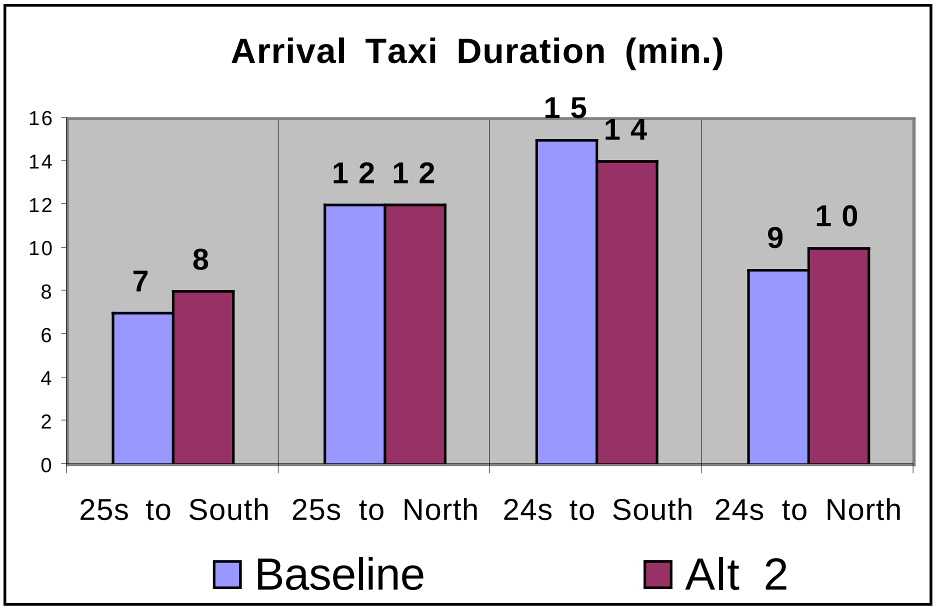

Figure 20: Alternative 2, Two South Locals, Arrival Taxi Duration

Average Departure Taxi Time Data

This table shows computed departure taxi times from pre-selected terminal locations (North, South, Nest, and Box) to the runways. “North” refers to the gates in the terminal area T1 - T3 and “South” refers to the terminal area T4 - T8. The taxi time is the elapsed time between the alleyway “SPOTS” and the beginning of the takeoff roll. For aircraft that push directly onto the taxiway, the time is calculated from the start of the forward taxi movement. They do <u>not include</u> any takeoff roll time.

		Alternative 2 Departures	
From	to	Taxi Time (min.)	Std Dev (min.)
North	24s	11	5.1
North	25s	19	2.8
South	25s	12	2.2
South	24s	17	3.9
Q-Nest	24s	15	6.2
Box	25s	13	1.8
Box	24s	16	2.6

Table 7: Alternative 2, Two South Locals, Departure Taxi Times

The chart in the Figure 21 demonstrates that taxi times for departures on 25s in Alternative 2 operations were about the same as in Baseline scenarios. Taxi times for departures on 24s were higher in Alternative 2 than in Baseline.

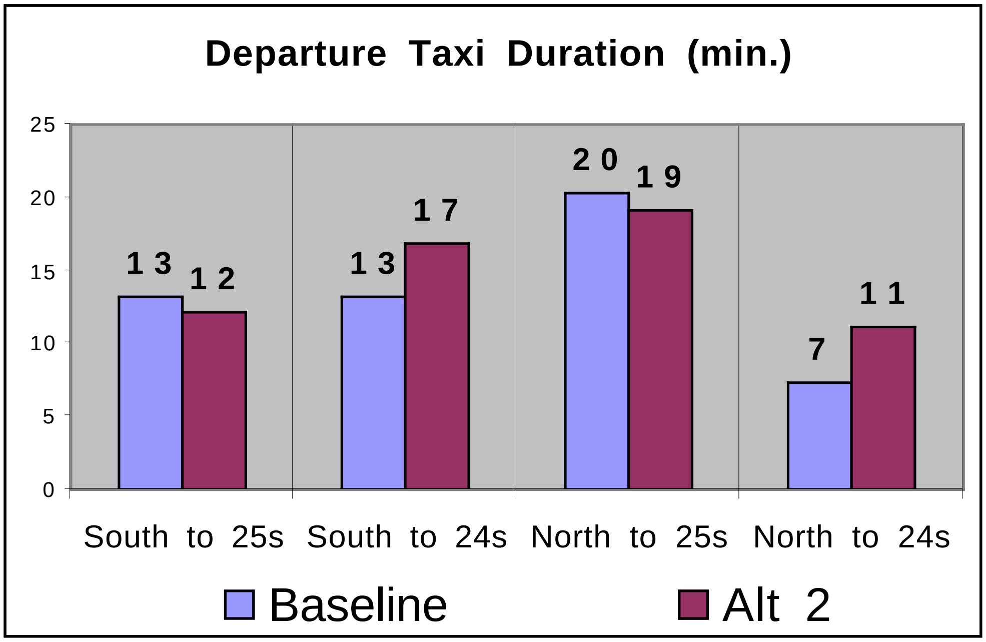

Figure 21: Alternative 2, Two South Locals, Departure Taxi Duration

Running Average Departure Rate Data

Departure rate data was computed separately for peak arrival and peak departure scenarios. Figure 22 compares Alternative 2 and Baseline departure rates.

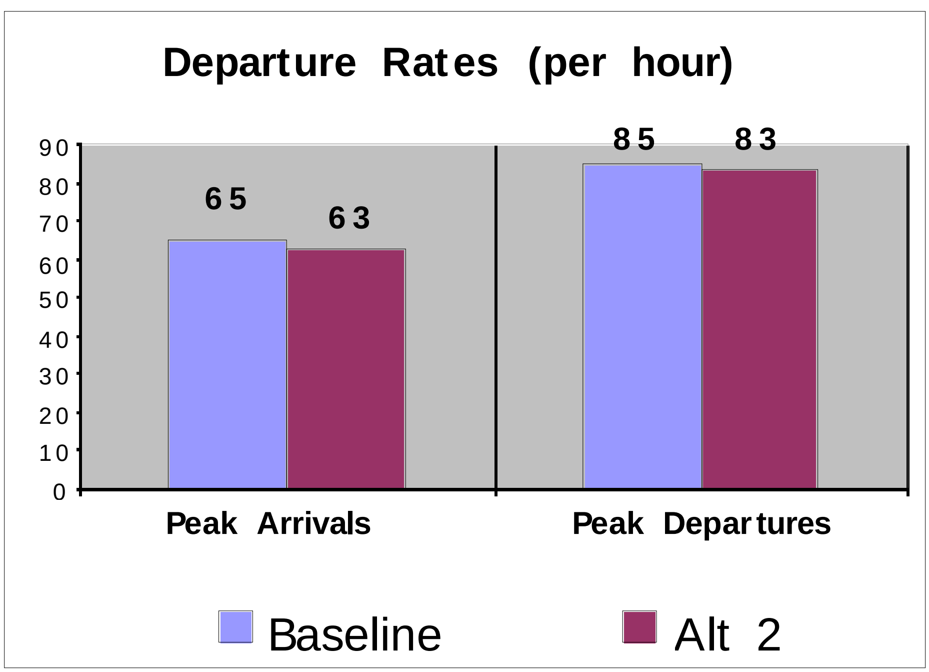

Figure 22: Alternative 2, Two South Locals, Departure Rates

Data from the chart in Figure 22 indicates that the departure rate in the Alternative 2 operations was lower by 3-4% for both peak arrival and peak departure scenarios relative to the Baseline operations.

4.2.3 Controller Voice Communication Data for Alternative 2

The following is a comparison of the voice data recorded from the Alternative 2 test runs in comparison with voice data recorded from the Baseline scenarios. The primary parameters for comparison are the 'Air Time Distribution' and 'Number of transmissions per hour'.

Figure 23 provides a comparison of the Air Time distribution for the Baseline and Alternative 2 at GC-1 position.

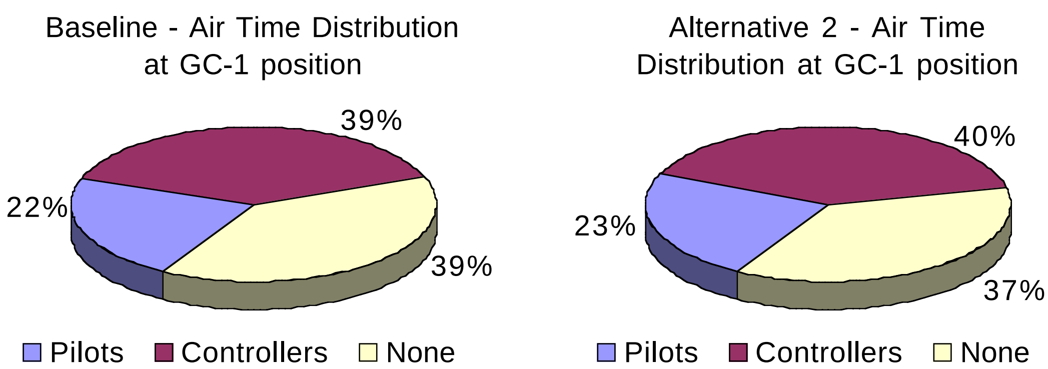

Figure 23: Alternative 2, Two South Locals, Air Time Distribution, GC-1 Position

Since the control of 25L and 25R was divided between LC-1 and LC-3, the amount of communication with pilots on each Local position was reduced in comparison with the Baseline. However, the coordination required between LC-1 and LC-3 contributed to the workload on both positions.

Verbal communication between LC-1 and LC-3 was recorded using a console microphone. The average of number of 'transmissions' per hour between the locals on Alternative 2 scenarios was 32.

The following chart demonstrates that the number of transmissions at the GC-1 position was 3-4% higher for Alternative 2 in comparison with the Baseline scenarios.

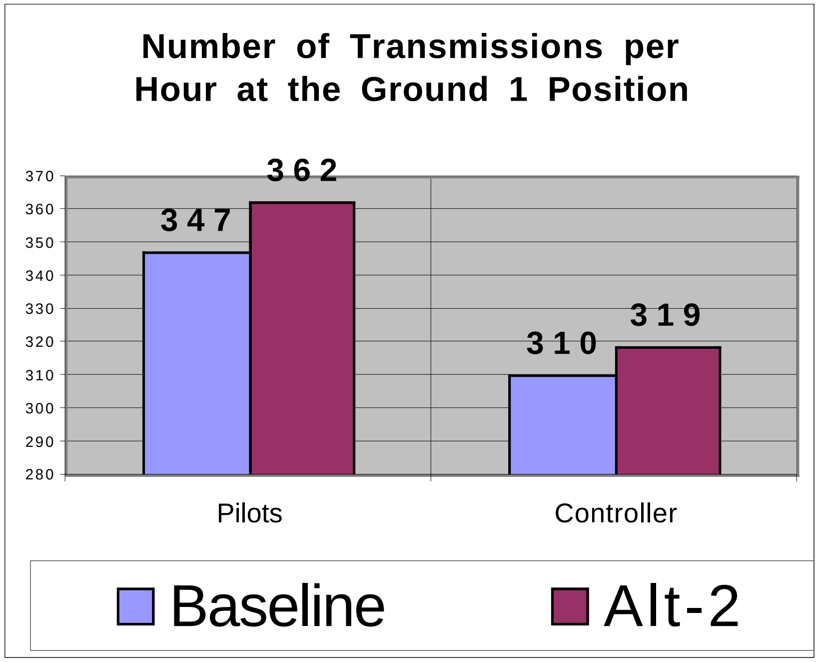

Figure 24: Alternative 2, Two South Locals, Voice Transmissions, GC-1 Position

The chart in the Figure 25 compares the number of transmissions per hour on the LC-1 position for the Baseline and LC-1 and 3 for Alternative 2. The sum of LC-1 and LC-3 transmissions is greater for pilots and controllers than in the Baseline for the LC-1 alone. This supports the subjective data that coordination was a critical problem for this alternative. (See section 4.2.1, Question 8.)

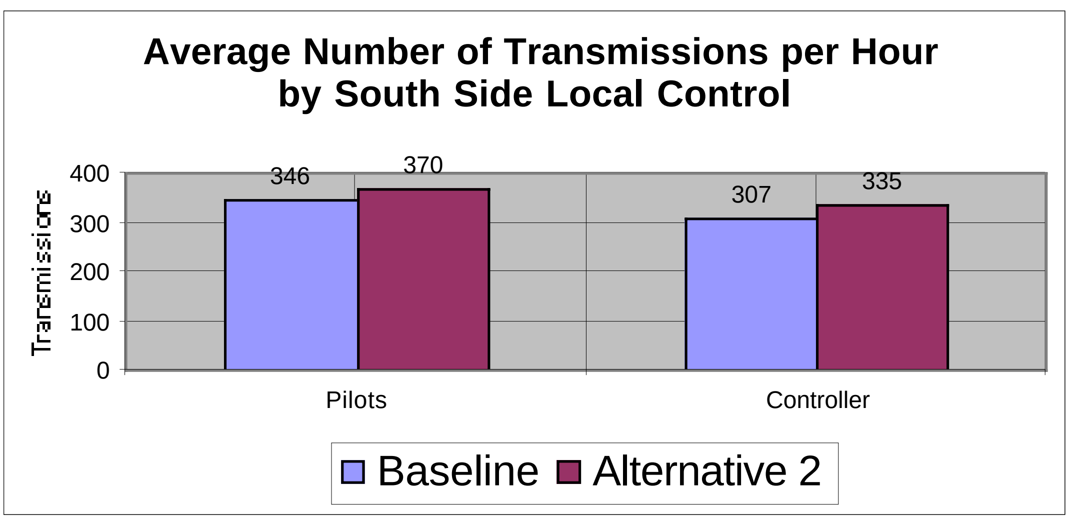

Figure 25: Alternative 2, Two South Locals, Voice Transmissions, South Side Local Control

Overall results of the voice data analysis for Alternative 2 indicate that the amount of controller-pilot communication at GC-1 position was 'More' than in the Baseline operations. Pilot communication, divided across two local controllers, was also higher than the Baseline.

4.3 Data Results for Alternative 3, B-16: AA, One Way

Alternative 3 was tested under following rules:

A proposed B16 extension is utilized to avoid crossing 25R. All aircraft arriving on 25L turn left onto the Taxiway A and stay on the local frequency until crossing 25L on Taxiway U, at which time they contact GC-3. Aircraft bound for the North Complex taxi via AA. Aircraft bound for the South Complex turn onto B. All 24L/R arrivals bound for the South Complex taxi via the South Route. The Bridge Route is not available.

Two runs of this alternative were performed during the first week of Phase II. LC-1, GC-1, and GC-3 control the south side of the airport; LC-2 and GC-2 control the north side. FFC supplied the controller for the LC-2 position.

4.3.1 Results of Controller Surveys for Alternative 3

Question 1: The amount of coordination required with the controllers on my side of the airport was: (1 represents 'Much more,' 5 - 'Much less')

Same-Side Coordination	LC-1	GC-1	GC-2	GC-3
Mean Rating	**4.00**	**4.50**	**2.50**	**3.00**
Standard Deviation	0.00	0.50	0.50	0.00

The data from this table shows that in comparison with current LAX operations Alternative 3 required 'Less' coordination on the south side, and 'More' on the north side at GC-2 position.

<u>Question 2:</u> The amount of coordination required with the controllers on other side of the airport was: (1 represents 'Much more,' 5 - 'Much less')

Cross-Cab Coordination	LC-1	GC-1	GC-2	GC-3
Mean Rating	**4.50**	**3.50**	**3.00**	**3.00**
Standard Deviation	0.50	0.50	0.00	0.00

The data from this table shows that in comparison with current LAX operations Alternative 3 required 'About the same' amount of coordination between Ground Controllers on the opposite sides of the airport, but much more coordination for LC-1.

<u>Question 3:</u> The amount of communication with the pilots was: (1 represents 'Much more,' 5 - 'Much less')

Communication	LC-1	GC-1	GC-2	GC-3
Mean Rating	**3.00**	**3.00**	**2.50**	**3.00**
Standard Deviation	1.00	0.00	0.50	0.00

Alternative 3 required 'About the same' amount of communication with the pilots as current LAX operations except for the GC-2 position where 'More' communication with pilots was required.

<u>Question 4:</u> The overall efficiency of this operation was: (1 represents 'Much less efficient;' 5 - 'Much more efficient')

Efficiency	LC-1	GC-1	GC-2	GC-3
Mean Rating	**3.50**	**3.00**	**3.00**	**3.50**
Standard Deviation	1.50	1.00	0.00	0.50

Subjective data from this question indicates that the efficiency of Alternative 3 appears to be 'About the same' as current operations at LAX.

<u>Question 5:</u> In your estimation, relative to current LAX operations, the potential for a runway incursion on this run was: (1 represents 'Much more,' 5 - 'Much less')

Safety	LC-1	GC-1	GC-2	GC-3
Mean Rating	**3.50**	**4.50**	**2.50**	**3.50**
Standard Deviation	1.50	0.50	0.50	1.50

The data from this table indicates that in comparison with current operations, Ground Controller 2 (north side) considered the potential for a runway incursion 'More' than under the current operation mode. In other control areas the potential for incursion appears to be 'Less.'

Question 6: Level of traffic complexity in your control area was: (1 - 'Much higher,' 5 - 'Much lower')

Complexity	LC-1	GC-1	GC-2	GC-3
Mean Rating	**3.00**	**4.50**	**2.00**	**3.50**
Standard Deviation	1.00	0.50	0.00	0.50

In comparison with current LAX operations, Alternative 3 presents a 'Higher' level of traffic complexity in Ground Control 2 area and a 'Lower' level of traffic complexity in other control areas.

Question 7: How would you rate your ability to manage the traffic flow under this scenario: (1 represents 'impossible to manage,' 5 – 'easier than under current operations')?

Manageability	LC-1	GC-1	GC-2	GC-3
Mean Rating	**3.50**	**4.50**	**3.00**	**4.00**
Standard Deviation	1.50	0.50	0.00	1.00

The data from this table indicates that all controllers except GC-2 consider traffic flow to be 'Easier' to manage under Alternative 3 than under the current operations mode.

The following diagram shows the overall mean rating for Alternative 3 in each tower position controlled by LAX controllers. The red line represents a rating of 'About the same' as current LAX operations.

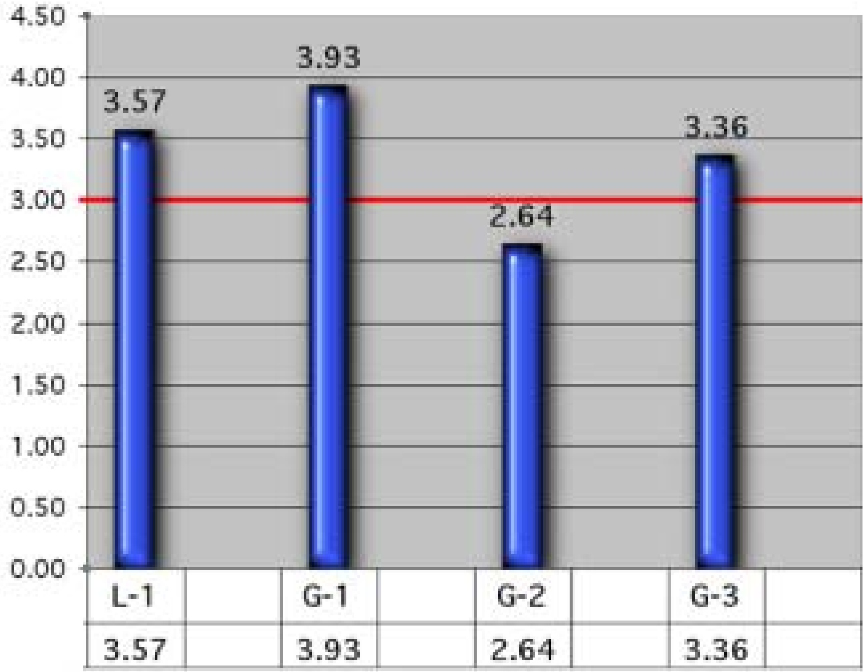

Figure 26: Alternative 3, B-16: AA, One Way, Mean Rating Questions 1 through 7

The data from Figure 26 indicate that subjectively, Alternative 3 presents a more favored operational environment than controllers experience under current LAX operation procedures. However, in the area of Ground Control 2 more challenges were introduced due to congestion on Taxiway E. (See Figure 27.)

Key Controller Comments:

GC-1: *"From the GC-1 stand-point, this problem has a very high mark."*
"The workload was much reduced and the Complex level was brought down."

LC-1: *"Less coordination w/ GC1 since all Rwy 25L arrivals turned left.*
"Crossing traffic at the runway end was the most critical. But not bad at all when having to cross."

GC-3: *"Normal operation, no conflictions or coordination issues."*
"I blocked taxiway AA once with crossing traffic. And with volume on taxiway E increased because "Bridge Route" isn't available and inbounds from south side came from AA, the potential to block runway exits more exists."

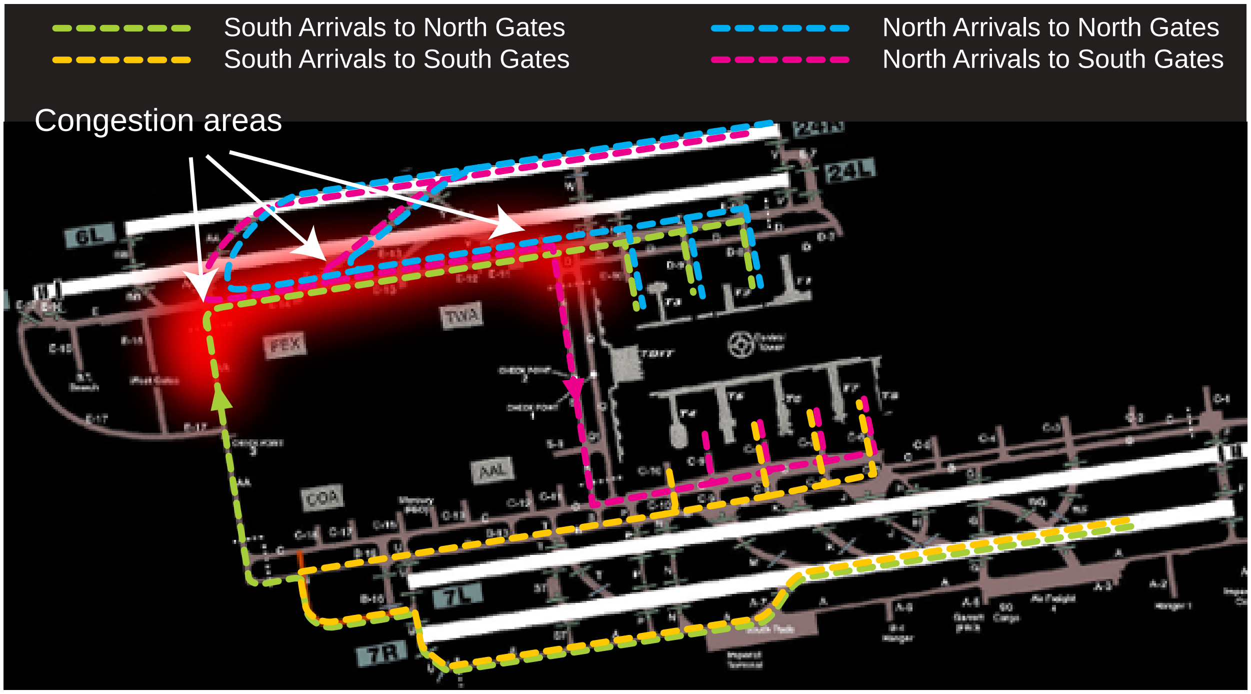

Figure 27: Alternative 3, B-16: AA, One Way, Traffic Congestion Areas

Question 8: The most critical problem(s) in this scenario was/were: (controllers could circle up to three choices)

Most Critical Problem(s)	L-1	G-1	G-2	G-3	Total number of Occurrences	Frequency of Occurrence
Communication	0	0	0	0	0	0.00
Coordination	0	0	1	0	1	0.13
Traffic Complexity	1	0	2	0	3	0.38
Workload	1	0	0	0	1	0.13
Safety	2	0	0	1	3	0.38
Manageability	0	0	1	0	1	0.13

Table 8: Alternative 3, B-16: AA, One Way, Most Critical Problems

The data from this table demonstrate that the most critical aspects of the Alternative 3 operations were:

At LC-1 position: Safety

At GC-2 position: Traffic Complexity, Manageability

At GC-3 position: Safety

Criteria that was mentioned the most as critical for Alternative 3:

- **Traffic Complexity** - Frequency of Occurrence = **0.38**
- **Safety** - Frequency of Occurrence = **0.38**

4.3.2 Statistical Airport Operations Data for Alternative 3

Average Arrival Taxi Time Data

The following table presents the calculated average arrival taxi times from the Alternative 3 simulation for pre-selected airport terminal locations. “North” refers to the gates at terminals T1 - T3 and gates 119-123 at the Tom Bradley International Terminal. “South” refers to the terminals T4 - T8 and gates 101-106 at the Tom Bradley International Terminal. The taxi time begins at the touch-down point and ends at the gate.

		Alternative 3	
		Arrivals	
From	to	Taxi Time (min.)	Std Dev (min.)
24s	North	10	2.6
24s	South	13	3.3
25s	South	11	3.0
25s	North	16	2.5
25s	C-Nest	6	3.0
24s	Q-Nest	3	-
25s	Box	13	1.6
24s	Box	10	1.7

Table 9: Alternative 3, B-16: AA, One Way, Arrival Taxi Times

Figure 28 shows that Alternative 3 taxi times on arrivals from the 25s to the south gates were 55% higher than the Baseline taxi times, and from the 25s to the north gates the taxi time was 33% higher than the baseline numbers.

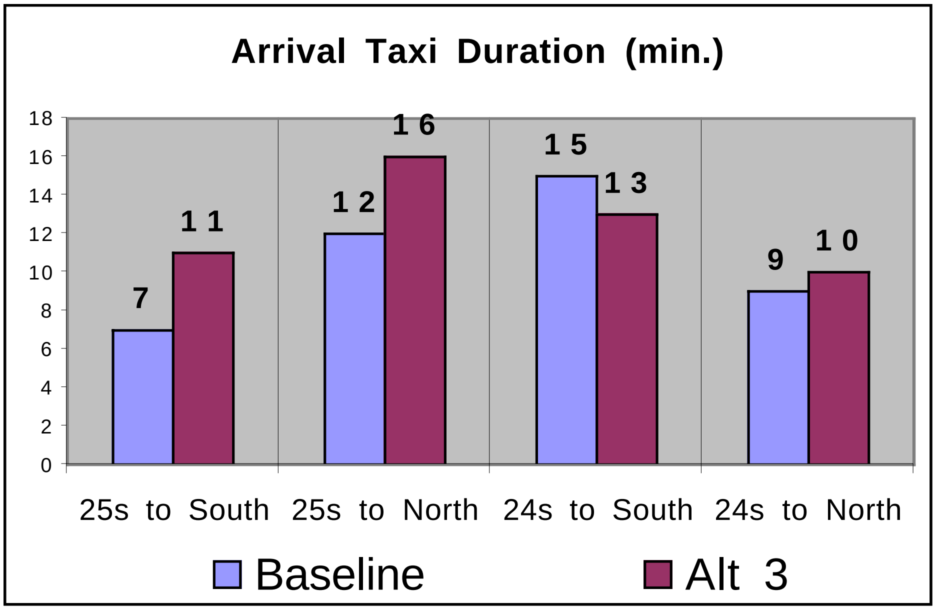

Figure 28: Alternative 3, B-16: AA, One Way, Arrival Taxi Duration

Average Departure Taxi Time Data

This table shows computed departure taxi times from pre-selected terminal locations (North, South, Nest, and Box) to the runways. "North" refers to the gates at terminals T1 - T3 and gates 119-123 at the Tom Bradley International Terminal. "South" refers to the terminals T4 - T8 and gates 101 –106 at the Tom Bradley International Terminal. The taxi time is the elapsed time between the alleyway "SPOTS" and the beginning of the takeoff roll. For aircraft that push directly onto the taxiway, the time is calculated from the start of the forward taxi movement. They do <u>not include</u> any takeoff roll time.

		Alternative 3 Departures	
From	to	Taxi Time (min.)	Std Dev (min.)
North	24s	11	4.7
North	25s	18	3.1
South	25s	12	4.2
South	24s	18	4.5
Q-Nest	24s	15	2.0
Box	25s	19	8.2
Box	24s	15	4.1

Table 10: Alternative 3, B-16: AA, One Way, Departure Taxi Times

Figure 29 shows that Alternative 3 taxi times for departures on the 25s were about 10% lower than taxi times in the Baseline scenarios. Taxi times for departures on the 24s from south and north gates were higher than Baseline numbers by 38% and 55% respectively.

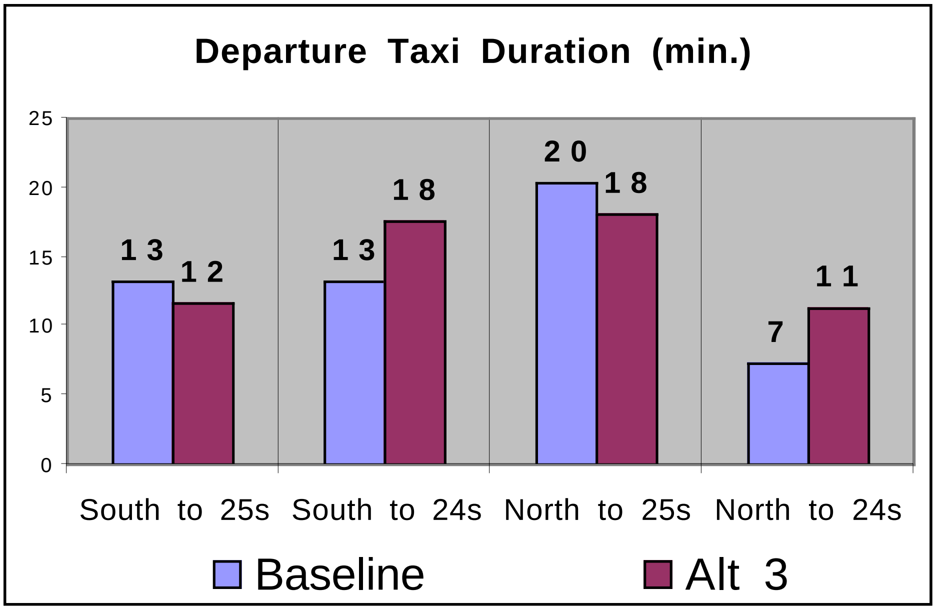

Figure 29: Alternative 3, B-16: AA, One Way, Departure Taxi Duration

Running Average Departure Rate Data

Departure rates were calculated separately for peak arrival (VFR-1) and peak departure (VFR-2) scenarios. Figure 30 shows the comparison in departure rates between Alternative 3 and the Baseline.

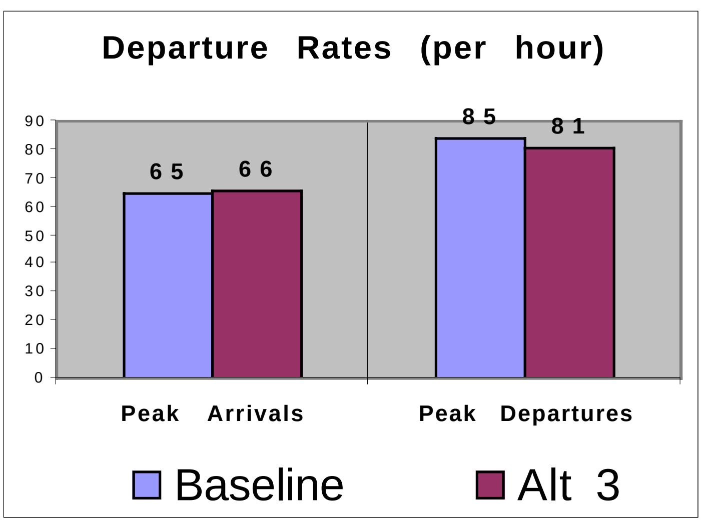

Figure 30: Alternative 3, B-16: AA, One Way, Departure Rates

Figure 30 indicates that the departure rate in Alternative 3 was about the same as in the Baseline scenarios during the peak arrival scenario and lower by 5% during the peak departure scenario.

4.3.3 Controller Voice Communication Data for Alternative 3

The following is a comparison of the voice data recorded during Alternative 3 with voice data recorded during the Baseline scenarios. The parameters compared are the 'Air Time Distribution' and 'Number of transmissions per hour'.

The following figure demonstrates that the GC-1 controller spent 12% less time talking to the pilots during Alternative 3.

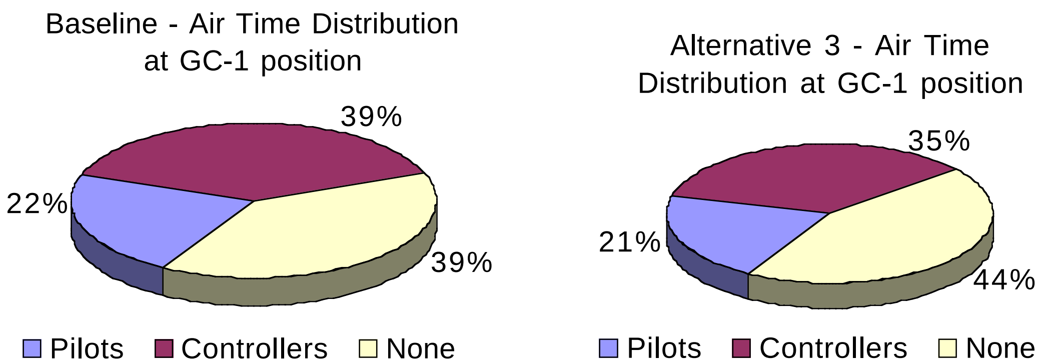

Figure 31: Alternative 3, B-16: AA, One Way, Air Time Distribution, GC-1 Position

The following figure provides a comparison of the Air Time distribution at the LC-1 position between Alternative 3 and Baseline, and shows no significant difference.

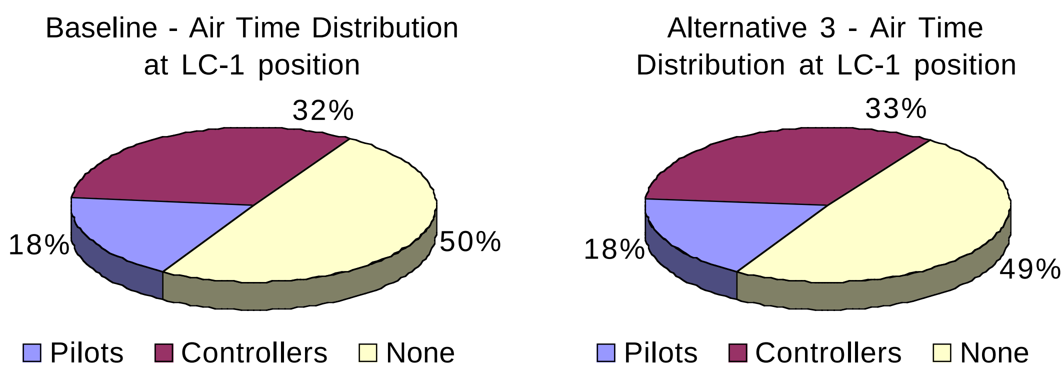

Figure 32: Alternative 3, B-16: AA, One Way, Air Time Distribution, LC-1 Position

Comparison of the voice data at GC-1 position shows that the 'Number of transmissions per hour' for Alternative 3 is slightly less than for the Baseline (See Figure 33.)

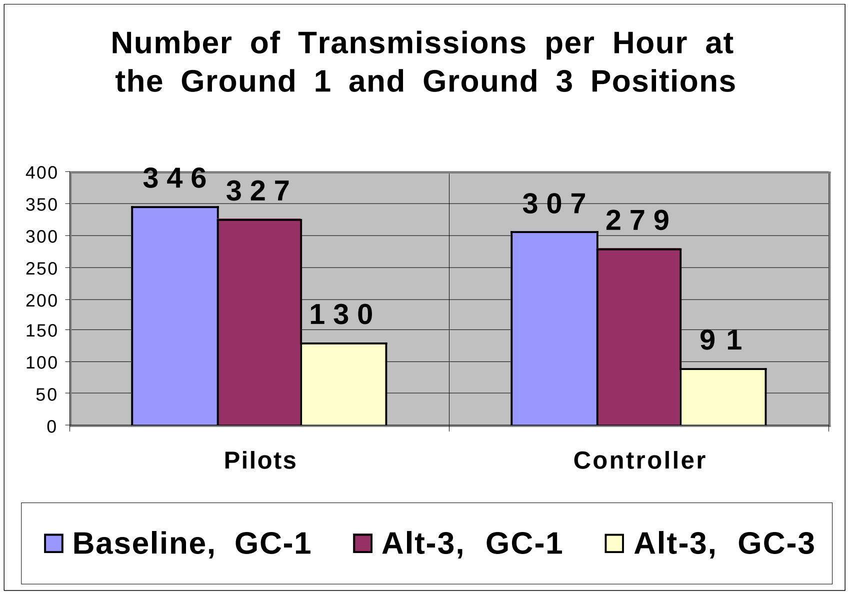

Figure 33: Alternative 3, B-16: AA, One Way, Voice Transmissions, GC-1 and GC-3 Positions

The average number of transmissions at LC-1 position very closely matches the results of the voice data recorded during the Baseline tests. (See Figure 34.) There is a slight increase in number of transmissions sent by LC-1. This might be attributed to the issue commented on by the LAX controllers working at this position during Alternative 3 test: “More communication since LC1 is responsible to issue initial taxi instructions and then issue runway crossing instructions.”

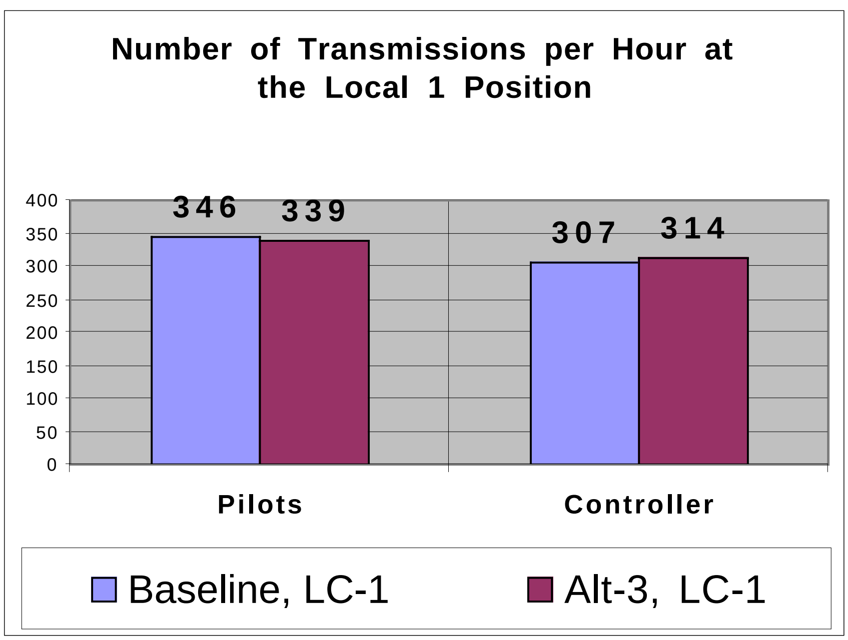

Figure 34: Alternative 3, B-16: AA, One Way, Voice Transmissions, LC-1 Position

Overall results of the voice data analysis for Alternative 3 support the findings from the subjective surveys which indicate that the amount of controller-pilot communication on the south side of the LAX is 'About the same' as for the Baseline. See the results of the controllers' survey for Alternative 3, Section 4.3.1, Question 3.

4.4 Data Results for Alternative 3a, B-16: Bridge Open

Alternative 3a was run under the following rules:

A proposed B16 extension was utilized to avoid crossing 25R. All aircraft arriving on 25L will turn left onto the Alpha taxiway. This alternative differs from Alternative 3 in that for aircraft bound for the North Complex taxiing on the B-16 extension, GC-3 has the option of the West Route (AA) or the North Route (Q). The Bridge Route is open.

Four runs of Alternative 3a were performed during the second week of Phase II. LC-1, GC-1, and GC-3 control the south side of the airport; LC-2 and GC-2 control the north side. FFC staff worked the LC-2 position.

4.4.1 Results of Controller Surveys for Alternative 3a

Question 1: The amount of coordination required with the controllers on my side of the airport was: (1 represents 'Much more,' 5 - 'Much less')

Same-Side Coordination	LC-1	GC-1	GC-2	GC-3
Mean Rating	**4.00**	**3.75**	**3.00**	**2.75**
Standard Deviation	0.71	0.83	0.00	0.83

This table shows that compared to current LAX operations Alternative 3a required 'More' coordination at the GC-3 position and 'Less' coordination at LC-1 and GC-1 positions.

Question 2: The amount of coordination required with the controllers on other side of the airport was: (1 represents 'Much more,' 5 - 'Much less')

Cross-Cab Coordination	LC-1	GC-1	GC-2	GC-3
Mean Rating	**4.25**	**3.75**	**3.25**	**3.25**
Standard Deviation	0.43	0.83	0.43	0.43

This table shows that compared to current LAX operations Alternative 3a required 'Less' coordination between Controllers on the opposite sides of the airport.

Question 3: The amount of communication with the pilots was: (1 represents 'Much more,' 5 - 'Much less')

Communication	LC-1	GC-1	GC-2	GC-3
Mean Rating	**3.25**	**4.00**	**3.00**	**2.75**
Standard Deviation	0.43	0.71	0.71	0.43

Alternative 3a required 'Less' communication with the pilots at LC-1 and GC-1 positions and 'More' at GC-3 position.

Question 4: The overall efficiency of this operation was: (1 represents 'Much less efficient,' 5 - 'Much more efficient')

	LC-1	GC-1	GC-2	GC-3
Mean Rating	**3.00**	**4.50**	**3.00**	**4.00**
Standard Deviation	1.22	0.50	0.71	0.71

Alternative 3a was rated 'More efficient' than current LAX operations at GC-1 and GC-3 positions and 'About the same' from the position of LC-1 and GC-2.

Question 5: In your estimation, relative to current LAX operations, the potential for a runway incursion on this run was: (1 represents 'Much more,' 5 - 'Much less')

Safety	LC-1	GC-1	GC-2	GC-3
Mean Rating	**4.25**	**4.25**	**3.25**	**4.00**
Standard Deviation	0.43	0.43	0.83	0.71

This table indicates that compared to current operations the potential for a runway incursion was rated 'Less' in all control areas.

Question 6: Level of traffic complexity in your control area was: (1 represents 'Much higher;' 5 - 'Much lower')

Complexity	LC-1	GC-1	GC-2	GC-3
Mean Rating	**2.50**	**4.00**	**3.25**	**2.25**
Standard Deviation	0.87	0.71	0.43	0.43

Compared to current LAX operations Alternative 3a presents a 'Higher' level of traffic complexity in control area of LC-1 and GC-3 but a 'Lower' level of traffic complexity in the area of GC-1 and GC-2.

Question 7: How would you rate your ability to manage the traffic flow under this scenario: (1 represents ‘impossible to manage;’ 5 – ‘easier than under current operations’)?

Manageability	LC-1	GC-1	GC-2	GC-3
Mean Rating	**2.75**	**4.25**	**4.00**	**4.00**
Standard Deviation	0.83	0.83	0.71	0.71

For Alternative 3a, all controllers consider traffic flow to be 'Easier' to manage except LC-1 position where it appeared to be slightly 'More difficult' to manage than under current operations.

The following diagram shows the combined mean rating for questions 1 through 7 by each tower position worked by LAX controllers. The horizontal red line represents a rating of 'About the same' as current LAX operations.

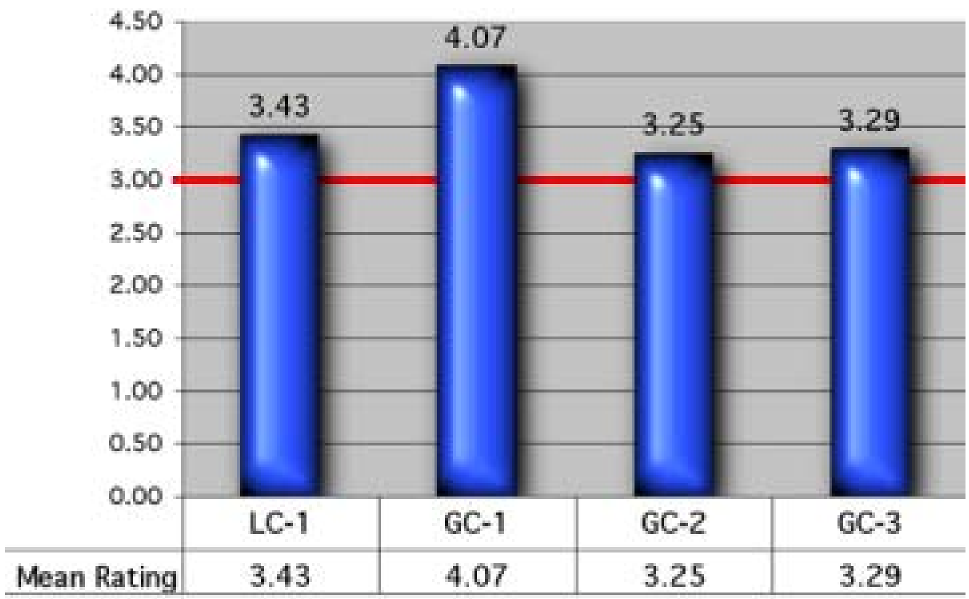

Figure 35: Alternative 3a, B-16: Bridge Open, Mean Rating for Question 1-7

Figure 35 indicates that controllers rated Alternative 3a better, or higher, than current LAX operations.

Key Controller Comments:

GC-1: *"Much smoother op. than normal LAX procedures."*
"Actually, there were no critical components."

LC-1: *"Less conflictions with ground traffic."*
"Traffic on the taxiways [are] longer = more congestion."
"Had to increase scan due to traffic on both sides of the runway"

GC-3: *"Ran smooth, no complications."*

Question 8: The most critical problem(s) in this scenario was/were: (circle up to three choices)

Most Critical Problems	Number of Occurrences per Position				Total number of Occurrences	Frequency of Occurrence
	L-1	G-1	G-2	L-3		
Communication	0	3	1	1	5	**0.31**
Coordination	0	2	1	0	3	**0.19**
Traffic Complexity	3	0	0	0	3	**0.19**
Workload	1	1	1	1	4	**0.25**
Safety	1	0	0	0	1	**0.06**
Manageability	4	0	0	0	4	**0.25**

Table 11: Alternative 3a, B-16: Bridge Open, Most Critical Problems

This table demonstrates that the most critical aspects of Alternative 3a operations were:

At LC-1 position: Traffic Complexity, Manageability

At GC-1 position: Communication, Coordination

Criteria that was mentioned the most as critical for Alternative 3a

- **Communication** - Frequency of Occurrence = **0.31**

4.4.2. Statistical Airport Operations Data for Alternative 3a

Average Arrival Taxi Time Data

The following table presents calculated average arrival taxi time data from the Alternative 3a simulation for pre-selected airport terminal locations. “North” refers to the gates at terminals T1 - T3 and gates 119-123 at the Tom Bradley International Terminal. “South” refers to the terminals T4 - T8 and gates 101 –106 at the Tom Bradley International Terminal. Taxi time begins at the touch-down point and ends at the gate.

		Alternative 3a Arrivals	
From	To	Taxi Time (min.)	Std Dev (min.)
24s	North	7	1.9
24s	South	13	3.4
25s	South	13	4.6
25s	North	13	4.0
25s	C-Nest	9	3.8
24s	Q-Nest	5	
25s	Box	16	2.4
24s	Box	8	1.9

Table 12: Alternative 3a, B-16: Bridge Open, Arrival Taxi Times

Figure 36 demonstrates that Alternative 3a taxi times on arrivals from the 25s to the south gates were 85% higher than Baseline taxi times, and from the 25s to the north gates, 8% higher. Arrival taxi times from the 24s were about 15% lower than during Baseline scenarios.

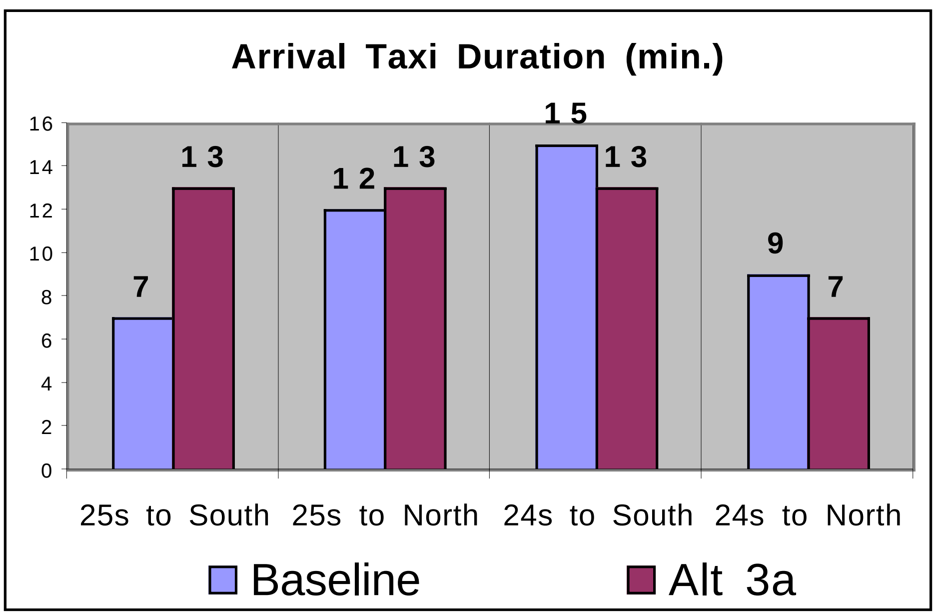

Figure 36: Alternative 3a, B-16: Bridge Open, Arrival Taxi Duration

Average Departure Taxi Time Data

This table shows the computed average departure taxi times from pre-selected terminal locations (North, South, Nest, and Box) to the runways. “North” refers to the gates at terminals T1 - T3 and gates 119-123 at the Tom Bradley International Terminal. “South” refers to the terminals T4 - T8 and gates 101 –106 at the Tom Bradley International Terminal. The taxi time is the elapsed time between the alleyway “SPOTS” and the beginning of the takeoff roll. For aircraft that push directly onto the taxiway, the time is calculated from the start of the forward taxi movement. They do <u>not include</u> any takeoff roll time.

		Alternative 3a	
		Departures	
From	To	Taxi Time (min.)	Std Dev (min.)
North	24s	6	2.6
North	25s	15	2.6
South	25s	9	2.8
South	24s	12	3.3
Q-Nest	24s	10	1.9
Box	25s	11	1.2
Box	24s	12	2.3

Table 13: Alternative 3a, B-16: Bridge Open, Departure Taxi Times

Figure 37 demonstrates that in Alternative 3a the taxi times for departures on the 25s showed 25 to 30% improvement over the Baseline scenarios. Taxi times for departures on the 24s from south and north gates were improved by 8% and 14% respectively.

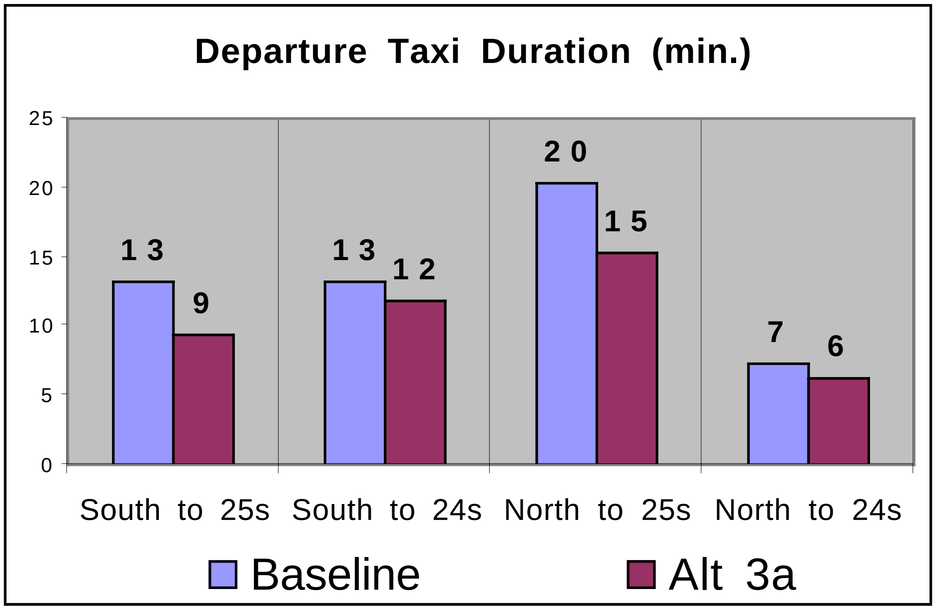

Figure 37: Alternative 3a, B-16: Bridge Open, Departure Taxi Duration

Running Average Departure Rate Data

Departure rate data was computed separately for peak arrival and peak departure scenarios. Figure 38 compares Alternative 3a and Baseline departure rates.

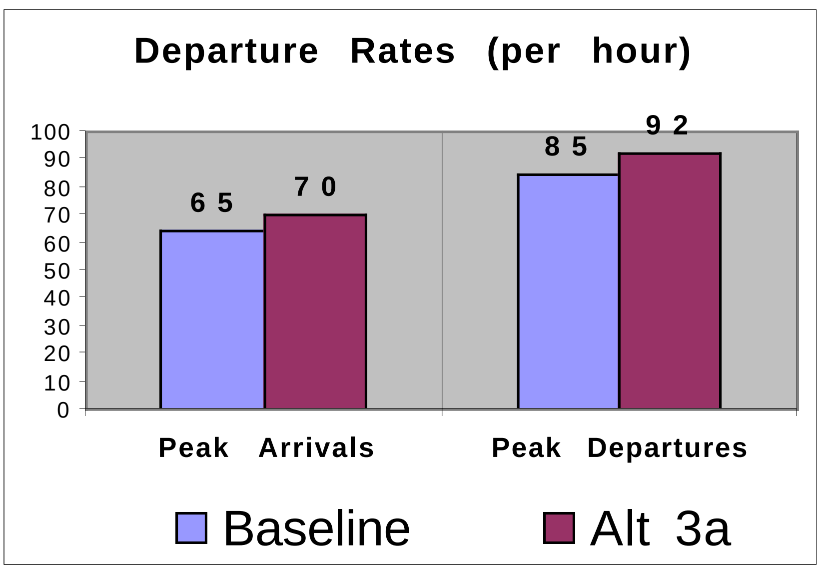

Figure 38: Alternative 3a, B-16: Bridge Open, Departure Rates

Figure 38 shows that departure rates in Alternative 3a were increased during peak arrival and peak departure scenarios by 10% and 8% respectively over Baseline rates.

4.4.3. Controller Voice Communication Data for Alternative 3a

The following is a comparison of the voice data recorded during the Alternative 3a and Baseline scenarios. The parameters compared are the 'Air Time Distribution' and the 'Number of transmissions per hour.'

The following diagram shows that the GC-1 controller spent 30% less time talking to the pilots in Alternative 3a. This workload reduction can be in part attributed to the fact that GC-3 was controlling some of the area that was under the control of GC-1 during Baseline scenarios.

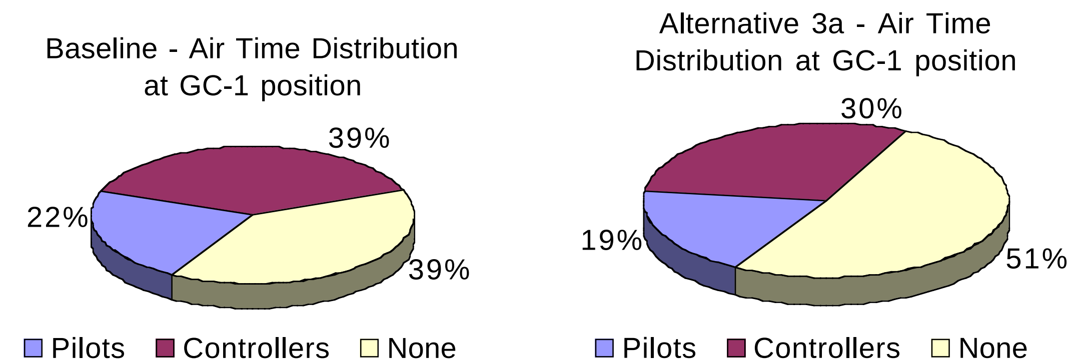

Figure 39: Alternative 3a, B-16: Bridge Open, Air Time Distribution, GC-1 Position

The diagram below provides a comparison of Air Time distribution at the LC-1 position between Alternative 3a and the Baseline.

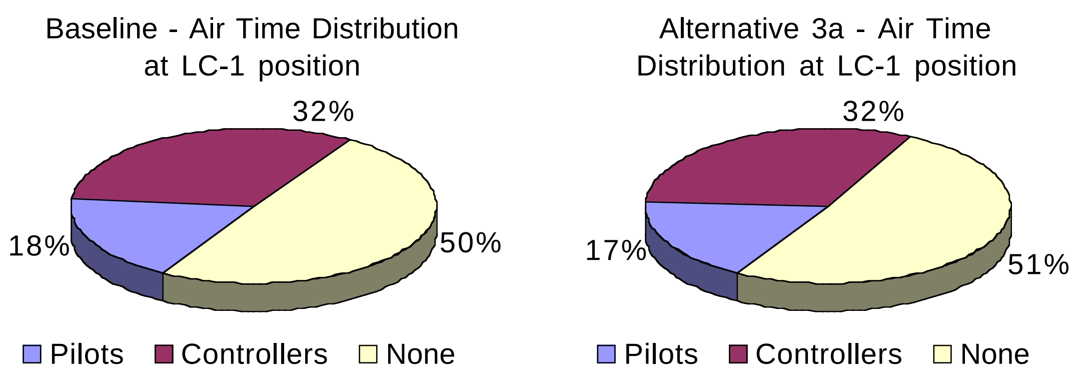

Figure 40: Alternative 3a, B-16: Bridge Open, Air Time Distribution, LC-1 Position

Figure 41 provides a comparison in the number of transmissions per hour by controllers and pilots at GC-1 and GC-3 positions. At GC-1 the average number of transmissions (by pilots and controllers) was less under Alternative 3a than under the Baseline.

The average number of transmissions at the LC-1 position very closely matches the voice data recorded during the Baseline tests (See Figure 42).

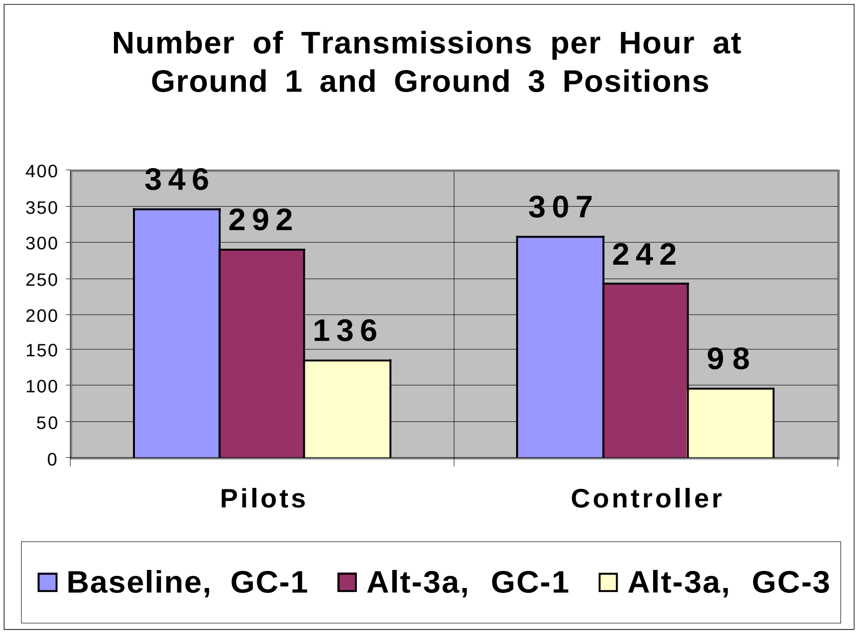

Figure 41: Alternative 3a, B-16:Bridge Open, Voice Transmissions, GC-1 and GC-3 Positions

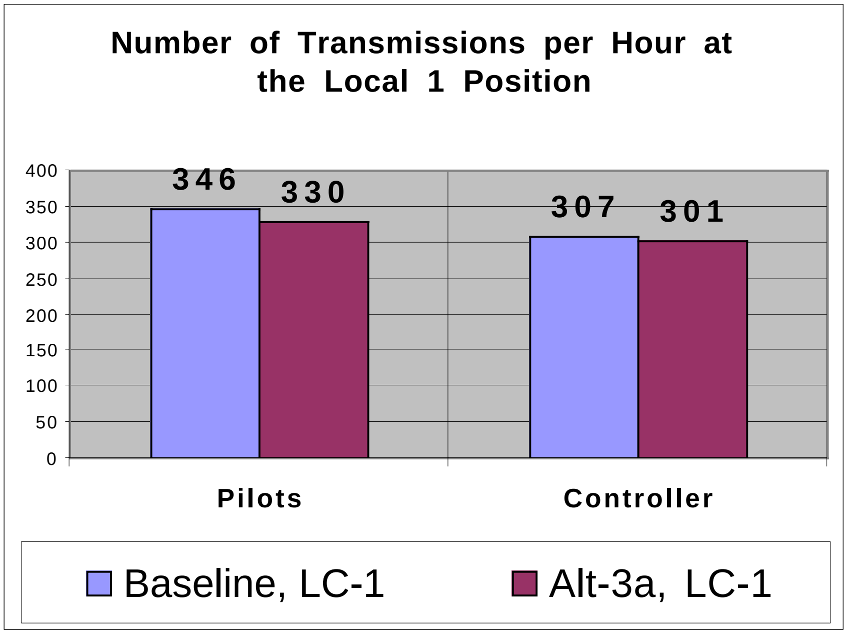

Figure 42: Alternative 3a, B-16: Bridge Open, Voice Transmissions, LC-1 Position

The overall results of the voice data analysis for Alternative 3a are that the amount of controller-pilot communication at LC-1 position is 'About the same' as for the Baseline. The amount of controller-pilot communication at GC-1 position was 'Less' than during in the Baseline scenario. See the results of the Controller Survey for Alternative 3, Section 4.4.1, Question 3.

4.5 Data Results for Alternative 4, B-16: ATC Discretion

Alternative 4 was tested under following rules:

The B-16 extension is used, but controllers have discretion over its use, with one basic rule to guide them. For arrivals on 25L, if the controller can issue an instruction to cross 25R without having to issue a hold-short command, he may exit the aircraft to the north (J, K, etc.). If the controller anticipates having to issue a hold-short command, he will exit the aircraft left onto Alpha. AA is controlled by GC-2, and the Bridge route is available. For aircraft bound for the North Complex taxiing on the B-16 extension, GC-3 has the option of the West Route (AA) or the North route (Q). Traffic sent along the West route must hold short of AA and contact GC-2. Traffic along Taxiway B will monitor GC-1, who will contact the aircraft as it approaches Taxiway S.

There were a total of six runs of this alternative during the two weeks of Phase II. LC-1, GC-1, and GC-3 control the south side of the airport; LC-2 and GC-2 control the north side. FFC staff worked the LC-2 position.

4.5.1 Results of the Controller Surveys for Alternative 4

Question 1: The amount of coordination required with the controllers on my side of the airport was: (1 represents 'Much more,' 5 - 'Much less')

Same-Side Coordination	LC-1	GC-1	GC-2	GC-3
Mean Rating	**4.17**	**2.50**	**3.00**	**2.33**
Standard Deviation	0.69	0.50	0.00	0.47

This table shows that compared to current LAX operations Alternative 4 required 'Less' coordination on LC-1 position and 'More' coordination between GC-1 and GC-3 positions.

Question 2: The amount of coordination required with the controllers on other side of the airport was: (1 represents 'Much more,' 5 - 'Much less')

Cross-Cab Coordination	LC-1	GC-1	GC-2	GC-3
Mean Rating	**4.00**	**2.83**	**3.00**	**3.17**
Standard Deviation	0.58	0.37	0.00	0.37

Compared to current LAX operations, at the LC-1 position, Alternative 4 required 'Less' coordination with controllers on the opposite side. At the GC-1 position, Alternative 4 required 'More' coordination.

Question 3: The amount of communication with the pilots was: (1 represents 'Much more,' 5 - 'Much less')

Communication	LC-1	GC-1	GC-2	GC-3
Mean Rating	**3.33**	**3.00**	**3.00**	**2.50**
Standard Deviation	0.75	0.58	0.00	0.50

At the GC-3 position, Alternative 4 required 'More' communication with the pilots and on other positions 'About the same' as current LAX operations.

Question 4: The overall efficiency of this operation was: (1 represents 'Much less efficient,' 5 - 'Much more efficient')

Efficiency	LC-1	GC-1	GC-2	GC-3
Mean Rating	**3.00**	**3.00**	**3.00**	**2.67**
Standard Deviation	1.15	0.58	0.00	0.75

The efficiency of Alternative 4 was rated **'About the same' as current operations at LAX**.

<u>Question 5:</u> In your estimation, relative to current LAX operations, the potential for a runway incursion on this run was: (1 represents 'Much more,' 5 - 'Much less')

Safety	LC-1	GC-1	GC-2	GC-3
Mean Rating	**4.00**	**3.00**	**3.00**	**3.50**
Standard Deviation	1.00	1.15	0.00	0.76

This table indicates that **LC-1 and GC-3 consider the potential for a runway incursion 'Less'** than under current operations. In other control areas potential for incursion appears to be 'About the same.'

<u>Question 6:</u> Level of traffic complexity in your control area was: (1 represents 'Much higher,' 5 - 'Much lower')

Complexity	LC-1	GC-1	GC-2	GC-3
Mean Rating	**3.17**	**3.17**	**3.17**	**2.17**
Standard Deviation	1.07	0.69	0.37	0.37

Alternative 4 presents a '**Higher' level of traffic complexity in the Ground Control 3** area and 'About the same' level of traffic complexity in other control areas.

Question 7: How would you rate ability to manage the traffic flow under this scenario: (1 represents ‘impossible to manage,’ 5 – ‘easier than under current operations’)?

Manageability	LC-1	GC-1	GC-2	GC-3
Mean Rating	**3.50**	**3.17**	**3.33**	**3.33**
Standard Deviation	1.12	0.69	0.47	0.47

This table indicates that **all controllers consider traffic flow to be 'Easier' to manage** under Alternative 4 than under current operations.

The following diagram shows the combined mean rating for questions 1 through 7 by each tower position worked by LAX controllers. The horizontal red line represents a rating of 'About the same' as current LAX operations.

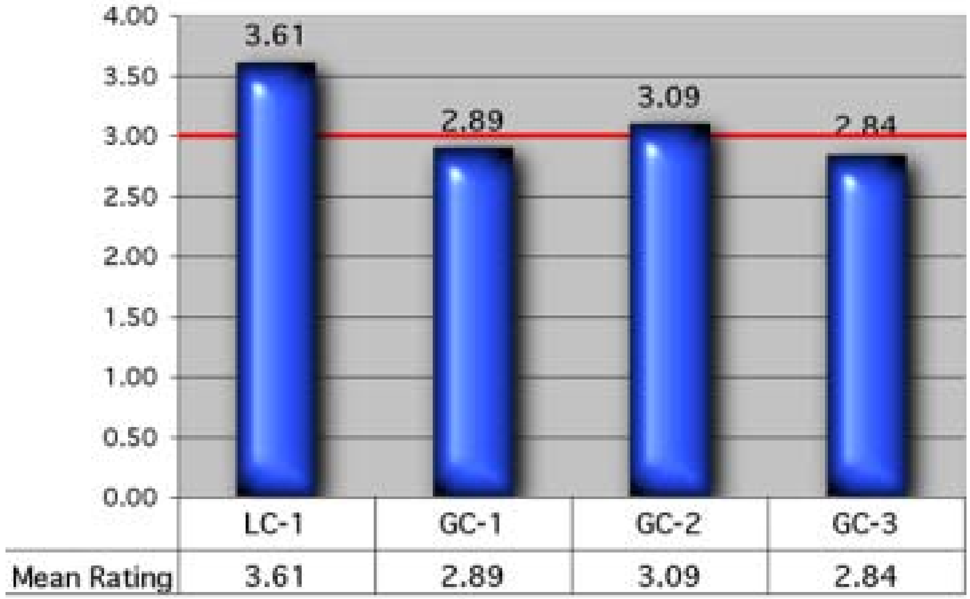

Figure 43: Alternative 4, B-16: ATC Discretion, Mean Rating for Questions 1 – 7

Figure 43 indicates that the controllers rated Alternative 4 better for the LC-1 position and slightly more challenging for the GC-3 position. On other positions the alternative was rated about the same as current LAX operations.

Key Controller Comments:

GC-1: *"Workload for GC1 is reduced a little but aircraft are on the taxiways longer which can create more problems.*
"It is better, more efficient, to some degree because it is not as critical to keep rwy exits available for arrival traffic."

LC-1: *"I seemed to have to scan much more to see where my arrivals were once they landed. This takes my attention away from other areas"*
"More things to watch at a greater distance apart, i. e. runway ends."
"This problem resides on having enough spacing between aircraft on final."

GC-2: *"No different than current LAX operations."*

GC-3: *"Aircraft are on the taxiways longer due to increase taxi distance."*
"A little more coordination due to northbound aircraft transitioning from south side airport to north side."
"More traffic in this position than normal."

Question 8: The most critical problem(s) in this scenario was/were: (controllers could circle up to three choices)

Most Critical Problem(s)	Number of Occurrences per Position				Total number of Occurrences	Frequency of Occurrence
	L-1	G-1	G-2	G-3		
Communication	1	0	0	0	1	**0.04**
Coordination	0	2	0	5	7	**0.29**
Traffic Complexity	2	2	1	0	5	**0.21**
Workload	3	3	0	3	9	**0.38**
Safety	2	1	0	0	3	**0.13**
Manageability	1	1	1	0	3	**0.13**

Table 14: Alternative 4, B-16: ATC Discretion, Most Critical Problems

This table demonstrates that the most critical aspects of the Alternative 4 operations were:

At LC-1 position: Traffic Complexity, Workload, Safety

At GC-1 position: Coordination, Traffic Complexity, Workload

At GC-3 position: Coordination, Workload

The criterion that was most mentioned as critical was:

- **Workload** - Frequency of Occurrence = **0.38**

4.5.2. Statistical Airport Operations Data for Alternative 4

Average Arrival Taxi Time Data

The following table presents the calculated average arrival taxi times from the Alternative 4 simulation for pre-selected airport terminal locations. “North” refers to the gates at terminals T1 - T3 and gates 119-123 at the Tom Bradley International Terminal. “South” refers to the terminals T4 - T8 and gates 101-106 at the Tom Bradley International Terminal. The taxi time begins at the touch-down point and ends at the gate.

		Alternative 4	
		Arrivals	
From	To	Taxi Time (min.)	Std Dev (min.)
24s	North	7	1.5
24s	South	11	3.0
25s	South	11	5.0
25s	North	14	2.3
25s	C-Nest	9	4.9
25s	Box	9	6.3
24s	Box	10	3.1

Table 15: Alternative 4, B-16: ATC Discretion, Arrival Taxi Times

The comparison chart in Figure 44 demonstrates that the Alternative 4 scenario had taxi times for arrivals on the 25s to the south gates that were 57% higher relative to the Baseline. Taxi times for arrivals on the 25s to the north gates were 16% higher relative to the baseline. Arrival taxi times from the 24s to the south gates were 27% lower and were 22% lower to the north gates relative to the Baseline.

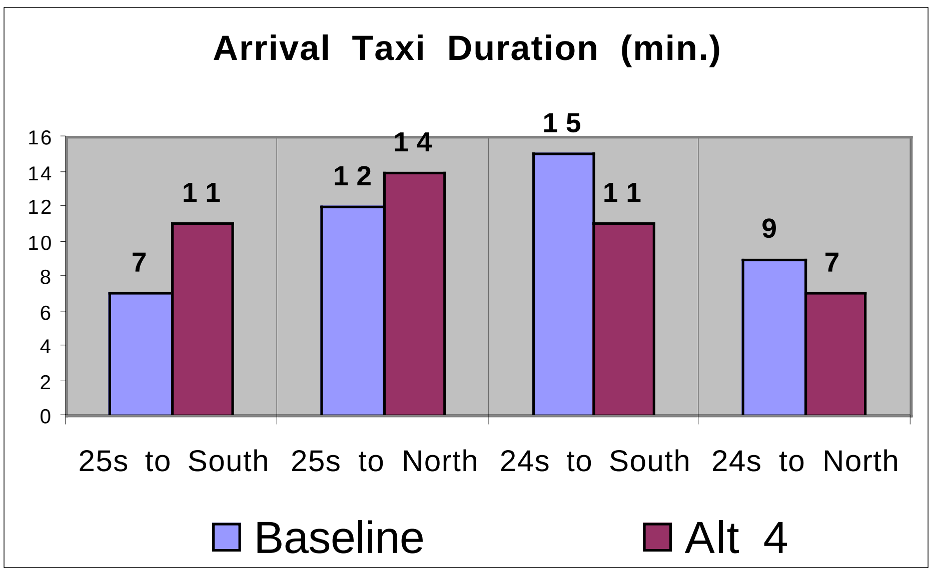

Figure 44: Alternative 4, B-16: ATC Discretion, Arrival Taxi Duration

Average Departure Taxi Time Data

This table shows the computed departure taxi times from pre-selected terminal locations (North, South, Nest, and Box) to the runways. “North” refers to the gates in the terminal area T1 - T3 and “South” refers to the terminal area T4 - T8. The taxi time is the elapsed time between the alleyway “SPOTS” and the beginning of the takeoff roll. For aircraft that push directly onto the taxiway, the time is calculated from the start of the forward taxi movement. They do <u>not include</u> any takeoff roll time.

		Alternative 4	
		Departures	
From	To	Taxi Time (min.)	Std Dev (min.)
North	24s	8	2.9
North	25s	16	4.0
South	25s	11	3.0
South	24s	12	3.6
Q-Nest	24s	14	2.8
Box	25s	11	1.1
Box	24s	14	2.0

Table 16: Alternative 4, B-16: ATC Discretion, Departure Taxi Times

Figure 45 demonstrates that for Alternative 4 the taxi times for departures on the 25s were about 15% shorter relative to the Baseline. Taxi times for departures on the 24s from south gates were about 20% shorter relative to the Baseline, and from the north gates taxi times were about the same as the Baseline.

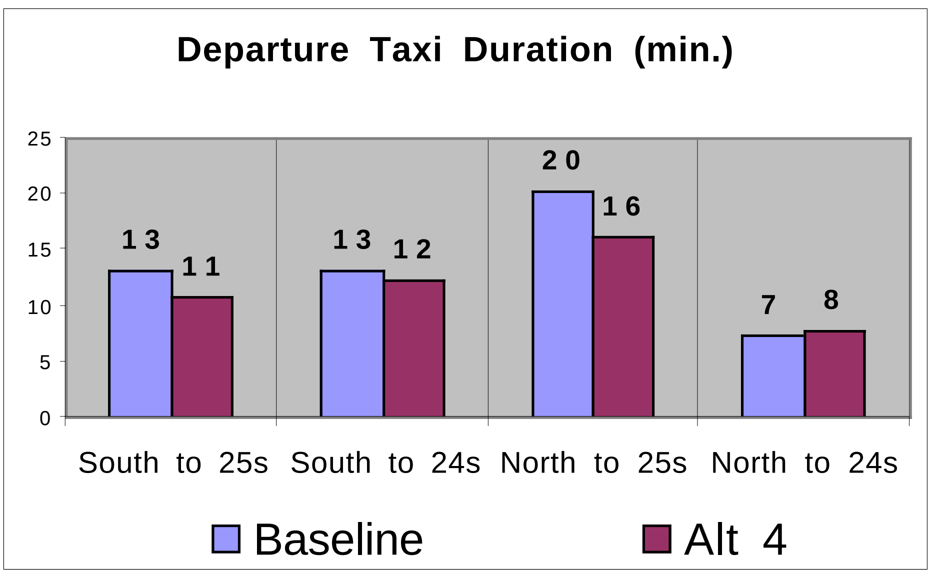

Figure 45: Alternative 4, B-16: ATC Discretion, Departure Taxi Duration

Running Average Departure Rate Data

Departure rate data was computed separately for peak arrival and peak departure scenarios. Figure 46 compares Alternative 4 and the Baseline departure rates.

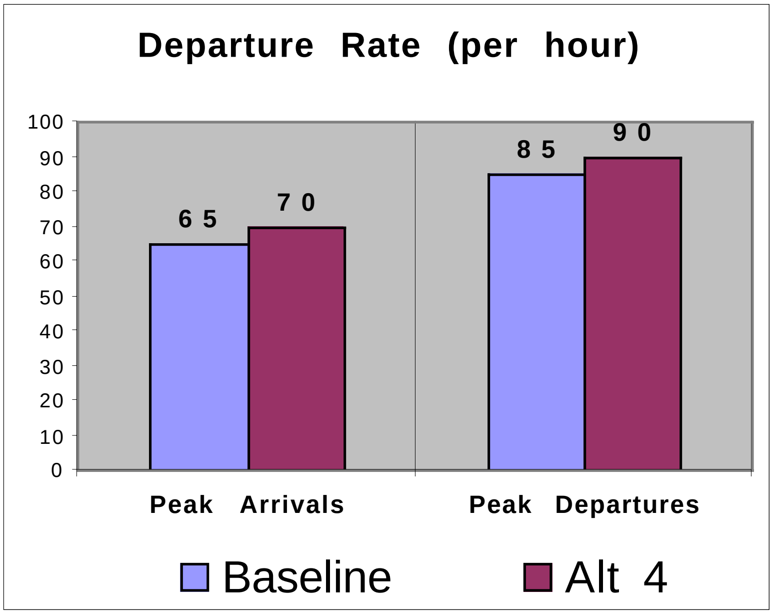

Figure 46: Alternative 4, B-16: ATC Discretion, Departure Rates

Data from Figure 46 indicates that departure rates in Alternative 4 were increased during peak arrival and peak departure scenarios by 8% and 6% respectively relative to baseline operations.

4.5.3. Controller Voice Communication Data for Alternative 4

This section presents analysis of the voice data recorded from Alternative 4 runs in comparison with voice data recorded from Baseline scenarios. The main parameters for comparison are 'Airtime Distribution' and 'Number of transmissions per hour'.

The following diagram indicates that communication time between the GC-1 position and the pilots was reduced by 15% for Alternative 4. This workload reduction can be in large part attributed to the fact that the GC-3 was controlling some of the area that was under the control of the GC-1 during the Baseline scenarios.

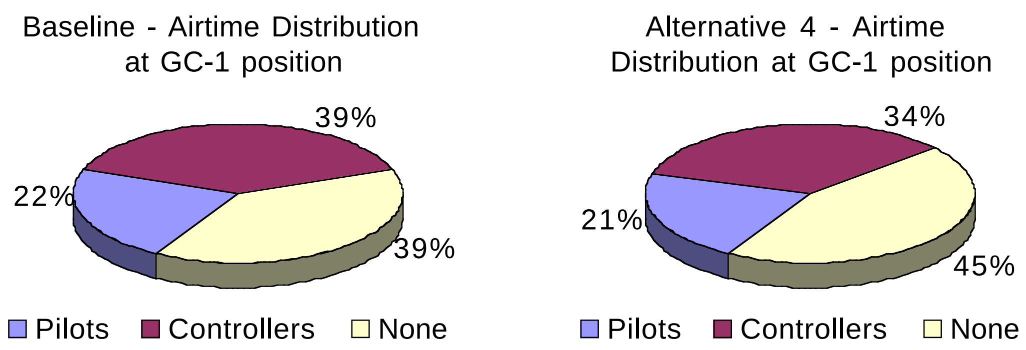

Figure 47: Alternative 4, B-16: ATC Discretion, Air Time Distribution, GC-1 Position

The following diagram provides the comparison in airtime distribution at the LC-1 position between Alternative 4 and Baseline and shows no significant difference.

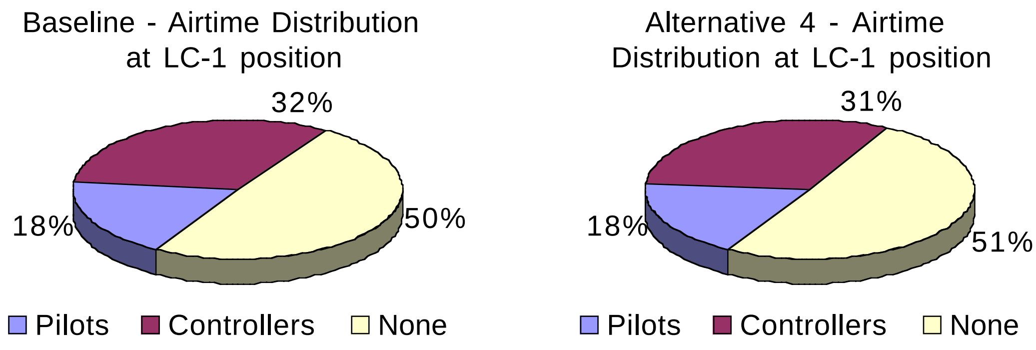

Figure 48: Alternative 4, B-16: ATC Discretion, Air Time Distribution, LC-1Position

Figure 49 compares the number of transmissions per hour by controllers and pilots on the GC-1 and GC-3 frequencies. For Alternative 4, the average number of controller transmissions on the GC-1 frequency was 11% less than for the Baseline. The Average number of pilot transmissions on the GC-1 frequency was 5% less than the Baseline.

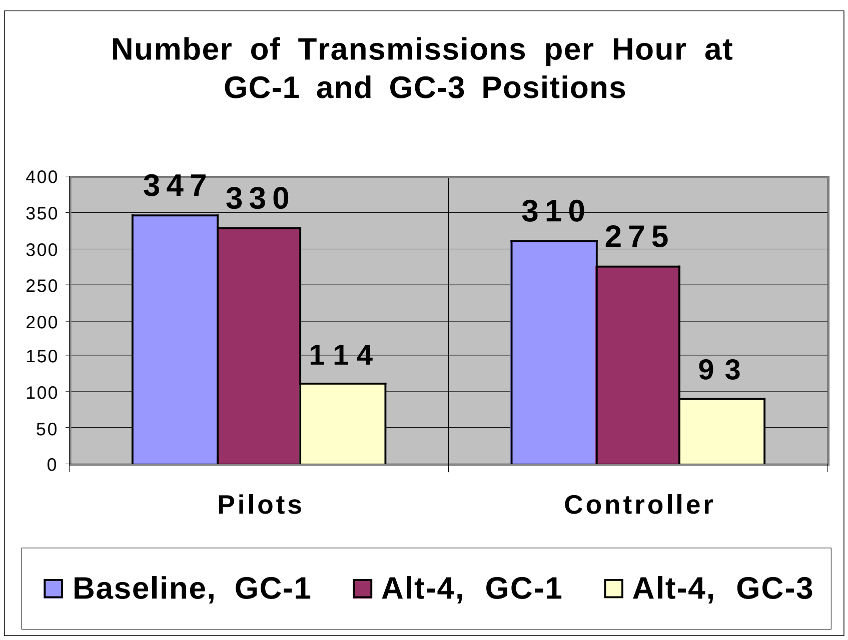

Figure 49: Alternative 4, B-16: ATC Discretion, Voice Transmissions, GC-1 and GC-3 Positions

The transmission-rate data on the LC-1 frequency very closely matched results of the voice data recorded from the Baseline scenarios. (See Figure 50.) The average number of pilot transmissions was just 1% less in Alternative 4, and the average number of controller transmissions was 3% less than in the Baseline.

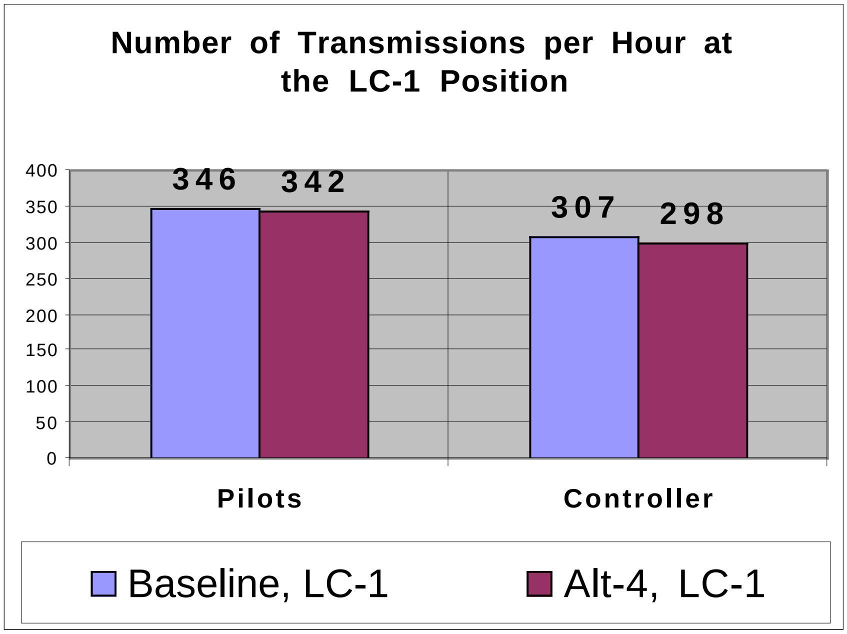

Figure 50: Alternative 4, B-16: ATC Discretion, Voice Transmissions, LC-1 Position

The amount of controller-pilot communication for Alternative 4 is judged to be "About the same" as for the Baseline scenarios.

For the results of the Alternative 4 controller surveys for communication, see Section 4.5.1, Question 3.

4.6 Data Results for Alternative 5, B-16: With Two Locals

Alternative 5 was defined by the following rules:
A second local controller (LC-3) is added to south-side operations. Runway 25R is under the control of LC-1, and 25L is under the control of LC-3.

The B-16 extension is utilized under the rules for Alternative 3a. For aircraft taxiing on the B-16 extension bound for the North Complex, GC-1 has the option of the West Route (Taxiway AA) or the North Route (Taxiway Q). The Bridge Route on AA is open.

Four runs were performed for this Alternative during first week of Phase II. LC-1, LC-3, and GC-1 control the south side of the airport; LC-2 and LC-3 control the north side. FFC staff worked the LC-2 position.

4.6.1 Results of Controller Surveys for Alternative 5, B-16: With Two Locals

Question 1: The amount of coordination required with the controllers on my side of the airport was: (1 represents 'Much more', 5 - 'Much less')

Same-Side Coordination	LC-1	GC-1	GC-2	LC-3
Mean Rating	**3.00**	**3.50**	**3.00**	**3.75**
Standard Deviation	1.22	0.50	0.00	0.83

The data from this table shows that in comparison with current LAX operations Alternative 5 required 'Less' or 'About the same' amount of coordination between controllers on the same side of the airport.

Question 2: The amount of coordination required with the controllers on other side of the airport was: (1 represents 'Much more,' 5 - 'Much less')

Cross-Cab Coordination	LC-1	GC-1	GC-2	LC-3
Mean Rating	**3.75**	**3.00**	**3.50**	**4.00**
Standard Deviation	0.43	0.00	0.87	0.71

The data from this table shows that, in comparison with current LAX operations, Alternative 5 required 'Less' or 'About the same' amount of coordination between Controllers on the opposite sides of the airport.

Question 3: The amount of communication with the pilots was: (1 represents 'Much more,' 5 - 'Much less')

Communication	LC-1	GC-1	GC-2	LC-3
Mean Rating	**4.00**	**2.25**	**3.00**	**3.75**
Standard Deviation	0.00	0.43	0.00	0.83

Alternative 5 required 'About the same' or 'Less' amount of communication than under the baseline mode except for GC-1, where 'More' communication with pilots was required.

Question 4: The overall efficiency of this operation was: (1 represents 'Much less efficient,' 5 - 'Much more efficient')

Efficiency	LC-1	GC-1	GC-2	LC-3
Mean Rating	**3.00**	**3.25**	**3.00**	**4.00**
Standard Deviation	0.71	0.83	0.00	1.22

Subjective data from this question indicates that efficiency of Alternative 5 is **'About the same' as current operations at LAX**. LC-3 controllers rated the efficiency of Alternative 5 operations 'more efficient,'

Question 5: In your estimation, relative to current LAX operations, the potential for a runway incursion on this run was: (1 represents 'Much more', 5 - 'Much less')

Safety	LC-1	GC-1	GC-2	LC-3
Mean Rating	**4.00**	**3.75**	**3.25**	**4.25**
Standard Deviation	0.00	0.43	0.43	0.83

The data from this table indicates that in comparison with current operations all controllers consider potential for a runway incursion 'Less' than under current operation mode.

Question 6: Level of traffic complexity in your control area was: (1 represents 'Much higher,' 5 - 'Much lower')

Complexity	LC-1	GC-1	GC-2	LC-3
Mean Rating	**3.75**	**2.75**	**3.25**	**3.75**
Standard Deviation	0.43	1.09	0.43	0.83

It appears that in comparison with current LAX operations Alternative 5 presents 'About the same' level of traffic complexity in Ground Control areas and 'Lower' level of traffic complexity in Local control areas.

Question 7: How would you rate ability to manage the traffic flow under this scenario: (1 represents 'impossible to manage,' 5 – 'easier than under current operations')?

Manageability	LC-1	GC-1	GC-2	LC-3
Mean Rating	**3.75**	**2.75**	**3.25**	**4.50**
Standard Deviation	1.30	0.43	0.43	0.50

The data from this table indicates that **all controllers except GC-1 consider the traffic flow to be 'Easier' to manage** under Alternative 5 than for the Baseline. The following diagram shows the overall mean rating of questions 1 through 7 for Alternative 5 in each tower position controlled by LAX controllers. The red line represents a rating of 'About the same' as current LAX operations.

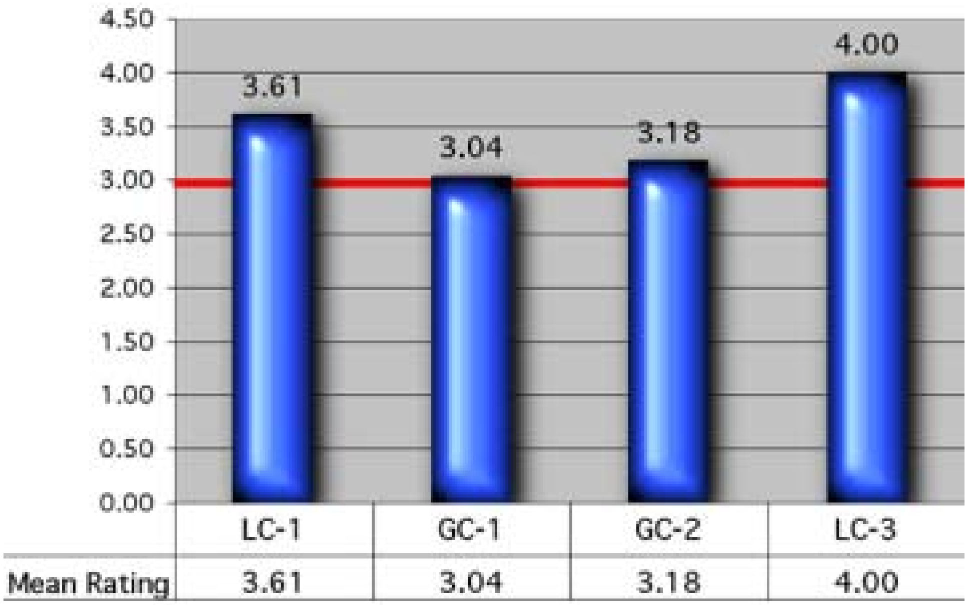

Figure 51: Alternative 5, B-16: With Two Locals, Mean Rating for Questions 1 -7

The subjective data from Figure 51 indicates that by controllers estimate, Alternative 5 presents a better operational environment than current LAX operations.

Key Controller Comments:

LC-1: *"Too much coordination with LC-3 made working difficult when busier."*
"No mid field runway crossings."

GC-1: *"Had to make more transmissions since aircraft were on the taxiways longer."*
"Very busy on the west end. Too much to look at. Could not keep back of traffic in the area of C-6 and C7."
"Less runway crossings."

GC-2: *"Normal operation (baseline for this side). No problems"*

Question 8: The most critical problems in this scenario were: (controllers could circle up to three choices)

Most Critical Problems	Number of Occurrences per Position				Total Number of Occurrences	Frequency of Occurrence
	L - 1	G - 1	G - 2	L - 3		
Communication	2	2	0	2	6	**0.38**
Coordination	1	0	0	0	1	**0.06**
Traffic Complexity	1	1	0	1	3	**0.19**
Workload	0	1	1	2	4	**0.25**
Safety	1	0	0	1	2	**0.13**
Manageability	0	1	0	0	1	**0.06**

Table 17: Alternative 5, B-16: With Two Locals, Most Critical Problems

The data from this table demonstrate that the most critical aspects of the Alternative 5 operations were:

- At LC-1 position: Communication
- At GC-1 position: Communication
- At LC-3 position: Communication, Workload

Criteria that was mentioned the most as critical for Alternative 5

- **Communication** **-** Frequency of Occurrence = **0.38**

4.6.2. Statistical Airport Operations Data for Alternative 5

Average Arrival Taxi Time Data

The following table presents the calculated average arrival taxi time data from the Alternative 3a simulation for pre-selected airport terminal locations. “North” refers to the gates at terminals T1 - T3 and gates 119-123 at the Tom Bradley International Terminal. “South” refers to the terminals T4 - T8 and gates 101 –106 at the Tom Bradley International Terminal. Taxi time begins at the touch-down point and ends at the gate.

From	To	Alternative 5 Arrivals Taxi Time (min.)	Alternative 5 Arrivals Std Dev (min.)
24s	North	7	1.2
24s	South	12	3.4
25s	South	11	4.6
25s	North	15	2.5
25s	C-Nest	9	3.9
24s	Q-Nest	3	0.2
25s	Box	12	5.8
24s	Box	8	2.1

Table 18: Alternative 5, B-16: With Two Locals, Arrival Taxi Duration

Figure 52 demonstrates that, in the Alternative 5, relative to the Baseline, the taxi times for arrivals from the 25s to the south gates were 57% higher, and from the 25s to the north gates 25% higher. Arrival taxi times from the 24s to the south gates were 25% lower and to the north gates 22% lower than the baseline scenarios.

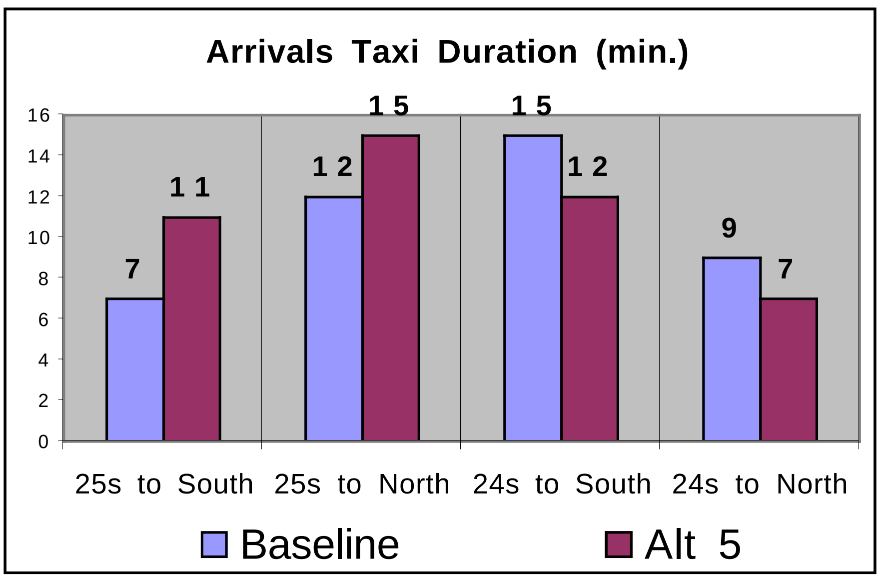

Figure 52: Alternative 5, B-16: With Two Locals, Arrival Taxi Duration

Average Departure Taxi Time Data

This table shows the computed departure taxi times from pre-selected terminal locations (North, South, Nest, and Box) to the runways. “North” refers to the gates in the terminal area T1 - T3 and “South” refers to the terminal area T4 - T8. The taxi time is the elapsed time between the alleyway “SPOTS” and the beginning of the takeoff roll. For aircraft that push directly onto the taxiway, the time is calculated from the start of the forward taxi movement. They do <u>not include</u> any takeoff roll time.

		Alternative 5 Departures	
From	To	Taxi Time (min.)	Std Dev (min.)
North	24s	7	3.0
North	25s	16	2.3
South	25s	9	2.4
South	24s	11	3.1
Q-Nest	24s	11	2.0
Box	25s	9	2.8
Box	24s	13	1.7

Table 19: Alternative 5, B-16: With Two Locals, Departure Taxi Times

Figure 53 demonstrates that in Alternative 5, the taxi times for departures on the 25s were reduced by 20-30% over the Baseline operation. Taxi times for departures on the 24s from south gates were reduced by 16% over baseline, while taxi times from the north gates remain unchanged.

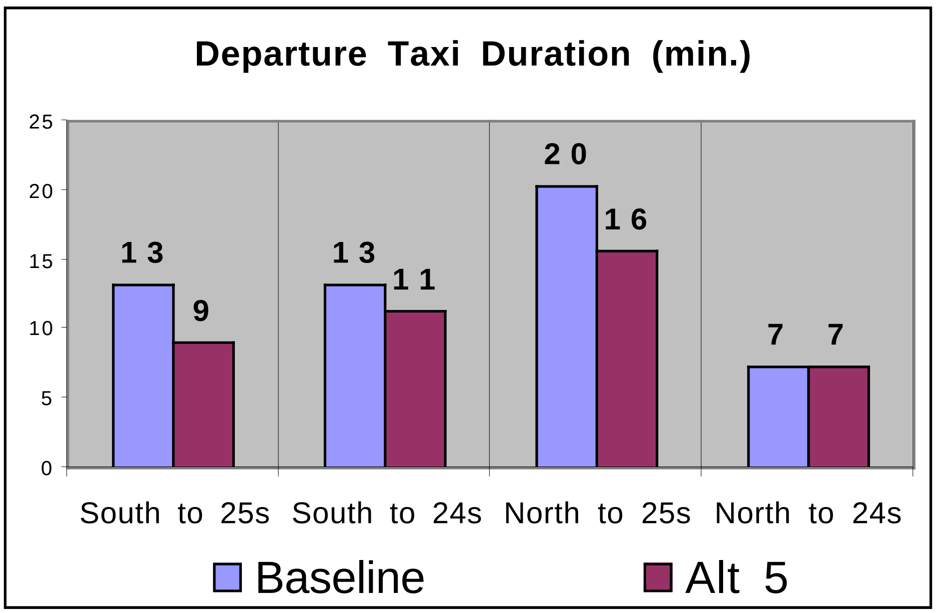

Figure 53: Alternative 5, B-16: With Two Locals, Average Departure Taxi Duration

Running Average Departure Rate Data

Data on departure rates was collected and calculated separately for peak arrival and peak departure scenarios. Figure 54 provides a comparison of departure rates between peak arrival and peak departure for Alternative 5 and its performance compared to the baseline scenarios.

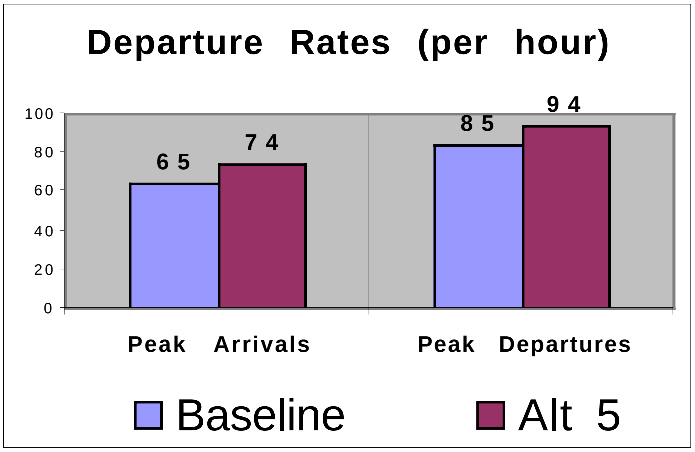

Figure 54: Alternative 5, B-16: With Two Locals, Departure Rates

Data from the chart in Figure 54 indicates that, relative to Baseline operations, departure rates in Alternative 5 were increased during peak arrival and peak departure scenarios by 14% and 10% respectively.

4.6.3. Controller Voice Communication Data for Alternative 5

The following is a comparison of the voice data recorded during Alternative 5 and the Baseline scenarios. The primary parameters for comparison are: 'Air Time Distribution' and 'Number of Transmissions per Hour.'

The following diagram demonstrates that communications between pilots and the GC-1 increased 8% over baseline.

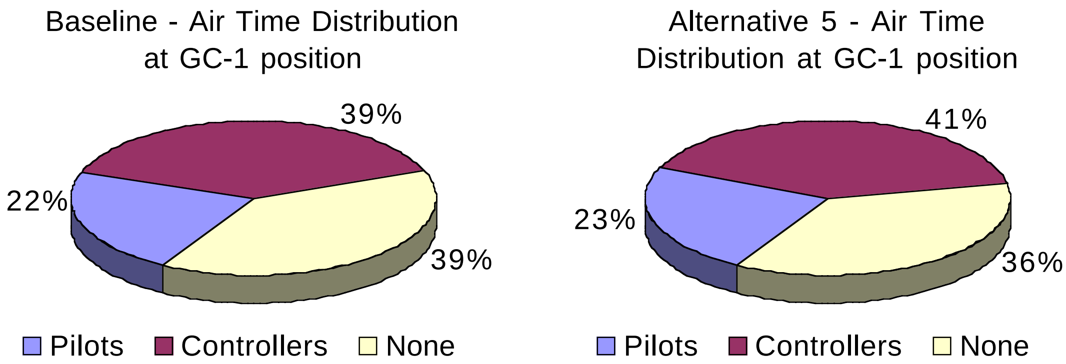

Figure 55: Alternative 5, B-16: With Two Locals, Air Time Distribution, GC-1 Position

The following diagram provides comparison of Air Time distribution at the LC-1 position between Alternative 5 and Baseline.

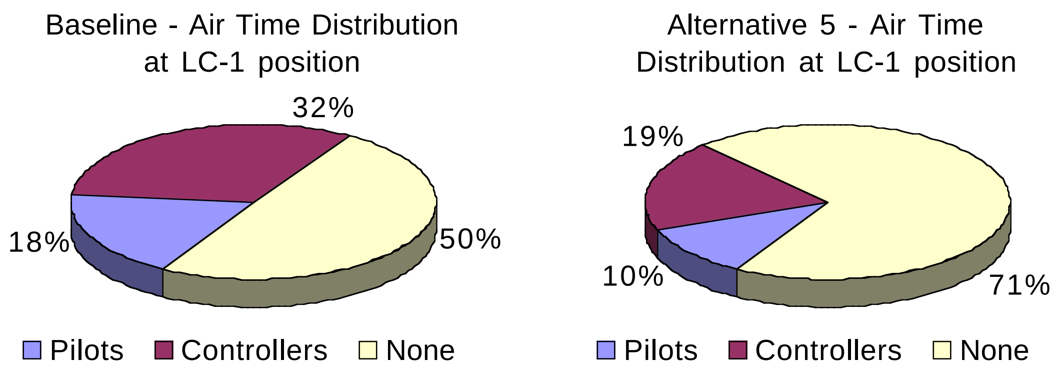

Figure 56: Alternative 5, B-16: With Two Locals, Air Time Distribution, LC-1 Position

The diagram in Figure 56 demonstrates a significant reduction in communication between the LC-1 and the pilots because arrivals and departures on 25L were under control of the LC-3.

Voice recordings from the console microphones were collected for the three positions in the South Complex.

Figure 57 provides a comparison of the average number of transmissions per hour by Ground Control 1 between the Baseline and Alternative 5. As shown, the average number of transmissions per hour by GC-1 is 5% higher than the Baseline.

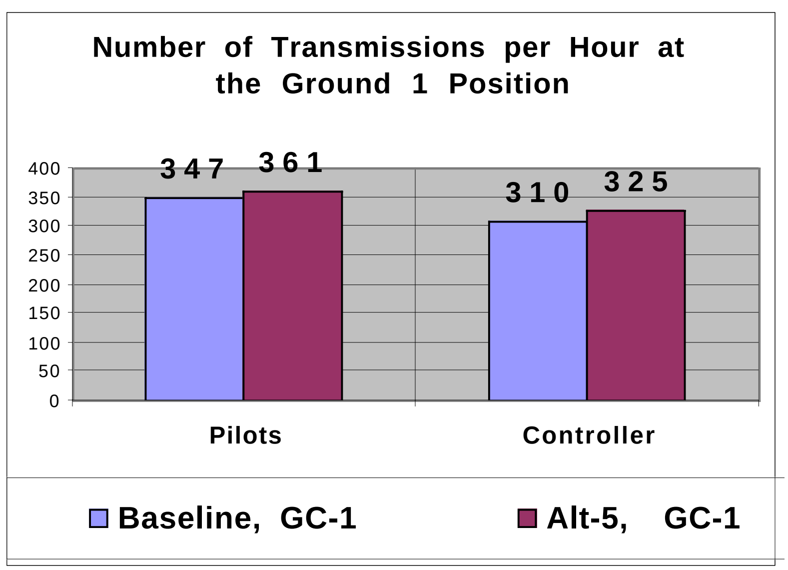

Figure 57: Alternative 5, B-16: With Two Locals, Voice Transmissions, GC-1 Position

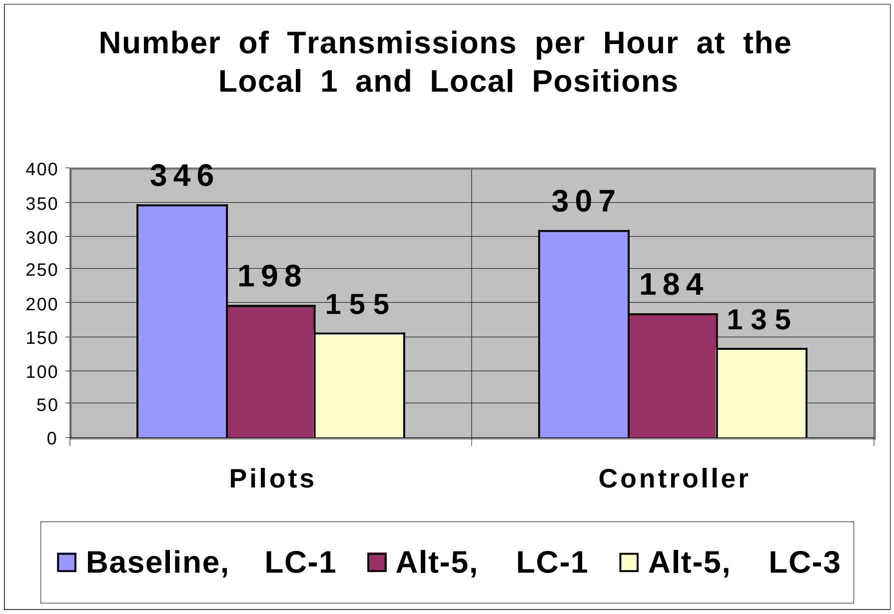

Figure 58: Alternative 5, B-16: With Two Locals, Voice Transmissions, LC-1 and LC-3 Positions

Figure 58 compares the average number of transmissions per hour by LC-1 for Baseline and by LC-1 and LC-3 for Alternative 5. The sum of Local 1 and Local 3 transmissions is slightly greater for both pilots and controllers than in the baseline for the Local 1 Position alone. In general, it is a reasonable outcome that an additional position in the tower increases pilot/controller communication.

Appendix A: Controller Questionnaires and Responses

Tower Cab Confidential Controller Survey

Run #

NAME ______________________ TOWER POSITION ______________________

DATE ____________ SCENARIO: ALT-1 ALT-2 ALT-3 ALT-4 CONDITION: VFR-1 VFR-2 IFR

INSTRUCTIONS

Please complete the following survey and then give it to the NASA experimenter. Circle the most appropriate answer for each question and also tell why. **All questions are relative to your experience under Baseline Operations at LAX. Ratings should be given in comparison with current LAX operations.** Add any other comments/observations on the opposite side if necessary.

1. The amount of coordination required with the controllers on my side of the airport was:

Much More	More	About the same	Less	Much less
1	2	3	4	5

2. The amount of coordination required with the controllers on other side of the airport

Much More	More	About the same	Less	Much less
1	2	3	4	5

3. The amount of communication with the pilots was:

Much More	More	About the same	Less	Much less
1	2	3	4	5

4. The overall efficiency of this operation was:

Much less	Less	About the same	More	Much More
1	2	3	4	5

5. In your estimation, relative to current LAX operations, the potential for a runway incursion on this run was:

Much More	More	About the same	Less	Much less
1	2	3	4	5

6. Level of traffic complexity in your control area was:

Much higher	Higher	About the same	Lower	Much lower
1	2	3	4	5

7. How would you rate ability to manage the traffic flow under this scenario - from 1 (impossible to manage) to 5 (easier then under current operations)

1	2	3	4	5

8. The most critical problem(s) in this scenario was/were: (circle up to three choices)

Communication	Coordination	Traffic complexity	Workload	Safety	Manageability of the traffic flow
1	2	3	4	5	6

Summary of Controllers Survey for Alternative 1:

	Alternative 1																						
	Results of Subjective survey on Questions 1-7																						
Position	**L - 1**			L-1			**G - 1**			G-1			**L - 2**			L-2		**G - 2**			G-2		
Scenario	VF1	VF2	VF2	VF1	VF1	VF2	VF1	VF2	VF2	VF1	VF1	VF2	VF1	VF2	VF2	VF1	VF2	VF1	VF2	VF2	VF1	VF1	VF2
Q-1	2	2	2	4	3	3	2	2	3	5	3	3	4	3	4	3	5	3	3	3	5	4	3
Q-2	4	3	3	5	4	5	3	3	3	5	4	3	5	3	4	4	5	3	3	3	5	3	3
Q-3	3	2	2	3	3	2	2	2	3	5	2	2	3	3	2	2	5	3	3	3	5	3	2
Q-4	2	2	2	1	1	4	3	2	4	1	4	2	2	4	3	2	4	3	3	2	5	3	2
Q-5	3	2	3	3	4	2	1	3	4	5	2	4	3	4	3	3	4	2	4	4	5	3	2
Q-6	2	3	3	2	1	2	2	2	4	5	3	2	2	4	2	1	5	3	3	3	4	4	4
Q-7	3	2	3	2	2	3	2	2	4	5	2	2	2	4	2	2	4	3	3	3	5	5	3
Total	19	16	18	20	18	21	15	16	25	31	20	18	21	25	20	17	32	20	22	21	34	25	19
	17.67			**19.67**			**18.67**			**23.00**			**22.00**			**24.50**		**21.00**			**26.00**		
Mean ratings at each position	**2.52**			**2.81**			**2.67**			**3.29**			**3.14**			**3.50**		**3.00**			**3.71**		
Average Rating for this Alternative	**3.08**																						

Alt.1 - Results of Subjective survey on Question 8

	L - 1			L-1			**G - 1**			G-1			**L - 2**			L-2		**G - 2**			G-2		
	VF1	VF2	VF2	VF1	VF1	VF2	VF1	VF2	VF2	VF1	VF1	VF2	VF1	VF2	VF2	VF1	VF2	VF1	VF2	VF2	VF1	VF1	VF2
Question 8-1																		X			X	X	X
8 - 2	X		X					X															
8 - 3	X		X	X	X		X	X				X	X			X							
8 - 4					X		X	X			X	X	X		X	X							
8 - 5	X	X				X			X					X		X							
8 - 6							X					X			X		X			X			

Summary of Controllers Survey for Alternative 2:

Alternative-2												
Results of Subjective Survey on Questions 1-7												
Position	**L - 1**			**G - 1**			**G - 2**			**L - 3**		
Scenario	VF1	VF2	IFR	VF1	VF2	IFR	VF1	VF2	IFR	VF1	VF2	IFR
Question -1	1	1	2	2	3	2	3	3	3	1	1	1
Question -2	5	5	4	3	3	3	5	3	4	5	3	3
Question -3	3	3	3	1	3	3	3	3	3	3	3	3
Question -4	1	3	2	2	3	2	1	3	3	1	1	2
Question -5	1	2	2	2	3	2	2	3	3	1	1	2
Question -6	2	4	2	2	3	3	2	3	3	1	4	4
Question -7	2	3	2	2	3	2	2	3	3	2	4	2
Mean Rating on each position	**2.52**			**2.48**			**2.90**			**2.29**		
Average Rating for Alternative 2	**2.55**											

Alt. 2 - Results of Subjective Survey on Question 8												
	L - 1			**G - 1**			**G - 2**			**L - 3**		
	VF1	VF2	IFR	VF1	VF2	IFR	VF1	VF2	IFR	VF1	VF2	IFR
Question 8-1				X								
8 - 2		X	X			X				X	X	X
8 - 3			X	X	X							
8 - 4		X			X		X					
8 - 5		X	X							X		X
8 - 6	X			X	X		X	X	X	X		X

Rating Table of Operational Criteria for Alternative 2 (subjective data from Question 8)

Operational Criteria	L - 1	G - 1	L - 2	G - 2	L - 3	Total number of Occurrence	Frequency of Occurrence
Communication	0	1	0	0	0	1	**0.08**
Coordination	2	1	0	0	3	6	**0.50**
Traffic Complexity	1	2	0	0	0	3	**0.25**
Workload	1	1	1	0	0	3	**0.25**
Safety	2	0	0	0	2	4	**0.33**
Managebility	1	2	2	1	2	8	**0.67**

Summary of Controllers Survey for Alternative 3:

	Alternative-3							
Position	**L - 1**		**G - 1**		**G - 2**		**G - 3**	
Scenario	VF1	VF2	VF1	VF2	VF1	VF2	VF1	VF2
Q - 1	4	4	5	4	2	3	3	3
Q - 2	5	4	4	3	3	3	3	3
Q - 3	2	4	3	3	2	3	3	3
Q - 4	2	5	4	2	3	3	3	4
Q - 5	2	5	4	5	2	3	5	2
Q - 6	2	4	5	4	2	2	3	4
Q - 7	2	5	5	4	3	3	3	5
Total per position	19	31	30	25	17	20	23	24
	25.00		**27.50**		**18.50**		**23.50**	
Average score on each position	**3.57**		**3.93**		**2.64**		**3.36**	
Average Score for this Alternative	**3.38**							

	L - 1		**G - 1**		**G - 2**		**G - 3**	
	VF1	VF2	VF1	VF2	VF1	VF2	VF1	VF2
Question 8-1								
8 - 2					X			
8 - 3	X				X	X		
8 - 4	X							
8 - 5	X	X						X
8 - 6					X			

Summary of Controllers Survey for Alternative 3a:

Alternative-3a															
L - 1				G - 1				G - 2				G - 3			
VF1		VF2	VF3	VF1		VF2	VF3	VF1		VF2	VF3	VF1		VF2	VF3
4	3	5	4	5	3	4	3	3	3	3	3	4	3	2	2
4	4	5	4	4	5	3	3	3	3	3	4	4	3	3	3
3	3	4	3	5	4	4	3	4	3	3	2	3	3	2	3
2	3	5	2	5	4	5	4	2	3	3	4	5	3	4	4
4	4	5	4	4	4	5	4	4	2	3	4	5	4	3	4
2	2	4	2	5	4	4	3	4	3	3	3	3	2	2	2
2	3	4	2	5	3	5	4	4	4	3	5	5	3	4	4
21	22	32	21	33	27	30	24	24	21	21	25	29	21	20	22
24.00				28.50				22.75				23.00			
3.43				4.07				3.25				3.29			
3.51															

L - 1				G - 1				G - 2				G - 3			
VF1		VF2	VF3	VF1		VF2	VF3	VF1		VF2	VF3	VF1		VF2	VF3
				X		X	X		X			X			
					X		X	X							
X	X		X												
X					X						X			X	
			X												
X	X	X	X							X					

Summary of Controllers Survey for Alternative 4:

	Alternative 4																							
Position	**L - 1**				L-1		**G - 1**				G-1		**G - 2**				G-2		**G - 3**				G-3	
Scenario	VF1		VF2		VF1	VF2	VF1		VF2		VF1	VF2	VF1		VF2		VF1	VF2	VF1		VF2		VF1	VF2
Q-1	4	4	5	4	5	3	3	3	3	2	2	2	3	3	3	3	3	3	2	3	2	2	2	3
Q-2	4	4	4	4	5	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	4
Q-3	4	3	2	4	3	4	4	3	3	3	2	3	3	3	3	3	3	3	3	3	2	2	2	3
Q-4	4	2	2	5	3	2	3	4	3	2	3	3	3	3	3	3	3	3	2	4	2	3	2	3
Q-5	4	4	2	5	4	5	2	2	5	2	3	4	3	3	3	3	3	3	4	4	4	2	4	3
Q-6	4	2	2	5	3	3	4	3	4	3	2	3	3	3	3	3	4	3	2	2	2	2	2	3
Q-7	4	2	2	5	4	4	4	3	4	2	3	3	3	3	4	3	4	3	3	4	3	3	3	4
Total per position	28	21	19	32	27	24	23	21	25	17	17	21	21	21	22	21	23	21	19	23	18	17	18	23
	25.00				**25.50**		**21.50**				**19.00**		**21.25**				**22.00**		**19.25**				**20.50**	
Average score on each position	**3.57**				**3.64**		**3.07**				**2.71**		**3.04**				**3.14**		**2.75**				**2.93**	
Average Score for this Alternative	**3.11**																							

	L - 1				L-1		**G - 1**				G-1		**G - 2**				G-2		**G - 3**				G-3	
	VF1		VF2		VF1	VF2	VF1		VF2		VF1	VF2	VF1		VF2		VF1	VF2	VF1		VF2		VF1	VF2
Question - 8-1				X																				
8 - 2									X			X							X		X	X	X	X
8 - 3		X	X					X		X								X						
8 - 4		X			X	X				X	X	X								X	X	X		
8 - 5		X	X					X																
8 - 6			X							X							X							

Summary of Controllers Survey for Alternative 5:

Alternative-5																
Position	**L - 1**				**G - 1**				**G - 2**				**L - 3**			
Scenario		VF1		VF2		VF1		VF2		VF1		VF2		VF1		VF2
Question -1	1	4	4	3	3	3	4	4	3	3	3	3	4	3	3	5
Question -2	4	4	4	3	3	3	3	3	5	3	3	3	5	3	4	4
Question -3	4	4	4	4	2	2	2	3	3	3	3	3	4	3	3	5
Question -4	2	4	3	3	3	2	4	4	3	3	3	3	4	2	5	5
Question -5	4	4	4	4	3	4	4	4	4	3	3	3	5	3	4	5
Question -6	4	4	4	3	3	1	3	4	4	3	3	3	5	3	3	4
Question -7	2	5	5	3	3	2	3	3	4	3	3	3	5	4	4	5
Total per position	21	29	28	23	20	17	23	25	26	21	21	21	32	21	26	33
	25.25				**21.25**				**22.25**				**28.00**			
Average score on each position	**3.61**				**3.04**				**3.18**				**4.00**			
Average Score for this Alternative	**3.46**															

	L - 1				**G - 1**				**G - 2**				**L - 3**			
	VF1			VF2	VF1			VF2	VF1			VF2	VF1			VF2
Question 8-1		X	X		X			X						X	X	
8 - 2	X															
8 - 3				X		X										X
8 - 4						X			X					X	X	
8 - 5	X														X	
8 - 6						X										

Appendix B. Comments Made by LAX Controllers and Observers

Question 1: The amount of coordination required with the controllers on my side of the airport
Question 2: The amount of coordination required with the controllers on other side of the airport
Question 3: The amount of communication with the pilots
Question 4: The overall efficiency of this operation
Question 5: The potential for a runway incursion on this Alternative relative to current LAX operations
Question 6: Level of traffic complexity in your control area
Question 7: How would you rate ability to manage the traffic flow under this scenario
Question 8: The most critical problems in this scenario

Comments: Alternative 1

Question 1: The amount of coordination required with the controllers on my side of the airport

Position	Scenario	Comments	Run
GC1	Arrival Rush	Needed to find out where each arrival would exit.	9
GC1	Arrival Rush	More coordination as it is especially critical to keep rwy exits open for arrivals vs. traffic taxing on TWY B.	10
LC1	Arrival Rush	More coordination due to landing 25R had to make sure GC1 was aware of what aircraft were doing.	9
LC1	Arrival Rush	Needed to tell him about nearly all arrivals.	10
LC1	Departure Rush	More coordination with GC1 since arrivals must clear rwy 25R to enter the taxiways.	15
LC2	Departure Rush	Runway exiting was not Complex.	15
LC2	Departure Rush	Tight inboards made it difficult to use 24L for heavy departures so a sidestep to outboard was necessary to keep departure moving.	21
Executive Survey	Arrival Rush	I think it would be busier – too hard to guess which exit a/c would really take on south off of RY25R.	10
Executive Survey 3	Departure Rush	Slow taxi out.	15

Question 2: The amount of coordination required with the controllers on other side of the airport

Position	Scenario	Comments	Run
GC1	Arrival Rush	No change.	9
LC1	Arrival Rush	No crossover coordination.	9
LC1	Arrival	No coordination without crossovers.	10

	Rush		
LC2	Arrival Rush	No coordination with LC1.	9
LC2	Arrival Rush	No crossover coordination.	20
LC2	Departure Rush	No crossovers.	15
Executive Survey	Arrival Rush	May eliminate RTs [right turns] @ M & N but increase @ F, RY25R & RY25L.	10
Executive Survey 1	Departure Rush	But @ F -- may be worse.	15

Question 3: The amount of communication with the pilots

Position	Scenario	Comments	Run
GC1	Arrival Rush	More stops.	9
GC1	Arrival Rush	More transmissions as related to #1 above – more control needed to keep rwy exits available.	10
GC1	Departure Rush	Had to protect highspeeds move, had to talk pilots more.	21
LC1	Arrival Rush	Each departure needed turn @ Foxtrot instructions and crossing RY25R instructions.	10
LC1	Departure Rush	More communication as there is a lot of communication with aircraft at twy F, e. g. “Hold short of F”, “At F cross rwy 25R, hold short rwy 25L”, etc.	15
LC2	Arrival Rush	Had to do runway changes to more aircraft to make it work.	20
LC2	Departure Rush	Needed to ascertain which runway they could accept for departure.	15
Executive Survey	Arrival Rush	LC-1 & GC-1 especially.	10
Executive Survey	Departure Rush	Easy for North Complex; difficult for South Complex.	21
Executive Survey 3	Departure Rush	Normal on North; difficult on South.	15

Question 4: The overall efficiency of this operation

Position	Scenario	Comments	Run
GC1	Arrival Rush	Some may have held longer.	9
GC1	Arrival Rush	Less efficient due to more taxi instructions and “paper stops”.	10
GC1	Arrival Rush	Airport runs less efficient when landing inboards. Can’t get as many departures out on outboard.	10
GC1	Departure Rush	Could not move airplanes as fast due to always having to protect for arrivals.	21
LC1	Arrival Rush	I cannot get as many departures out on runway 25L.	9

LC1	Arrival Rush	Departures were spaced apart more than they would be from RY25R.	10
LC1	Departure Rush	Some reduction in efficiency when heavy jets taxi full-length rwy 25R. Therefore, must use the "3 minute rule" from rwy 25L.	15
LC2	Arrival Rush	Less because aircraft must cross RWY 24L and depart RWY 24R, i. e. increased taxi time.	9
LC2	Arrival Rush	Not having to cross runway that are not in front of me, had a safer feel.	10
LC2	Departure Rush	A few departures had to hold for RY24L, but arrivals did not have to hold at all.	15
LC2	Arrival Rush	Could not get as many departures out with this configuration.	20
Executive Survey 1	Departure Rush	About the same for North; difficult on South.	15

Question 5: The potential for a runway incursion on this Alternative relative to current LAX operations

Position	Scenario	Comments	Run
GC1	Arrival Rush	Unless we say "go around".	9
GC1	Arrival Rush	No runway crossing with arrivals.	10
GC1	Departure Rush	Less runway crossings.	21
LC1	Arrival Rush	Less runway crossings.	9
LC1	Arrival Rush	More runway crossings → each departures.	10
GC2	Arrival Rush	Aircraft are waiting to switch to ground before they exit the runway.	9
GC2	Departure Rush	No runway crossings with arrivals.	15
LC2	Arrival Rush	Again, all my crossings are in front of me, at one place.	10
LC2	Departure Rush	Most departures cross the runway while arrivals tend to be on the runway a little longer.	15

Question 6: Level of traffic complexity in your control area

Position	Scenario	Comments	Run
GC1	Arrival Rush	Arrival to RY25R always increase complexity.	9
GC1	Arrival Rush	Same reasons as above—Less efficient due to more taxi instructions and "paper stops".	10
GC1	Departure Rush	The complexity of this problem was reduced due to the lack of multiple crosses.	15
LC1	Arrival Rush	Not too much more.	10

LC2	Arrival Rush	Higher since most of the departures were from RWY 24R – not what we "normally" do.	9
LC2	Arrival Rush	Complexity was lower due to not having to cross at multiple places.	10
LC2	Arrival Rush	Worked much harder because of changing rwys.	20
LC2	Departure Rush	Getting pilots over to RY24R increases complexity and workload.	15

Question 7: How would you rate ability to manage the traffic flow under this scenario

Position	Scenario	Comments	Run
GC1	Arrival Rush	Harder because of constant swivel head. Can't really give too much attention to any one area.	9
GC1	Arrival Rush	Same reasons as above—Less efficient due to more taxi instructions and "paper stops".	10
GC1	Departure Rush	Position got busy due to increased traffic conflicts.	21
LC1	Arrival Rush	Departure flow was not as efficient.	10
LC2	Arrival Rush	Again, difficult but only maybe because it's "new".	9
LC2	Departure Rush	When an aircraft needed RY24L for departure, that's where the traffic management became difficult.	15

Question 8: The most critical problems in this scenario

Position	Scenario	Comments	Run
GC1	Arrival Rush	Departure line does not move as fast. Taxiway E is blocked longer; hard to get arrivals to the gate.	10
LC1	Arrival Rush	More runway crossings.	10
LC1	Arrival Rush	In my opinion, we (LAX) would not be able to run near as many departures. Additionally, GC-1 would go straight down the pipes.	20
GC2	Arrival Rush	The delay in communication transfer [is greater] than normal.	9
GC2	Departure Rush	Taxi to 24 right, hold short of 24 left creates a workload issue, along with increases potential for wake turbulence.	21
LC2	Arrival Rush	Complexity & workload were issues – it seemed harder to get departures out.	9
LC2	Arrival Rush	Workload increased due to taxiway & runway restrictions.	20
LC2	Departure Rush	Landing RY24L and departing RY24R makes it more difficult for the controller.	15

Other Comments

Position	Scenario	Comments	Run
GC1	Arrival	This scenario was very easy, much busier even on slow	20

	Rush	periods @ LAX.	
GC1	Arrival Rush	Very similar to LAX GC-1.	29
GC1	Departure Rush	When landing rwy 25R, ground has to protect the high-speed exits for every arrival. Local does not have the time to work around them. This increases the complexity.	21
LC1	Arrival Rush	This option most likely cause gridlock due to what I circled. Airport congestion goes up when landing on inboards!	9
LC1	Arrival Rush	This scenario would decrease the efficiency of LAX. The departure rate would be half of today's ops. It also creates gridlock for GC-1.	29
GC2	Arrival Rush	Easy problem.	9
GC2	Arrival Rush	Slower than real life baseline.	29
GC2	Departure Rush	This scenario does not affect GC2.	15
Executive Survey 1	Arrival Rush	This scenario does not accurately reflect traffic congestion in the south terminal area. Particularly, when gates are full. Scenario would have been much tougher. This scenario would restrict departure capacity. We would be unable to hold larger than a B767 between 25L/25R. Not enough pressure placed on runway departures in this scenario.	20
Executive Survey 1	Arrival Rush	The ability to arrive acft to outboard runway severely hampered controllers options when landing inboards due to the fact of hold distances between rwys. Acft ability to cross over @ approach end of rwys caused several go-arounds. Acft still holding between rwys North & South Complex.	29
Executive Survey 1	Departure Rush	Workload on south Complex seemed increased. Workload on north Complex seemed reduced. If arrival/departure runways are switched , it seems more probable to switch them on the north Complex and not the south Complex.	21
Executive Survey 2	Arrival Rush	Local-1 seem to have a greater workload with a missed approaches within 12 min. Hard to gauge whether it was due to controller familiarity with procedure or increased workload.	20
Executive Survey 2	Departure Rush	Departing majority acft off of outboards dictates that some leaves with [the] need to depart 25R. Acft will land 25L then still hold, while acft with company call signs are crossing downfield. This is [a] potential for a runway incursion.	15
Executive Survey 4	Departure Rush	The use of 25R for heavy a/c made the scenario have to revert to what they do today.	15

Comments: Alternative 2

Question 1: The amount of coordination required with the controllers on my side of the airport

Position	Scenario	Comments	Run
GC1	Arrival Rush	Had to coordinate with two people instead of one. LC3 did not know if he was crossing at times.	5
GC1	IFR	The more coordination was necessary because of 2 LC.	11
LC1	Arrival Rush	Because there is an extra controller, duties of 1 are now done by 2.	5
LC1	Departure Rush	Had to coordinate all runway crossing.	6
LC1	IFR	More coordination due to rwy crossings info. w/ LC3.	11
GC2	Departure Rush	No real changes.	6
GC2	IFR	No change.	11
LC3	Arrival Rush	Much more coordination with LC1 for rwy crossing & LC1 for same.	5
LC3	Departure Rush	The amount of coordination was not reduced but increased non-relative to workload reduction.	6
LC3	IFR	Way too much coordination between locals, distracts from working traffic.	11
Executive Survey 1	Arrival Rush	Procedures were unsure.	5
Executive Survey 2	Arrival Rush	Appear to me that there was an increase in side-by departures & arrivals.	5

Question 2: The amount of coordination required with the controllers on other side of the airport

Position	Scenario	Comments	Run
GC1	Arrival Rush	The pilots radio procedures make it very hard to work. Must repeat a lot of instructions.	5
LC1	Arrival Rush	Not one bit of coordination.	5
LC1	Departure Rush	No coordination required.	6
GC2	Departure Rush	No real changes.	6
GC2	IFR	No change.	11
LC3	Arrival Rush	The other side was non-existent.	5
Executive Survey 1	Arrival Rush	Since coordination logistics between locals was work in progress from this initial run, it is hard to tell frequency congestion was reduced.	5
Executive Survey 1	Departure Rush	Less freq congestion.	6

Question 3: The amount of communication with the pilots

Position	Scenario	Comments	Run
LC1	Arrival Rush	A few frequency changes more (crossing to depart RY25L).	5
GC2	Departure Rush	No real changes.	6
GC2	IFR	No change.	11
LC3	Arrival Rush	Same communication as with “Normal” configuration.	5
Executive Survey 1	Arrival Rush	Hard to coordinate crossings.	5
Executive Survey 1	Departure Rush	Easier than normal – reduced workload LC1.	6
Executive Survey 1	IFR	If a g/a [go-around] occurred – could get Complex.	11
Executive Survey 2	Arrival Rush	The workload could have been increased due to the sorting of coordination between locals.	5

Question 4: The overall efficiency of this operation

Position	Scenario	Comments	Run
GC1	Arrival Rush	I felt the operation was slower due to extra coordination.	5
GC1	IFR	More coordination was needed because of the 2nd LC.	11
LC1	Arrival Rush	Departure flow seemed to suffer → hard to determine when RY25L should be used because LC1 doesn’t control it throughout.	5
LC1	IFR	Efficiency reduced due to the two plans – i. e. LC1 traffic & LC3 traffic – and the need to coordinate.	11
GC2	Departure Rush	No real changes.	6
GC2	IFR	No change.	11
LC3	Arrival Rush	Efficiency was compromised due to excessive coordination and trying to fit RWY crossings with LC1 & GC1 traffic.	5
LC3	IFR	I felt it was slower due to coordination.	11
Executive Survey 1	Arrival Rush	Less freq talk – more coordination in cab.	5
Executive Survey 1	Departure Rush	See above – coordination seemed smoother.	6
Executive Survey 1	IFR	Coordination more – freq. congestion less.	11
Executive Survey 2	Arrival Rush	The intensity appears the same.	5

Question 5: The potential for a runway incursion on this Alternative relative to current LAX operations

Position	Scenario	Comments	Run
GC1	Arrival Rush	More coordination, more possibility for error.	5

LC1	Arrival Rush	As with anything new, there was confusion – "memory joggers" in place for current ops do not exist yet.	5
LC1	Departure Rush	More coordination, more chance to miss something or confuse instructions.	6
LC1	IFR	Coordination – miscommunication – of rwy crossings could result in rwy incursion.	11
GC2	Departure Rush	No real changes.	6
GC2	IFR	No change.	11
LC3	Arrival Rush	Much more but based on excessive coordination & the possibility of misunderstanding. The potential for the pilots was the same."	5
LC3	IFR	More of a chance for missed communication between controllers.	11
Executive Survey 1	Arrival Rush	Too soon to tell.	5
Executive Survey 1	Departure Rush	Less communication.	6
Executive Survey 2	Arrival Rush	If the amount of side-bys is discounted, [it] appeared more eyes on the runways, less frequency congestion is a safer airport.	5

Question 6: Level of traffic complexity in your control area

Position	**Scenario**	**Comments**	**Run**
GC1	Arrival Rush	Higher due to coordination & pilots not following instructions.	5
LC1	Arrival Rush	Each runway crossing increased stress level.	5
LC1	Departure Rush	Slow sim.	6
LC1	IFR	More Complex due to more coordination.	11
GC2	Departure Rush	No real changes.	6
GC2	IFR	No change.	11
LC3	Arrival Rush	Much higher. Again due to the excessive coordination for RWY crossings & departure coordination.	5
LC3	IFR	Not working departures, reduced traffic load.	11
Executive Survey 1	Arrival Rush	For now because controller was unsure of plans."	5
Executive Survey 1	Departure Rush	Positioned LC3 to left side of LC1—[it] appeared to work better.	6

Question 7: How would you rate ability to manage the traffic flow under this scenario

Position	**Scenario**	**Comments**	**Run**
LC1	Arrival Rush	Could improve with more experience with the scenario.	5
LC1	IFR	Harder to manage due to coordination.	11
GC2	Departure	No real changes.	6

	Rush		
GC2	IFR	No change.	11
LC2	Arrival Rush	I don't think that this scenario was true to life. The inboard [were] too frequent.	5
LC3	Arrival Rush	Beating a dead horse – coordination issues.	5

Question 8: The most critical problems in this scenario

Position	Scenario	Comments	Run
GC1	IFR	There was too much coordination than was necessary.	11
LC1	Arrival Rush	Seemed very hard to figure out, improved during session, but there wasn't much departure traffic, so with high volume I think it may be very difficult.	5
LC1	Departure Rush	Workload was increased a little due to this coordination. Safety because of possible miss coordination as stated above.	6
LC1	IFR	Again, coordination leads to increased workload & compromise safety.	11
GC2	IFR	Always hard in IFR.	11
LC3	Arrival Rush	The three main problems were – coordination, coordination and coordination.	5
LC3	Departure Rush	Anytime you insert another person in the coordination procedure, the chance of a mistake has increased by (in my opinion) double.	6

Other Comments

Position	Scenario	Comments	Run
GC1	Departure Rush	With no inboard arrivals, coordination and traffic management with LC1, LC3 was manageable	6
GC1	IFR	Pilots were not cooperating. They were not focused and I don't feel they wanted to work the problem. It made the problem much more difficult.	11
LC1	Departure Rush	Much more coordination between locals and ground due to many people involved.	6
LC1	IFR	It is too easy to be lulled into a false sense of security by not paying 100% attention to LC3's traffic. And worse case is a go-around – what to do with departure tfc [traffic].	11
LC2	Arrival Rush	I feel that the a/c performance should be modified, i.e., a DA90 taking all of the runway to depart.	5
LC3	Arrival Rush	Some of this could be more manageable by working on the procedures, e. g. LC1 should be next to GC1.	5
LC3	Departure Rush	I feel this is not a good problem to reduce runway incursions.	6
LC3	IFR	The chance for a runway incursion by ATC is increased in this sim due to more coordination & the chance to miss something."	11
Executive	Arrival	In real life – how would run down help LC3? If no RWY	5

Survey 1	Rush	crossings, AA to Alpha, it would simplify scenario.	
Executive Survey 2	Arrival Rush	The initial moments of the problem, there seem to be more coordination problems between controllers than @LAX. Frequency congestion was reduced with dual locals controllers were able to give departure & arrival instructions simultaneously, thus increasing efficiency	5
Executive Survey 2	Departure Rush	LC-1 & 3 had a greater reduction in workload. Frequency congestion was minimal. Aircraft holding between runways was reduced. Traffic flow from locals to ground controllers appeared to be more efficient.	6

Comments: Alternative 3

Question 1: The amount of coordination required with the controllers on my side of the airport

Position	Scenario	Comments	Run
GC1	Departure Rush	No runway crossings, did not need to talk to local controller.	8
LC1	Arrival Rush	Less coordination w/ GC1 since all Rwy 25L arrivals turned left.	7
LC1	Departure Rush	I did not have to worry about my high speeds being blocked or traffic on the south taxiway.	8
GC2	Arrival Rush	Asked LC2 more often when he was crossing.	7
GC3	Departure Rush	No change.	8
Executive survey	Arrival Rush	Except RY24 line-up was stretched out more than normal on E.	7

Question 2: The amount of coordination required with the controllers on other side of the airport

Position	Scenario	Comments	Run
LC1	Arrival Rush	No cross-over traffic.	7
GC2	Arrival Rush	No change.	7
GC3	Departure Rush	No change.	8
Executive Survey	Arrival Rush	No south side crossings mid-field.	7

Question 3: The amount of communication with the pilots

Position	Scenario	Comments	Run
LC1	Arrival	More communication since LC1 is responsible to issue initial	7

	Rush	taxi instructions and then issue rwy crossing instructions.	
LC1	Departure Rush	I did not have to transmit whom to follow once crossed.	8
GC2	Arrival Rush	More holding points used.	7
GC3	Departure Rush	No change.	8
Executive survey	Arrival Rush	A bit more difficult for GC2.	7

Question 4: The overall efficiency of this operation

Position	Scenario	Comments	Run
GC1	Departure Rush	Aircraft taxiing to west end is not the fastest way to the gate.	8
LC1	Arrival Rush	Less due to workload as mentioned in #3.	7
LC1	Departure Rush	I did not have to stop departures for crossing traffic.	8
GC2	Arrival Rush	Some may have held longer while others got things quicker.	7
GC3	Departure Rush	Not as many aircraft seemed to hold.	8
Executive survey	Arrival Rush	Except GC2 – but manageable	7

Question 5: The potential for a runway incursion on this Alternative relative to current LAX operations

Position	Scenario	Comments	Run
GC1	Departure Rush	No inboard runway crossing.	8
LC1	Arrival Rush	More chance of a rwy incursion because LC must <u>continually</u> scan since all Rwy 25L crossings are on the LC freq., i. e. too many rwy crossings.	7
LC1	Departure Rush	Obvious.	8
GC2	Arrival Rush	I blocked taxiway AA once with crossing traffic. And with volume on taxiway E increased because "Bridge Route" isn't available and inbounds from southside came from AA, the <u>potential</u> to block runway exits more exists."	7
GC3	Arrival Rush	No runway 25R crossing.	7
GC3	Departure Rush	Crossing at the departure end of the runway required a larger crossing hole.	8

Question 6: Level of traffic complexity in your control area

Position	Scenario	Comments	Run
GC1	Departure	Did not have to protect runway exits.	8

	Rush		
LC1	Arrival Rush	Higher due to #3, 4, 5 above.	7
GC2	Arrival Rush	More volume due to aircraft being on taxiways longer → longer taxi routes.	7
GC2	Departure Rush	More Complex since more aircraft were northbound on twy AA – therefore more awareness to protect aircraft exiting RWY 24R at AA but it was not unmanageable.	8
GC3	Departure Rush	Without holding for occupied gates, very simple.	8
Executive Survey	Departure Rush	Longer inbound taxi – shorter departure queue.	8
Executive survey	Arrival Rush	Less efficient taxiing, however more efficient departure sequence for RY25 – no crossings.	7

Question 7: How would you rate ability to manage the traffic flow under this scenario

Position	**Scenario**	**Comments**	**Run**
GC1	Departure Rush	Same as 6 above—Did not have to protect runway exits.	8
LC1	Arrival Rush	More difficult due to more workload.	7
GC2	Arrival Rush	Same because you have a lot of planning on this position whenever volume is high. Mistakes - personal or pilot[s'] – are what creates unmanageability.	7
GC3	Departure Rush	Very simple.	8

Question 8: The most critical problems in this scenario

Position	**Scenario**	**Comments**	**Run**
GC1	Arrival Rush	From the GC-1 stand-point, this problem has a very high mark.	7
GC1	Departure Rush	No issues.	8
LC1	Departure Rush	Crossing traffic at the runway end was the most critical. But no[t] bad at all when having to cross.	8
LC1	Arrival Rush	Safety is compromised.	7
GC2	Arrival Rush	Had to stay on top of things the entire time.	7
GC2	Departure Rush	No critical problems.	8
GC3	Arrival Rush	No issues for GC3.	7
GC3	Departure Rush	Crossing at Uniform needs to be <u>very</u> timely.	8

Other Comments

Position	Scenario	Comments	Run
GC1	Arrival Rush	The workload was much reduced and the Complex level was brought down.	7
LC1	Arrival Rush	The crossing scenario would be better managed if traffic could land and be instructed to hold short of TWY U. In that way all Rwy 25L arrivals could turn onto TWY A and talk to GC3. GC3 then crosses at TWY U without coordination.	7
GC3	Arrival Rush	GC3 normal operation, no conflictions or coordination issues."	7

Comments: Alternative 3a

Question 1: The amount of coordination required with the controllers on my side of the airport

Position	Scenario	Comments	Run
LC1	Arrival Rush	Less conflictions with ground traffic.	22
LC1	Arrival Rush	Did not coordinate runway crossings.	31

Question 2: The amount of coordination required with the controllers on other side of the airport

Position	Scenario	Comments	Run
LC1	Arrival Rush	No coordination.	22

Question 3: The amount of communication with the pilots

Position	Scenario	Comments	Run
N/A	N/A	None	N/A

Question 4: The overall efficiency of this operation

Position	Scenario	Comments	Run
LC1	Arrival Rush	Taking aircraft to west end is less efficient.	22
LC1	Arrival Rush	Aircraft were on the taxiway much longer.	31

Question 5: The potential for a runway incursion on this Alternative relative to current LAX operations

Position	Scenario	Comments	Run
N/A	N/A	None	N/A

Question 6: Level of traffic complexity in your control area

Position	Scenario	Comments	Run
LC1	Arrival	Had to increase scan due to traffic on both sides of the runway.	22

	Rush		
LC1	Arrival Rush	Had to increase scan. Runway crossings took longer at U.	31
GC3	Arrival Rush	More traffic using the west end.	34

Question 7: How would you rate ability to manage the traffic flow under this scenario

Position	**Scenario**	**Comments**	**Run**
N/A	N/A	None	N/A

Question 8: The most critical problems in this scenario

Position	**Scenario**	**Comments**	**Run**
GC1	Departure Rush	Actually, there were no critical components.	23
GC2	Departure Rush	Taking departures to south side of airport makes traffic call more Complex.	23

Other Comments

Position	**Scenario**	**Comments**	**Run**
GC1	Arrival Rush	Thanks for all the good work!	34
GC1	Departure Rush	Much smoother op. than normal LAX procedures.	23
LC1	Arrival Rush	Traffic on the taxiways [are] longer = more congestion.	22
LC1	Arrival Rush	Things can get stacked up on taxiway Alpha.	34
GC2	Departure Rush	Pilots did a great job in this sim. [Sim] ran well.	23
GC3	Arrival Rush	Ran smooth, no complications.	31
Executive Survey	Arrival Rush	No acft holding between rwys by definition eliminates rwy incursions. 2:30 minutes wait to x-cross 25L @ U, longest with for #1. Five acft line up the most backup. Might add more taxi & wait time to acft traffic but safe."	22
Executive Survey	Arrival Rush	With two grd controllers, traffic efficient on B, but congested on twy A.	34
Executive Survey	Arrival Rush	LCL 1 & GRD 1 had normal workload compared to LAX ops. GRD 3 had less workload. B-16 to A seemed to simplify the workload for GRD 3. Option appeared to be much safer but a little inefficient for Skywest ops, taxiing the west end.	31

Comments: Alternative 4

Question 1: The amount of coordination required with the controllers on my side of the airport

Position	Scenario	Comments	Run
GC1	Arrival Rush	Local told me about RY25R arrivals, but didn't have to say anything about runway crossings.	12
GC1	Departure Rush	Local told me of each RY25R crossing. GC3 had to give me verbal and paper strip coordination.	16
GC1	Departure Rush	Had to work with GC3 more due to conflicting traffic.	28
LC1	Arrival Rush	Did not have to give traffic call to a/c crossing the right runway.	12
LC1	Arrival Rush	No runway crossing, [I] did not have to talk to GC1 as much.	14
LC1	Departure Rush	No coordination at all.	13
GC2	Arrival Rush	No changes.	14
GC3	Arrival Rush	Had to coordinate with ground one more to get the aircraft on the north route.	12
GC3	Departure Rush	A little more coordination due to northbound aircraft transitioning from south side airport to north side.	13
GC3	Departure Rush	Had to coordinate with GC1 more to miss each other's traffic.	16
GC3	Departure Rush	More coordination with GC1 for aircraft parking on the north side.	27

Question 2: The amount of coordination required with the controllers on other side of the airport

Position	Scenario	Comments	Run
GC1	Arrival Rush	No change.	12
GC1	Departure Rush	No change.	16
LC1	Departure Rush	Only 1 crossover.	13
LC1	Arrival Rush	No coordination.	14
GC2	Arrival Rush	No changes.	14
Executive Survey	Departure Rush	Most definitely.	13

Question 3: The amount of communication with the pilots

Position	Scenario	Comments	Run
GC1	Arrival Rush	Fewer runways – exiting aircraft means instructions to pilots are not so time critical.	12
GC1	Departure Rush	Lots of taxi changes that always happen.	16
LC1	Departure Rush	Had to tell pilots on RY25L to turn left and had given each one progressive instruction.	13
GC2	Arrival Rush	No changes.	14
GC3	Departure Rush	More due to more taxi instructions, i. e. “taxi via B-16 and twy B.	13
GC3	Departure Rush	More traffic, more traffic calls.	16
GC3	Departure Rush	More traffic in this position than normal.	27

Question 4: The overall efficiency of this operation

Position	Scenario	Comments	Run
GC1	Arrival Rush	Aircraft didn’t have to stop on the taxiways as much but the ones landing RY25L had to taxi further.	12
GC1	Arrival Rush	It is better, more efficient, to some degree because it is not as critical to keep rwy exits available for arrival traffic.	14
GC1	Departure Rush	Arrivals are taken away from their gates to get to B-16.	16
LC1	Departure Rush	Arrivals had to taxi longer and usually wait for at least one more arrival before they could cross RY25L.	13
LC1	Arrival Rush	Could not move arrivals as fast to gates. Having to go to west ends, slows operation a lot.	14
GC2	Arrival Rush	No changes.	14
GC3	Arrival Rush	Aircraft are on the taxiways longer due to increase taxi distance.	12
GC3	Arrival Rush	The amount of a/c is reduced all at once.	14
GC3	Departure Rush	Aircraft had to taxi to the west end, were on the taxiways longer, creating more problems.	16
GC3	Departure Rush	Aircraft on this ground longer, makes more work and less efficient.	27

Question 5: The potential for a runway incursion on this Alternative relative to current LAX operations

Position	Scenario	Comments	Run
GC1	Arrival Rush	Same amount of runway crossings but crossing at taxiway Uniform means you have a smaller crossing hole.	12
GC1	Arrival Rush	More likely for rwy incursions since LC has to cross rwy 25L at the departure end. Aircraft are not as easy to observe (two miles away).	14

GC1	Departure Rush	No runway crossings.	13
GC1	Departure Rush	Local is turning planes left and right, so he could make mistakes → his potential for mistakes increases.	16
GC1	Departure Rush	No runway crossings mid field.	28
LC1	Arrival Rush	No runway crossings.	14
LC1	Departure Rush	I was crossing RY25L @ Uniform with traffic on 2-mile final. Pilots have to be on-the-ball, probably have to move faster than normal. And I don't know how that may affect making a 90° turn at B-16. Crossing in front of arrivals can be difficult.	13
GC2	Arrival Rush	No changes.	14
GC3	Arrival Rush	Less runway crossings.	12
GC3	Departure Rush	More due to instruction "… taxi via B-16 …". There is a possibility the aircraft will not turn as instructed and instead cross Rwy 25R.	13
GC3	Departure Rush	Less runway crossing.	16
GC3	Departure Rush	Less runway crossings.	27

Question 6: Level of traffic complexity in your control area

Position	Scenario	Comments	Run
GC1	Arrival Rush	Very few runway exits to protect.	12
GC1	Departure Rush	GC3 handling traffic west of S reduced my workload.	13
GC1	Departure Rush	Still busy.	16
LC1	Arrival Rush	More things to watch at a greater distance apart, i. e. runway ends.	14
LC1	Departure Rush	I seemed to have to scan much more to see where my arrivals were once they landed. This takes my attention away from other areas. If B-16 is not used, the arrival lands, is observed to hold short RY25R, and doesn't need to be observed again until I say "cross "RY25R."	13
GC2	Arrival Rush	No changes.	14
GC3	Arrival Rush	More aircraft for this position.	12
GC3	Arrival Rush	Higher but not an increase workload.	14
GC3	Departure Rush	Again, due to more taxi instructions.	13

GC3	Departure Rush	More airplanes than normal.	16
GC3	Departure Rush	More airplanes than normal.	27

Question 7: How would you rate ability to manage the traffic flow under this scenario

Position	Scenario	Comments	Run
GC1	Arrival Rush	Seemed easier.	12
GC1	Departure Rush	Everyone inbound starts at S.	16
LC1	Departure Rush	I have to give much more attention to the arrival after he lands. Therefore, my departure flow is probably not as efficient.	13
LC1	Arrival Rush	Tough to stay ahead of traffic at times.	14
GC2	Arrival Rush	No changes.	14

Question 8: The most critical problems in this scenario

Position	Scenario	Comments	Run
GC1	Arrival Rush	I didn't feel there were any critical problems.	12
GC1	Arrival Rush	More complexity, but for LC, not necessarily for GC & related safety issues.	14
GC1	Departure Rush	Had to watch GC3's traffic and coordinate north route traffic and miss each other.	13
GC1	Departure Rush	These increased because everyone is at the same place.	16
GC1	Departure Rush	Complexity level was close to "real life" @ LAX. Nice job! Pilots did well!	27
LC1	Arrival Rush	I don't feel there was a problem in this run.	12
LC1	Arrival Rush	This was a hard sim to work. Traffic stays busy and there is a lot of scanning which affects the three identified [items?] in this area.	14
LC1	Departure Rush	I don't think it's as safe. A smaller crossing hole is more difficult to manage. Crossing between departures (RY25R) ensures more control. Between arrivals (RY25L, B-16) relies on pilot compliance.	13
LC1	Departure Rush	The B-16 route needs a name when coming off the runway to reduce verbage.	16
GC2	Arrival Rush	No changes.	14
GC3	Arrival Rush	Same as #1 above—Had to coordinate with ground one more to get the aircraft on the north route.	12
GC3	Arrival Rush	Workload increases but not a problem.	14

GC3	Departure Rush	As noted above.	13
GC3	Departure Rush	Working more with GC1.	16
GC3	Departure Rush	Same as #1 above—More coordination with GC1 for aircraft parking on the north side.	27

Other Comments

Position	**Scenario**	**Comments**	**Run**
GC1	Departure Rush	Workload for GC1 is reduced a little but aircraft are on the taxiways longer which can create more problems.	13
GC1	Departure Rush	Couple pilots missed turns which made it real like.	27
LC1	Departure Rush	This problem resides on having enough spacing between aircraft on final.	27
LC1	Departure Rush	Pilots did good! Sending all aircraft on Alpha route, makes it easier with less chance of a rwy incursion.”	28
GC2	Arrival Rush	No different than current LAX operations.	12
GC2	Departure Rush	Routine – no different than present operation.	16
GC3	Departure Rush	Using A routes appears to be easier but I wonder how it will do with other factors, such as, Socal arrival rate, heavy inboards, maintenance tows, etc.	28
Executive Survey 1	Arrival Rush	Increased taxi distance, the question is whether time was saved?	14
Executive Survey 1	Departure Rush	The B-16 option reduces congestion in [CTIA?] (sic) area, traffic flowing to B-16 ran smoothly minimal hold-short of 25L in safe area. One crossing from 25L thru 25 to taxiway B with acft waiting for takeoff on 25R. More activity from west on B & C.	13
Executive Survey 2	Arrival Rush	The queuing of the aircraft to the southeast creates greater congestion but it is spread over the entire south runway Complex, vice concentrated between B & C from C-6 to Taxiway S.	14
Executive Survey 3	Arrival Rush	Need high speeds to the left of 25L are needed – forced go-arounds – inbound taxi times may increase.	14

Comments: Alternative 5

Question 1: The amount of coordination required with the controllers on my side of the airport

Position	**Scenario**	**Comments**	**Run**
LC1	Arrival Rush	Too much coordination with LC-3 made working difficult when busier.	25

Question 2: The amount of coordination required with the controllers on other side of the airport

Position	**Scenario**	**Comments**	**Run**
LC1	Arrival Rush	No crossovers.	25

Question 3: The amount of communication with the pilots

Position	**Scenario**	**Comments**	**Run**
GC1	Arrival Rush	Had to make more transmissions since aircraft were on the taxiways longer.	30
LC1	Arrival Rush	Not talking to runway 25L airplanes.	25

Question 4: The overall efficiency of this operation

Position	**Scenario**	**Comments**	**Run**
LC1	Arrival Rush	Aircraft did not move as fast.	25

Question 5: The potential for a runway incursion on this Alternative relative to current LAX operations

Position	**Scenario**	**Comments**	**Run**
GC1	Arrival Rush	Less runway crossings.	30
LC1	Arrival Rush	No mid field runway crossings	25

Question 6: Level of traffic complexity in your control area

Position	**Scenario**	**Comments**	**Run**
GC1	Arrival Rush	Very busy on the west end. Too much to look at. Could not keep back of traffic in the area of C-6 and C7.	30

Question 7: How would you rate ability to manage the traffic flow under this scenario

Position	**Scenario**	**Comments**	**Run**
N/A	N/A	None	N/A

Question 8: The most critical problems in this scenario

Position	**Scenario**	**Comments**	**Run**
LC3	Arrival Rush	Workload on GC1 seem to be increased, freedom to cross the right was restricted.	30

Other Comments

Position	**Scenario**	**Comments**	**Run**
GC2	Departure Rush	Normal operation (baseline for this side). No problems.	26
LC3	Departure Rush	After heavy jet rotated RY25R, I had four to cross RY25R. The first two were fast; the second two were very slow, almost stopping on RY25R.	26

Executive Survey	Arrival Rush	LCL 1 & 3 did not have coordination issues with all acft exiting south. Grd 2 workload seemed the same except congestion @ S & Q, B & C vice between C-6 to C-10. Issue 00 52 80 was in excess of 11:23 min. off of A-7 to gate 65.	30
Executive Survey	Arrival Rush	The scenario seemed much safer but less efficient. UA 221 took 15:00+ [minutes] from time exiting A-7 to taxi lane. There was also a lineup on B from C-8 to B-16.	33

Appendix C: Controller Voice Communication Data

Alternative 1, Swapped Runways, Number of Voice Transmissions per Hour

Alternative 1	Ground 1		Local 1	
Date Scenario	Pilots	Controller	Pilots	Controller
# of Transmissions/hr for VFR-1	419	376	344	315
# of Transmissions/hr for VFR-2	349	319	359	323
# of Transmissions/hr for VFR-1	349	321	344	317
Average Number of Transmissions/Hour	**372**	**339**	**349**	**318**

Table 20: Alternative 1, Swapped Runways, Voice Transmissions per Hour

Alternative 2, Two South Locals, Number of Voice Transmissions per Hour

Alternative 2	Ground 1		Local 1		Local 3	
	Pilots	Controller	Pilots	Controller	Pilots	Controller
# of Transmissions/hr for VFR-1	356	320	201	193	187	177
# of Transmissions/hr for VFR-2	337	305			156	149
# of Transmissions/hr for IFR	393	331	163	141	220	176
Average Number of Transmissions /Hour	**362**	**319**	**182**	**167**	**188**	**168**

Table 21: Alternative 2, Two South Locals, Voice Transmissions per Hour

Alternative 3, B-16: AA, One Way, Number of Voice Transmissions per Hour

Alternative 3	Ground 1		Local 1		Ground 3	
	Pilots	Controller	Pilots	Controller	Pilots	Controller
# of Transmissions/hr for VFR-1	323	289	344	324	140	96
# of Transmissions/hr for VFR-2	332	269	335	304	120	87
Average Number of Transmissions/Hour	**327**	**279**	**339**	**314**	**130**	**91**

Table 22: Alternative 3, B-16: AA, One Way, Voice Transmissions per Hour

Alternative 3a, B-16: Bridge Open, Number of Voice Transmissions per Hour

Alternative 3a	Ground 1		Local 1		Ground 3	
	Pilots	Controller	Pilots	Controller	Pilots	Controller
# of Transmissions/hr for VFR-1	288	227	376	339	129	96
# of Transmissions/hr for VFR-2	279	249	315	289	99	77
# of Transmissions/hr for VFR-1	317	275	335	296	161	127
# of Transmissions/hr for VFR-1	283	216	293	281	155	91
Average Number of Transmissions/Hour	**292**	**242**	**330**	**301**	**136**	**98**

Table 23: Alternative 3a, B-16: Bridge Open, Voice Transmissions per Hour

Alternative 4, B-16: ATC Discretion, Number of Voice Transmissions per Hour

During the third run, voice data for GC-3 was not recorded.

Alternative 4	GC-1		LC-1		GC-3	
	Pilots	Controller	Pilots	Controller	Pilots	Controller
# of Transmissions/hr for VFR-1	321	268	387	311	122	129
# of Transmissions/hr for VFR-2	345	284	321	288	120	76
# of Transmissions/hr for VFR-1	318	258	337	303	-	-
# of Transmissions/hr for VFR-2	333	288	324	291	100	73
Average Number of Transmissions/Hour	**330**	**275**	**342**	**298**	**114**	**93**

Table 24: Alternative 4, B-16 with ATC Discretion, Voice Transmissions per Hour

Alternative 5, B-16: With Two Locals, Number of Voice Transmissions per Hour

Alternative 5	Ground 1		Local 1		Local 3	
	Pilots	Controller	Pilots	Controller	Pilots	Controller
# of Transmissions/hr for VFR-1	397	368	233	184	192	161
# of Transmissions/hr for VFR-2	360	308		193	137	107
# of Transmissions/hr for VFR-1	353	320	199	171	128	144
# of Transmissions/hr for VFR-1	335	304	161	188	161	127
Average Number of Transmissions/Hour	**361**	**325**	**198**	**184**	**155**	**135**

Table 25: Alternative 5, B-16: With Two Locals, Number of Transmissions per Hour

Appendix D: Surface Parameter Definitions

- **Arrival Rate:** number of flights that arrive during a simulation run normalized for an hour

- **Average Non-Movement Time:** the cumulative total of the departure Non-Movement Area times divided by the total number of departures and cumulative total of the arrival Non-Movement Area times divided by the total number of arrivals

- **Average Runway Occupancy Time:** the cumulative total of runway occupancy times divided by the total number of arrival aircraft

- **Average Taxi Time:** the cumulative total of taxi time divided by the total number of taxiing aircraft

- **Departure Delay:** an elapsed time that exceeds the average outbound taxi time plus 15 minutes

- **Departure Rate:** number of flights that depart during a simulation run, normalized for an hour

- **Inbound Taxi Time:** the elapsed time between touchdown of an aircraft and the arrival of the aircraft at the gate

- **Movement Area[*]:** the runways, taxiways, and other areas of an airport/heliport which are utilized for taxiing/hover-taxiing, air taxiing, takeoff and landing of aircraft, exclusive of loading ramps and parking areas. At those airports/heliports with a tower, specific approval for entry onto the movement area must be obtained from ATC.

- **Non-Movement Area[*]:** Taxiway and apron (ramp) areas not under the control of air traffic.

- **Non-Movement Area Time:** the elapsed time from a gate pushback of an aircraft to the movement of the aircraft into the FAA Movement Area or vice versa

- **Outbound Taxi Time:** the elapsed time between departure of an aircraft from the Non-Movement Area and the beginning of the take-off roll

- **Running Average Departure Rate:** the running average departure rate is calculated by adding each successive departure in the scenario to a running total and computing a new average departure rate normalized for an hour

- **Runway Occupancy Time:** the elapsed time between touchdown of an aircraft and the tail of the aircraft clearing the active runway

- **Taxi Hold Time:** the elapsed time from start to end of a taxi hold

- **Taxi Hold:** the execution of a full stop from taxi speed and resumption to taxi speed of an aircraft

[*] definitions from the FAA's atcpub website.