Appendix H-8

LAX SPECIFIC PLAN AMENDMENT STUDY REPORT

Comparative Safety Risk Assessment Interim Taxiways Safety Improvement Project

July 2010

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Los Angeles International Airport

Comparative Safety Risk Assessment
Interim Taxiways Safety Improvement Project

Prepared by:
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In Association With:
CDM
Washington Consulting Group, Inc.
Johnson Aviation

July 2010

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LIST OF ACROYNMS

ASDE-X	Airport Surface Detection Equipment
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
BOAC	LAWA Board of Airport Commissioners
CFR	14 Code of Federal Regulations
EAT	End-Around Taxiway
FAA	Federal Aviation Administration
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
ITSIP	Interim Taxiways Safety Improvement Project
LAWA	Los Angeles World Airport
NASA	National Air and Space Administration
OFZ	Object Free Zone
PHA	Preliminary Hazard Analysis
REDIM	Runway Exit Design Interactive Model
ROT	Runway Occupancy Time
SME	Subject Matter Expert
SPAS	Specific Plan Amendment Study
SOP	Standard Operating Procedures
SRM	Safety Risk Management
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

I. Executive Summary

The Federal Aviation Administration (FAA) places runway safety as one of its highest priorities. This priority is shared by the Los Angeles World Airport (LAWA) and both continue to work together in a collaborative effort to reduce the potential and likelihood of compromising airfield safety. LAWA is enhancing safety by planning for and implementing long-term and short-term improvements for the North and South Airfields. Examples of a long-term improvement concept for the North Airfield under evaluation can be found in past and ongoing assessments such as the LAX Final Master Plan, the Specific Plan Amendment Study (SPAS), as well as other independent evaluations. An example of short-term improvements includes the installation of the ground radar system or otherwise known as the Airport Surface Detection Equipment (ASDE-X), installation of runway status lights and the Interim Taxiway Safety Improvement Project (ITSIP).

1.1 LAWA Safety Goal

The dynamic environment of the aviation industry exposes it to many and varied risks every day; including its systemic susceptibility to human error. The FAA and LAWA's overall safety goal is to plan and implement an airfield system that minimizes the risk of human error, while maintaining airfield efficiency.

LAWA is and will continue to be proactive in enhancing safety on the LAX airfield, while maintaining efficient movement of aircraft. To achieve this goal, LAWA has identified two primary objectives:

- Identify Long-Term Improvements: Eliminate and/or substantially reduce levels of risk while maintaining airfield operational efficiency
- Implement Short-Term Improvements: Reduce risk levels as much as feasible while maintaining airfield operational efficiency.

Related to the long-term improvements at LAX, LAWA has conducted numerous evaluations and assessments to identify the most effective means to enhance safety based on current and future fleet mix and operational characteristics. These assessments include:

- LAX Final Master Plan[1];
- Completion of the LAX North Airfield Special Peer Review[2];
- Completion of a Supplemental North Airfield Assessment Reconfiguration Options[3]
- Completion of the LAX North Airfield Safety Risk Assessment[4];
- Completion of an independent Analysis of the LAX North Airfield Alternatives[5];
- Completion of an Aviation Industry Assessment of the North Airfield[6]; and
- Sponsoring the independent North Airfield Safety Study (Academic Panel/NASA).

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1 LAWA, *LAX Final Master Plan*. April 2004.
2 DMJM Harris-AECOM and Peer Review Group, *LAX North Airfield Special Peer Review.* March 2007.
3 URS Corporation, *Los Angeles International Airport North Airfield Assessment*. May 2007.
4 Washington Consulting Group, Inc., *LAX North Airfield Proposed Runway Configuration – Safety Risk Assessment*. May 2007.
5 International Aviation Management Group, Inc., *Analysis of LAX North Airfield Alternatives.* May 2007.
6 Airline Pilots Association, *Los Angeles International Airport Modernization-Tomorrow is Now.* May 2007.

In addition to these assessments, LAWA has implemented substantial changes to enhance safety for the South Airfield via the South Airfield Improvement Program. Ultimately, long-term improvements related to the North Airfield will be further evaluated via the SPAS effort, which is currently underway.

Short-term improvement examples that have been implemented at LAX include:

- Completion of Enhanced Marking and Lighting System for both the South and North Airfield;
- Completion of the installation of South and North Airfield Runway Status Light System Pilot Program; and
- Completion of the ASDE-X system installation (provides the ground radar surveillance and control logic for the Runway Status Light System), which LAWA provided financial assistance toward installation of the system.

1.2 Background

As a result of the North Airfield evaluations listed above, the LAWA Board of Airport Commissioners (BOAC) requested an interim design and subsequent risk assessment to address as many identified hazards as possible, while the long-term future layout of the North Airfield continues to be assessed as part of the SPAS. This assessment led to the initiation of ITSIP. The main focus of ITSIP is to identify and implement, as soon as possible, changes to the existing North Airfield that will mitigate (or lessen the degree of) those hazards identified in the *LAX North Airfield Safety Risk Assessment* report with a medium risk level (depicted in yellow in Exhibit 8, “Identified Potential Hazards Risk Matrix of Current Configuration”, of the LAX North Airfield Safety Risk Assessment report published May 2007).[7]

1.2.1 2007 Safety Risk Management Assessment

In 2007, a Safety Risk Management (SRM) assessment was conducted on the current LAX North Airfield Runway/Taxiway System. The assessment focused on the evaluation of moving Runway 24R 340 feet north and its relationship to the proposed North Airfield System, which would provide for a center-runway taxiway system similar to the LAX South Airfield configuration. [8]

The 2007 Safety Report identified ten (10) hazards associated with the current north airfield system design.[9] The following is a detailed description of the identified hazards:

Runway 24R arrival crossing Runway 24L with or with-out a clearance with arrival and departure aircraft using Runway 24L where:

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7 Washington Consulting Group, Inc., *LAX North Airfield Proposed Runway Configuration – Safety Risk Assessment*. May 2007, page 15.

8 Safety Risk Assessment Panel – May 2007 Participants: Raymond Jack, LAWA Airside Operations; Kurt Rammelsberg, FAA Air Traffic Control Tower; Michael Doucette, LAWA Airport Planning; Walt Smith, Washington Consulting Group, Inc. SMS/SRM Expert; Nick Johnson, Johnson Aviation, source of information.

9 Washington Consulting Group, Inc., *LAX North Airfield Proposed Runway Configuration – Safety Risk Assessment*. May 2007.

- LAX 001 – Aircraft crossing at Taxiway Z or Taxiway Y (Non-Heavy aircraft departing Runway 24L) resulting in a high severity operational error;
- LAX 002 – Aircraft crossing at Taxiway Z or Taxiway Y (Heavy aircraft departing Runway 24L) resulting in a high severity operational error;
- LAX 003 – Aircraft crossing at Taxiway AA or Taxiway BB (Heavy aircraft departing Runway 24L) resulting in a significant increase in air traffic control (ATC) workload; and
- LAX 004 – Aircraft crossing at Taxiway AA or Taxiway BB (Non-Heavy aircraft departing Runway 24L) resulting in a slight reduction in safety margins.

Runway 24L and Runway 24R in use for arrivals and departures where:

- LAX 005 – Runway 24L Departure with a Runway 24L Arrival (Over-flight) resulting in a moderate severity operational error;
- LAX 006 – Runway 24R Departure with a Runway 24R Arrival (Over-flight) resulting in a moderate severity operational error; and
- LAX 007 – Runway 24R Arrival with a preceding Runway 24R arrival at Taxiway AA or Taxiway BB resulting in a high severity operational error.

Runway 24L arrival or departure where:

- LAX 008 – Design Group V or VI aircraft simultaneously using Taxiway E at the east end resulting in a moderate severity operational error.

Runway 24L and Runway 24R in use where:

- LAX 009 – Increased activity and complexity of Design Group V and VI operating on the North Airfield Complex resulting in moderate severity operational error; and
- LAX 010 – Aircraft Rescue and Firefighting (ARFF) equipment operating within the runway safety area at northeast end of Runway 24R resulting in an increase of Air Traffic Controller workload and a distracter to aircrews.

The hazards level of risk severity and likelihood was identified based on qualitative information gathered during the assessment. **Table I-1** provides the study conclusions related to the existing North Airfield hazards. The SRM assessment concluded that with the long-term improvement related to moving Runway 6L-24R 340 feet to the north, hazards LAX 001, LAX 002 and LAX 008 would be eliminated. In addition, this concept would mitigate the remaining hazards to a low level of risk (green area).

1.2.2 The System and LAX North Airfield

A system is defined based on a series of components that interact together to deliver an expected outcome. For an airfield, the system is made up of the runways, exit taxiways, taxiways, lighting, service roads, navigation aids, signage, aircraft pilots, air traffic control, etc. All of these elements together are designed to accommodate safe and efficient aircraft movement between a terminal gate and a runway and back again.

Table I-1

Existing North Airfield Comparative Safety Risk Assessment Matrix

Severity / Likelihood	No Safety Effect 5	Minor 4	Major 3	Hazardous 2	Catastrophic 1
Frequent – A More than once per week	Low Risk	Medium Risk	High Risk	High Risk	High Risk
Probable – B Once every month	Low Risk	Medium Risk	High Risk	High Risk	High Risk
Remote – C Once every year	Low Risk	Low Risk	Medium Risk: **LAX 005 LAX 008 LAX 009**	High Risk	High Risk
Extremely Remote – D Once every 10-100 years	Low Risk	Low Risk: **LAX 003 LAX 004 LAX 010**	Low Risk: **LAX 006**	Medium Risk: **LAX 001 LAX 002 LAX 007**	High Risk
Extremely Improbable – E Less than once every 100 years	Low Risk	Low Risk	Low Risk	Low Risk	Medium Risk / High Risk *

High Risk

Medium Risk

Low Risk

* High risk hazards are unacceptable with single point and common cause failures.

Source: Washington Consulting Group, Inc., May 2007 (hazard severity and likelihood); Federal Aviation Administration, FAA Safety Management System Manual, May 2004 (severity and likelihood classifications).
Prepared by: Ricondo & Associates, Inc., November 2009.

Pilots and air traffic controllers are very effective at operating a complex and dynamic system like the LAX North Airfield. This human benefit makes it impractical to design an airfield system that would remove all possibility of human interaction in the system. Because the possibility of human error exists, the FAA's overall goal is to provide airfield system design guidelines to airports that minimize the risk of human error without compromising safety. As a result, FAA's design and operational guidance focuses on creating enough time and space for human decision making and action in the air traffic system. The most widely and effective design element to enhance safety and accommodate for human error is proper airfield geometry and space. For aircraft in the air, the FAA requires minimum separation, both horizontally and vertically, to ensure that both pilots and controllers have time and distance to react to human errors. When an aircraft is cleared to use a runway for a landing or takeoff, the entire runway and area around the runway, known as the Object Free Zone (OFZ), is unavailable to anyone else. For spacing between taxiways and runways, the FAA provides standard distances between both to ensure aircraft using both have adequate space between them that not only provides clearance from wingtip to wingtip, but also space designed to provide safety margin for error (reaction time, opportunity to avoid a collision, etc.). As reported in previous evaluations, the North Airfield does not currently meet these guidelines for the type of aircraft operating on it, specifically Group V (e.g., Boeing 777-300ER) and Group VI aircraft (e.g., Airbus 380)

In 2007, the FAA released an engineering brief that contains several design recommendations between taxiways and runways which are intended to prevent runway incursions.[10] A specific recommendation applicable to the ITSIP project is the following FAA recommendation:

> The risk of a Category A or B [severe loss of separation between two aircraft] incursion is higher for crossings occurring in the first third of the runway and lower in the last two thirds. Since it is not possible to entirely eliminate runway crossing situations, establishing designs and associated surface traffic flow strategies keeping taxiway-runway crossings by aircraft in the last two thirds of the runway (as measured from the arrival threshold) significantly reduces the risk. ***The preference is for aircraft to cross in the last third of the runway whenever possible***, [Emphasis added] since within the middle third of the runway the arriving/ departing aircraft is usually on the ground and traveling at a high rate of speed. The studies also indicated a larger propensity for Category A and B incursions when the angle of intersection of the taxiway and runway is not at a 90° angle or the taxiway is very wide, than those occurring at 90-degree intersections with normal widths. (FAA Engineering Brief 75, page 3).

The premise behind the first element, crossing at the last third of the runway, is intended to give more time for the system (air traffic control and pilots) to react to a potential imminent incursion or collision. The second element, a 90 degree angle at the intersection of a taxiway and runway, is intended to provide pilots in the aircraft, that are about to cross a runway, a better vantage point to look down the runway to visually confirm it is safe to cross.

Exhibit I-1 depicts the existing North Airfield. The North Airfield has two parallel runways. Runway 6R-24L is 10,285 feet long, and Runway 6L-24R is 8,925 feet long and both are 150 feet wide. The runways are separated by 700 feet. There are six (6) taxiway exits for Runway 6L-24R. There is no centerfield taxiway between both runways. For aircraft landing on Runway 24R, there are four (4) runway exits available (Taxiway Y, Z, AA and BB). Note that Taxiway Y and Z cross through the middle third (yellow area) of Runway 24L. Each runway and taxiway are lighted and equipped with navigational aids.

Identifying short-term safety improvements was based on developing airfield geometry that may be able to mitigate hazards with medium risk levels in the Comparative Safety Risk Assessment matrix to low risk levels. According to the FAA SRM Manual, this focus is called "Design for Minimum Risk." If the design cannot eliminate a risk, then a new design should be developed to change the system to mitigate the risk to an "acceptable" or low level, or green area of the Comparative Safety Risk Assessment matrix. Eliminating Hazards LAX 001, LAX 002 and LAX 008 and mitigating hazards LAX 003, LAX 004, LAX 005, LAX 007, LAX 009 and LAX 010 would require:

[10] Federal Aviation Administration, *Engineering Brief 75: Incorporation of Runway Incursion Prevention Into Taxiways and Aprons*. November 19, 2007.

Exhibit I-1

Existing North Airfield System

Source: LAWA, April 2004 (Airport Layout Plan); Ricondo & Associates, Inc., November 2009 (Runway 24L 1st, 2nd and 3rd Thirds).
Prepared by: Ricondo & Associates, Inc., November 2009.

- increasing the distance between both runways;
- providing a center taxiway with adequate separation between both runways to accommodate Group VI independent operations and designed 90-degree turns; and
- making available adequate separation between a parallel taxiway south of Runway 6R-24L.

With the runway locations remaining at the existing locations during the interim period (prior to implementing a long-term solution), hazards LAX 001 and LAX 002 may be mitigated if Taxiway Y and Z are either removed or relocated.

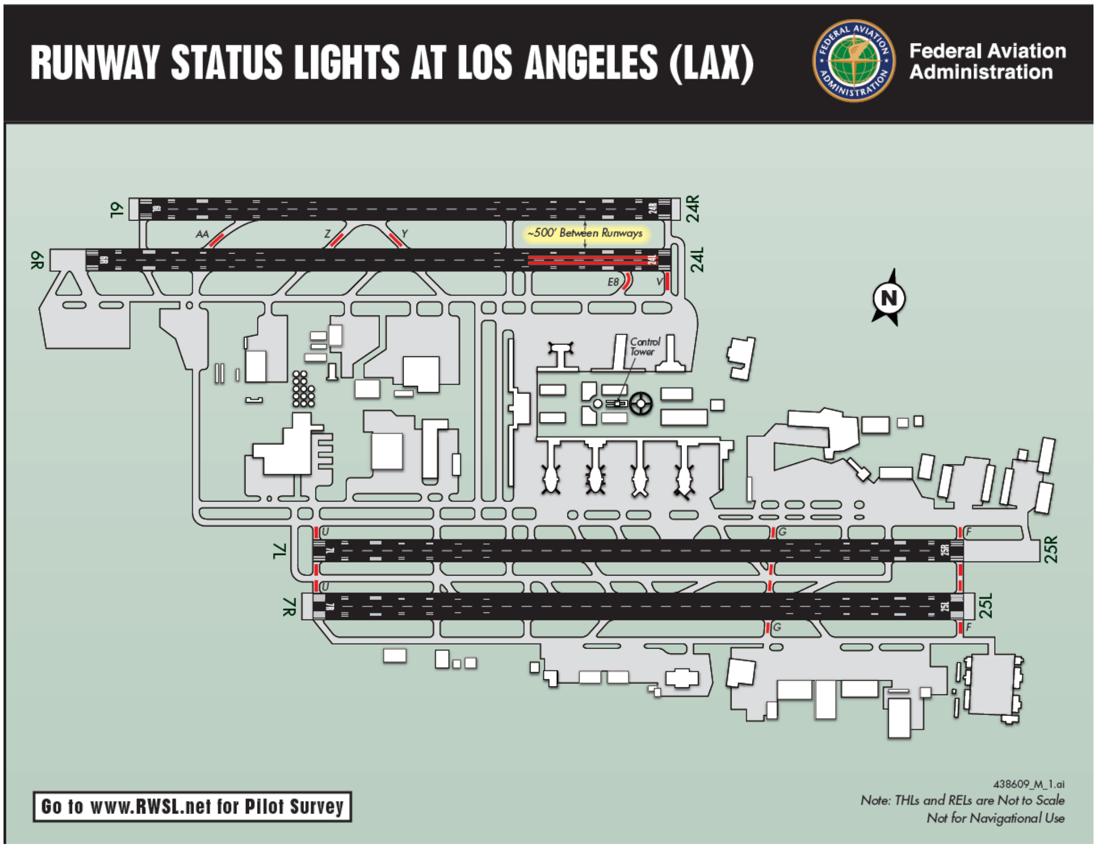
Since the 2007 LAX North Airfield Safety Risk Assessment report was completed, the following safety improvements at LAX were completed:

- Implementation of South and North Airfield Runway Status Light System program; and
- Completion of the ASDE-X system installation, which FAA provided LAWA financial assistance.

The locations of the Runway Status Lights on the North Airfield are depicted in **Exhibit I-2**. Although these elements further enhance safety on the North Airfield, they do not include airfield geometry adjustments that can change the overall runway system. Note that the additional elements mentioned above added to the North Airfield system were included as part of the existing North Airfield system.

Exhibit I-2

Runway Status Lights at LAX – Pilot Training Card from FAA



Source: Federal Aviation Administration, Air Traffic Organization Pacific Service Area, Surface Technology Assessment, April 13, 2009 (www. http://rwsl.ll.mit.edu/pdf/LAX_RWSL_Pilot_Training_Card.pdf).
Prepared by: MIT Lincoln Laboratory, April 13, 2009.

1.2.3 ITSIP Concept Evaluation

Based on the LAX North Airfield Safety Risk Assessment and subsequent analysis by LAWA, the FAA, and Subject Matter Experts (SMEs), LAWA concluded that two hazards, LAX 001 and LAX 002, may be potentially mitigated either by reducing the severity of the outcome or reducing the likelihood of the predicted outcome by relocating the location of high-speed Taxiway Y and Z. Hazards LAX 001 and 002 are graphically depicted in the **Appendix**. LAWA conducted a high level qualitative assessment of actual takeoff distances conducted by aircraft using Runway 24L and evaluated eight (8) North Airfield high-speed exit taxiway configuration concepts[11] and one End-Around Taxiway (EAT) concept designed to mitigate hazards that are directly related to the existing high-speed taxiway locations.

1.2.3.1 Description of LAX001 and LAX002 Hazards

Hazard LAX 001: This hazard was identified during the 2007 SRM assessment as a potential event when an aircraft lands on Runway 24R and uses either Taxiway Y or Z to exit while at the same time a Non-Heavy aircraft (e.g., Boeing 737 Series, Airbus 318/319/320 Series, McDonnell Douglas MD-

[11] The eight (8) ITSIP concepts are described and depicted in Section 2.3.2.3.

80 series, Regional Jets, and Turboprops) departure is cleared for takeoff and is rolling forward on Runway 24L or an aircraft is about to land on Runway 24L.

The hazard during this scenario is the potential of the arrival aircraft from Runway 24R that is using Taxiway Y or Z continues south and crosses over the hold line for Runway 24L inadvertently while the aircraft departing Runway 24L begins the takeoff roll or an arriving aircraft is about to touch down on Runway 24L. If the hazard actually occurs, the result is a runway incursion. A runway incursion involves a loss of safe separation between two aircraft.

The hold line on either Taxiway Y or Z designates the beginning of an area around Runway 6R-24L that must be clear of any obstacles or obstructions when an aircraft is cleared to use the runway. This is known as the Object Free Zone (OFZ). When ATC clears an aircraft to land or takeoff, the runway is to be used only for that aircraft and all other movements must stay clear of the runway and the protected OFZ. If a taxiing aircraft crosses the hold line while another aircraft is using the runway, safety has been compromised and an incursion has occurred.

Hazard LAX002: This hazard is similar to LAX 001, but involves a Heavy aircraft (e.g., Boeing 747 Series, Boeing 767 Series, Boeing 777-300, Airbus 380, Airbus 340, Airbus 300, Airbus 310, Airbus 330, and McDonnell Douglas MD-11) departure from Runway 24L. Due to the fact that the aircraft is heavier, it will require more runway length to takeoff and the climb performance (how fast it will climb up) is lower compared to Non-Heavy jet aircraft. If an aircraft inadvertently crosses the hold line on Taxiway Y or Z and begins to cross Runway 24L while a Heavy aircraft begins its takeoff roll, the possible effect of the incursion may involve severe or abrupt movements by either or both aircraft to avoid a collision. The degree of the outcome may be considered somewhat higher compared to the outcome for hazard LAX 001 because of the different performance characteristics of a Heavy jet departure, but the level of the outcome would be the same.

1.2.3.2 Preferred ITSIP Alternative

As discussed above, the purpose behind ITSIP was to develop a preferred concept that would change the airfield system by reducing the severity of the hazard or the likelihood of it occurring. Given that ITSIP is a short-term measure, certain elements of the North Airfield system were not changed. Those elements that remain unchanged include:

- Location and dimensions of Runways 6L-24R and 6R-24L
- Taxiway system around the Terminals
- Gate locations
- FAA air traffic procedures
- Navigation Aids

The specific change associated with ITSIP is related to the location and shape of Taxiway Y and Z high-speed exits. In simple terms, the overall logic is to assess the viability of having all Runway 24R arrivals cross Runway 24L further down the runway compared to where they do today on Taxiway Y and Z. LAWA set the following objectives that can be achievable within the existing North Airfield layout:

1. Provide more space between the departing aircraft on Runway 24L and the point where aircraft that landed on Runway 24R would cross Runway 24L based on FAA guidelines;

2. Design the high-speed exit so that aircraft crossing Runway 24L are doing so as close as perpendicular as possible so pilots have a better view angle and can see down Runway 24L when crossing;
3. Keep the time an aircraft lands and exits Runway 24R at or below approximately 50 seconds[12];
4. Do not substantially affect the efficiency of the North Airfield; and
5. Maintain existing capacity.

LAWA reviewed eight (8) concepts that involved relocating Taxiway Y and Z and/or closing Taxiway Y and Z and replacing them with new ones further west along Runway 24R. At an April 6, 2009 meeting, LAWA provided the BOAC an initial draft concept for further analysis. The additional analysis conducted after that date has resulted in the refined Preferred ITSIP Alternative depicted in **Exhibit I-3**.

Compared to other concepts, the preferred option was found to meet the following objectives:

1. Aircraft that landed on Runway 24R cross at the last third (shaded in green in Exhibit I-3 below) of Runway 24L, which is consistent with FAA Engineering Briefing #75 and allows more time for the pilot controlling the departing aircraft on Runway 24L to react;
2. The time it takes for an aircraft to land and exit Runway 24R is maintained at approximately 50 seconds, which continues to allow for final approach separation of two and half miles between sequential arrivals; therefore maintaining current runway efficiency and throughput;
3. The Preferred ITSIP Alternative provides the same number of available runway exits for Runway 24R arrivals compared to the current system. Taxiway Y is no longer available for Runway 24R arrivals, so an additional high-speed taxiway (Taxiway AA-1) was added towards the west end of the runway. This maintains existing capacity and minimizes effect on runway occupancy time; and
4. The Preferred ITSIP Alternative does not adversely affect the overall efficiency of the existing North Airfield system. With the Preferred Alternative, the average unimpeded taxi time and delay for each aircraft that uses the North Airfield runways and taxiways is expected to increase by less than one (1) minute.

The next step in the ITSIP evaluation process identified by LAWA and directed by the BOAC in April of 2009 was to reconvene a Safety Risk Assessment Panel (SRAP) comprised of LAWA, the FAA, and consultant SMEs in airport operations, airport planning, and air traffic control to conduct a Comparative Safety Risk Assessment.[13] The Comparative Safety Risk Assessment for ITSIP focused on first reviewing hazards LAX 001 and LAX 002 to confirm that the hazards still exist based on current operations and the implementation of short-term enhancements like the runway status lights.

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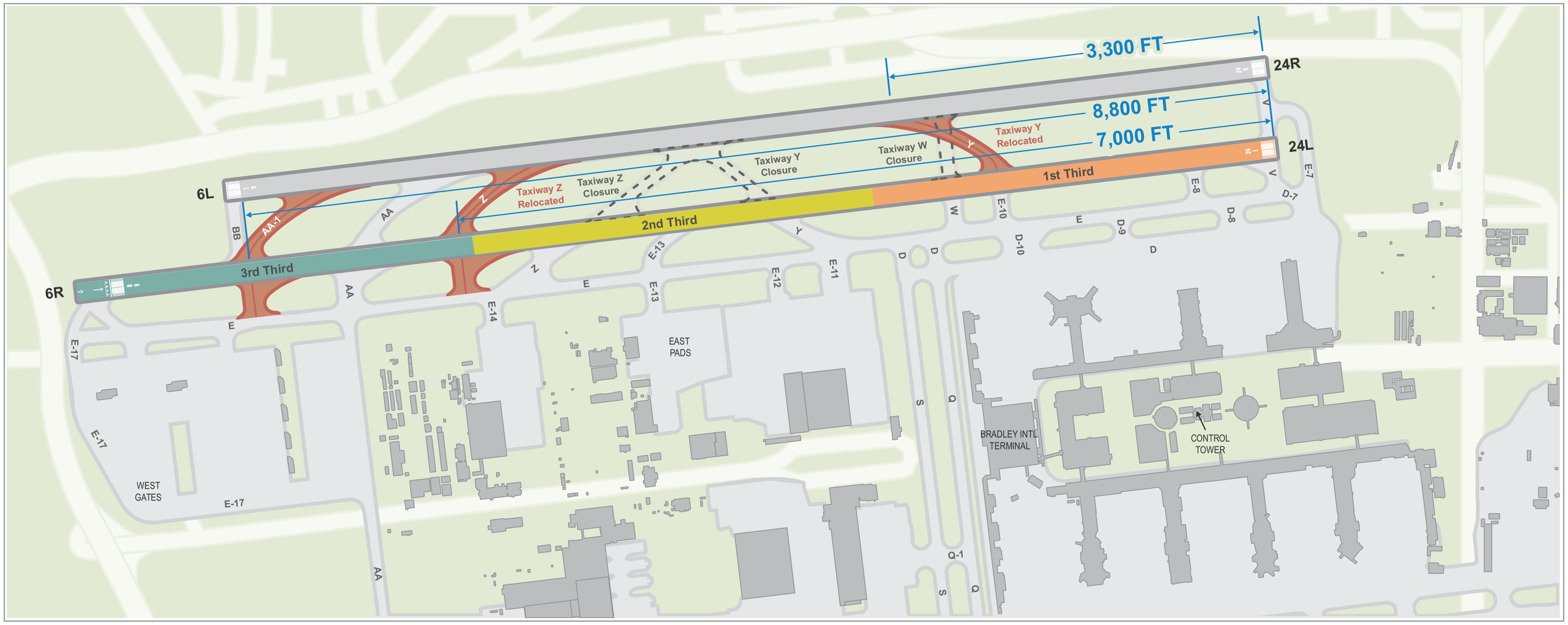
12 FAA Order 7110.65S, Air Traffic Control, Para 5-5-4 (g); allows for a minimum radar separation of two and a half (2.5) nautical miles, instead of three (3) to five (5) nautical miles, between two (2) aircraft on final approach within 10 nautical miles of the landing runway as long as the weight of the trailing aircraft is the same or less than the leading aircraft, although heavy aircraft can participate as long as it is a trailing aircraft.

13 LAX Safety Risk Assessment Panel – September 2009 participants: Marv Shappi, FAA Air Traffic Control Tower; Kurt Rammelsberg, FAA Air Traffic Control Tower; Dave Kurner, FAA Runway Safety Western Pacific Office; Raymond Jack, LAWA Airside Operations Manager; Jacqueline Yaft, LAWA Deputy Executive Director of Operations; Cynthia Guidry, Chief of Airport Planning; Jaideep Vaswani, Chief of Airport Planning I; Walt Smith, Washington Consulting Group, Inc., SRM/SMS Expert and moderator; Joseph Huy, Ricondo & Associates, Inc., ITSIP Concept Planning source of information; Stephen Smith, Ricondo & Associates, Inc., ITSIP Concept Planning source of information; Rick Wells, ITSIP Concept Planning source of information; Nick Johnson, Johnson Aviation, ITSIP Concept Planning and historic source of information.



New Taxiways

Source: Los Angeles World Airports, June 2003 (Airport Layout Plan); Ricondo & Associates, Inc., October 2009 (Preferred Alternative highspeed taxiway layout).
Prepared by: Ricondo & Associates, Inc., February 2010.

Exhibit I-3

Not to Scale.

north

Preferred ITSIP Alternative

Next, the SRAP reviewed the Preferred ITSIP Alternative and determined if it would reduce the severity or likelihood of the hazards occurring. Third, the SRAP evaluated the potential of the Preferred ITSIP Alternative to cause additional hazards and/or worsening other existing hazards, i.e. evaluation of unintended consequences.

1.3 Safety Risk Assessment Panel Findings and Conclusion

On September 25, 2009 the SRAP met to analyze the level and likelihood of hazards LAX 001 and LAX 002 if the Preferred ITSIP Alternative was implemented, and determine if other hazards may be caused due to the airfield taxiway system change. The SRAP used the FAA's SMS guidelines and the five step process which describes the system, identifies the hazards (real or potential), quantifies risk associated with the hazards, assesses the risks and treats the risks with mitigation solutions. The process is detailed in Section III of this report.

The SRAP determined that the severity and likelihood of hazard LAX 001 in the current North Airfield system remains hazardous (possibility for a significant operational error) and extremely remote (may occur once every 10 to 100 years), because of the introduction of de-rated[14] thrust used by the airlines for departures. Hazard LAX 002, which is associated with Heavy jet departures (lower climb performance compared to Non-Heavy jets) remains hazardous (possibility for a significant operational error) and extremely remote (may occur once every 10 to 100 years) due to the current locations of Taxiway Y and Z, which continue as mid-field crossing points in the existing configuration.

As depicted in Exhibit I-3, the Preferred ITSIP Alternative is designed to have aircraft cross 7,000 feet down Runway 24L. This change to the system design moves taxiway locations; and therefore introduces new runway crossing points further down Runway 24L into the last third of the runway, as recommended by the FAA.

As depicted in **Table I-2**, the SRAP's Comparative Safety Risk Assessment (or severity and likelihood analysis) resulted in the following findings:

- **Hazard LAX 001**: The SRAP concluded that the result of the hazard, if it occurred, would not be as severe compared to the existing locations of Taxiway Y and Z. The potential for lost separation between the two aircraft can still occur and the safety margin can still be significantly impacted, but the outcome may not lead to serious or fatal injuries to some people on board either aircraft. This would change the severity of the risk from hazardous to major according to FAA criteria (as depicted in Table I-1). The reason for the SRAP's determination is that with the relocation of Taxiway Y to the east and the relocation of Taxiway Z to the west, the level of possible incursions would be reduced to low/moderate levels (FAA Category B or C in Operational Error classification[15]).

[14] de-rated thrust is a thrust setting used by airlines to apply an appropriate level of thrust that saves both engine wear-and-tear and fuel. Application of de-rated thrust results in longer take-off distances for aircraft.

[15] An operational error occurs when less than 90 percent of the applicable separation minima (keep an aircraft 1,000 feet above or below another aircraft and 2.5 nautical miles laterally) between two or more airborne aircraft or between an aircraft and an obstacle or terrain as required by FAA Order 7110.65, *Air Traffic Control*. Category A Operational Error is when a loss of non-wake turbulence separation occurs where the separation conformance is less than 34 percent or approximately less than 300 feet vertically and 5,100 feet laterally (less than 70 percent for wake turbulence separation). Category B is when a loss of separation occurs where the separation conformance is more than 34 percent but less than 75 percent or at/below 700 ft and less than 2 nautical miles laterally (equal to or greater than 70 percent and less than 85 percent for wake turbulence). Category C is when a loss of horizontal/vertical separation occurs where the separation conformance is more than 75 percent, but is less than 90 percent or at/below 800 feet and less than 2.25 nautical miles (equal to or greater than 85 percent and less than 100 percent for wake turbulence).

Table I-2

LAWA Preferred Alternative-North Airfield Comparative Safety Risk Assessment Matrix

Severity / Likelihood	No Safety Effect	Minor	Major	Hazardous	Catastrophic
	5	4	3	2	1
Frequent – A More than once per week					
Probable – B Once every month					
Remote – C Once every year			LAX 005 LAX 008 LAX 009		
Extremely Remote – D Once every 10-100 years		LAX 003 LAX 004 LAX 010	LAX 001 LAX 006	LAX 001 LAX 002 LAX 007	
Extremely Improbable – E Less than once every 100 years				LAX 002	*

High Risk

Medium Risk

Low Risk

* High risk hazards are unacceptable with single point and common cause failures.

Source: Washington Consulting Group, Inc., May 2007 (hazard severity and likelihood); Federal Aviation Administration, FAA Safety Management System Manual, May 2004 (severity and likelihood classifications); LAX Safety Risk Assessment Panel, September 2009 (ITSIP Preferred Alternative hazard severity and likelihood for LAX 001 and LAX 002).
Prepared by: Ricondo & Associates, Inc., November 2009.

The reasoning is based on the fact that the aircraft would now cross through the last third portion of Runway 24L, as recommended in the FAA's Engineering Brief #75[16]. The likelihood for hazard LAX 001 with the Preferred ITSIP Alternative would still remain extremely remote, or qualitatively estimated it would occur once in every 10 to 100 years. **Therefore, the SRAP concluded that the Preferred ITSIP Alternative can mitigate Hazard LAX 001 from a medium level to low level risk**.

- **Hazard LAX 002**: The SRAP concluded that the result of the hazard, if it occurred, would still be as severe compared to what may occur with the existing locations of Taxiway Y and Z. The required length of Heavy aircraft departures is longer and its climb performance is lower compared to Non-Heavy jets. The possibility of a of an incursion between a Heavy jet departing Runway 24L and an aircraft crossing Runway 24L at a point further down the runway can still lead to the potential of a serious loss in separation (FAA Category A Operational Error or less than 300 feet between both aircraft) that would require extreme action by either or both pilots to avoid a collision. However the SRAP determined that the likelihood of LAX 002 occurring has been reduced to extremely improbable as a result of increased time and distance for the pilot or air traffic controller to react when and if a taxiing aircraft inadvertently crosses Runway 24L, because the aircraft would now cross through the last third of Runway 24L as recommend in the FAA's Engineering Brief #75. **Therefore, the SRAP concluded that the Preferred ITSIP Alternative can mitigate Hazard LAX 002 from a medium level to low level of risk.**

Based on qualitative information using the FAA's Safety Risk Management process, the SRAP's findings conclude that the Preferred ITSIP Alternative would mitigate the level of risk associated with hazards LAX 001 and LAX 002 from a medium to low risk level.

II. Background

In 2006, the FAA implemented a SMS and SRM process for the busiest and most complex commercial use airport traffic control facilities in the National Airspace System (NAS). The FAA SMS/SRM is designed to identify operational hazards, analyze the risks associated with these hazards and establish mitigating strategies to ensure the safe and expeditious management of air traffic.

In response to the FAA's safety initiatives, LAWA's Executive Director chartered the SRAP to follow the SMS/SRM process to specifically develop and prioritize airport improvements that will enhance the level of airfield safety at LAX. The North Airfield Complex at LAX was the focus of the Panel's evaluation at LAX. The SRAP consisted of personnel from the FAA, LAX Airport Traffic Control Tower, LAX Airside Field Operations, and Subject Matter Experts (SMEs). The scope and efforts of the SRAP are further described in Section III.

The ITSIP is a product of efforts from the SRAP as well as the BOAC to identify short-term safety enhancements at LAX. The ITSIP identifies specific safety enhancements to the North Airfield that can be completed prior to long-term improvements. Long-term safety improvements to the North Airfield are being further evaluated via the SPAS process.

This section summarizes the various North Airfield safety assessments that have been conducted over

[16] As stated in the cover page of Engineering Brief No. 75, the FAA plans to incorporate key elements of the briefing into their next comprehensive revision to Advisory Circular 150/5300-13.

the past three years under the direction of the SRAP and the BOAC. This section identifies specific improvements that have recently been completed, that are ongoing, and additional improvements that have been evaluated and recommended.

2.1 LAX North Airfield Safety Risk Assessment

In 2007, a Safety Risk Management Assessment[17] was conducted on the current LAX North Airfield Runway/Taxiway System and its relationship to the proposed North Airfield System moving Runway 24R 340' north which generates a center-runway taxiway system similar to the LAX South Airfield configuration. The 2007 Safety Report identified and addressed ten (10) hazards associated with the current system design. The following is a summary description of the hazards reviewed during this assessment:

1. Runway 24R arrival crossing Runway 24L with a clearance with arrival and departure aircraft using Runway 24L where:
   - LAX 001 – Aircraft crossing at Taxiway Z or Taxiway Y (Non-heavy aircraft) resulting in a high severity operational error;
   - LAX 002 – Aircraft crossing at Taxiway Z or Taxiway Y (Heavy aircraft) resulting in a high severity operational error;
   - LAX 003 – Aircraft crossing at Taxiway AA or Taxiway BB (Heavy aircraft) resulting in a significant increase in ATC workload; and
   - LAX 004 – Aircraft crossing at Taxiway AA or Taxiway BB (Non-heavy aircraft) resulting in a slight reduction in safety margins.
2. Runway 24L and Runway 24R in use for arrivals and departures where:
   - LAX 005 – Runway 24L Departure with a Runway 24L Arrival (Over-flight) resulting in a moderate severity operational error;
   - LAX 006 – Runway 24R Departure with a Runway 24R Arrival (Over-flight) resulting in a moderate severity operational error; and
   - LAX 007 – Runway 24R Arrival with a preceding Runway 24R arrival at Taxiway AA or Taxiway BB resulting in a high severity operational error.
3. Runway 24L arrival or departure where:
   - LAX 008 – Design Group V or VI aircraft simultaneously using Taxiway E at the east end resulting in a moderate severity operational error.
4. Runway 24L and Runway 24R in use where:
   - LAX 009 – Increased activity and complexity of Design Group V and VI operating on the North Airfield Complex resulting in moderate severity operational error; and
   - LAX 010 – Aircraft Rescue and Firefighting (ARFF) equipment operating within the runway safety area at northeast end of Runway 24R resulting in an increase of Air Traffic Controller workload and a distracter to aircrews.

The hazards level of risk severity and likelihood was identified based on qualitative information gathered during the risk assessment. **Table II-1** provides the levels of risk severity and likelihood as

[17] Washington Consulting Group, Inc., *LAX North Airfield Proposed Runway Configuration – Safety Risk Assessment*. May 2007.

well as provides the conclusions made during the assessment as they relate to the existing North Airfield hazards.

Table II-1

Existing North Airfield Comparative Safety Risk Assessment Matrix

Severity / Likelihood	No Safety Effect	Minor	Major	Hazardous	Catastrophic
	5	4	3	2	1
Frequent – A More than once per week					
Probable – B Once every month					
Remote – C Once every year			**LAX 005** **LAX 008** **LAX 009**		
Extremely Remote – D Once every 10-100 years		**LAX 003** **LAX 004** **LAX 010**	**LAX 006**	**LAX 001** **LAX 002** **LAX 007**	
Extremely Improbable – E Less than once every 100 years					*

High Risk

Medium Risk

Low Risk

* High risk hazards are unacceptable with single point and common cause failures.

Source: Washington Consulting Group, Inc., May 2007 (hazard severity and likelihood); Federal Aviation Administration, FAA Safety Management System Manual, May 2004 (severity and likelihood classifications).
Prepared by: Ricondo & Associates, Inc., November 2009.

The levels of likelihood for the hazards are described in time intervals. The levels of risk severity are shown in descriptive categories. The categories for risk severity include potential impacts to both the flying public as well as air traffic control. **Table II-2** provides additional definition of the risk severity to the flying public and air traffic control.

With a long-term improvement similar to the Runway 6L-24R 340' North Airfield concept, all the hazards would be mitigated with the exception of LAX 001, LAX 002 and LAX 008, which would be eliminated. Although the elimination of hazard LAX 008 (and other hazards shown in yellow) will require long-term improvements to the North Airfield, hazards LAX 001 and LAX 002 could be mitigated with short-term improvements.

Table II-2

Risk Severity Impacts on the Flying Public and Air Traffic Control

	No Safety Effect	Minor	Major	Hazardous	Catastrophic
Effect on Flying Public	a. No effect on flight crew; b. Has no effect on safety; or c. Inconvenient	a. Slight increase in crew workload; b. Slight reduction in safety margin or functional capabilities; or c. Physical discomfort of passengers	a. Significant increase in crew workload; b. Significant reduction in safety margin or functional capabilities; or c. Physical distress including possible injuries	a. Large reduction in safety margin or functional capabilities; b. Serious or fatal injury to small number of occupants or cabin crew; or c. Physical distress/excessive workload	Outcome would result in: hull loss; multiple fatalities
Effect on Air Traffic Control (ATC)	Slight increase in ATC Workload	a. Slight reduction in ATC Capability; or b. Significant increase in ATC Workload	a. Reduction in separation as defined by low/moderate severity operational error; or b. Significant reduction in ATC Capability	a. Reduction in separation as defined by a high severity operational error; or b. Total loss of ATC Capability	Collision with other aircraft, obstacles or terrain

Source: Ricondo & Associates, November 2009.
Prepared by: Ricondo & Associates, Inc., November 2009.

2.2 LAWA Board of Airport Commissioners

Based on conclusions from the 2007 LAX North Airfield Safety Risk Assessment, the BOAC recognized the need for interim North Airfield safety enhancements while long-term planning solutions were being developed as part of the Specific Plan Amendment Study (SPAS) process. To accomplish this, the BOAC directed LAWA staff to identify additional short-term improvements to further enhance safety within the existing airfield structure. The main goals and objectives of these improvements would be to:

- Reduce level of safety risk identified in the 2007 Safety Assessment for the existing North Airfield without adversely affecting efficiency and Runway Occupancy Time (ROT), and
- Mitigate previously identified hazards where possible by reducing the level of severity and/or likelihood of its occurrence.

In addition to these efforts by LAWA staff, the BOAC sponsored an analysis involving an academic panel and NASA, who were to conduct a North Airfield Safety Study to provide an external and independent assessment of long-term improvements. The following sections provide a summary of the subsequent risk assessments and efforts conducted by LAWA to date to enhance safety for the North Airfield.

2.3 Airfield System Improvements to North Airfield

Since completion of the LAX North Airfield Safety Risk Assessment, LAWA has been implementing various safety improvements to the existing North Airfield. Some of these improvements have been completed, some are on-going, and some are still being evaluated. The following sections provide a summary of these various safety improvement initiatives.

2.3.1 Safety Improvements Recently Completed and On-Going

LAWA has completed the installation of Enhanced Marking and Lighting System for both the North and South Airfield and has completed the installation of the ASDE-X radar system.

- **Enhanced Marking and Lighting Systems** – The installation of these systems are completed and include new in-pavement hold bar lights at all runway-taxiway intersections and new runway centerline markings.
- **ASDE-X Radar System** – This radar is a traffic management system for the airport surface that provides seamless coverage and aircraft identification to air traffic controllers. The system uses a combination of surface movement radar and transponder sensors to display aircraft position labeled with flight call-signs on an ATC tower display. The integration of these sensors provides data with an accuracy, update rate and reliability suitable for improving airport safety in all weather conditions. The installation of this system is complete.
- **Runway Status Light Systems Pilot Program** – The Runway Status Light System Pilot Program is a fully automatic, advisory safety system designed to reduce the number and severity of runway incursions to help prevent runway accidents while not interfering with airport operations. These systems are primarily comprised of Takeoff Hold Lights and Runway Entrance Lights and are designed to be compatible with existing procedures. Runway Status Lights have been installed on the North and South Airfields.
- **Runway Status Lights Program** – On February 16, 2010, LAWA and the FAA entered into a Memorandum of Agreement for the FAA to install a full complement of Runway Status Lights to augment an existing prototype system installed in June 2009, which includes installing lights for four (4) taxiway-runway intersections on the North Airfield.
- **FAA Procedure Improvements** - As part of the overall goal of improving operational safety at LAX, the FAA has made procedural improvements since 2007 that are related to airspace operations. The FAA also continues to evaluate other potential safety improvements.

2.3.2 Additional North Airfield Safety Assessments

In addition to recently completed and on-going safety enhancements at LAX, LAWA is also focusing other airfield geometry safety improvements that may be able to mitigate hazards with medium risk levels in the Comparative Safety Risk Assessment matrix (see Table II-1) to low risk levels. According to the FAA SRM Manual, this focus is called “Design for Minimum Risk.” If the design cannot eliminate a risk, derive a design change in the system to mitigate the risk to an “acceptable” level, or green area of the Comparative Safety Risk Assessment matrix.

Mitigating or eliminating hazards LAX 005, LAX 007, LAX 008 and LAX 009 will require increasing the distance between both runways and adequate separation between a parallel taxiway south of Runway 6R-24L. However, hazards LAX 001 and LAX 002 may be mitigated prior to increasing North Airfield runway/taxiway separation distances with certain taxiway modifications.

To evaluate the various options to mitigate hazards LAX 001 and LAX 002, LAWA has conducted additional North Airfield safety assessments that include a Runway 24L Departure Lift-Off Analysis, an End-Around Taxiway Assessment, and a High Speed Exit Screening Assessment. The following sections provide a summary of results for each of these three efforts.

2.3.2.1 North Airfield Lift-Off Analysis

The purpose of this evaluation was to assess flight track radar data and other supplemental date sources to estimate lift-off points for departures from Runway 24L at LAX. The analysis resulted in the following conclusions:

- Developed predictive statistical model to identify lift-off locations for departures along Runway 24L.
- The estimated average lift-off distance for 86.65% of all departures is 7,000 feet; and 8,000 feet for 96.67% of all departures (i.e. prior to Taxiway AA)[18].
- All lift-off distances are based on calculated estimates.
- Radar data did not provide the level of fidelity to determine the exact aircraft lift off location.

Conclusions related to estimated lift-off distances are also depicted on **Exhibit II-1**.

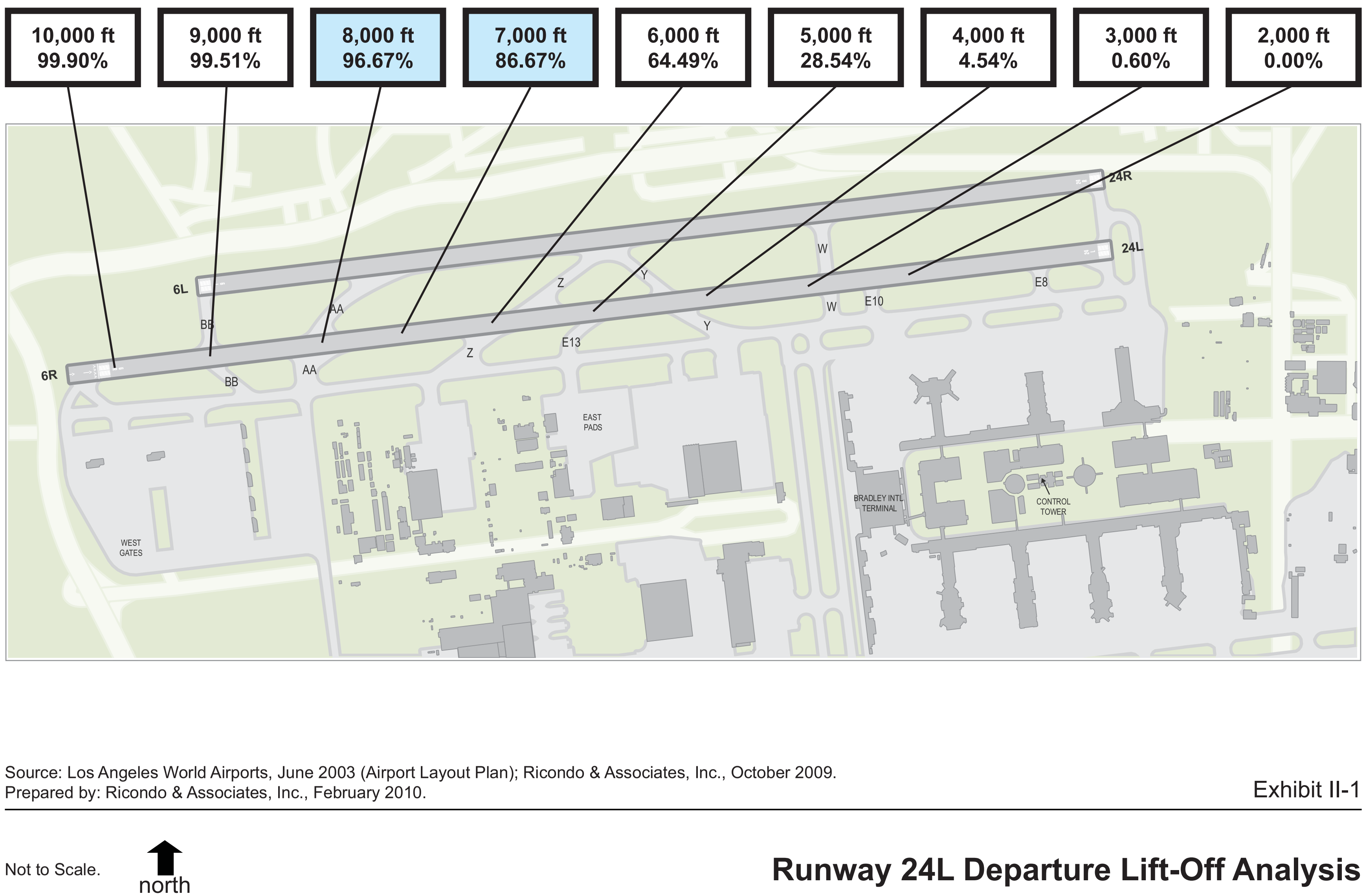
2.3.2.2 End-Around Taxiway Assessment

The End-Around Taxiway (EAT) concept is intended to act as a holding area for aircraft that are too large to hold between a pair of runways. For LAX, an EAT concept was evaluated for the North Airfield to enable the Air Traffic Control Tower (ATCT) to maintain uninterrupted departure operations on Runway 24L while accepting arrivals on Runway 24R. As depicted in **Exhibit II-2**, this concept provides an EAT that is accessed via a high-speed exit to the north of Runway 24R. The EAT runs west parallel to the extended runway centerline, and turns south to intersect Taxiway E along an alignment just to the west of the Runway 24L end. The taxiway would permit unimpeded crossing west of Runway 24R during VFR arrival operations, when aircraft are cleared to cross Runway 24L. Heavy aircraft types that cannot, or have limited ability to, hold between Runway 24L and 24R include the following series of aircraft: Boeing 747s, 777s, 748s, and Airbus 340s and 380s.

The primary theoretical benefit would be reduced delay time for aircraft departing on Runway 24L, as they would no longer be immediately impeded by an arriving aircraft that could not hold between the runways, allowing the ATCT to maintain unrestricted departures until the departure queue for Runway 24L clears or a maximum holding time is exceeded.

Two alternatives were modeled using SIMMOD; the first model, acting as the baseline and depicted in **Exhibit II-3**, consisted of the SPAS "No Yellow Light Project" alternative with the Runway 24L extension being the only alteration from the existing North Airfield. The EAT experiment consisted of the baseline alternative with the addition of the EAT as described above. Both experiments utilize the 2020 Design Day Flight Schedule (DDFS) consisting of 2,285 daily operations.

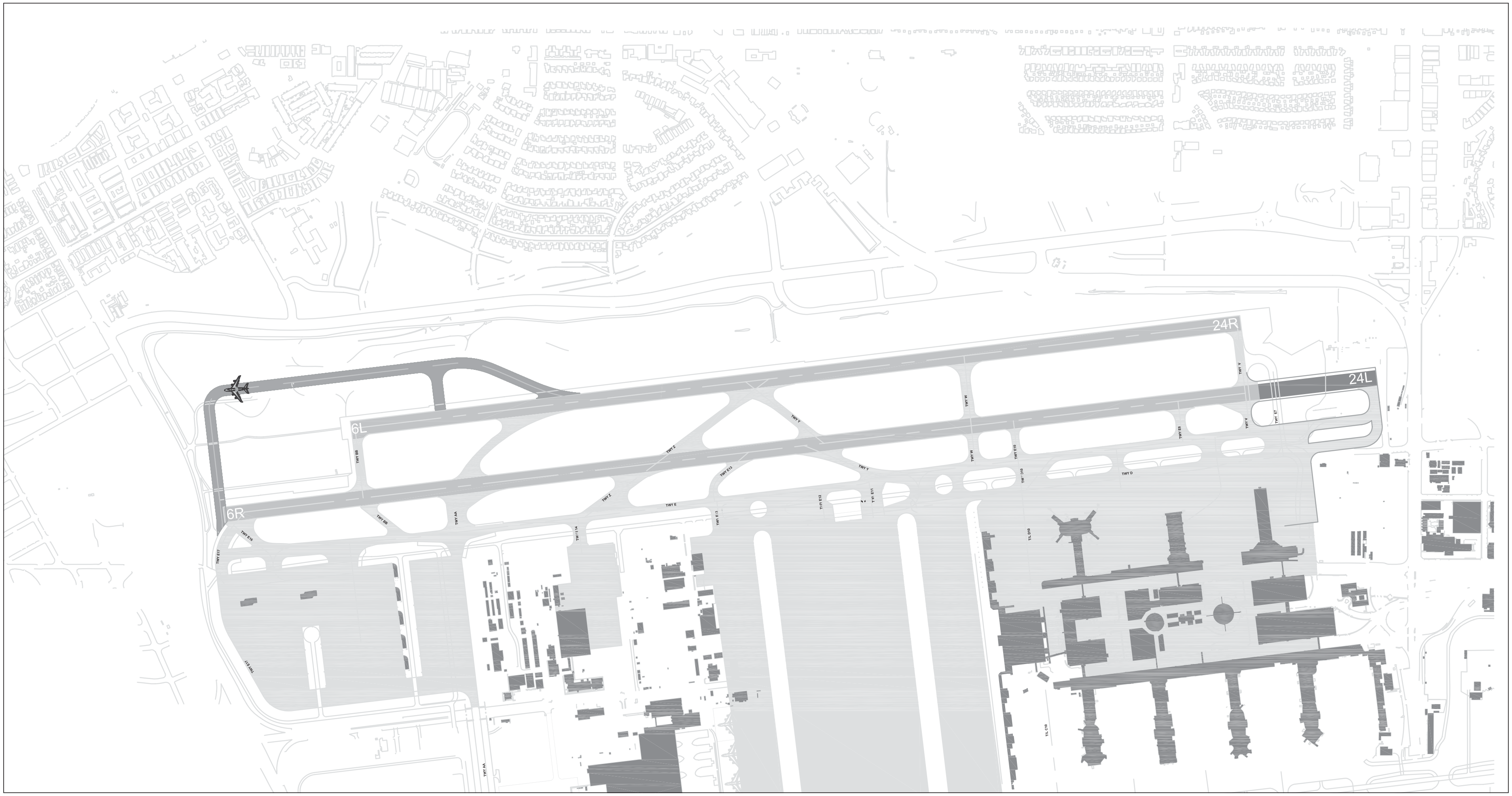
[18] ATAC Corporation, *Presentation for LAX Runway 24L Departure Lift-off Analysis,* August 20, 2008.



Source: Los Angeles World Airports, June 2003 (Airport Layout Plan); Ricondo & Associates, Inc., October 2009.
Prepared by: Ricondo & Associates, Inc., February 2010.

Exhibit II-1

Runway 24L Departure Lift-Off Analysis



Source: Los Angeles World Airports, June 2003 (Airport Layout Plan).
Prepared by: Ricondo & Associates, Inc., February 2010.

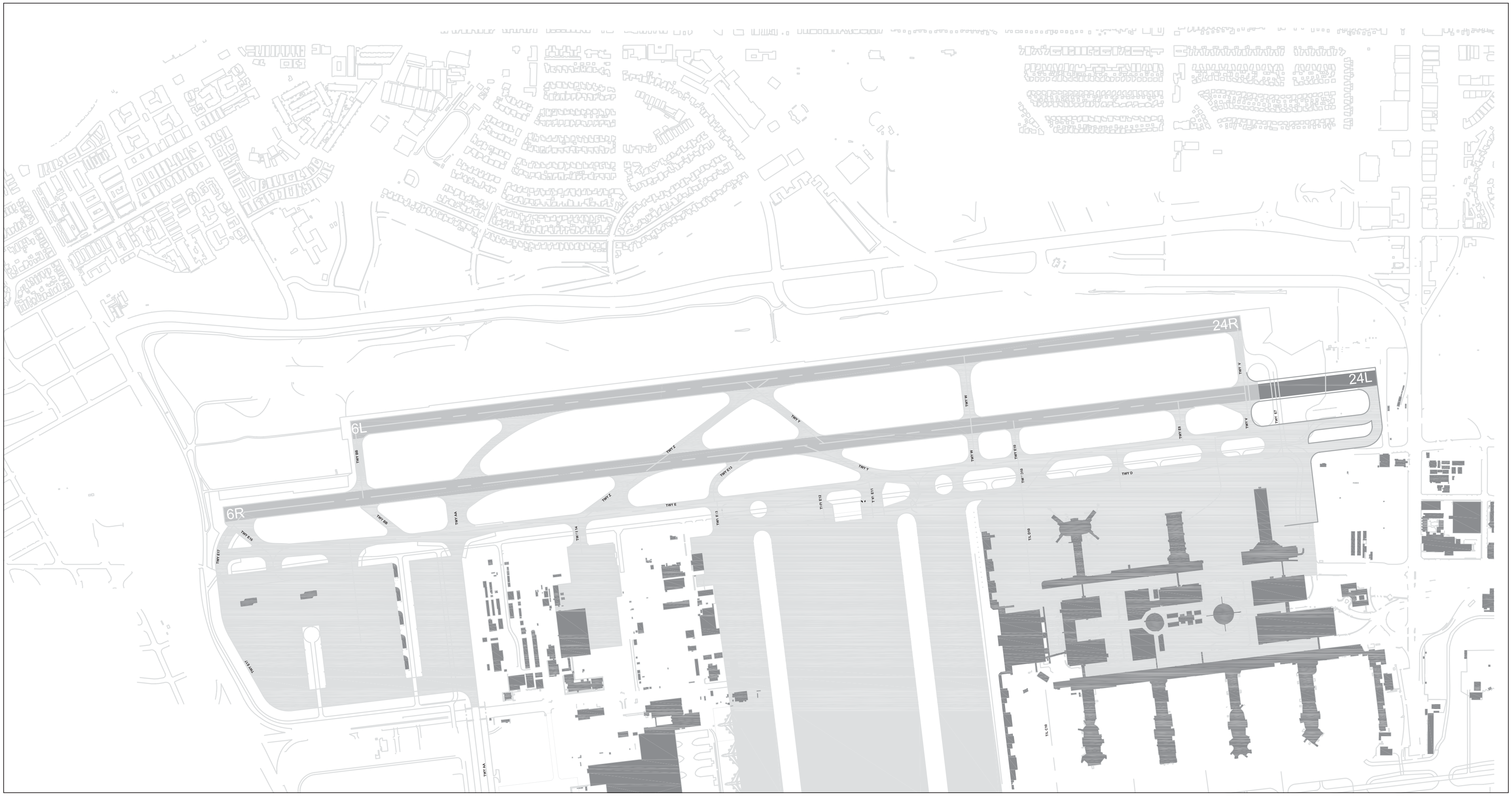
Exhibit II-2

0 1000 ft.
north

LEGEND

- Existing Taxiway
- Proposed Taxiway
- Existing Taxiway
- Runway Extension
- EAT Holding Position

North Airfield Baseline with End Around Taxiway



Source: Los Angeles World Airports, June 2003 (Airport Layout Plan).
Prepared by: Ricondo & Associates, Inc., February 2010.

Exhibit II-3

LEGEND

- Existing Taxiway
- Proposed Taxiway
- Existing Taxiway
- Runway Extension

North Airfield Baseline without End Around Taxiway

The following operating assumptions were made for the EAT alternative:

- The full length of extended Runway 24L would be available for take-off; therefore aircraft on the EAT would hold parallel to the runways as depicted in Exhibit II-2 and cross via the EAT when there are no active departures from Runway 24L.
- Departures for Runway 24R were given priority over EAT crossings.
- Under VMC conditions, EAT crossing can occur while aircraft are arriving on Runway 24R.
- All aircraft greater than 200' in length would use the EAT (e.g., Boeing 747-All Models, Airbus 340, Airbus 380 and Boeing 777-300).
- Aircraft holding on the EAT would not be given priority over departing traffic on Runway 24L until hold time exceeds 15 minutes.
- Taxiway D, east of Taxiway Q, was assumed to be Design Group VI capable to prevent interruptions to Runway 24L departures.

Additionally, it was assumed the EAT would not be used during Instrument Meteorological Conditions (IMC). The EAT would require aircraft to traverse through Runway 24R's localizer critical area. If an aircraft is within this area, no aircraft conducting Category II or III approaches can be within the final approach fix. **Table II-3** summarizes the averaged delay and unimpeded ground movement times for multiple iterations for both the baseline and EAT experiments. A total of 11 simulation iterations were conducted to develop the results. The only reduction in delay time is for departing aircraft; the baseline analysis calculated 9.69 minutes of West Flow VMC average delay per operation, and the EAT experiment resulted in 9.23 minutes of West Flow VMC average delay per operation. This is slightly offset by an increase in the unimpeded taxi time of arriving aircraft, from an average of 7.64 minutes per operation in the baseline model to 7.80 minutes in the EAT experiment. The average delay and unimpeded taxi times is 18.78 minutes for the baseline experiment and 18.64 minutes for the EAT experiment; a total reduction of less than one minute.

While there is a slight reduction in the overall delay times with the use of EAT, the reduction does fall within the margin of error for the simulation. Additionally, changing the assumptions to prevent departures from using Runway 24R during peak departure periods when aircraft are beyond Taxiway BB on the EAT would increase departure delay times. Runway 24R is used from time to time during peak departure periods, and is a critical option for ATCT in reducing departure delay. An aircraft moving along the EAT would make this option unavailable, and would most likely increase departure delay by an amount greater than the reduction associated with fewer runway crossings made available by the EAT.

2.3.2.3 LAX North Airfield Safety Study

The LAX North Airfield Safety Study[19] was conducted to estimate as specifically as possible the level of future safety of several alternate configurations of the North Airfield. The study was

[19] Dr. Arnold Barnett (Massachusetts Institute of Technology), Dr. Michael Ball (University of Maryland), Dr. George Donohue (George Mason University), Dr. Mark Hansen (University of California, Berkeley), Dr. Amedeo Odoni (Massachusetts Institute of Technology), Dr. Antonio Trani (Virginia Polytechnic Institute and State University), *LAX North Airfield Safety Study,* February 2010.

undertaken by an academic panel comprised of six professors with educational expertise in mathematics, operations research, aerospace engineering, and civil engineering. The panel received substantial simulation support from the NASA-Ames Research Center in Mountain View, California. The alternative configurations evaluated in the study included the following:

Table II-3

End-Around Taxiway Assessment - Average Delay and Unimpeded Taxi Time

		Average Delay (Minutes per Operation)													
		Arrivals					Departures					Average			
Configuration	Annual Use	Cancellations	Flow	Airspace	Ground	Total	Cancellations	Gatehold	Airspace	Ground	Total	Airspace	Total Ground	Taxi Only	Total
VFR Visual West Flow - Baseline	69.2%	0	0	7.40	3.53	10.94	0	0	0.07	9.69	9.76	3.74	6.61	5.66	10.35
VFR Visual West Flow - EAT	69.2%	0	0	7.42	3.54	10.96	0	0	0.07	9.23	9.30	3.75	6.39	5.45	10.13
											Average Unimpeded Taxi Time (minutes per Operations)				
											Arrivals		Departures		Average
VFR Visual West Flow	69.2%										7.64		9.22		8.43
VFR Visual West Flow - EAT	69.2%										7.80		9.21		8.50
											Average delay and Unimpeded Taxi Time (minutes per Operations)				
											Arrivals		Departures		Average
VFR Visual West Flow	69.2%										18.57		18.98		18.78
VFR Visual West Flow - EAT	69.2%										18.76		18.51		18.64

Note: Totals may not add due rounding
20xx Master Plan Alternative (without cancellations).

Source: Ricondo & Associates, Inc., *End Around Taxiway Simulation And Analysis – West Flow Configuration*, November 2008.
Prepared by: Ricondo & Associates, Inc., January 2010.

- (1A) The existing configuration - Runways 24L and 24R separated by 700 feet.
- (1B) The existing configuration - with changes to the taxiways leading from Runway 24R so that aircraft landing on 24R would cross runway 24L closer to its west end (ITSIP concept).
- (2) Move Runway 24R 100 feet North – includes a centerline taxiway between the runways.
- (3) Move Runway 24R 340 feet North – includes a centerline taxiway between the runways.
- (4) Move Runway 24L 340 feet South - includes a centerline taxiway between the runways.
- (5) Three-Runway Option – replaces Runways 24L and 24R with a single runway.

An auxiliary goal of the academic panel was to provide useful information about the capacity implications of the various configurations, in light of projections about LAX traffic levels in 2020.

A central component of the study was a human-in-the-loop simulation exercise. But the study also relied heavily on empirical evidence about runway safety and capacity, based on historical experience at LAX and elsewhere. The academic panel considered the changes completed in 2008 on the LAX South Airfield, which moved the two parallel runways 100 feet further apart and created a centerline taxiway between the runways.

As is explained and summarized in the report, the Academic Panel concluded:

> The LAX North Airfield is extremely safe under the current configuration. Changes to the configuration could create even greater safety, but they would be expected to reduce only slightly the overall risk that LAX air travelers face in their journeys. (That overall risk level is itself minuscule because air travel is exceedingly safe.) Considerations of capacity appear to make some alterations to the North Airfield less attractive, and others—particularly the option of moving Runway 24R 340 feet North—significantly more so. But the AP [Academic Panel] believes that it would be difficult to argue for reconfiguring the North Airfield on safety grounds alone. [20]

Although the Academic Panel has concluded that physical improvements would provide only small safety improvements in theory, the panel did provide some observances and conclusions that should be considered if and when improvements are made to the North Airfield, specifically ITSIP. These observances and conclusions included the following:

- Runway exit geometry can influence the likelihood of incursions.
- Turning angle at hold lines and sight distance and angle from the reference eye position in the flight deck are critical parameters to verify if an aircraft is taking off from a runway to be crossed.
- Human visual inspection becomes the last condition to avoid a runway incursion.

The planning and evaluation of the final ITSIP alternative incorporated these observances and conclusions.

2.3.2.4 High Speed Exit Screening Assessment

LAWA evaluated a series of Runway 24R High-Speed Taxiway concepts based on results of the North Airfield Lift-Off Analysis (see Section 2.3.2.1.) and the FAA Engineering Brief No. 75: *Incorporation of Runway Incursion Prevention into Taxiway and Apron Design, November 19, 2007*. The FAA engineering brief states that "the risk of a Category A or B incursion is higher for crossings

[20] Ibid, pg. 153.

occurring in the first third of the runway and lower in the last two thirds. Because it is not possible to entirely eliminate runway crossing situations, establishing designs and associated surface traffic flow strategies keeping taxiway-runway crossings by aircraft in the last third of the runway (as measured from the arrival threshold) significantly reduces the risk. The preference is for aircraft to cross in the last third of the runway whenever possible, because within the middle third of the runway the arriving/ departing aircraft is usually on the ground and traveling at a high rate of speed."

2.3.2.5 ITSIP Concept Development and Assessment

The concepts and evaluation effort associated with the High-Speed Exit assessment has become identified as the Interim Taxiway Safety Improvement Project (ITSIP).

Based on these guidelines, a total of eight (8) concepts were developed which included six (6) preliminary concepts and two (2) concepts that were added during the evaluation process. During development of the preliminary concepts, the following characteristics were concluded:

- Retaining Taxiways Y and Z at their current locations would not provide any substantial collision risk reduction unless Runway 24L is extended to the east; if both were maintained without extending Runway 24L, high utilization of taxiways that lead to crossing points less than 7,000 feet would continue to occur.
- Preliminary concepts were also limited to those that do not reduce the number of Runway 24R arrival exits below the current total of five (Taxiways W, Y, Z, AA and BB).
- None of the concepts were designed to exclusively improve Runway Occupancy Times (ROT) for Runway 24R. Any ROT improvements indicated by the analysis were a consequence of the changes proposed for safety improvements.

Each of the preliminary concepts is identified below.

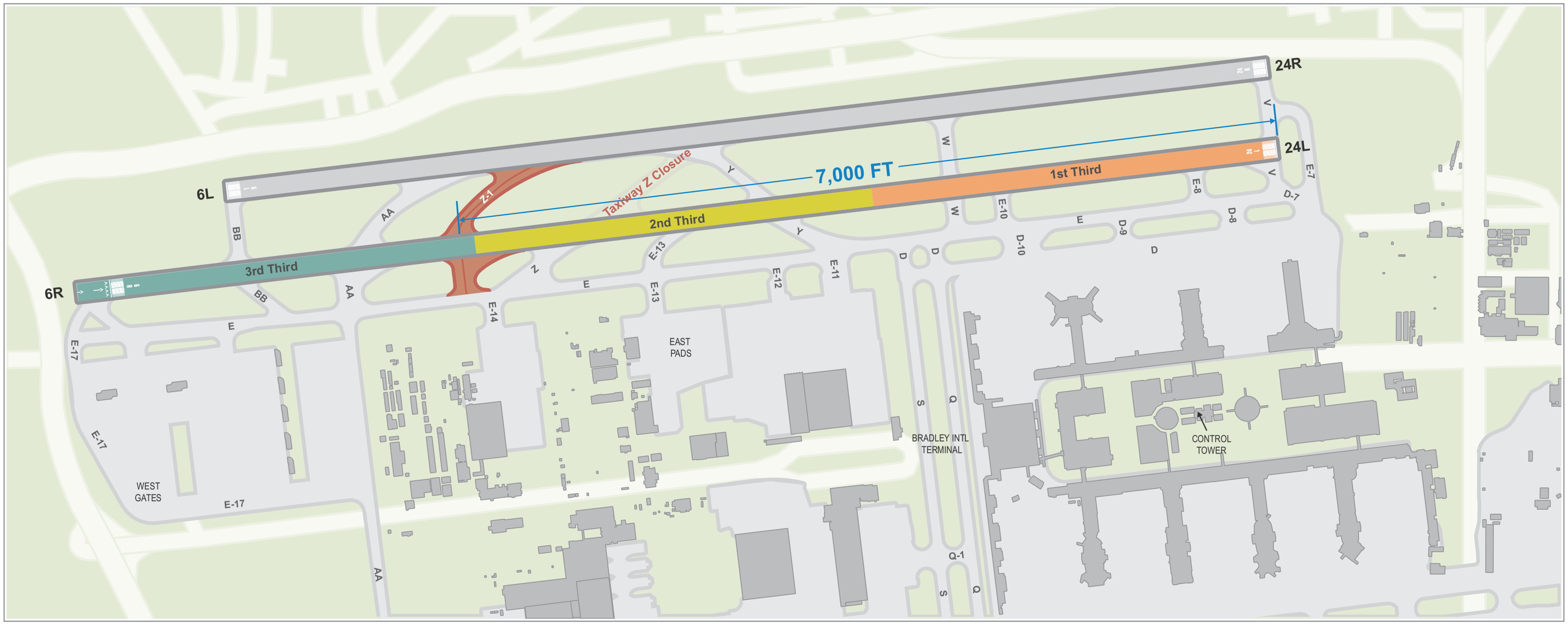
<u>Preliminary Concepts</u>

Concept #1 – As depicted in **Exhibit II-4**, this option closes Taxiway Z and adds a new high-speed exit (Z-1) at a distance of 7,000 feet from the arrival threshold of Runway 24L. This places Taxiway Z-1 crossings of Runway 24L in the last third of the runway. This concept still allows aircraft landing on either Runway 24R to exit at Taxiway Y and cross in the middle third of Runway 24L.

Concept #2 – As depicted in **Exhibit II-5**, this option relocates Taxiways Y and W and adds a new high-speed exit (Z-1) at a distance of 7,000 feet from the arrival threshold of Runway 24L. This concept keeps Taxiway Z open which still allows aircraft landing on Runway 24R to exit at Taxiway Z and cross in the middle third of Runway 24L.

Concept #3 – As depicted in **Exhibit II-6**, this option closes Taxiway Z, relocates Taxiways Y and W, and adds two new high-speed exits (Z-1 and AA-1) at distances of 7,000 and 8,800 feet, respectively, from the arrival threshold of Runway 24L. This concept eliminates the ability of an aircraft landing on Runway 24R to cross in the middle third of Runway 24L.

Concept #4 – As depicted in **Exhibit II-7**, this option extends Runway 24L to the east increasing the distance between the runway crossing points and the Runway 24L threshold. This option still allows aircraft landing on Runway 24R to exit at Taxiway Y or Z and cross in the middle third of Runway 24L.



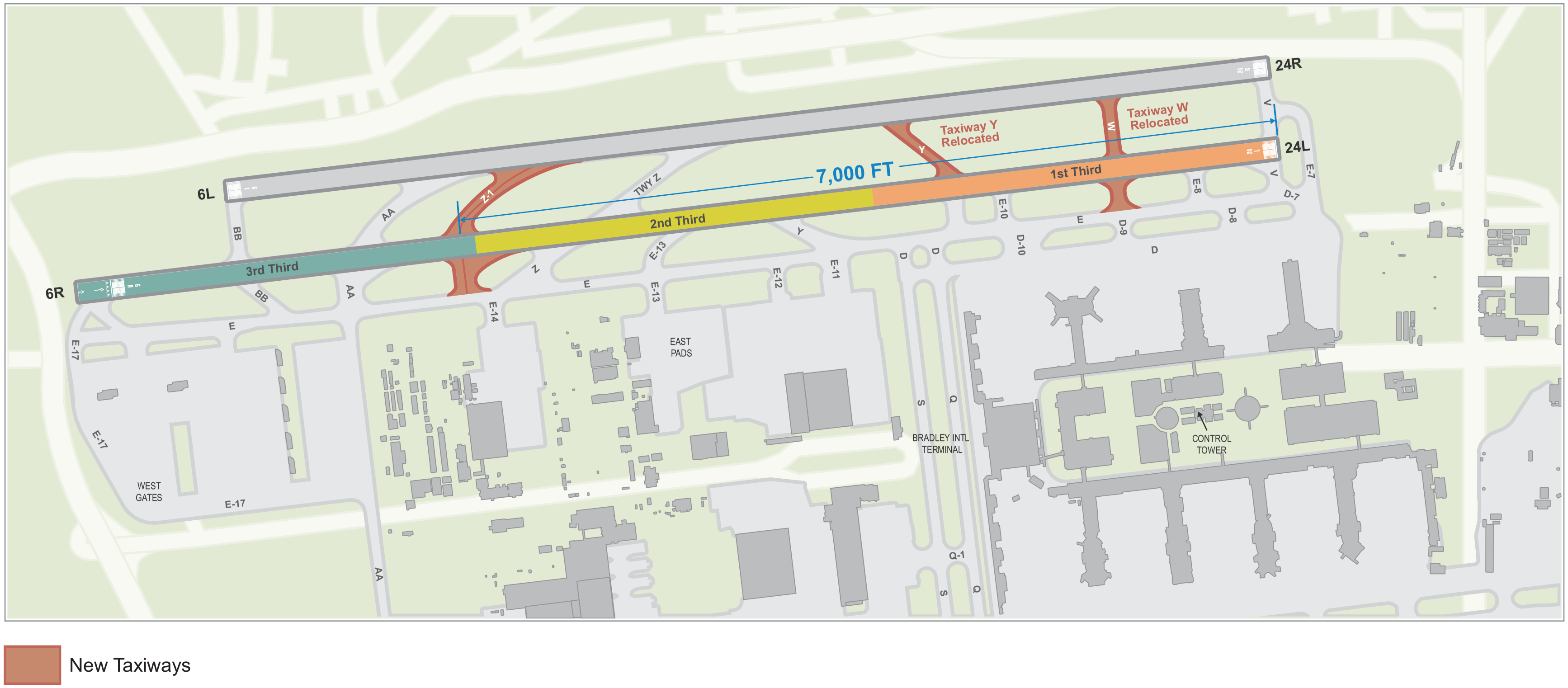
New Taxiways

Source: Los Angeles World Airports, June 2003 (Airport Layout Plan); Ricondo & Associates, Inc., October 2009.
Prepared by: Ricondo & Associates, Inc., February 2010.

Exhibit II-4

Not to Scale. north

ITSIP Concept #1

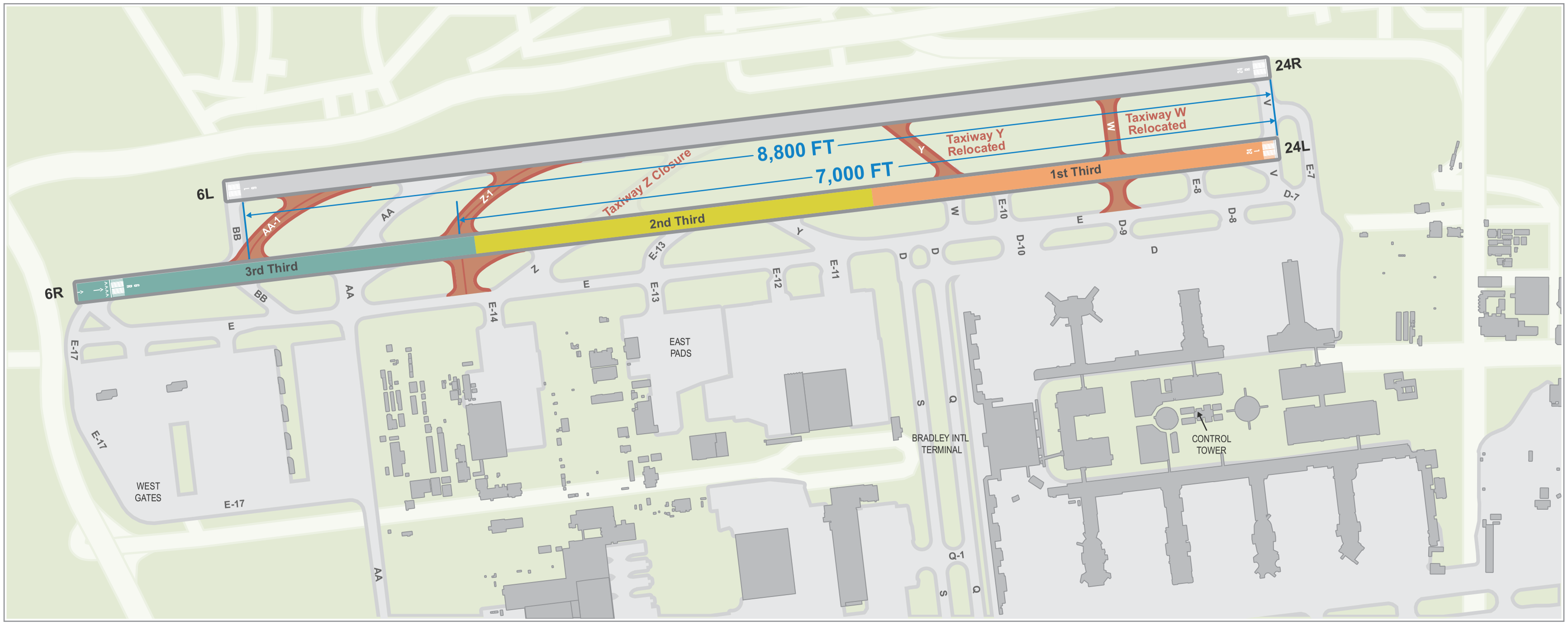


Source: Los Angeles World Airports, June 2003 (Airport Layout Plan); Ricondo & Associates, Inc., October 2009.
Prepared by: Ricondo & Associates, Inc., February 2010.

Exhibit II-5

Not to Scale. north

ITSIP Concept #2



New Taxiways

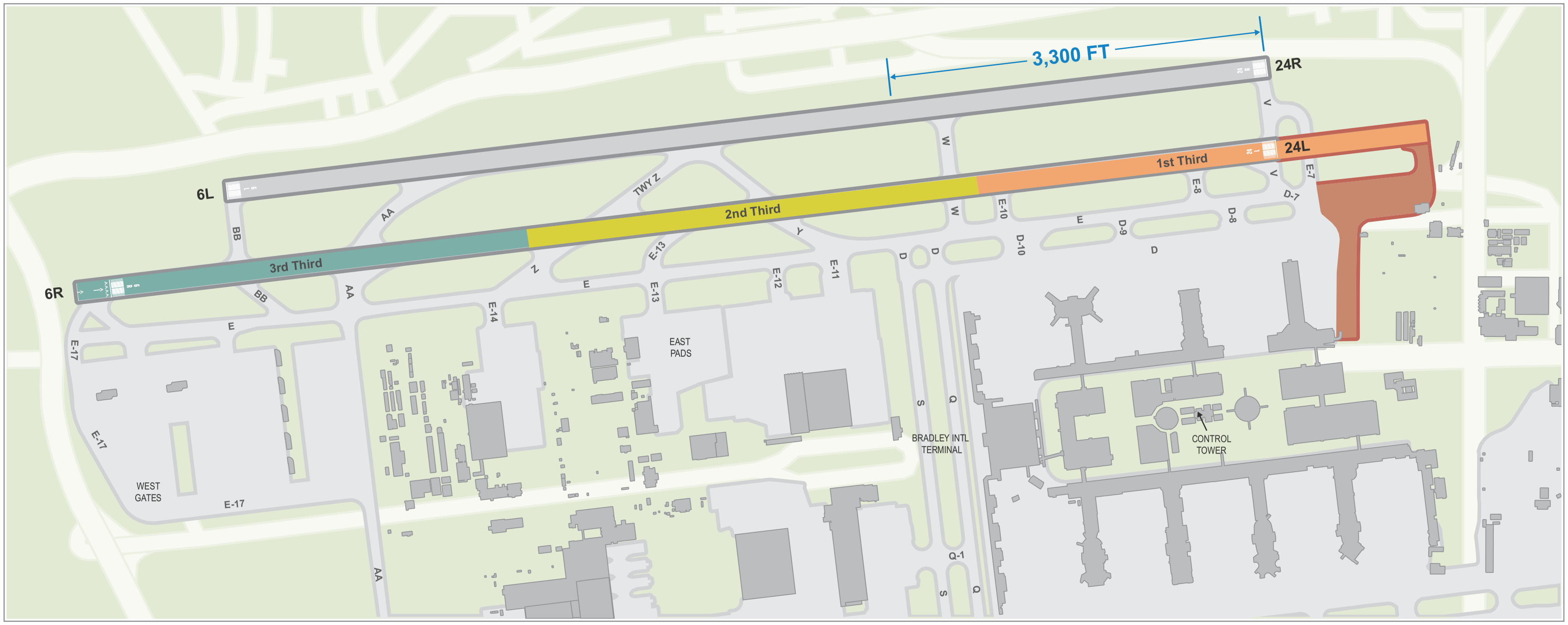
Source: Los Angeles World Airports, June 2003 (Airport Layout Plan); Ricondo & Associates, Inc., October 2009.
Prepared by: Ricondo & Associates, Inc., February 2010.

Exhibit II-6

Not to Scale.

north

ITSIP Concept #3



New Taxiways

Source: Los Angeles World Airports, June 2003 (Airport Layout Plan); Ricondo & Associates, Inc., October 2009.
Prepared by: Ricondo & Associates, Inc., February 2010.

Exhibit II-7

Not to Scale.

north

ITSIP Concept #4

Concept #5 – As depicted in **Exhibit II-8**, this option is a combination of Concepts #2 and #4. Although this concept relocates Taxiways Y and W, aircraft landing on Runway 24R can still use Taxiway Z or Relocated Taxiway Y and cross in the middle third of Runway 24L.

Concept #6 – As depicted in **Exhibit II-9**, this concept has the same configuration as Concept #5 except that Taxiway Z is closed. This concept does not allow aircraft landing on Runway 24R to cross in the middle third of Runway 24L.

Screening of Preliminary Concepts

The preliminary concepts were analyzed to determine the implications on ROT and to assess the potential reduction in collision risk compared to baseline conditions (Collision Risk Reduction Indicator: Exit Utilization x Lift-Off Probability). The Runway Exit Design Interactive Model (REDIM) was used to assess estimated ROT. The model was calibrated to actual runway exit observations and LAX fleet mix observed on March 21 and 22, 2008. ROT for each concept was developed and compared to the baseline concept ROT of 48.28 seconds. **Table II-4** provides a summary of the ROT and Collision Risk Reduction Indicator for the concepts.

Table II-4

High-Speed Exit Screening Analysis

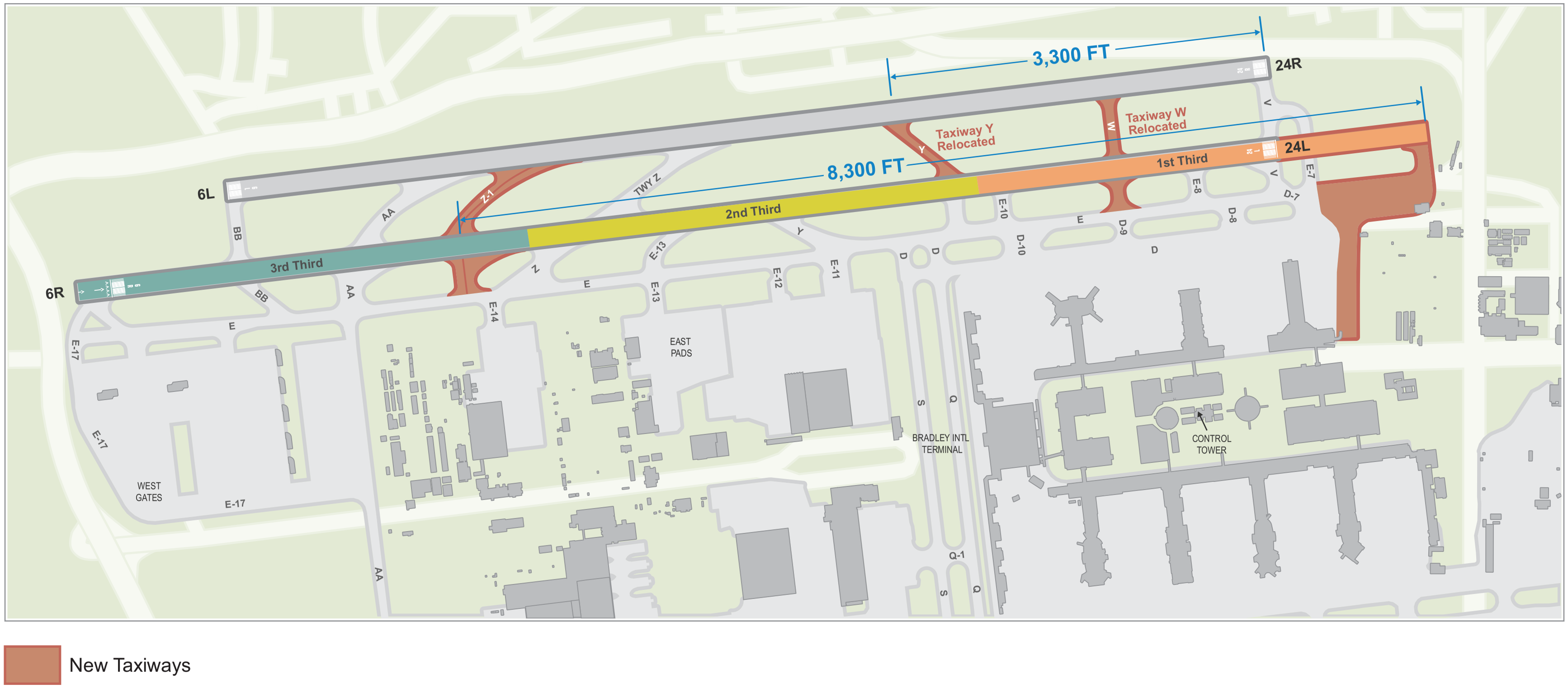
Option	REDIM ROT[1/] (in seconds)	Collision Risk Indicator[2/]
Baseline	48.28	55.9%
Concept 1	49.29	55.7%
Concept 2	50.18	75.0%
Concept 3	54.18	87.8%
Concept 4	48.28	76.7%
Concept 5	50.18	90.6%
Concept 6	54.18	90.9%

Notes:
1/ REDIM = Runway Exit Design Interactive Model.
2/ Probability of departure lift-off at or before Runway 24L crossings.

Source: REDIM/ROT analysis, Ricondo & Associates, Inc., March 2009.
Prepared by: Ricondo & Associates, Inc., January 2010.

In addition to the ROT and Collision Risk assessments, the concepts were reviewed by LAWA staff, the FAA, and Subject Matter Experts (SMEs). Upon review by this group, the following conclusions were reached:

- All crossings from Runway 24R (West Flow) should occur in the last third of Runway 24L.
- The level of likelihood of hazards LAX 001 and 002 would be reduced if runway crossings occurred along the last third of Runway 24L.
- Additional concepts should be developed to address factors considered above.
- The group recommended that LAWA reconvene with additional subject matter experts (e.g. FAA, Pilots) to conduct an SMS safety assessment to determine the following:
  - Specific level of risk reduction
  - Evaluation of unintended consequences of actions taken on existing operations
  - Impact of de-rated thrust on operations

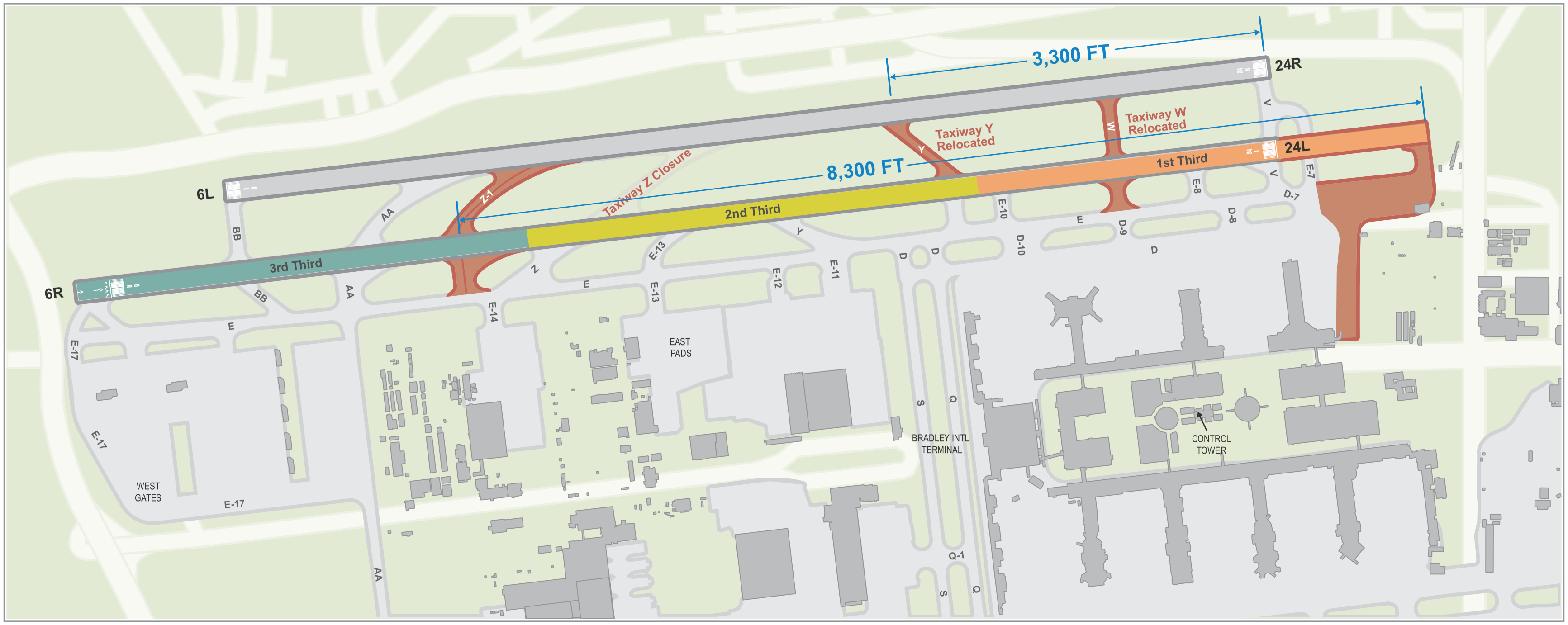


Source: Los Angeles World Airports, June 2003 (Airport Layout Plan); Ricondo & Associates, Inc., October 2009.
Prepared by: Ricondo & Associates, Inc., February 2010.

Exhibit II-8

Not to Scale. north

ITSIP Concept #5



New Taxiways

Source: Los Angeles World Airports, June 2003 (Airport Layout Plan); Ricondo & Associates, Inc., October 2009.
Prepared by: Ricondo & Associates, Inc., February 2010.

Exhibit II-9

Not to Scale. north

ITSIP Concept #6

Additional Concepts

Based on the review of the preliminary concepts by the expert group identified above, two additional concepts were developed that move all crossing from Runway 24R to the last third of Runway 24L. These concepts are described as follows:

Concept #7 – As depicted in **Exhibit II-10**, this option has the same configuration as Concept #3 except Taxiway W is not relocated. It was determined by LAWA and FAA ATCT that the relocation of Taxiway W would not be necessary. This concept eliminates the ability of an aircraft landing on 6L or 24R to cross in the middle third of Runway 6R-24L. In addition, FAA ATCT indicated that the ROT time should be at or within 50 seconds, which was based on actual observations for similar landing distances on the South Airfield.

Concept #8 – As depicted in **Exhibit II-11**, this option has the same configuration as Concept #7 but with an extension to the east end of Runway 6R-24L. This concept also eliminates the ability of an aircraft landing on 6L or 24R to cross in the middle third of Runway 6R-24L.

Initial Conclusions and Recommendation

A qualitative review of all eight concepts was conducted with LAWA staff. Using the guidance of FAA Engineering Brief No. 75, the review focused on eliminating crossings in the first two-thirds of the runway. Of the eight options, only Concepts #3, #6, #7, and #8 would eliminate those crossings for air carrier aircraft[21]. However, Concepts #6 and #8 also include a runway extension which was determined not to be feasible as a short-term solution. The remaining two options, Concepts #3 and #7 were the same except Concept #3 included the relocation of Taxiway W. It was determined by LAWA staff that the relocation of Taxiway W was not necessary because an exit taxiway between the relocated Taxiway Y and existing Taxiway V at the end is not necessary. Therefore, the LAWA staff recommended that Concept #7 be the "ITSIP Alternative for Further Evaluation" to mitigate hazards LAX 001 and LAX 002. Concept #7 was presented to the SRAP in September 2009 for their review and evaluation. Upon completion of the their review and evaluation, the SRAP concluded that Concept #7 does improve airfield safety by reducing the severity of hazard LAX 001 and by reducing the likelihood of hazard LAX 002.

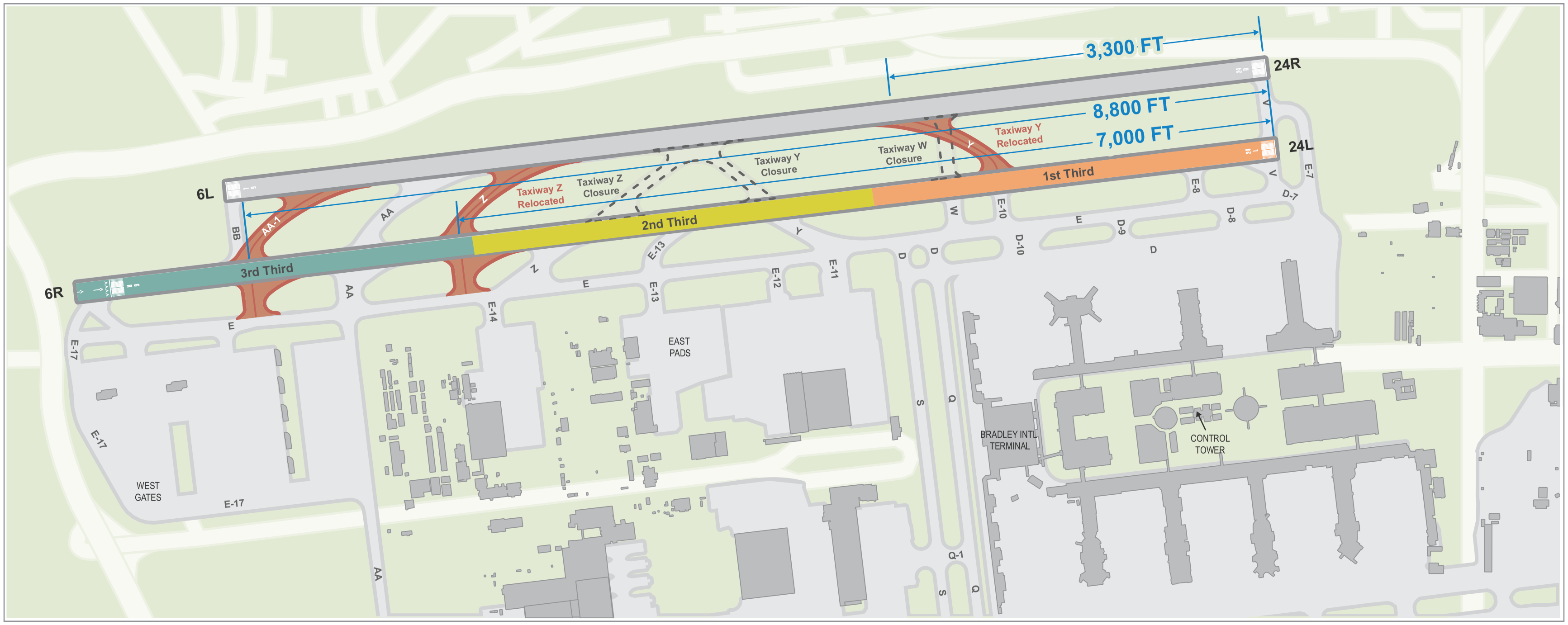
III. Scope of Safety Risk Assessment Panel (SRAP)

This section identifies the overall scope and efforts by the SRAP. It identifies the participants and the specific processes used to conduct an evaluation of the preferred ITSIP concept.

3.1 Scope of the Panel

The scope of the SRAP was to verify the identified hazards related to the existing North Airfield and determine if the "ITSIP Alternative for Further Evaluation" would mitigate the LAX001 and LAX002 hazards associated with the North Airfield at LAX. The primary guidance for the panel included the FAA's SMS and SRM documents and processes which are identified below. These documents and processes are designed to identify operational hazards, analyze the risks associated with these hazards and establish mitigating strategies to ensure the safe and expeditious management of airport traffic.

[21] As previously stated in this section, it could be possible for small aircraft landing on Runway 24R to stop in time and exit the runway using Taxiway W and/or Relocated Y and cross in the first or middle third of Runway 24L. Conversely, small aircraft landing on Runway 6L could stop in time and exit at Taxiway Z-1 and cross in the first third of Runway 6R.



New Taxiways

Source: Los Angeles World Airports, June 2003 (Airport Layout Plan); Ricondo & Associates, Inc., October 2009.
Prepared by: Ricondo & Associates, Inc., February 2010.

Exhibit II-10

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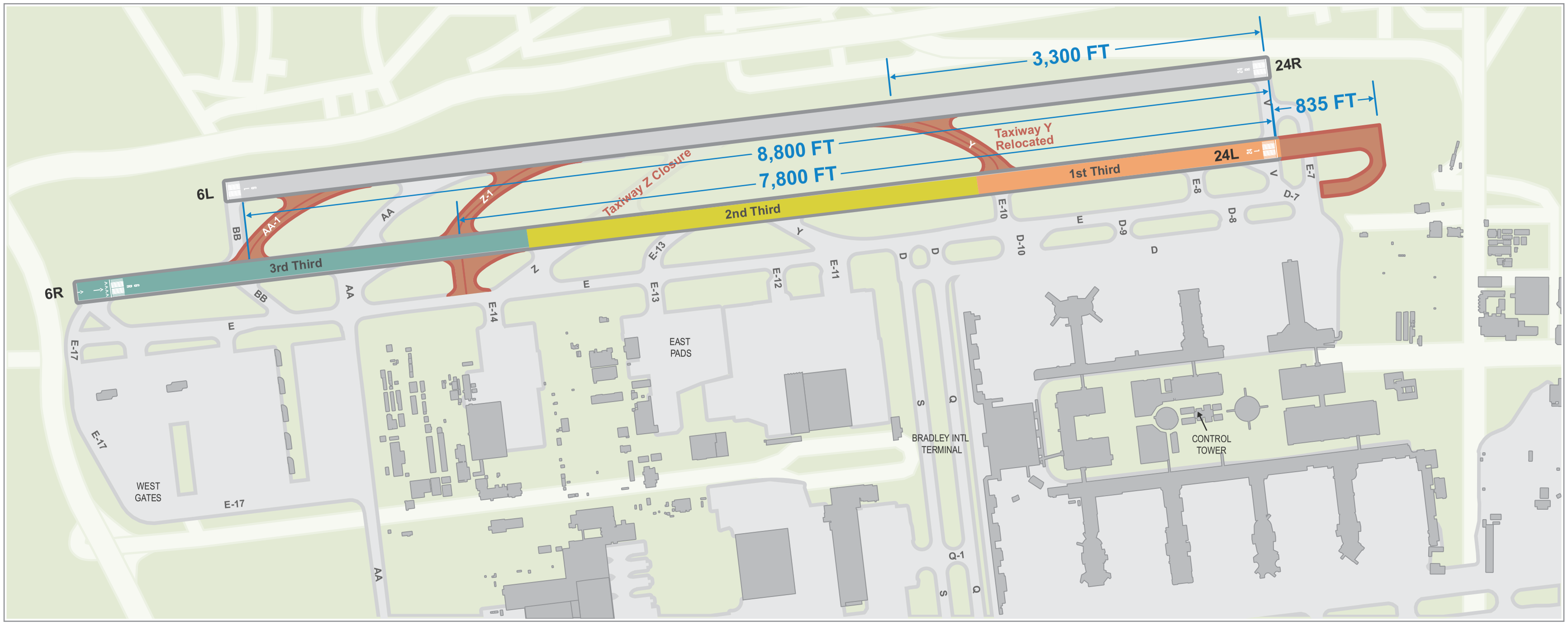
ITSIP Concept #7



New Taxiways

Source: Los Angeles World Airports, June 2003 (Airport Layout Plan); Ricondo & Associates, Inc., October 2009.
Prepared by: Ricondo & Associates, Inc., February 2010.

Exhibit II-11

Not to Scale.

north

ITSIP Concept #8

3.1.1 Panel Participation and Definition

To ensure safety is at an acceptable level, the LAX North Airfield SRAP is comprised of professionals within the aviation industry. This includes representatives from the Federal Aviation Administration, LAX airfield operations, LAX planning and aviation industry Subject Matter Experts (SMEs). The SRAP process is a structured table top analysis of airport operations and/or airspace procedures. This panel consisted of the following individuals:

SRAP Members	Organization	Role
Jacqueline Yaft	LAWA – Deputy Exec Director of Operations	Airport Operations/FAR Part 139 Expertise
Cynthia Guidry	LAWA – Chief of Airport Planning	Airport Planning Expertise
Raymond Jack	LAWA-Airside Operations Manager	Airport Operations/FAR Part 139 Expertise
Jaideep Vaswani	LAWA – Chief of Airport Planning I	Airport Planning Expertise
Jake Adams	LAWA – Airside Element Manager	Airport Expertise
Marvin Shappi	FAA-LAX ATCT	ATC Procedures
Kurt Rammelsberg	FAA-LAX ATCT	ATC Procedures
Dave Kurner	FAA Runway Safety	Safety
Walt Smith (facilitator)	WCG, Inc.	SMS/SRM Expertise
Nick Johnson	Johnson Aviation	Airport SME
Joseph Huy	Ricondo & Associates	Aviation SME
Stephen Smith	Ricondo & Associates	Aviation SME
Rick Wells	Wells Consulting	Aviation SME

3.2 FAA SMS Guidelines

As defined in the FAA's SMS guidelines[22], effective safety management requires a systems approach to the development of safety policies, procedures and practices to allow the organization to achieve its safety objectives. Similar to other management functions, safety management requires planning, organizing, communicating and providing direction.

A SMS provides a proactive, systematic, and integrated method of managing safety for airport operators. Essential to a SMS are formal safety risk management procedures that provide risk analysis and assessment. Generally accepted industry standards and International Civil Aviation Organization (ICAO) guidance describes Safety Management Systems in terms of four distinct elements. They include:

- Safety Policy and Objectives
- Safety Risk Management
- Safety Assurance
- Safety Promotion

These FAA SMS guidelines were incorporated into the planning process for identifying and evaluating safety enhancements for the North Airfield at LAX.

[22] Federal Aviation Administration, *Advisory Circular 150/3200-37 – Introduction To Safety Management Systems (SMS) For Airport Operators*, February 28, 2007.

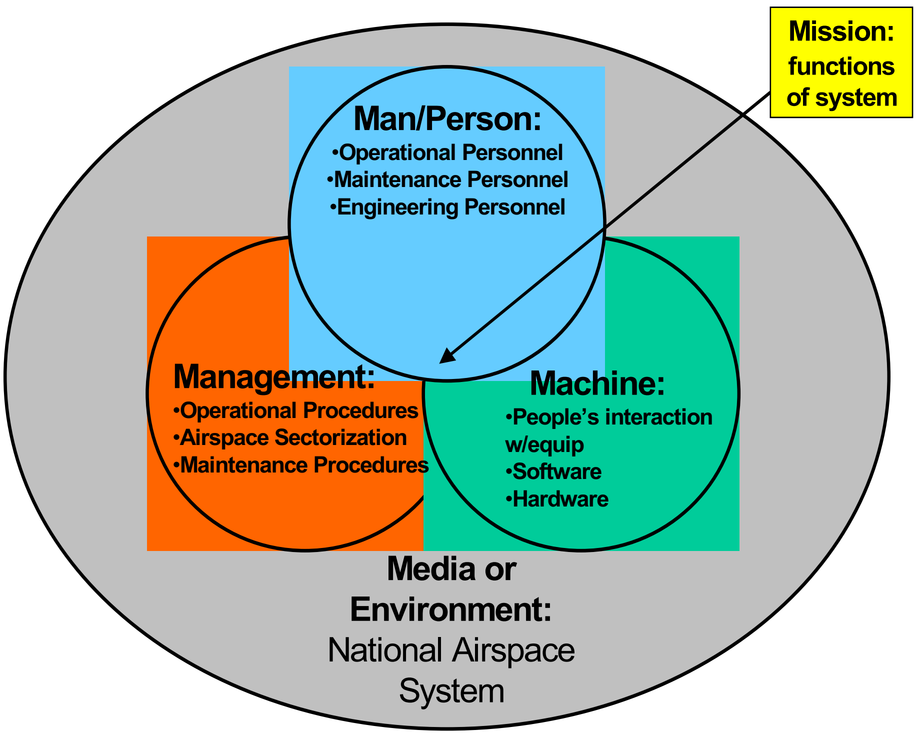
3.3 Applied SRM Doctrine

Within the FAA Safety Risk Management process is the FAA 5M System Assessment Model which provides a process to ensure every aspect of influence on the system is recognized and applied. It considers the mission, or function of the system; the people engaged in the system; the management controls; the aircraft and machines; and the environment of the National Airspace System. The 5M SMS/SRM Assessment Model is depicted is **Exhibit III-1**.

The general guidelines of the SRM Doctrine were incorporated into the planning process for identifying and evaluating safety enhancements for the North Airfield at LAX.

Exhibit III-1

FAA 5M SMS/SRM Assessment Model



Source: Federal Aviation Administration, *FAA System Safety Handbook*, Chapter 3: Principles of System Safety, December 30, 2000.
Prepared by: Washington Consulting Group, January 2010.

3.4 SRM Five-Step Process

The FAA Safety Risk Management process framework is a five-step process, and as depicted in **Exhibit III-2,** follows a clear and definitive methodology to:

- Describe the airport system
- Identify existing hazards
- Analyze risks and causal factors
- Assess risk severity and frequency
- Develop a range of options to mitigate risks to an acceptable level of safety

The SRAP was responsible for verifying the existing hazards and associated risk levels; and assess the degree in which the "ITSIP Alternative for Further Evaluation" can mitigate hazards LAX 001 and LAX 002 to acceptable levels.

Exhibit III-2

The FAA Safety Risk Management (SRM) Five-Step Process

Source: Federal Aviation Administration, *FAA Order 8000.1 - Safety Management System Doctrine*, August 11, 2006.
Prepared by: Washington Consulting Group, January 2010.

3.5 SRAP Assessment of ITSIP Alternative for Further Evaluation

On September 24 and 25, 2009 the SRAP conducted a safety assessment specifically focused on the ITSIP Alternative for Further Evaluation and associated hazards LAX 001 and LAX 002 from the 2007 Safety Risk Assessment of the North Airfield. The SRAP was given the FAA-compliant SRM training and doctrine familiarization immediately prior to convening the formal panel. Following this, the panel initiated its assessment by evaluating and describing the complexity of the North Airfield design as a system.

The panel recognized that the North Airfield is fundamentally a legacy design which has been modified from the late 1960's and early 1970's using aircraft fleet mix of DC-6/7 and Boeing 727 technology. High speed taxiway and runway egress into an immediate adjacent active runway was an accepted risk largely due to lower capacity usage and aircraft significantly smaller than the B777, B747 and A380.

3.5.1 Describing the North Airfield System

The FAA-compliant SRAP describes the system, which is below, and includes the scope of the problem or change. The system and operation is described and modeled in sufficient detail for the safety assessment to proceed to the next stage, which is further clarifying the hazards.

Useful descriptions of the system exhibit two essential characteristics:

- Correctness: The description accurately reflects the system with an absence of ambiguity or error in its attributes.
- Completeness: No attributes have been omitted and are essential and appropriate to the level of detail in the change.

3.5.1.1 The Existing System

LAX has an FAA terminal ATC facility that provides 24-hour traffic advisories, spacing, sequencing, and separation services to visual flight rules (VFR) and instrument flight rules (IFR) aircraft operating within the Class B airspace designated for the airport. The air traffic controllers at LAX, using a combination of terminal surveillance radar and visual observation, direct air traffic so it flows smoothly and efficiently. The controllers give aircrews instructions to operate on the airport movement area, air traffic clearances, and advice based on their own observations and information received from the automated weather system, radar systems, pilots, and other sources.

The FAA controllers provide separation services between landing and departing aircraft, transfer control of aircraft on instrument flights when the aircraft leave their airspace, and receive control of aircraft on instrument flights coming into their airspace from controllers at adjacent facilities.

The LAX Class B airspace consists of specified airspace within which all aircraft operators are subject to the minimum pilot qualification requirements, operating rules, and aircraft equipment requirements of 14 Code of Federal Regulations (CFR) Part 91. Within Class B airspace, no person may operate an aircraft unless (1) the aircraft has an operable two-way radio capable of communications with ATC on appropriate frequencies and (2) the aircraft is equipped with the applicable operating transponder and automatic altitude reporting equipment.

Operations within Class B airspace can be conducted in instrument meteorological conditions (IMC) or visual meteorological conditions (VMC) under IFR or VFR.

3.5.1.2 Fleet Mix at LAX

LAX is primarily known as an “air carrier” airport. All of the major U.S. domestic air carriers and numerous U.S. international air carriers are the primary users of the Airport. An extensive and significant number of non-U.S. international air carriers also use LAX. The United States Air Force also operates at LAX, mostly using the C-5A, C-17 and the C-130 aircraft.

The aircraft mix consists of the very largest to the very smallest aircraft types on an hourly and daily basis, every day of the year, 24 hours each day. This fleet includes all of the Boeing commercial aircraft types, including the projected use of the 787 series and the largest daily concentration of Boeing 747s of any U.S. airport. The Airbus 380 is currently operating daily commercial service from LAX to Sydney, Australia. At the same time, nearly one third of the daily operations at LAX are made by small commuter aircraft with 30 to 50 seats. Most of the smaller fleet mix operates on the North Airfield.

3.5.1.3 Operations and/or Procedures within the system as outlined in the 5M model

Systems will always have sub-components of a larger system. This section presents a system description using the 5M Model to ensure a complete and accurate description of the system and all of the elements:

Mission

The mission is the safe and expeditious flow of air traffic at the LAX and the efficient utilization of the new runway configuration to maintain airfield capacity, enhance safety control factors, including design, reduce air quality impacts and decrease operators' costs.

(hu)Man

The panel decided that the human element consisted of all the ATC personnel at the LAX Airport Traffic Control Tower (ACTC), the pilot community that includes commercial air carriers, general aviation and the military; and the airfield employees and operators.

Machine

The machine element is bounded by all the necessary equipment needed to safely perform commercial aircraft operations at LAX. This includes aircraft, routine ground service vehicles, emergency responding apparatus, field maintenance and construction equipment.

Management

The management element is bounded by FAA Order 7110.65, Air Traffic Control, LAX ATCT, operator's procedures and LAWA airside standard operating procedures (SOP).

Media/Environment

The media/environment refers to the NAS element that will be affected. The SRAP bounded the media/environment to LAX ATCT, pilots using LAX, companies operating at LAX and the airport operator.

3.5.1.4 Resources

The data sources relied upon for this assessment included:

- FAA Order 7110.65S, Air Traffic Control
- FAA Safety Management System Manual, version 1.1
- Historical data from LAWA and FAA
- ITSIP Concept development background

3.5.2 Identification of Hazards

As provided in Section 2.1, hazards LAX 001 and LAX 002 were identified as candidates for mitigation through short-term improvements.

3.5.3 Analyzing the Risk

During the risk analysis process, the SRAP reviewed the severity and likelihood of risk events. Discussions centered on existing systems and recent changes to the system. For example:

- Air carrier operators are more predominately using de-rated thrust for takeoff reducing costs but generating greater risks at mid-field crossing points.
- ASDE-X and new prototype runway status lights have enhanced safety.
- The FAA has changed procedures and communications with air traffic control and the flight crews, i.e. aircraft must stop prior to crossing unless cleared across an active runway.

- Continued enhancements to the FAA and Airport Standard Operating Procedures (SOP).

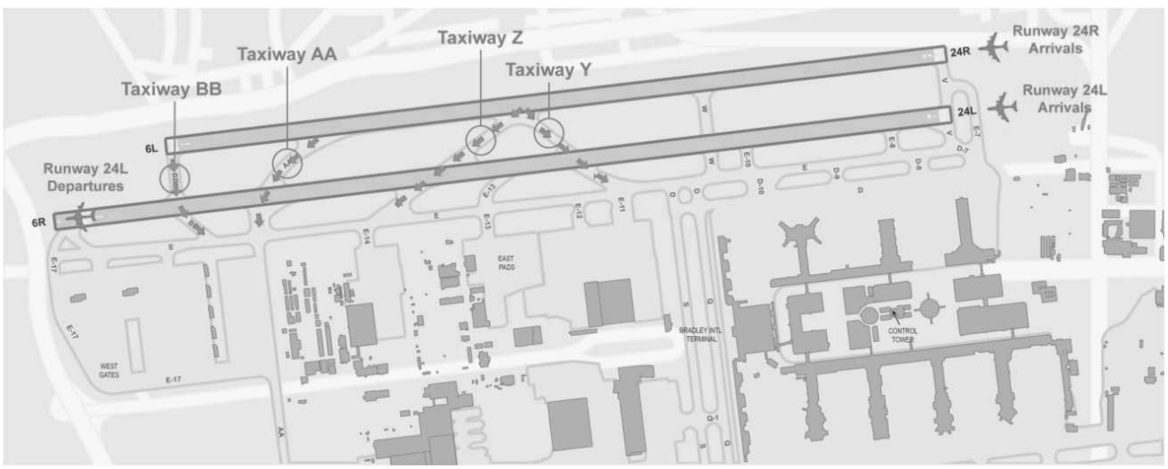
After its assessment on the existing systems and recent changes to the system, the SRAP determined that the severity and likelihood of hazard LAX 001 in the current system remains hazardous and extremely remote because of the introduction of de-rated thrust used by the airlines for departures. Hazard LAX 002 remains hazardous and extremely remote due to the current locations of Taxiways Y and Z which continue as midfield crossing points.

3.5.4 Assessing the Risk with the ITSIP Alternative for Further Evaluation

The ITSIP Alternative for Further Evaluation is designed to have aircraft cross 7,000' down Runway 24L. This change to the system design moves taxiway locations and therefore introduces new runway crossing points. **Exhibits III-3** and **III-4** identify the current system with midfield crossing points and the Preferred ITSIP Alternative with adjusted crossing points in the last third of the runway.

Exhibit III-3

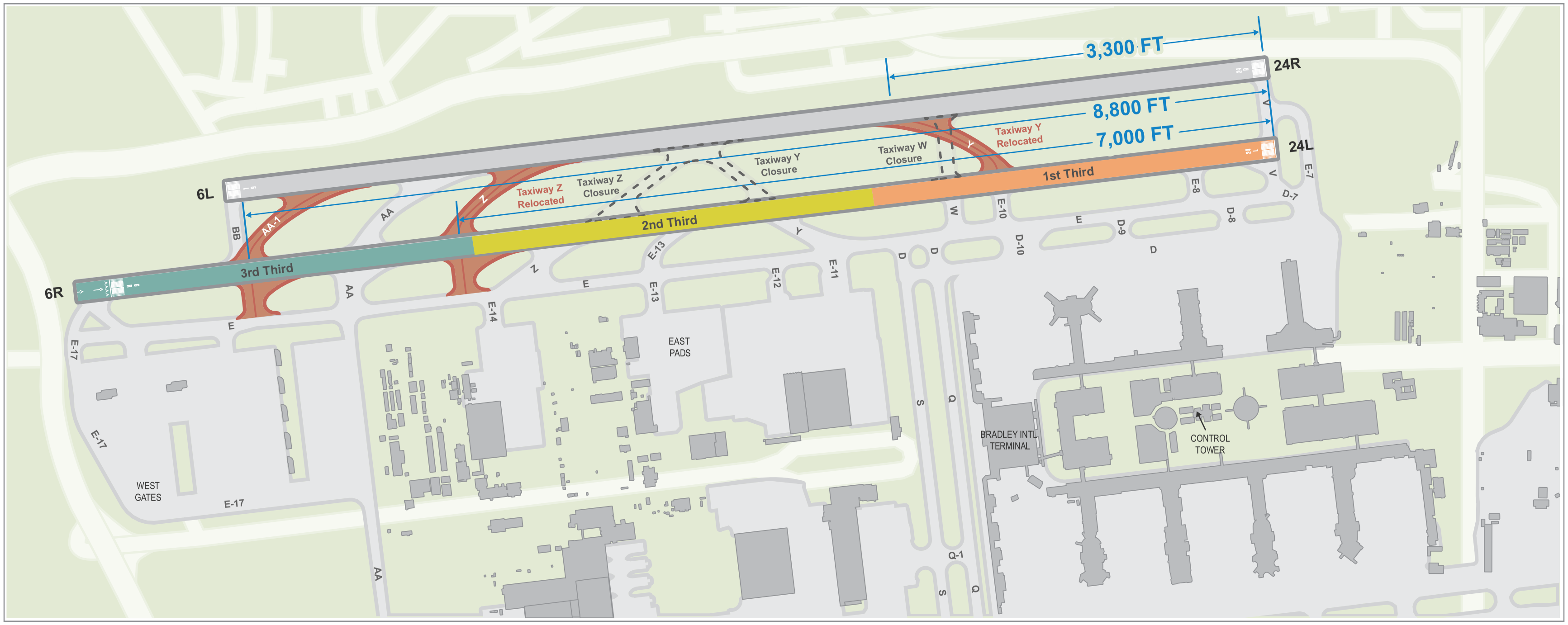
Existing North Airfield Runway 24L Crossing Operations



Source: Ricondo & Associates, Inc., September 2009.
Prepared by: Ricondo & Associates, Inc., September 2009.

The SRAP severity and likelihood analysis made the following conclusions:

- **Hazard LAX 001 risk severity level was *reduced from a hazardous classification to a major classification* because the nature of the hazard changed.** With the relocation of Taxiway Y and the closure of Taxiway Z, the level of possible incursions would also be reduced to low/moderate (FAA Level B or C in Operational Error classification). Therefore, the likelihood for a major risk is considered extremely remote.
- Hazard LAX 002 risk severity level was maintained as hazardous because of the required length of heavy departures. The possibility of a severe level of incursion (FAA level A) remains possible. **The likelihood of hazard LAX 002, however, has been *reduced to extremely improbable* as a result of the increase time for the system to react to the operational error or incursion.**



New Taxiways

Source: Los Angeles World Airports, June 2003 (Airport Layout Plan); Ricondo & Associates, Inc., October 2009 (Preferred Alternative highspeed taxiway layout).
Prepared by: Ricondo & Associates, Inc., February 2010.

Exhibit III-4

Not to Scale. north

Preferred ITSIP Alternative

3.5.5 Mitigating or Treating the Risk and applying the Preliminary Hazard Analysis

A Preliminary Hazard Analysis (PHA) was generated by the SRAP. As provided in **Table III-1**, this analysis provided the Panel with a broad overview of the issues relating to hazards LAX 001 and LAX 002. The PHA identified the hazard, described the risk associated with the hazard, listed appropriate causes and provided an overview of the system. The PHA then provided insight into the possible effect, the severity classification, current mitigating controls and likelihood of occurrence to a possible unsafe event. The PHA then list the current risk matrix, applied new mitigation processes and revealed the resulting residual risk. This process used qualitative data from the SME's who served on the SRAP. Furthermore, the Safety Risk Assessment Panel used the FAA Safety Order of Precedence as established in the FAA Safety Management Manual. The system design is the critical part to the safety equation as it relates to the LAX North Airfield Complex.

3.5.6 FAA Severity and Likelihood Matrix

The SRAP used the FAA Severity and Likelihood Matrix to depict the initial risk level and associated residual risk results after application of the Preferred ITSIP Alternative. As shown in **Table III-2**, the horizontal classifications of severity on the chart indicate implications of events and their effect on people, property and the function of the system.

A no safety effect category, as an example, is an increase in air traffic workload capability, a minor assessment is a slight reduction in air traffic capability, a major category is a reduction in separation and significant reduction in air traffic capability, the hazardous category is a high severity operational error, total loss of air traffic capability and the catastrophic assessment is a collision of aircraft/vehicles or terrain.

The vertical column on the chart depicts likelihood. Frequent is likelihood of more than once a week at the LAX North Airfield complex. A probable category is an assessment of about once a month, a remote assessment is about once every year, extremely remote is about once every 10 to100 years, and an extremely improbable is once every 100 years. These classifications are from the FAA Safety Management System Manual likelihood classifications for air traffic control facilities developed from FAA engineers using mathematical equations. This matrix lists hazard LAX 001 initially as "Hazardous and Extremely Remote". With the application of the Preferred ITSIP Alternative, it is reduced to "Major - Extremely Remote". Hazard LAX 002 is initially listed as "Hazardous and Extremely Remote" and is reduced to "Hazardous and Extremely Improbable" with the Preferred ITSIP Alternative.

3.6 FAA Safety Order of Precedence

Table III-3 depicts the FAA standards for precedence in mitigating risks to an acceptable level. The system design is the most significant and enduring application and lists the appropriate example that if a collision hazard exists because of crossing points in the NAS, it is best to move the crossing point to another location.

The 2007 Safety Risk Assessment of the North Airfield clearly determined that a system design change mitigates risks with the current and future fleet mix. Most importantly, the new design improves situational awareness of aircrews and airport personnel by increased visibility, standardization and enhanced efficiency**.**

Table III-1

Preliminary Hazard Analysis (PHA)

(1) Hazard#	(2) Hazard Description	(3) Causes	(4) System State	(5) Possible Effect	(6) Severity & Rationale	(7) Current Controls	(8) Likelihood	(9) Likelihood Rationale	(10) Current Risk	(11) Recommended Safety Requirements	(12) Residual Risk
Hazard LAX 001	Aircraft Departing or arriving 24L with aircraft inadvertently crossing at taxiway Yankee or Zulu	Communication Error Equipment Malfunction Runway Hazard	Simultaneous use of Rwy24L & Rwy 24R Non-Heavy Aircraft	Near collision Hazardous with high severity operational error	2D Medium Risk Hazardous Severity Based on subject matter expertise	ASDE, 7110.65, Visual Aids, Training Runway Guide Lights	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	2D Medium Risk Hazardous Severity	ITSIP Preferred Alternative eliminates mid-field crossings which introduces and adopts the FAA runway crossing points in the last one-third of the active runway reducing the severity to a low risk.	3D Low Risk Major Severity
Hazard LAX 002	Same scenario as LAX Hazard 001	As Above	Simultaneous use of Rwy24L & Rwy 24R Heavy Aircraft	As Above	2D Medium Risk Hazardous Severity Based on subject matter expertise	As Above	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	2D Medium Risk Hazardous Severity	Risk severity level remains as hazardous relating to required length of heavy departures. The likelihood is reduced to a low risk extremely improbable as a result of the increase time for the system to react to the operational error or incursion	2E Low Risk Hazardous Severity

Source: Washington Consulting Group, Inc., January 2010.
Prepared by: Washington Consulting Group, Inc., January 2010.

Table III-2

FAA Severity and Likelihood Matrix

Severity / Likelihood	No Safety Effect	Minor	Major	Hazardous	Catastrophic
	5	4	3	2	1
Frequent – A More than once per week					
Probable – B Once every month					
Remote – C Once every year					
Extremely Remote – D Once every 10-100 years				LAX 001 LAX 002	
Extremely Improbable – E Less than once every 100 years					*

High Risk

Medium Risk

Low Risk

* High risk hazards are unacceptable with single point and common cause failures.

Source: LAX Safety Risk Assessment Panel, September 2009
Prepared by: Washington Consulting Group, Inc., January 2010.

Table III-3

FAA Safety Order of Preference

Description	Priority	Definition	Example
Design for minimum risk	1	Design the system (e.g., operation, procedure, or equipment) to eliminate risks. If the identified risk cannot be eliminated, reduce it to an acceptable level through selection of alternatives.	• If a collision hazard exists because of a transition to a higher Minimum En Route Altitude at a crossing point, moving the crossing point to another location would eliminate the risk.
Incorporate safety devices	2	If identified risks cannot be eliminated through alternative selection, reduce the risk via the use of fixed, automatic, or other safety features or devices, and make provisions for periodic functional checks of safety devices.	• An automatic "low altitude" detector in a surveillance system • Ground circuit in refueling nozzle • Automatic engine restart logic
Provide warning	3	When neither alternatives nor safety devices can effectively eliminate or adequately reduce risk, warning devices or procedures are used to detect the condition and to produce an adequate warning.	• A warning in an operators manual • "Engine Failure" light in a helicopter • Flashing warning on a radar screen
Develop procedures and training	4	Where it is impractical to eliminate risks through alternative selection, safety features, and warning devices, procedures and training are used, with management approval for catastrophic or hazardous severity.	• A missed approach procedure • Training in stall/spin recovery • Procedures for loss of communications

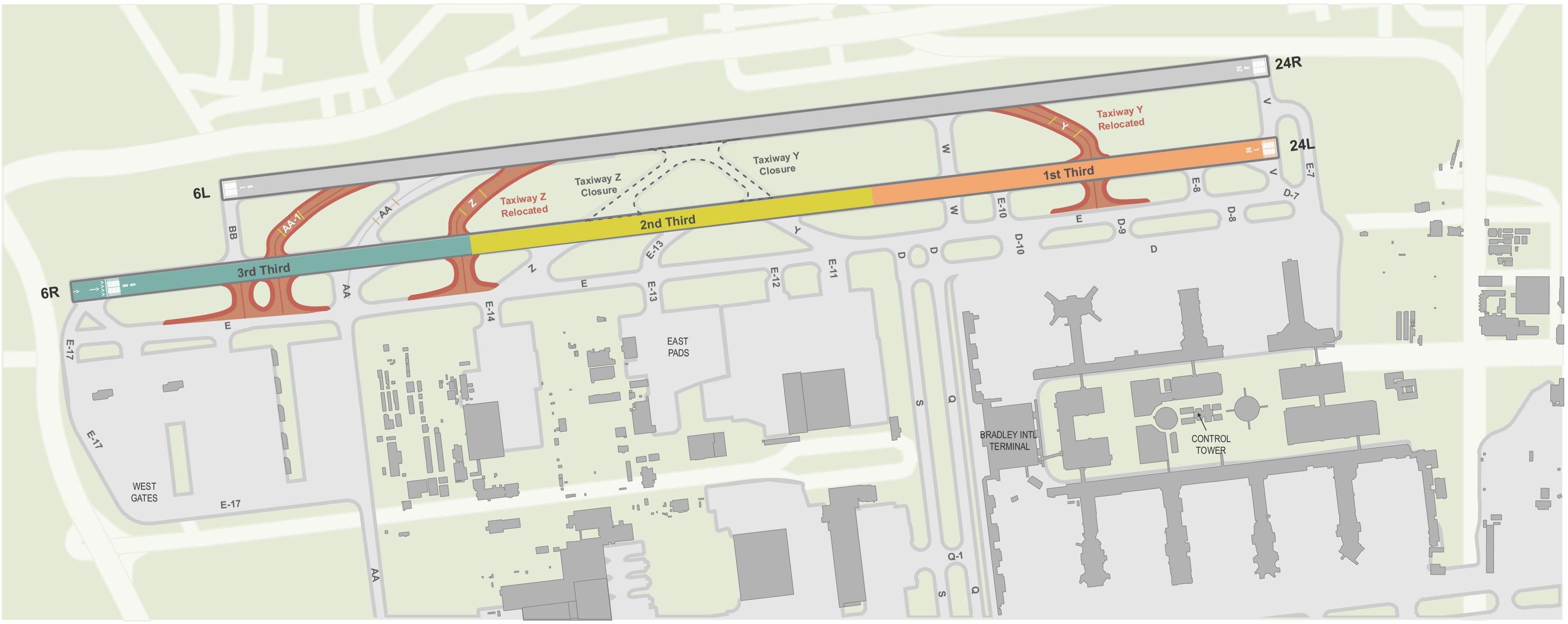
Source: Washington Consulting Group, Inc., January 2010
Prepared by: Washington Consulting Group, Inc., January 2010.

IV. ITSIP Design Considerations

As with any design process, some changes in the recommended plan may occur due to engineering concerns, operational needs, cost considerations, etc. Regardless of necessary engineering changes, the final design for the ITSIP improvements had to maintain some key elements and functional aspects to ensure that safety improvements are realized and the level of existing airfield operations are not compromised. These key elements and functional aspects included the following:

- Same number of taxiway exits that exist today
- All aircraft exiting Runway 6L-24R should cross Runway 6R-24L in the last third of the runway.
- Maintain the current ability to hold certain aircraft between the runways.
- Maintain the same taxiing exit speeds aircraft use today when exiting the runway.
- Provide maximum pilot visibility of the end of Runway 24L as much as possible just prior to crossing the runway pavement.

Additionally, engineers took into consideration the observations and conclusions made by the Academic Panel that are noted in Section 2.3.2.3 of this report, which was primarily pilot visibility of the end of the runway he/she is about to cross. Incorporating the design considerations listed above, the ITSIP design engineers developed numerous variations to recommended Concept #7. Upon review of the variations, LAWA staff identified Design Alternative #6, depicted on **Exhibit IV-1**, as the option that best incorporates the safety enhancements identified by the SRAP in Concept #7 and the observation and conclusions identified by the Academic Panel.



Sources: URS, May 2010 (Alternative 6 exit geometry); Ricondo & Associates, Inc., (graphical depiction of airfield)
Prepared by: Ricondo & Associates, Inc., May 2010.

Exhibit IV-1

Not to Scale

north

Design Alternative 6

As shown, there are two primary differences between Design Alternative #6 and Concept #7; 1) the end of the high-speed exits are turned to a 90 degree angle just past the holdline to Runway 6R-24L to provide maximum visibility to departing operations, and 2) a shift of Taxiway Y to the east to capture more arrivals during east flow and the ability to maintain Taxiway W, which maintains existing east flow capacity.

In July of 2010, the SRAP reviewed and evaluated Design Alternative #6 and concluded that the assessment regarding Concept #7 remains the same for Design Alternative #6. The SRAP agreed that the design alternative does provide some enhancement to safety with the enhanced 90 degree crossing.

V. Summary of ITSIP Analysis

The LAX North Airfield ITSIP analysis process used the SMS approach to SRM. A group of SMEs in aviation and airport operations, planning and safety were assembled as a SRM Panel to analyze the LAX North Airfield based on their knowledge, experience and expertise. The SRAP members participated in a one-day, facilitated discussion with a follow-up session on the second day. A follow-up session on July 8, 2010 was also conducted to evaluate design considerations and finalize the findings report.

The SRAP was made up of varying levels and types of knowledge and experience about runway and aviation safety. Members included FAA air traffic controllers, airport operations experts specifically at LAX, runway safety analysis experts with both general knowledge in the field and specific knowledge of LAX, safety management expert and airport planning and design experts with both general and specific knowledge in the field and specific knowledge of LAX. Some members of the SRAP had worked on airfield safety issues at LAX and some members were new to the process. Some members had experience in SMS and SRM and some members were new to the process.

The Panel started with a briefing on previous LAX SMS objectives, analysis and outcome. As part of this briefing, the SRAP reviewed LAX North Airfield existing design layout and operational issues. The SRAP was presented with background information on previously identified hazards, analysis and decisions. As part of this briefing the Panel was also presented with a limited set of options characterized as “interim” solutions to perceived safety risks on the LAX North Airfield. Upon reviewing the previous SMS study, the SRAP did not identify any new hazards beyond those previously identified in the earlier SMS study and focused on two of the previously identified hazards as being relevant to this particular study. The description of each hazard can be found in Tables II-2 in Section 2-1.

The rate and probability of aircraft incidents and accidents is very low when compared to many other forms of transportation. Commercial and business aircraft accidents are the lowest among all aircraft operations (the types that make up the vast majority of aircraft operating at LAX). Despite this low rate and probability of accidents, the consequences of an aircraft collision on the airfield are almost certainly catastrophic given the high probability for the loss of life among passengers, crew and people on the ground in the vicinity of an accident. As a result, the aviation industry devotes an extraordinary amount of time and resources to preventing even minor incidents that could lead to an aircraft collision.

Perceived risk of an aircraft collision was based on the history of runway incursions specifically occurring at LAX as well as the general risk of runway incursions throughout the NAS. Specific attention was placed on those runway incursions and one fatal aircraft collision at LAX that have taken place on the North Airfield. The general risk of runway incursions and collisions throughout the NAS helps to inform improvements to airfield design, aircraft operations and airfield vehicle controls.

The Panel reviewed runway, taxiway, lighting, marking, signage, sensing systems and control systems like the use of Runway Status Lights that have been recently installed at LAX. The Panel placed special emphasis on the addition of Runway Status Lights to the LAX North Airfield as a major safety improvement that had been implemented by LAWA and FAA since the 2007 Safety Risk Assessment. This change in the operational environment provides an added layer of information to pilots about the use of the runways even if air traffic controllers mistakenly clear an aircraft into the path of another aircraft.

FAA provides both general and specific guidance to the aviation industry on the treatment of actual and perceived risk of aircraft collisions through improvements to the airfield design, new safety devices, operator and user warnings, new procedures and training. These safety treatments and controls have a descending order of priority where the highest priority is to design or redesign for minimum risk. This highest level of treatment is also the most difficult and expensive to achieve or accommodate in a busy operating system like the North Airfield at LAX. In this case it is important to add as many layers as possible of the lower priority and lower level safety treatments. The history of runway incursions on the North Airfield at LAX have already prompted LAWA, in conjunction with the FAA and airport users, to develop an extensive airfield safety program that includes safety devices, warnings, improved procedures and training to all people who can or do come in contact with the airfield environment. These controls are effective because the universe of people in the system (pilots, air traffic controllers, airline ramp employees, airport personnel and construction contractors) are relatively few and all require specific authorization by either LAWA or the FAA (in some cases both LAWA and the FAA) before they are allowed to operate in the system.

The level of perceived risk reduction and/or risk mitigation afforded by each of the interim taxiway options was based on the Panel's perception of the risk, the options and their intended benefits. The options were designed to provide additional time and distance between the arriving aircraft and the departing aircraft. The wide array of aircraft types that operate at LAX and their varying operational characteristics presented special circumstances to the SRAP for classifying and treating the perceived risks. In general, aircraft were split into two main categories for this assessment: 1) non-heavy aircraft as defined by FAA for operational purposes ("large" and "small" aircraft that are capable of max gross takeoff weights less than or equal to 255,000 pounds) and 2) "heavy" aircraft as defined by FAA (those aircraft that are capable of max gross takeoff weights greater than 255,000 pounds). In general, the amount of takeoff runway length required for heavy aircraft is substantially more than that required for non-heavy aircraft.

The existing design of the LAX North Airfield and the associated runway lengths are those necessary to accommodate heavy aircraft. At the same time, the taxiway layout for arriving aircraft on Runway 24R is intended to minimize the amount of time non-heavy aircraft occupy the runway before it is available for the next arriving aircraft. This particular layout; that was intended to increase operational efficiency, has shown an unintended tendency to place arriving aircraft to cross in the path of departing aircraft on Runway 24L if the pilot of the taxiing aircraft misses the signs, lights, runway status lights and airfield markings indicating the runway intersection.

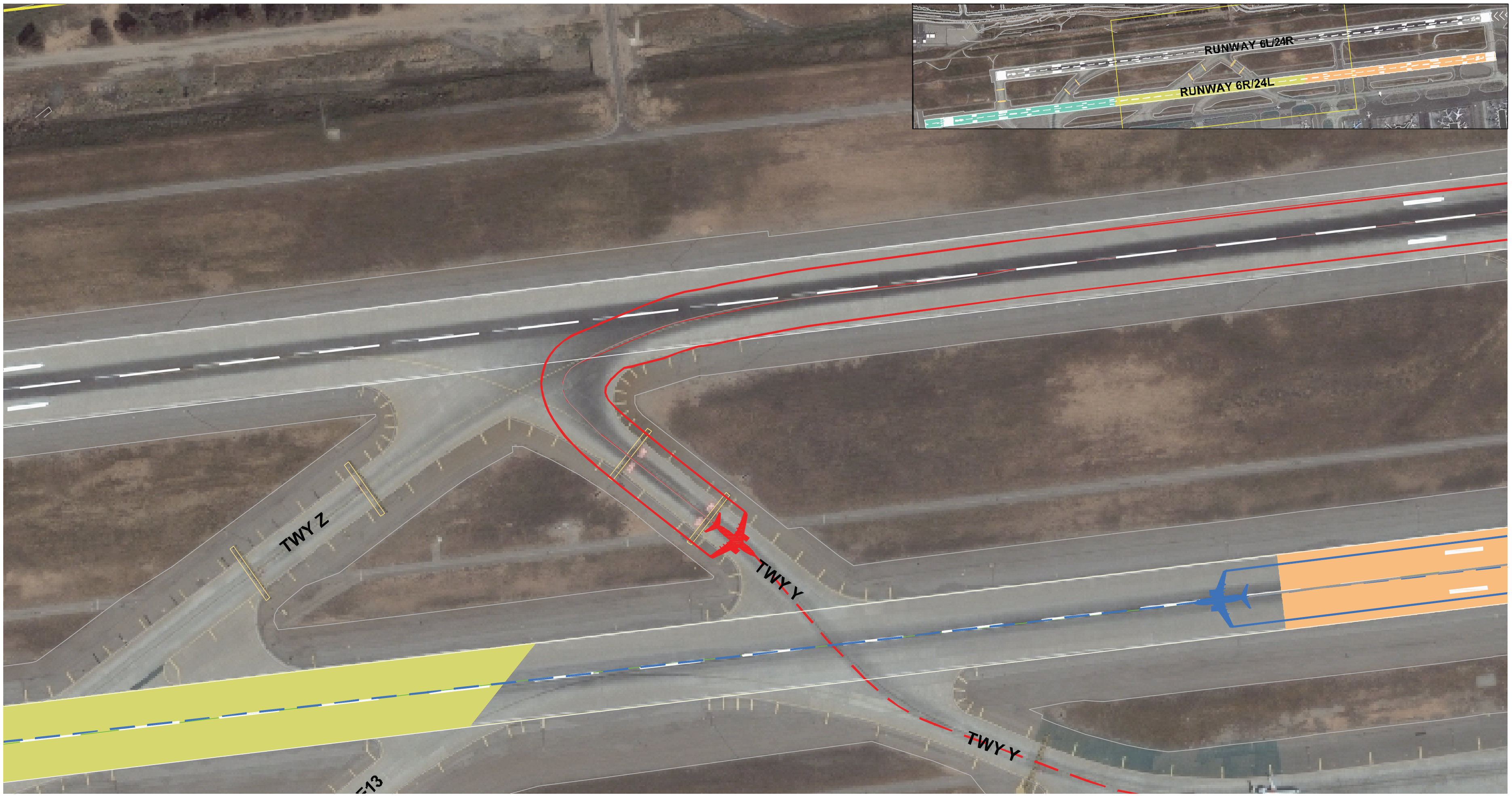
Aircraft departing on Runway 24L accelerate to speeds of 120 to 170 miles per hour on the runway before lifting off. These speeds combined with the high gross takeoff weights create very high levels of inertia and potential energy with relatively low levels of directional control. This vulnerable condition leaves a pilot with very few options to avoid an aircraft that may blunder in its path during the critical departure phase of flight.

The SRAP reviewed basic operational information that included the vertical profile of aircraft departing Runway 24L, takeoff roll length, fleet mix and the use of de-rated thrust. A large body of data and information is available on all of these parameters except for the conditions, use and operational effect of de-rated thrust. Each carrier and individual pilots employ de-rated thrust differently based upon the operating conditions at the time of departure. As a result, there is little if any predictability in the application of this technique. With the lack of specific parameters for de-rated thrust, the SRAP was left to assume the worst case that de-rated thrust is always in use and increasing the takeoff length and lowering the climb profile of non-heavy aircraft.

The deliberations of the SRAP were extensive on the parameters and conditions surrounding the identified hazards LAX 001 and 002 and the effect of the proposed Taxiway Y and Z relocations to in fact increase airfield safety without creating new hazards. Key areas of discussion and concern among the Panel members came down to the difference between the classifications of “Major” versus “Hazardous” levels of risk severity and “Extremely Remote” versus “Extremely Improbable” levels of risk likelihood. Concerns remain among SRAP members with this airfield layout and the operation of aircraft using de-rated thrust on takeoff from Runway 24L. The longer runway acceleration distance and lower climb profile of these aircraft place them in the path of aircraft that happen to cross Runway 24L without a clearance or mistakenly cleared by air traffic control.

The collective conclusion of the SRAP was to relocate Taxiways Y and Z from the current locations on the LAX North Airfield to locations further to the west and outside of the middle third of Runway 24L. This design change was perceived by the SRAP to be less hazardous to aircraft passengers and crew than the existing airfield layout. This change will not eliminate the collision risk on the airfield but it will reduce the likelihood of a collision below the existing level. On July 8, 2010, the SRAP reviewed Design Alternative #6. The SRAP concluded that the level of hazard migration to a lower level of risk remains the same as ITSIP Concept #7, but also indicated some safety enhancements with the modified 90 degree crossings prior to Runway 6R-24L.

Appendix A - Hazards LAX 001 and 002



Source: Los Angeles World Airports, June 2003 (Airport Layout Plan).
Prepared by: Ricondo & Associates, Inc., November 2009.

Exhibit A-1

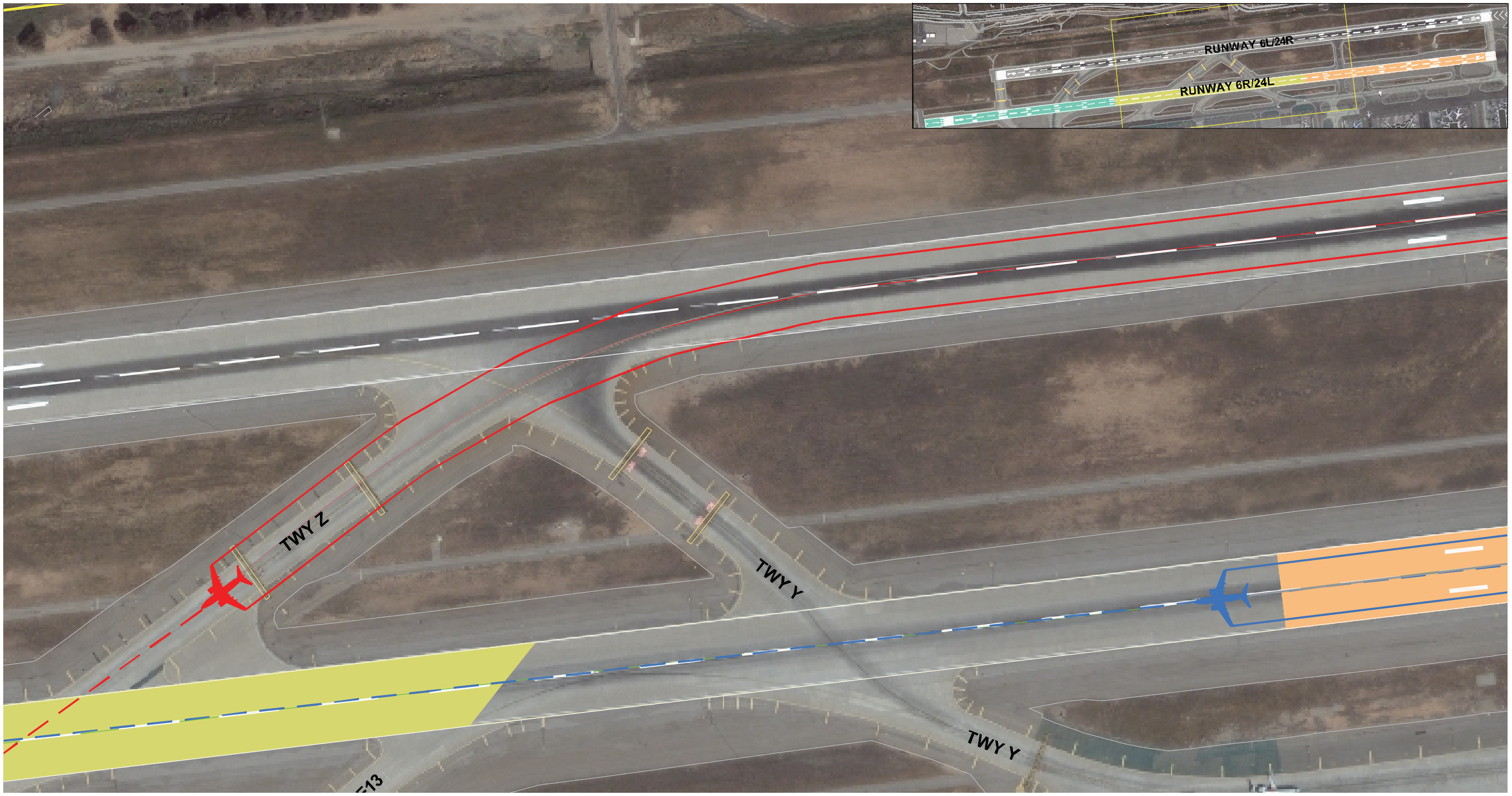
0 200 ft. north

LEGEND

1st Third
2nd Third
3rd Third
Holdbar
737-700 Arrival Path
737-700 Departure Path

Drawing: P:\LAX\SPAS Phase 2\IRSIP\IRSIP 24R High Speed Exits Concepts\LAX_BASE\LAX_BASE_cleanedforDrawings_111009_planeschanged_v2.dwg_Layout: 11x17L_Nov 11, 2009, 11:50am

LAX Hazard 001
Taxiway Y



Source: Los Angeles World Airports, June 2003 (Airport Layout Plan).
Prepared by: Ricondo & Associates, Inc., November 2009.

Exhibit A-2

0 200 ft. north

LEGEND

- 1st Third
- 2nd Third
- 3rd Third
- Holdbar
- 737-700 Arrival Path
- 737-700 Departure Path

LAX Hazard 001
Taxiway Z

Drawing: P:\LAX\SPAS Phase 2\IRSIP\IRSIP 24R High Speed Exits Concepts\LAX_BASE\LAX_BASE_cleanedforDrawings_111009_planeschanged_v2.dwg_Layout: 11x17L_Nov 11, 2009, 12:30pm

Source: Los Angeles World Airports, June 2003 (Airport Layout Plan).
Prepared by: Ricondo & Associates, Inc., November 2009.

Exhibit A-3

LAX Hazard 002
Taxiway Y

Drawing: P:\LAX\SPAS Phase 2\IRSIP\IRSIP 24R High Speed Exits Concepts\LAX_BASE\LAX_BASE_cleanedforDrawings_111009_planeschanged_v2.dwg_Layout: 11x17L Heavy_Nov 11, 2009, 12:44pm

Source: Los Angeles World Airports, June 2003 (Airport Layout Plan).
Prepared by: Ricondo & Associates, Inc., November 2009.

Exhibit A-4

LAX Hazard 002
Taxiway Z

Drawing: P:\LAX\SPAS Phase 2\IRSIP\IRSIP 24R High Speed Exits Concepts\LAX_BASE\LAX_BASE_cleanedforDrawings_111009_planeschanged_v2.dwg_Layout: 11x17L Heavy_Nov 11, 2009, 12:16pm

Appendix B – Safety Risk Assessment / LAX North Airfield

Los Angeles World Airports

LAX North Airfield
Proposed Runway Configuration

Safety Risk Assessment

WCG, Inc. - LAX Version 1.0

May 2007

Washington Consulting Group, Inc.
4915 Auburn Avenue, Suite 301, Bethesda, Maryland 20814

Executive Summary

In 2006 the Federal Aviation Administration implemented a Safety Management System (SMS) and Safety Risk Management (SRM) process for the busiest and most complex commercial use airport traffic control facilities in the National Airspace System (NAS).

The FAA SMS/SRM is designed to identify operational hazards, analyze the risks associated with these hazards and establish mitigating strategies to ensure the safe and expeditious management of air traffic. It is a structured, table-top analysis of airport operations or airspace procedures.

The five step process follows a clear and definitive methodology to:

- Describe the airport system
- Identify existing hazards
- Analyze risks and causal factors
- Assess risk severity and frequency
- Develop a range of options to mitigate risks to an acceptable level of safety

The Los Angeles World Airports Executive Director chartered a Safety Risk Management Panel to follow this process and to specifically develop and prioritize airport improvements that will increase the level of airfield safety at LAX. The North Airfield Complex at LAX was the focus of the Panel's evaluation at LAX.

The Safety Risk Management Panel consisted of the Washington Consulting Group, Inc., personnel from the Federal Aviation Administration LAX Airport Traffic Control Tower and LAX Airside Field Operations. The Los Angeles World Airports senior staff served as a resource for information.

The current configuration of the LAX North Airfield Complex was completed in the 1970's when it was designed to efficiently accommodate FAA Design Group III and IV aircraft, such as the Boeing 727-737, DC-9 and DC-10 (See Appendix 3) which were the dominating fleet until the late 1990's. Today's fleet mix at LAX has a quickly growing number of Design Group V and VI aircraft (Boeing 747-767-787, A340-380, C5A) that generate significant air traffic complexities not originally considered into the North Airfield design.

The North Airfield Complex consists of Runway 24L/06R and 24R/06L. Runway 24L/06R is 10,285 feet long and Runway 24R/06L is 8,925 feet long. Both runways are 150 feet wide. These runways accommodate the fleet mix of aircraft using LAX, however, with procedures that have several restrictions and prohibited taxi areas when simultaneous similar type aircraft operations are

occurring. These restrictions are reflected in the current LAX Jeppesen Airport Chart (See Appendix 5).

The Safety Risk Assessment was conducted on these procedures and other operational scenarios based on aircraft landing and departing, taxiing to and from the North Airfield and arriving aircraft taxiing off Runway 24R/06L using the current configuration of high speed exit taxiways and crossing the adjacent parallel runway.

The assessment further addressed the projected increase of aircraft diversity of very large to very small aircraft (fleet mix) in the National Airspace System (NAS) and the impact of this changing fleet mix on the North Airfield Complex. The analysis also assessed the use of “Taxiway Echo” which parallels runway 24L/06R.

Figure 1
The Washington Consulting Group, Inc. used the FAA Safety Management System (SMS) and Safety Risk Management (SRM) five step process to conduct this analysis.

Source: FAA SMS Manual

The hazards and risks associated with the current LAX North Airfield configuration has been identified in this document. While these hazards have been mitigated to an acceptable level of risk based on present day usage, this study found that significant improvements can be made to the safety level of the operation by modernizing the North Airfield design to meet the standards for the existing and future aircraft fleet.

Examples of the mitigation include numerous control factors which are utilized within the National Airspace System (NAS). The controls include the following:

- Aircraft separation standards established by the Air traffic Control handbook, FAA Order 7110.65;
- Aircraft operating techniques/responsibilities in the Federal Aviation Regulations (FAR's) and in the Airmen's Information Manual (AIM);

- Mandatory communications protocols such as “hear-back-read back” phraseology between controllers and pilots;

- Airport markings, lighting and signage that meet and exceed FAA Standards;

- Aircrew and Air Traffic Control (ATC) certification;

- Initial and recurrent training of system user’s including airport operators, pilots and controllers;

- System awareness by user’s of existing airfield hazards;

- Technology applications including : Airport Movement Advisory Safety System (AMASS) and Traffic Conflict Avoidance System (TCAS); and

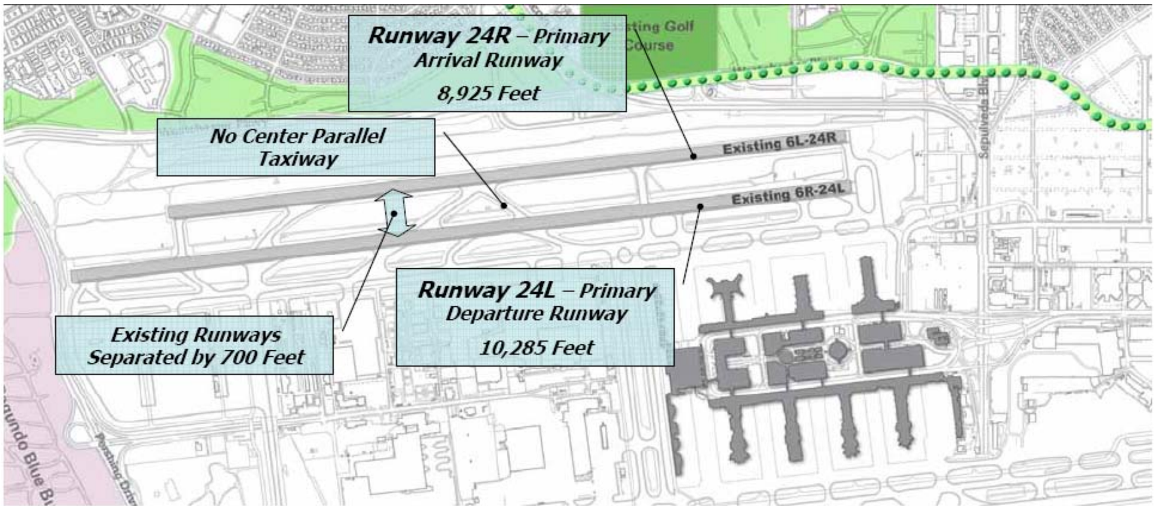
- Airfield system design including runways, taxiways, lighting, marking, signage and technology applications.

The continuing number of runway incidents, along with the projected increase of operations with new large aircraft (NLA), such as the A380, resulted in the analysis to focus on the airfield system design and a new runway configuration to ensure operations in the North Airfield Complex safely maintains an acceptable level of risk and maintains the integrity of the National Airspace System (NAS).

The proposed North Airfield configuration is designed to improve accessibility for large aircraft at LAX and maintain existing system efficiency. Most importantly, this design mitigates the potential for runway incursions, thereby enhancing the safety of passengers and aircraft at LAX.

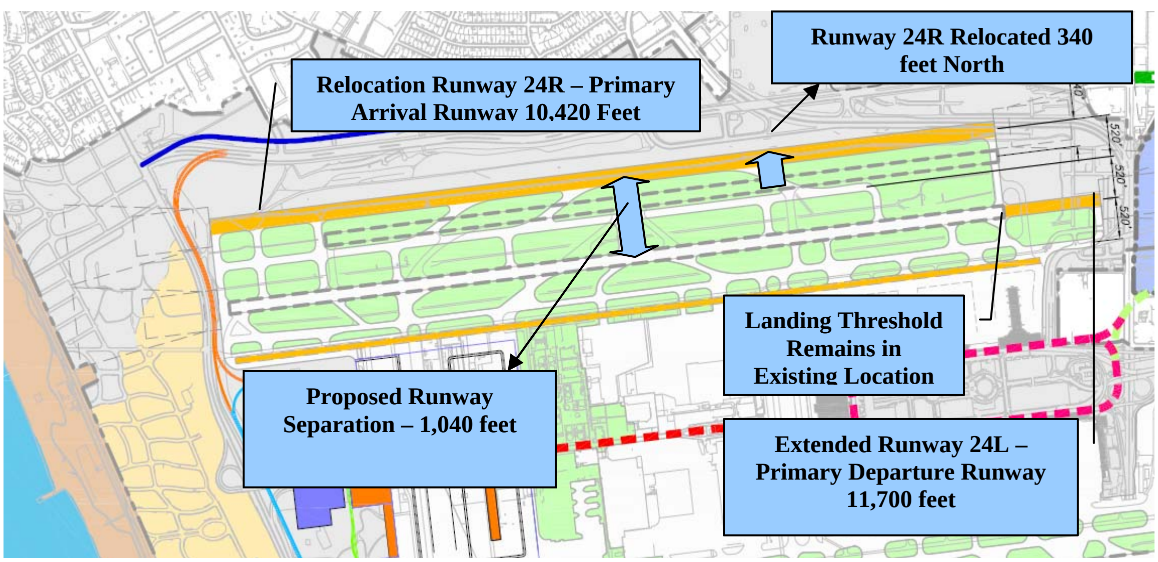
This Safety Risk Assessment specifically compared the current airfield configuration risks with the proposed configuration. Significant safety-related issues were mitigated to a lower level of risk with the new runway configuration.

Figure 2
Current Configuration of North Airfield Complex



Source: Los Angeles World Airports, 2007

Figure 3
Proposed Configuration of the North Airfield Complex



Source: Los Angeles World Airports, 2007

Using the FAA SRM process, the Safety Risk Management Panel (SRMP) developed a Preliminary Hazard List (PHL). The panel reviewed each hazard, followed the FAA SRM process to categorize similar risks and developed the Preliminary Hazard Analysis (PHA).

The PHA then identified the causes, system states, possible effects, severity, existing controls, likelihood, and current risks of the present runway configuration. The same process was conducted with the proposed configuration which resulted in the significant reduction and, in some cases, elimination of risks through an improved mitigation of the identified hazards.

The panel assessed each of the risks identified in this Safety Risk Assessment. Once this assessment was completed and the hazards mitigated using control factors as noted above, a safety assessment risk matrix was charted to compare the current North Airfield Complex with the proposed configuration.

The panel identified ten (10) hazards associated with aircraft operating on the existing LAX North Airfield (See Figure 4). The assessment/treatment of these with the implementation of the proposed North Airfield configuration resulted in the significant reduction or elimination of risks. These airfield improvements directly relate to the removal of the midfield high speed turnoffs to the immediate and adjacent parallel runway, increased distance between the parallel runways and operational opportunity for large/heavy aircraft to fully clear a runway after landing and the change to procedures for aircraft taxiing on Taxiway Echo.

By implementing the recommended North Airfield design changes, these hazards and the associated risks are greatly reduced for runway incursions, near mid-air collisions, surface collisions, and increased pilot/controller workload.

Figure 4

The analysis developed a Preliminary Hazard List (PHL)

Hazard Number	Hazard Description	Possible Effect
LAX 001	**Aircraft landing Runway 24R, crossing Runway 24L without ATC clearance at taxiway Yankee or Zulu with a NON-HEAVY aircraft departing**	**Reduction of separation by a high severity operational error that could lead to an aircraft collision, large reduction in safety margin, serious or fatal injury, physical distress and excessive workload**

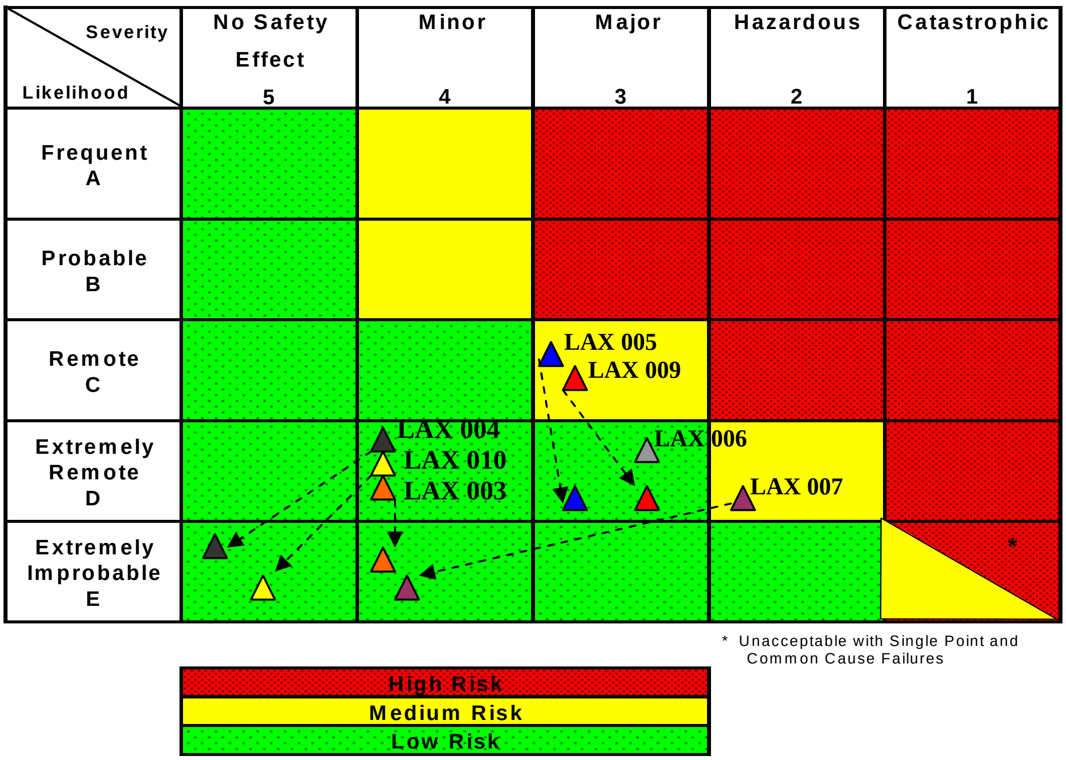
Hazard Number	Hazard Description	Possible Effect
LAX 002	**Aircraft landing Runway 24R, crossing Runway 24L without ATC clearance at taxiway Yankee or Zulu with a HEAVY aircraft departing**	**Reduction of separation by a high severity operational error that could lead to an aircraft collision, large reduction in safety margin, serious or fatal injury, physical distress and excessive workload**
LAX 003	**Aircraft landing Runway 24R, crossing Runway 24L without an ATC clearance at taxiway Alpha-Alpha or Bravo-Bravo with a HEAVY aircraft departing Runway 24L**	**Significant increase in ATC and Flight Crew workload; reduction in safety margin and physical discomfort of passengers**
LAX 004	**Aircraft landing Runway 24R, crossing Runway 24L without an ATC clearance at taxiway Alpha-Alpha or Bravo-Bravo with a NON-HEAVY aircraft departing Runway 24L**	**Slight reduction in ATC capability, slight increase in Flight Crew workload, reduction in safety margin and physical discomfort of passengers**
LAX 005	**Runway's 24L and 24R in use for arrivals and departures** **Runway 24L arrival with a Runway 24L departure resulting in an over flight hazard**	**Reduction of separation by a moderate severity operational error, significant increase in Flight Crew workload, significant reduction in safety margin, physical distress to passengers or possible injury**
LAX 006	**Runway's 24L and 24R in use for arrivals and departures** **Runway 24R arrival with a runway 24R departure resulting in an over flight hazard**	**Reduction of separation by a moderate severity operational error, significant increase in Flight Crew workload, significant reduction in safety margin, physical distress to passengers or possible injury**

Hazard Number	Hazard Description	Possible Effect
LAX 007	Runway's 24L and 24R in use for arrivals and departures Runway 24R arrival holding at taxiway AA or BB with a Runway 24R trailing arrival and Runway 24L departure Resulting in the preceding aircraft remaining in the Obstacle Free Zone (OFZ)	Reduction of separation by a high severity operational error that could lead to an aircraft collision, large reduction in safety margin, serious or fatal injury, physical distress and excessive workload
LAX 008	Runway 24L in use for arrivals and departures Taxiway Echo in use with a Design Group V or VI aircraft Resulting in taxiing aircraft tail impeding on the Runway 24L Object Free Zone (OFZ)	Reduction of separation by a moderate severity operational error, significant increase in Flight Crew workload, significant reduction in safety margin, physical distress to passengers or possible injury
LAX 009	Runway 24L/06R and Runway 24R/06L in use with increase of complexity associated with new fleet mix of Design Group V/VI Aircraft	Reduction of separation by a moderate severity operational error, significant increase in Flight Crew workload, significant reduction in safety margin, physical distress to passengers or possible injury
LAX 010	Runway 24R in use and Aircraft Rescue and Firefighting (ARFF) equipment operating with-in the runway safety area northeast of the runway Resulting in ARFF equipment inadvertently in the OFZ	Slight increase of ATC complexity No effect on flight Crew Inconvenience

Source: LAX-WCG, Inc. Safety Risk Management Panel, 2007

Figure 5

The Washington Consulting Group, Inc. used the severity and likelihood chart below to represent the matrix of the residual and significant improvements from the proposed design of the North Airfield Complex vs. the hazards associated with the current complex design. This is further defined in Section 6, 7 and 8 of this document



Summary of residual hazards and risks from current airfield configuration to proposed airfield configuration

Notes:

- **LAX 001 Eliminated as a hazard from a medium risk in the current configuration**
- **LAX 002 Eliminated as a hazard from a medium risk in the current configuration**
- **LAX 003 Remained a low risk**
- **LAX 004 Reduced to no safety effect from a minor low risk**
- **LAX 005 Reduced to a low risk from a medium risk in the current configuration**
- **LAX 006 Remained a low risk**
- **LAX 007 Reduced to a low risk from a medium risk in the current configuration**
- **LAX 008 Eliminated as a hazard from a medium risk in the current configuration**
- **LAX 009 Reduced to a low risk from a medium risk in the current configuration**
- **LAX 010 Reduced to no safety effect from a minor low risk**

Source: Washington Consulting Group, Inc.

With the existing control factors applied to mitigate risks, the Panel maintained a focus on the system design as the principle solution to improve safety and maintain efficiency of the North Airfield Complex.

The Panel addressed a worst-case scenario that discussed historical data and current mitigation efforts. While the likelihood of a credible event that may occur with a catastrophic outcome remains low, increasing airport activities and aircraft fleet complexities increase the likelihood of a catastrophic aircraft collision.

“Hear-back – read-back” incidents or aircraft crossing an active runway without a clearance from ATC are still occurring. The most recent occurrence was on the North Airfield Complex on February 24, 2007.

The outcome of a communication error provided the opportunity for the WCG Inc., SMS/SRM expert, to address a worst-case scenario. Using the SMS/SRM process WCG determined the possibility as listed below:

Describe the System

The LAX North Airfield Complex (Runway 24R and Runway 24L) in use for aircraft arrivals and departures. Personnel involved include FAA Certified Professional Controllers, Commercial Air Carrier Aircrews, Executive Corporate Aircrews, General Aviation Pilots, Military Aircrews, airport operators and LAX airside personnel. Machines include aircraft, ground service equipment, air traffic resources, emergency responding apparatus and possible construction equipment. The system is managed by FAA Orders, LAWA SOP’s, individual airline operating procedures and airport operator procedures. The environment is the North Airfield Complex and associated runways and taxiways.

Identify the Hazard

Aircraft arriving on Runway 24R and exiting the runway at Taxiway Yankee or Zulu and crossing Runway 24L without a clearance or misunderstanding hold instructions to avoid crossing in front of a departing or arriving aircraft on Runway 24L.

Departure aircraft on Runway 24L has accelerated to a high velocity but has not reached rotation speed leaving few alternatives such as veering left or right to avoid a collision, attempting to abort takeoff and stop or before a collision attempt an early rotation and risk stalling the airplane to avoid a collision. Arrival aircraft is in the process of a go-around (over-flight).

Analyze the Hazard

Arriving or departing aircrew must respond (see and avoid) or air traffic instructions must be timely to provide mitigation and avoid a collision.

The immediate availability of the high-speed exit, coupled with close proximity of the adjacent parallel runway provides little latitude for aircrews or air traffic controllers to mitigate miscommunication. At the same time, the proximity of the crossing taxiway location relative to the acceleration of the departing aircraft, or go around (over-flight) creates the credible scenario for an aircraft collision on the airfield. Severity level is catastrophic.

Assess the Risk

Worst credible outcome: miscommunication between arriving/departing aircraft and ATC; air traffic instructions not timely due to late or non-existent AMASS alert; distractions or frequency congestion.

The collateral effects are possible loss of control, departing aircraft experiencing a stall, colliding with other ground traffic or extreme damage to brakes and aircraft structure. The likelihood assessment is considered extremely remote based on current control factors; however, the qualitative description is that the event is unlikely to occur, but possible in an item's life cycle.

Treating the Risk

Given the multitude of air traffic control factors and the remaining hazard, the only remaining mitigation tool is to change the design of the system (North Airfield Complex). The addition of a center parallel taxiway system and additional separation of the runways; coupled with new 90 degree connecting taxiways for crossing the active runway will enhance safety, provide aircrews time to acclimate to the surface environment and allow new large aircraft to clear the runway Obstacle Free Zones (OFZ's).

Source: LAWA.Org

This credible worst case scenario occurrence was derived from subject matter experts using qualitative discussions; as such, the Panel concludes that increasing activity, complexities of the current system state and diversity of air traffic certainly have an impact on increasing the possibilities of a catastrophic event.

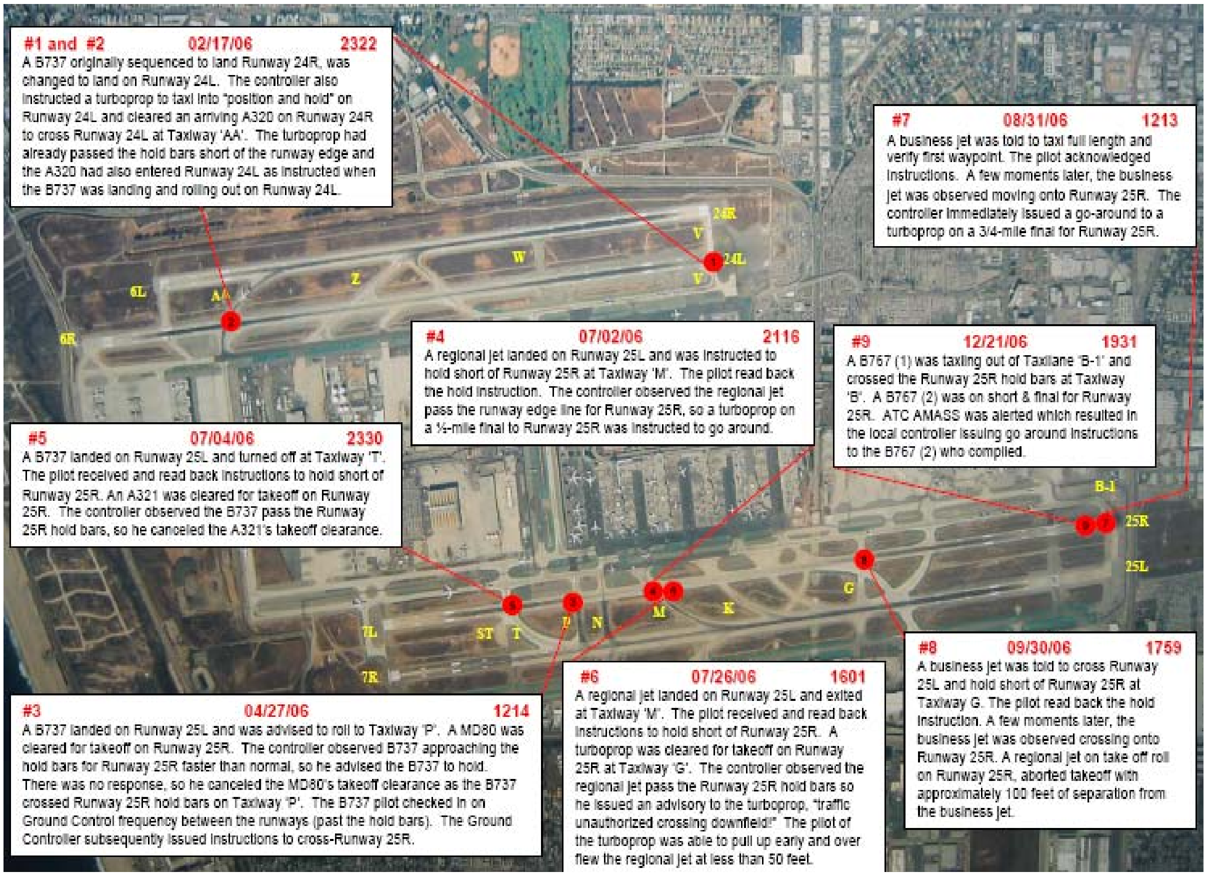
In addition to addressing a credible, worst-case scenario based upon the continuance of runway incidents, the Panel further recognized that airfield “standardization” is a principle concern in the National Airspace System (NAS). The LAX South Airfield Complex is completing a reconfiguration that will provide a center parallel taxiway between Runway 25L and Runway 25R. The South Airfield will also have a new network of high-speed exit taxiways from Runway 25L leading to the new center parallel taxiway followed by 90-degree exit taxiways for crossing Runway 25R.

This design will have an influencing impact on mitigating a significant history of runway incursion incidents.

The proposed design of the North Airfield Complex also includes a center taxiway between Rwy24L and Rwy24R. In addition to mitigation of potential incidents, the center taxiway provides a significant level of efficiency as it relates to Design Group V and VI aircraft.

The SRM panel concluded that the implementation of the proposed runway configuration results in improving the LAX safety by eliminating three significant hazards and reducing six other hazards to lower risks. LAX 006 remained in the major severity, extremely remote category.

LAX Runway Incidents 2006



Source: LAWA.Org

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Appendices

Appendix 9 – FAA Advisory Circular AC 150 5200 137 SMS for NAS Airports

List of Figures

Introduction

In 2006, the Federal Aviation Administration developed a Safety Management System (SMS) and Safety Risk Management (SRM) process as a result of requirements to the member states of the International Civil Aviation Organization (ICAO). The FAA SMS/SRM process meets those requirements and provides a methodology to identify, assess and treat potential and immediate hazards within the aviation industry. As an extension of the FAA's initial efforts to introduce SMS to its internal lines-of business, the FAA has recently introduced a SMS process for major airports in the National Airspace System (NAS).

The Los Angeles World Airports (LAWA) anticipated this action and has conducted a safety risk assessment for the Los Angeles International Airport (LAX) North Airfield Complex. The assessment was specifically focused on the hazards associated with the current runway/taxiway configuration and to test the efficacy of the proposed airfield configuration. The LAX North Airfield improvements are designed to improve accessibility for large aircraft arriving to their terminal, reduce delays by a more efficient taxiway layout that will reduce airline operating costs, and mitigate the potential for runway incursions; thereby enhancing the safety of passengers and aircraft at LAX.

In conducting the safety assessment described in this document, the Safety Risk Management (SRM) process has been applied as defined by the Federal Aviation Administration (FAA) Safety Management System (SMS) Manual. The current assessment, along with the identified risks, risk analysis, and treatment of risks are contained in this Safety Risk Assessment.

The current configuration of the North Airfield Complex is the result of numerous evolutions beginning with the construction of Runway 24L/06R in the 1960's and Runway 24R in the 1970's.

Air traffic practices during this period provided what appeared to be a simple process, or system, of using the outboard runway (Runway 24R) primarily for arrivals and the in-board runway (Runway 24L) primarily for departures. Lower air traffic density and a fleet mix of smaller aircraft at the time allowed the high speed taxiways to serve as a timely way to safely and efficiently cross an active inboard runway and proceed to the taxiway and terminal environment ahead of the next departing aircraft.

During this period, the separation of the runways and the operating size of the aircraft did not impede the runway Obstacle Free Zones (OFZ). As a result, The North Airfield Complex successfully provided a system for Design Group III and IV Aircraft for over 30 years.

Also during this period, the North Field Complex experienced two serious accidents and a series of incidents, which are identified as systems errors or operational errors by FAA standards. Those errors and accidents provided quantifiable data for the Safety Risk Management Panel to analyze hazard locations within the Complex.

It is expected that the North Airfield Complex will experience a significant increase in the proportion of large, heavy aircraft as system user's balance costs in operating from the North Airfield Complex versus the South Airfield Complex, particularly with Design Group V and VI aircraft.

The expanding and complex fleet mix using both the National Airspace System (NAS) generally and LAX specifically will generate a burden on the current airfield configuration and increase the likelihood of additional system errors, increase delays and manifest higher operating costs for the consumer, resulting in a negative impact on the overall safety and efficiency of LAX.

The SRM Panel reviewed significant incident data from both the South and North Airfield Complexes relative to runway incursions while focusing on the North Airfield current complexities. As a result, the Panel views the proposed North Airfield configuration as a design and physical solution to greatly reduce the risk of runway incursions.

A runway incursion, as defined by the Federal Aviation Administration (FAA), is any occurrence in the airport runway environment involving an aircraft, vehicle, person, or object on the ground that creates a collision hazard or results in a loss of required separation with an aircraft taking off, intending to takeoff, landing, or intending to land.

In June 2006, the FAA Air Traffic Organization, Terminal Business (ATO-T) aggressively initiated a program to address system errors at the most prominent field facilities within the NAS. While the majority of the system errors were in the Terminal Radar Approach Facilities (TRACONS), such as New York, Chicago, Southern and Northern California (SCT & NCT), including Dallas Fort-Worth (DFW) and Atlanta (ATL); Los Angeles Airport Traffic Control Tower (LAX), along with Chicago ATCT (ORD) and several others, were identified as "airports of interest"

Continuing into 2007, this program requires the facility manger and key staff to brief the ATO-T Vice-President every 120 days on methodologies to mitigate system errors or incidents.

Further, and of historical significance, the FAA in 2002 published a study entitled, "FAA Runway Safety Report: Runway Incursion Trends at Towered Airports in the United States – CY 1998 – CY 2001." This report identified a total of 1,460 runway incursions out of 268 million airport operations in the U.S. that resulted in three collisions and four fatalities over the four years studied. LAX experienced

38 total runway incursions during the period of the FAA study and had an average rate occurrence of 1.24 incursions per 100,000 operations.

Within the first quarter of Calendar Year (CY) 2007, the North Airfield has already experienced an operational error similar to the hazard identified in LAX 004 of the Preliminary Hazard List (PHL).

Figure 6
Runway Incidents for 1st Quarter CY-2007

Source: LAWA.Org

The FAA also classifies runway incursions by their relative severity. The highest severity is given to an incursion in which extreme action is needed to avoid a collision or if a collision occurs. Five of the 38 runway incursions at LAX during the period of the FAA study were in this category, however, none of the five resulted in a collision.

While over 80 percent of these incursions took place on the South Field Complex, it is of historical significance to review the system design during this period which is similar to the North Airfield current configuration. These incidents were at such an alarming rate that the South Field Complex is completing a major reconfiguration and adding a parallel taxiway between Runway 25L/07R and Runway 25R/07L which is expected to mitigate future incidents.

The principle goal of the FAA is to raise awareness of runway incursions, identify solutions, and implement strategies to reduce their severity and frequency as well as the risk of a runway collision. Airport surface radar technology and airport infrastructure implementation at key airports, similar to LAX, are some of the strategies identified by the FAA to help solve the problem.

LAWA has already implemented improvements to airfield lighting, taxiway marking, runway signage, and has sponsored on-going seminars on airfield familiarization with airport users. However, more improvement is needed. Taxiway system configuration is one of the key infrastructure methods to solving the problem.

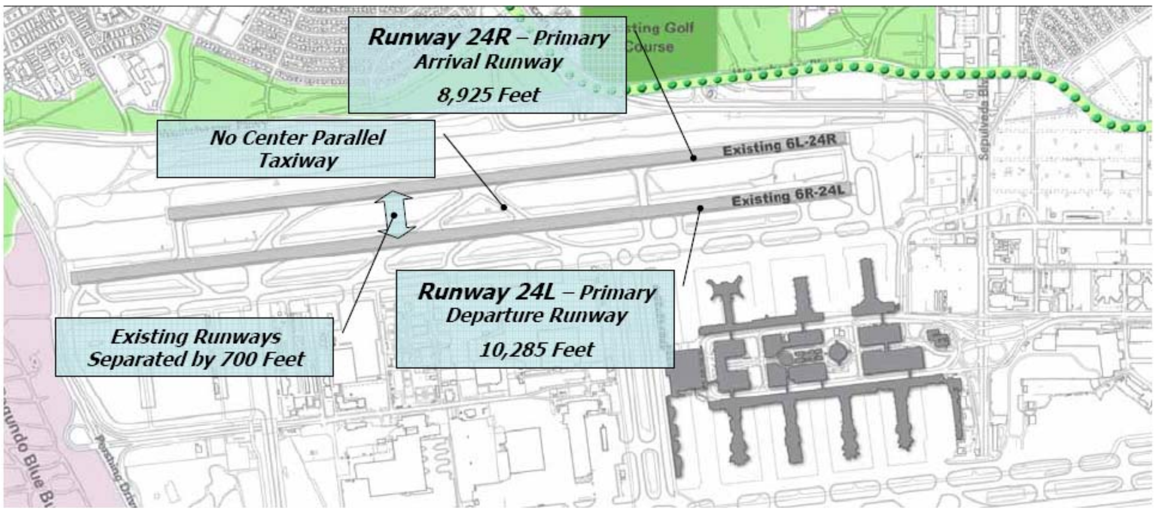
LAWA, in cooperation with NASA Ames Research Center, conducted a study titled “Los Angeles International Airport Runway Incursion Studies, Phase III – Center Taxiway Simulation” (published on July 31, 2003), comparing the cost and benefits of a center parallel taxiway and an “end-around” taxiway on the South Airfield Complex. LAWA sponsored and participated in this operational analysis and “human-in-the-loop” testing that included FAA Air Traffic Controllers from LAX Tower.

The study concluded that the end-around taxiway greatly increased taxi time and delays for arriving aircraft and thereby increased the operational costs of this option and did not produce any increased safety margin. ***Air traffic controllers also found the center parallel taxiway to be an operationally efficient solution to the primary cause of the most severe types of runway incursions experienced at LAX.***

Section 1 – Current System (Baseline)

The LAX North Airfield Complex has two parallel operational runways. These runways are oriented in an east-west direction. Runway 24L/06R is 10,285 feet long. Its elevation on the east end is 111 feet above sea level and the elevation on the west end is 108 feet above sea level. Runway 24R/06L is 8,925 feet long. Its elevation is 117 feet above sea level on the east end and 112 feet on the west end. Both runways are 150 feet wide.

Both runways are lighted and equipped with navigational aids, which allows aircraft arrivals and departures under both visual and instrument landing conditions. Parallel-dependent ILS approaches are conducted to Runways 24L/24R and 06L/06R.



Source: LAWA.Org

There currently exist several restrictions and prohibited operations with the North Airfield Complex. These include significant restrictions with taxiways which negatively impact the use of Runway 24L for arrivals and departures. Another impacting restriction relates to Runway 24R arrivals and is associated with aircraft that cannot exit past the runway Obstacle Free Zone (OFZ) after arrival.

Similar to air traffic practices established in the early design of the 1970's, the current air traffic practices use Runway 24R as the primary arrival runway and Runway 24L is the primary departure runway.

As a result, exiting arrivals of Group V aircraft generates complexities which are listed in the PHL and PHA of this study.

The existing runways are separated by 700 feet. There is no center parallel taxiway and high speed exits go directly into the adjacent runway.

Section 2 – Proposed System - North Airfield Configuration

The proposed North Airfield Configuration provides several significant changes associated with safety and efficiency. It is primarily designed to improve accessibility for large aircraft, reduce delays and mitigate the potential for runway incursions; thereby, enhancing the safety of passengers, LAWA employees and aircrews at LAX.

This proposal has the LAWA Airport Planning staff extending significant efforts to ensure long range operations identify, mitigate and fully address potential hazard areas while also maintaining efficiency, cost savings and overall effective operations.

The proposed system has Runway 24R/06L relocated 340 feet north and extended an additional 1,495 feet to the west for a total length of 10,420 feet. It is expected to remain as a primary arrival runway. Runway 24L/06R is extended 135 feet west and 1,280 feet east for a total length of 11,700 feet. It is expected to remain as the primary departure runway.

The proposed configuration provides 1,040 feet separation between the parallel runways. It provides a significant change that removes the high speed exits directly into the adjacent runway.

A center parallel taxiway generates an additional opportunity for aircrews to exit the runway expeditiously while maintaining integrity of runway safety zones. It further reduces the possibilities of untimely "hear back – read back" errors that have produced quantifiable incidents.

In addition to the safety implications, the center taxiway mitigates air traffic control complexities and provides alternatives to move aircraft east or west without generating delays and accommodates Design Group V and VI aircraft.

The new parallel center taxiway would be 10,420 feet long and 100 feet wide. It would be planned as a full-length Modified Group VI parallel taxiway located 520 feet north of Runway 24L/06R and 520 feet south of Runway 24R/06L.

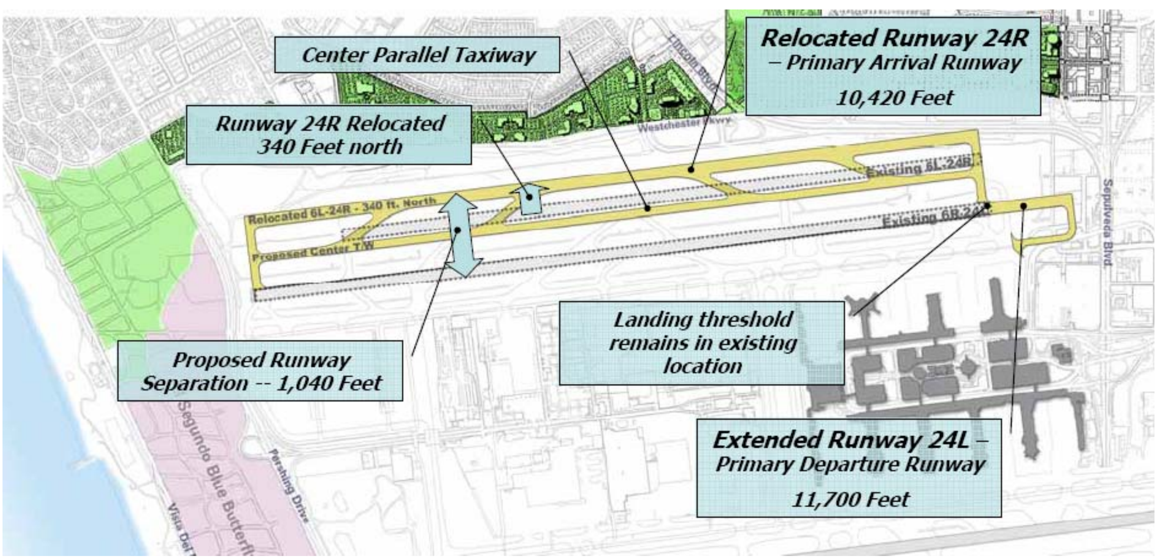
FAA Design Group VI taxiway separation standards call for 600 feet between a runway centerline and taxiway centerline intended to serve aircraft with Design Group VI tail heights, lengths and wing-span. Significant analysis was provided in the Draft LAX Master Plan, Chapter VI, Section 3.2.6.3, Justification for the Modified Group VI Standards to Accommodate the New Large Aircraft (NLA) at LAX, documenting the feasibility of using 520 feet separation at LAX and meet the same safety standards set by FAA for airfield safety. FAA has approved the use of these modified Group VI standards in their approval of the LAX Airport Layout Plan.

The new North Airfield center parallel taxiway, combined with the configuration of the exit taxiways, is instrumental in the physical solution to runway incursions. Exiting high-speed or acute angled exits off of Runway 24R/06L diverge from the runway centerline to the south and are aligned to cross Runway 24L/06R, directing arriving aircraft to Taxiway E.

The new exit taxiways associated with Runway 24R/06L would similarly diverge at acute angles from the runway centerline toward the south until they intersect with the new center parallel taxiway centerline.

Arriving aircraft would then proceed west or east (depending on the direction from which they arrived) for a short distance before coming to a perpendicular connecting taxiway that crosses Runway 24L/06R. This required turn, associated with this taxiway layout, provides time for pilots to fully acclimate to the airport surface environment, to comply with air traffic control taxi instructions and to clearly see runway hold bars prior to crossing the inboard runway.

All of these safety benefits are achieved without degrading the arrival and departure capacity of the north airfield runways.



Source: LAWA.org

Section 3 – Safety Risk Management Planning and Impacted Organizations

The Los Angeles World Airports staff, in coordination with the Washington Consulting Group, Inc., identified the stakeholders to support and participate with this safety assessment.

The key stakeholders were identified as the Safety Risk Management Panel (SRMP) responsible for conducting a safety risk assessment of the current LAX North Airfield Complex and the proposed North Airfield Configuration. The SRM Panel met on February 26 through February 28, 2007. The SRM Panel also met on March 8, 2007, March 21, 2007 and March 27 – 28, 2007.

During these meetings, the SRM Panel discussed hazards, risks, mitigation strategies, and other related issues.

SRM Panel Members	**Organization**	**Role**
Walt Smith	WCG, Inc.	SMS/SRM Expertise
Raymond Jack	LAWA-Airside Operations	Field Level Expertise
Kurt Rammelsberg	FAA-LAX ATCT	ATC Procedures
Michael Doucette	LAWA-Airport Planning	Source of Information
Nick Johnson	Johnson Aviation	Source of Information
Jacob Brothers	LAWA – Staff	Technical Assistant

Organizations impacted by this Safety Risk Assessment range from the LAX ATCT facility through the customers of the NAS (aircraft operators) that use LAX, and the airport operator (LAWA).

LAWA, together with the FAA, is responsible for the safe conduct of air traffic operations at LAX. The FAA Southern California TRACON (SCT) will also adjust procedures as the new runway configuration is commissioned to meet residual risk mitigation.

There were no high risk determinations as a result of this analysis (this would be a case where an identified hazard and its associated risk has no mitigating controls short of an immediate operational change). Medium risk hazards were clearly mitigated to a lower risk based on prudent control factors and the new design of the proposed configuration, which is intended to enhance safety, accommodate an increase of Design Group V and VI aircraft and reduce operational costs for LAX operators.

Section 4 – Assumptions

Projected domestic and international demands for the Los Angeles International Airport indicate a significant use of Group V and VI aircraft.

Current planning scenarios, including the modernization and expansion of the Bradley International Terminal, will generate a defining increase of international passenger usage at LAX.

The current air carriers at LAX have purchased large numbers of Group V and IV aircraft.

Regional aviation planners are addressing safety concerns with runway incursions, reduce air quality impacts from existing North Airfield taxiways and gate locations; balance long-haul departing aircraft operations between the North and South Complex and improve runway and taxiway spacing to ease large aircraft movement and safety.

The proposed North Airfield Runway configuration specifically facilitates these concerns.

While current air traffic procedures provides a safe use of the parallel runways in the North Airfield with Group IV aircraft, it has inherent design flaws that generate air traffic complexities with modern large aircraft (Groups V and VI) usage that will also impact efficiency.

Historical and quantifiable data on both the South Airfield and North Airfield Complexes shows that the continuing use of the high-speed exit taxiways by aircraft immediately proceeding into the adjacent runway is a continuing hazard for the passengers and air crews operating on the North Airfield Complex.

Air traffic operations will continue to generate complexities as increased activities with Design Group V and VI aircraft use the North Airfield Complex.

For air traffic efficiency, the airport will maintain the existing arrival and the departure rate while making taxiway improvements and removing taxiway obstructions to reduce delays and maintain a safe and expeditious traffic flow.

Section 5 – System Description (Phase 1)
Fleet Mix - Using the 5M Model to describe the system

LAX has a FAA terminal air traffic control (ATC) facility that provides 24-hour traffic advisories, spacing, sequencing, and separation services to visual flight rules (VFR) and instrument flight rules (IFR) aircraft operating within the class B airspace designated for the airport. The air traffic controllers at LAX, using a combination of terminal surveillance radar and visual observation, direct air traffic so it flows smoothly and efficiently. The controllers give aircrews instructions to operate on the airport movement area, air traffic clearances, and advice based on their own observations and information received from the automated weather system, radar systems, pilots, and other sources.

The FAA controllers provide separation services between landing and departing aircraft, transfer control of aircraft on instrument flights when the aircraft leave their airspace, and receive control of aircraft on instrument flights coming into their airspace from controllers at adjacent facilities.

The LAX Class B airspace consists of specified airspace within which all aircraft operators are subject to the minimum pilot qualification requirements, operating rules, and aircraft equipment requirements of 14 Code of Federal Regulations (CFR) Part 91. Within Class B airspace, no person may operate an aircraft unless (1) the aircraft has an operable two-way radio capable of communications with ATC on appropriate frequencies and (2) the aircraft is equipped with the applicable operating transponder and automatic altitude reporting equipment.

Operations within Class B airspace can be conducted in instrument meteorological conditions (IMC) or visual meteorological conditions (VMC) under instrument flight rules (IFR) or visual flight rules (VFR).

5.1 – Fleet Mix at Los Angeles International Airport

The Los Angeles International Airport is primarily known as an "air carrier" airport. All of the major U.S. domestic air carriers and numerous U.S. international air carriers are the primary users of the airport. An extensive and significant number of non-U.S. international air carriers also use LAX.

The United States Air Force also operates at LAX, mostly using the C-5A, C-17 and the C-130 aircraft.

The aircraft mix consists of the very largest to the very smallest aircraft types on an hourly and daily basis, every day of the year, 24 hours each day. This fleet includes all of the Boeing commercial aircraft types, including the projected use of the 787 series and the largest daily concentration of Boeing 747s of any US airport. The Airbus 380 is planned for daily commercial service starting in 2008 from LAX. At the same time, nearly one third of the daily operations at LAX are made by small commuter aircraft with 30 to 50 seats.

5.2 – The 5M Model that describes the system, operation or procedure

Systems will always have sub-components of a larger system. This section presents a system description using the 5M Model to ensure a complete and accurate description of the system and all of the elements:

Mission

The mission is the safe and expeditious flow of air traffic at the Los Angeles International Airport and the efficient utilization of the new runway configuration to maintain airfield capacity, enhance safety control factors, including design, reduce air quality impacts and decrease operators' costs.

(hu)Man

The panel decided that the human element consisted of all the ATC personnel at the LAX Airport Traffic Control Tower, the pilot community that includes commercial air carriers, general aviation and the military; and the airfield employees and operators.

Machine

The machine element is bounded by all the necessary equipment needed to safely perform commercial aircraft operations at Los Angeles International Airport This includes aircraft, routine ground service vehicles, emergency responding apparatus, field maintenance and construction equipment.

Management

The management element is bounded by FAA Order 7110.65, ATC Procedures, LAX ATCT, operator's procedures and LAWA airside standard operating procedures (SOP).

Media/Environment

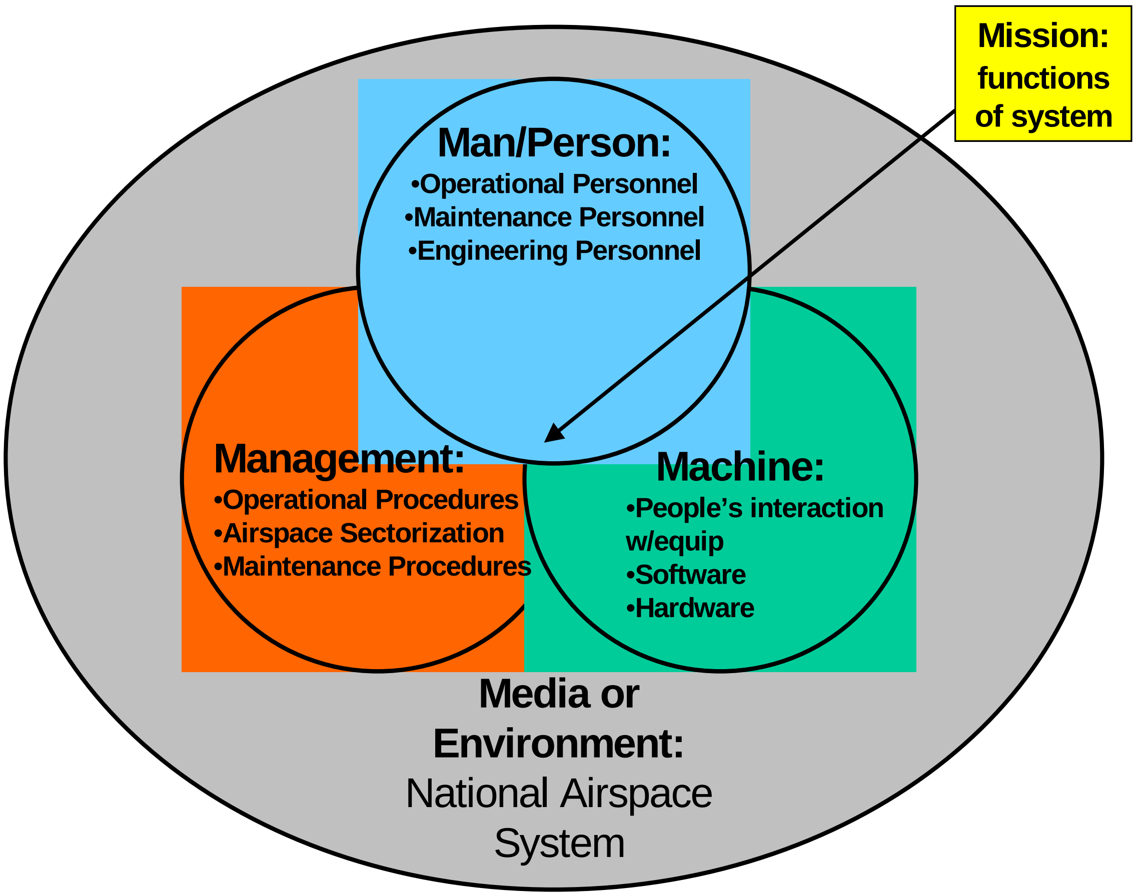
The media/environment refers to the NAS element that will be affected. The SRM Panel bounded the media/environment to LAX Airport Traffic Control Tower, pilots using LAX, companies operating at LAX and the airport operator.

5.2 – Resources

The data sources relied upon for this assessment included:

- FAA Order 7110.65
- FAA Safety Management System Manual, version 1.1
- Historical data from LAWA and FAA

Figure 7
The SMS/SRM 5M Model



Source: FAA SMS manual

Safety Risk Management Panels must describe the system which includes the scope of the problem or change. The system and operation must be described and modeled in sufficient detail for the safety assessment to proceed to the next stage, which is identifying the hazards.

Useful descriptions of the system exhibit two essential characteristics:

- Correctness: The description accurately reflects the system with an absence of ambiguity or error in its attributes.

- Completeness: No attributes have been omitted and are essential and appropriate to the level of detail in the change.

System description should include as it is configured today, as well as planned future configurations.

Section 6 – Identified Potential Hazards (Phase 2)
Describe Each Risk

The Safety Risk Management Panel (SRMP) identified six medium risk hazards and four low risk hazards associated with the current North Airfield Complex.

6.1 – Description of Hazards

The following is a detailed description of the identified hazards reviewed during this assessment.

Runway 24R arrival crossing Runway 24L with or with-out a clearance with arrival and departure aircraft using Runway 24L where:

- **LAX 001** – Aircraft crossing at taxiway ZULU or YANKEE (Non-heavy aircraft) resulting in a high severity operational error;

- **LAX 002** – Aircraft crossing at taxiway ZULU or YANKEE (Heavy aircraft) resulting in a high severity operational error;

- **LAX 003** – Aircraft crossing at taxiway Alpha-Alpha or Bravo-Bravo (Heavy aircraft) resulting in a significant increase in ATC workload;

- **LAX 004** – Aircraft crossing at taxiway Alpha-Alpha or Bravo-Bravo (Non-heavy aircraft) resulting in a slight reduction in safety margins;

Runway 24L and Runway 24R in use for arrivals and departures where:

- **LAX 005** – Runway 24L Departure with a Runway 24L Arrival (Over-flight) resulting in a moderate severity operational error;

- **LAX 006** – Runway 24R Departure with a Runway 24R Arrival (Over-flight) resulting in a moderate severity operational error;

- **LAX 007** – Runway 24R Arrival with a preceding Runway 24R arrival at taxiway Alpha-Alpha and Bravo-Bravo resulting in a high severity operational error;

Runway 24L arrival or departure where:

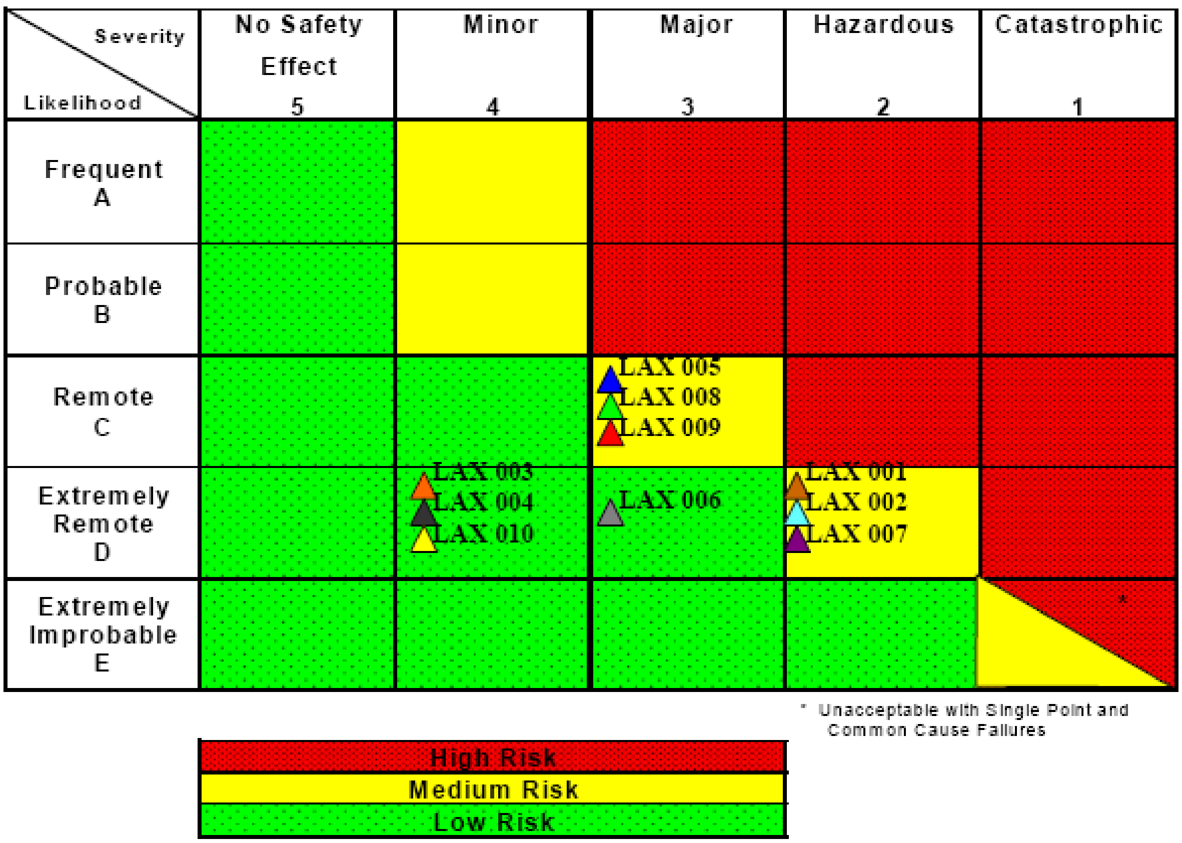
- **LAX 008** – Design Group V or VI aircraft simultaneously using Taxiway Echo at the east end resulting in a moderate severity operational error;

Runway 24L and Runway 24R in use where:

- **LAX 009** – Increased activity and complexity of Design Group V and VI operating on the North Airfield Complex resulting in moderate severity operational error;

- **LAX 010** – Aircraft Rescue and Firefighting (ARFF) equipment operating within the runway safety area at northeast end of runway 24R resulting in an increase of ATC workload and a distracter to aircrews.

Figure 8
Identified Potential Hazards
Risk Matrix of Current Configuration



Source: LAX-WCG, Inc. Safety Risk Management Panel

Section 7 – Risk Analysis & Risk Assessment (Phase 3 & 4)

The Safety Risk Management Panel (SRMP) methodology for risk analysis is based on the approach outlined in the FAA Safety Management System and the five step process detailed in the SMS Manual: Describe the System, Identify the Hazards, Analyze the Hazards, Assess the Risk, and Treat the Risk.

Figure 9
Safety Risk Management
Five Step Process

Source: FAA SMS Manual

Describing and Bounding the System

The Panel identified the system as the current North Airfield Configuration and the Proposed North Airfield Configuration. The 5M Model indicates a multitude of participants with this system as outlined in Section 5 of this document.

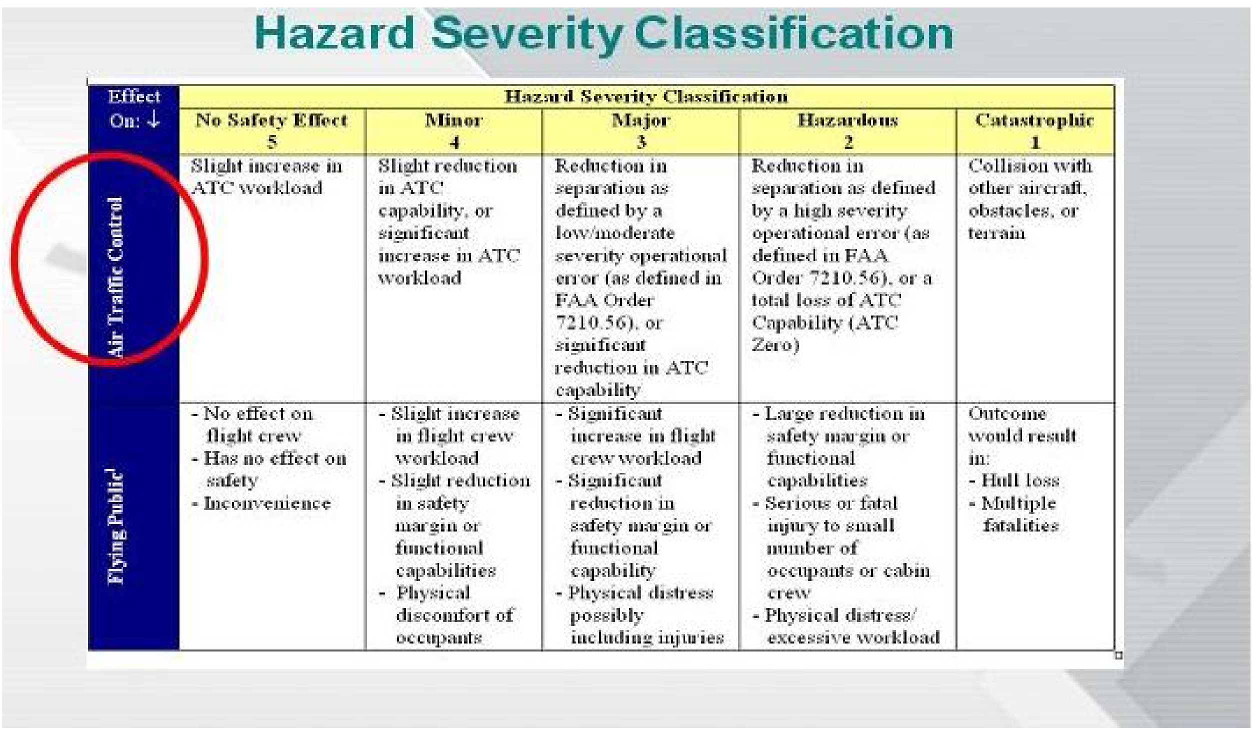
Hazard Analysis

The Panel held a discussion on each of the identified hazards. The purpose of these discussions were to examine the cause of the hazard, validate the severity of consequence for each of the hazards, and assign a qualitative likelihood of occurrence based on the operational expertise of the WCG, Inc., the LAX FAA air traffic control personnel and the airport airside staff. Quantitative data from similar configurations, such as the LAX South Airfield configuration prior to the new construction, was instrumental in determining severity and likelihood.

Risk Determination

Risk is the composite of predicted "severity and likelihood" of the potential effect of a hazard in the worst credible system state. Risk is determined by two factors: severity of consequence and likelihood of occurrence. Risk is not determined simply by the likelihood that the hazard will occur, but the worst credible outcome will occur. The risk matrix from section 4.41 of the FAA SMS Manual, Appendix A, was used to identify and document the risk levels.

Figure 10
Hazard Severity Classification



Hazard Severity Classification

Effect On: ↓	Hazard Severity Classification				
	No Safety Effect 5	Minor 4	Major 3	Hazardous 2	Catastrophic 1
Air Traffic Control	Slight increase in ATC workload	Slight reduction in ATC capability, or significant increase in ATC workload	Reduction in separation as defined by a low/moderate severity operational error (as defined in FAA Order 7210.56), or significant reduction in ATC capability	Reduction in separation as defined by a high severity operational error (as defined in FAA Order 7210.56), or a total loss of ATC Capability (ATC Zero)	Collision with other aircraft, obstacles, or terrain
Flying Public[1]	- No effect on flight crew - Has no effect on safety - Inconvenience	- Slight increase in flight crew workload - Slight reduction in safety margin or functional capabilities - Physical discomfort of occupants	- Significant increase in flight crew workload - Significant reduction in safety margin or functional capability - Physical distress possibly including injuries	- Large reduction in safety margin or functional capabilities - Serious or fatal injury to small number of occupants or cabin crew - Physical distress/ excessive workload	Outcome would result in: - Hull loss - Multiple fatalities

Source: FAA SMS Manual

Severity is determined by the worst credible outcome. Credible outcome is dependent on the system state (weather, evening hours, etc).

The NAS and the Los Angeles International Airport incorporate numerous controlling factors within the system that significantly impact positive reduction of severity. These include control instructions, crew procedures, separation standards, surface radar, etc. Severity is determined independent of likelihood.

Figure 11
Likelihood of Occurrence Chart

The Safety Risk Management Panel determined likelihood on a qualitative basis from the FAA Safety Management System chart below

	NAS Systems			Flight Procedures	ATC Operational	
	Quantitative	Qualitative				
		Individual Item/System	ATC Service/ NAS Level System		Per Facility	NAS-wide
Frequent	Probability of occurrence per operation/ operational hour is equal to or greater than 1×10^{-3}	Expected to occur about once every 3 months for an item	Continuously experienced in the system	Probability of occurrence per operation/ operational hour is equal to or greater than 1×10^{-5}	Expected to occur more than once per week	Expected to occur more than every 1-2 days
Probable	Probability of occurrence per operation/ operational hour is less than 1×10^{-3}, but equal to or greater than 1×10^{-5}	Expected to occur about once per year for an item	Expected to occur frequently in the system		Expected to occur about once every month	Expected to occur about several times per month
Remote	Probability of occurrence per operation/ operational hour is less than or equal to 1×10^{-5} but equal to or greater than 1×10^{-7}	Expected to occur several times in life cycle of an item	Expected to occur numerous times in system life cycle	Probability of occurrence per operation/ operational hour is less than or equal to 1×10^{-5} but equal to or greater than 1×10^{-7}	Expected to occur about once every year	Expected to occur about once every few months
Extremely Remote	Probability of occurrence per operation/ operational hour is less than or equal to 1×10^{-7} but equal to or greater than 1×10^{-9}	Unlikely to occur, but possible in an item's life cycle	Expected to occur several times in the system life cycle	Probability of occurrence per operation/ operational hour is less than or equal to 1×10^{-7} but equal to or greater than 1×10^{-9}	Expected to occur about once every 10-100 years	Expected to occur about once every 3 years
Extremely Improbable	Probability of occurrence per operation/ operational hour is less than 1×10^{-9}	So unlikely that it can be assumed that it will not occur in an item's life cycle	Unlikely to occur, but possible in system life cycle	Probability of occurrence per operation/ operational hour is less than 1×10^{-9}	Expected to occur less than once every 100 years	Expected to occur less than once every 30 years

Source: FAA SMS Manual

Likelihood notes:

- The FAA SMS likelihood chart assumes operation 24x7 (365 days) or approximately 8760 hrs/year for a single item/system
- The chart assumes NAS-Wide occurrence is an order of magnitude greater than an individual item/system.
- The chart assumes the hazard is 3 times likely to occur in the NAS than in a single facility.

The Preliminary Hazard Analysis (PHA)

The PHA, listed below, was developed by the SRMP, and used to identify the hazards and analyze the risks. Each step is outlined below.

Figure 12
Preliminary Hazard Analysis (PHA)
Describing the System – Identifying the Hazard – Analyzing the Risk

(1) Hazard #	(2) Hazard Description	(3) Causes	(4) System State	(5) Possible Effect	(6) Severity & Rationale
LAX 001	Aircraft departing or arriving 24L with aircraft inadvertently crossing at taxiway <u>Yankee or Zulu</u>	Communication Error Equipment Malfunction Runway Hazard	Simultaneous use of Rwy24L & Rwy 24R <u>Non-Heavy</u> Aircraft	Near collision Hazardous with high severity operational error	2D Medium Risk Hazardous Severity Based on subject matter expertise
LAX 002	Same scenario as LAX 001	As Above	Simultaneous use of Rwy24L & Rwy 24R <u>Heavy</u> Aircraft	As Above	2D Medium Risk Hazardous Severity Based on subject matter expertise
LAX 003	Aircraft departing or arriving 24L with aircraft inadvertently crossing at taxiway <u>Alpha-Alpha or Bravo-Bravo</u>	As Above	Simultaneous use of Rwy24L & Rwy 24R <u>Heavy</u> Aircraft	Reduction of ATC capabilities and increase of controller aircrew workload	4D Low Risk Minor Severity Based on subject matter expertise
LAX 004	Same scenario as LAX 003	As Above	Simultaneous use of Rwy24L & Rwy 24R <u>Non-Heavy</u> Aircraft	Same as LAX 003 above	4D Low Risk Minor Severity Based on subject matter expertise
LAX 005	Runway 24L & Runway 24R used for arrivals and departures at same time	As Above	Runway 24L arrival with a Runway 24L departure (Over flight)	Near collision Major with moderate severity operational	3C Medium Risk Major Severity

(1) Hazard #	(2) Hazard Description	(3) Causes	(4) System State	(5) Possible Effect	(6) Severity & Rationale
				error	
LAX 006	Same scenario as LAX 005	Communication Error Equipment Malfunction Runway Hazard	Runway 24R arrival with a Runway 24R departure (Over flight)	Reduction of ATC capabilities and increase of controller aircrew workload	3D Low Risk Major Severity Based on subject matter expertise
LAX 007	Same scenario as LAX 005	As Above	Runway 24R arrival with a preceding arrival – Taxiway Alpha-Alpha or Bravo-Bravo	Near collision Hazardous with high severity operational error	2D Medium Risk Hazardous Severity
LAX 008	Runway 24L and Taxiway Echo in use	As Above	Design Group V or VI aircraft using Taxiway Echo	Near collision Major with moderate severity operational error	3C Medium Risk Major Severity
LAX 009	Increase complexity of fleet mix on North Airfield	As Above	Design Group V or VI aircraft using areas with restrictions and complex coordination	Near collision Major with moderate severity operational error	3C Medium Risk Major Severity
LAX 010	ARFF equipment using northeast end of LAX	Communication Error Equipment Malfunction	Runway 24R in use	Reduction of ATC capabilities and increase of controller aircrew workload	4D Low Risk Major Severity Based on subject matter expertise

Source: LAX-WCG, Inc. SRM Panel

Section 8 – Treatment of Risks/Mitigation of Hazards (Phase 5)
Risk Treatment

For each hazard, the Panel identified existing safety requirements and recommended safety mitigation strategy (s) that will lessen the risk or control the hazards using the safety order of precedence from Table 4.4 of the FAA SMS Manual. After the hazards were defined and possible effects were identified, means to control the hazards were developed.

Los Angeles International Airport has detailed (quantitative) information available for operations on the North Airfield and South Airfield operations that includes the historical data associated with incidents, accidents and systems errors as defined by the FAA.

However, as a result of analyzing the proposed North Airfield configuration, the Panel decided to base the analysis on qualitative data obtained from subject matter experts. The quantitative data was used to assist in framing the issues and mitigation strategies. This methodology was consistently applied across of the hazards.

After applying the mitigations strategies associated with the proposed runway configuration, Hazard LAX 001, LAX 002 and LAX 008 were mitigated from a medium risk to complete elimination as a hazard.

LAX 005, LAX 007 and LAX 009 were mitigated from medium to low risks. LAX 003, LAX 004, LAX 006 and LAX 010 remained at a low risk.

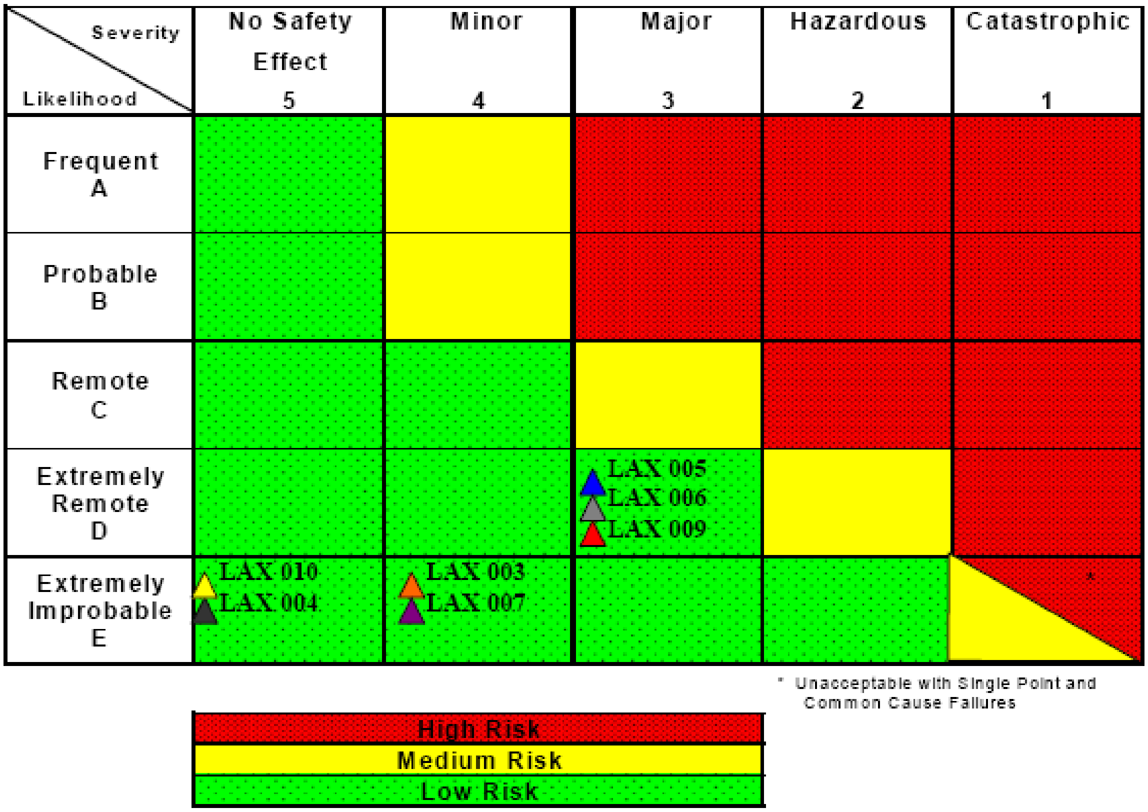
The ten identified hazards; their severity, likelihood and risk were discussed in the previous section. Six hazards, LAX 001, LAX 002, LAX 005, LAX 007, LAX 008 and LAX 009 were judged to be the most serious hazards that could lead to high severity operational errors. These six hazards are considered to be at medium risk with the current configuration of the North Airfield Complex.

The remaining four hazards have a lesser risk that would result with increased ATC and aircrew workload.

The proposed North Airfield configuration resulted in hazards LAX 001, LAX 002 and LAX 008 to be eliminated. LAX 005 and LAX 009 were reduced to a low risk and significantly, LAX 007 shifted from a medium risk with hazardous severity to a low risk with minor severity.

Figure 13

Safety Risk Matrix with Proposed Configuration



Note: LAX 001 - 002 and LAX 008 were eliminated as a hazard with the proposed configuration

Source: LAX-WCG, Inc. SRM Panel

The chart below incorporates the identified hazards into definable groups of interdependent operations; thereby providing a clear analysis of the overall mitigating strategy as a result of implementing the proposed North Airfield Runway configuration.

Figure14

Risk Mitigation Strategies

Hazard #'s	Risk	Mitigation
LAX 001 LAX 002 LAX 003 LAX 004	**Runway 24R crossing Runway 24L with or without a clearance at taxiways Yankee – Zulu – Alpha-Alpha or Bravo-Bravo**	**- New center taxiway between Runway 24L/06R and Runway 24R/06L eliminates the complexity of aircraft immediately proceeding through the**

Hazard #'s	Risk	Mitigation
		adjacent or flanking runway
LAX 005 **LAX 006** **LAX 007**	**Runway 24L/06R and Runway 24R/06L in use for arrivals and departures resulting in possible over flights from aircraft on short final or aircraft exiting with out clearing the runway safety area**	**- Proposed configuration results in a displaced threshold for Runway 24L that mitigates over flights** **- New center taxiway between Runway 24L/06R and Runway 24R/06L provides for aircraft exit without delay and additional distance from the runway safety area to clear the runways**
LAX 008 **LAX 009** **LAX 010**	**Increased use of Design Group V and VI aircraft**	**- Proposed configuration is designed to provide an efficient system for arrivals and departures to include aircraft operating in the movement area**

Source: LAX-WCG, Inc. SRM Panel

The panel recognizes that numerous control factors are utilized within the National Airspace System (NAS). The controls clearly mitigate known and projected hazards and risks. ***One of the most compelling control factors is the system design.***

The Safety Risk Management Panel made note of the following mitigations:

- Separation standards established by FAA Order 7110.65
- Operating techniques/responsibilities in the Airmen's Information Manual
- Mandatory communications and "hear-back-read back phraseology
- Airport (ICAO) markings – lighting – signage
- Aircrew and ATC certification
- Training of system user's including airport operators
- System awareness by user's
- Technology

- System design

Figure 15
Preliminary Hazard List (PHA)
Assess and Treat the Risk

Hazard	(7) Current Controls	(8) Likelihood	(9) Likelihood Rationale	(10) Current Risk	(11) Recommended Safety Requirements	(12) Residual Risk
LAX 001	AMASS, ASDE, 7110.65, Visual Aids, Training Runway Guide Lights	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	2D Medium Risk Hazardous Severity	New center taxiway between Runway 24L/06R and 24R/06L eliminates the Complexity of aircraft immediately proceeding through the adjacent flanking runway	Eliminated
LAX 002	As Above	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	2D Medium Risk Hazardous Severity	As Above	Eliminated
LAX 003	As Above	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	4D Low Risk Minor Severity	As Above	4E Low Risk Minor severity
LAX 004	As Above	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	4D Low Risk Minor Severity	As Above	5E Low Risk No safety effect
LAX 005	As Above	Remote	Expected to occur several times in life cycle of an item	3C Medium Risk Major Severity	As Above	3D Low Risk Medium Severity
LAX 006	As Above	Extremely Remote	Unlikely to occur, but	3D Low	As Above	3D Low Risk

Hazard	(7) Current Controls	(8) Likelihood	(9) Likelihood Rationale	(10) Current Risk	(11) Recommended Safety Requirements	(12) Residual Risk
			possible in an item's life cycle	Risk Major Severity		Medium Severity
LAX 007	As Above	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	2D Medium Risk Hazardous Severity	As Above	4E Low Risk Minor Severity
LAX 008	As Above	Remote	Expected to occur several times in life cycle of an item	3C Medium Risk Major Severity	As Above	Eliminated
LAX 009	As Above	Remote	Expected to occur several times in life cycle of an item	3C Medium Risk Major Severity	As Above	3D Low Risk Major Severity
LAX 010	As Above	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	4D Low Risk Minor Severity	As Above	5E No safety effect

Source: LAX-WCG, Inc. SRM Panel

Section 9 – Tracking and Monitoring Hazards

The Safety Risk Management Panel identified the following hazards as medium risks while developing the Preliminary Hazard List (PHL). While these hazards were mitigated to a low risk with the Preliminary Hazard Analysis (PHA), they are recommended to be monitored:

- LAX 001 Inadvertent Runway Crossing
- LAX 002 Inadvertent Runway Crossing
- LAX 005 Over-flight due to go-around
- LAX 007 Holding in the OFZ on Rwy24R
- LAX 008 A/C on Taxiway Echo-Rwy24L arrival
- LAX 009 Excess coordination Group V & IV

The hazard tracking should include continuous monitoring of operational errors (OE's), operational deviations (OD's), surface incidents and Quality Assurance Reviews (QAR's) related to the North Airfield Complex.

Aircrew safety reports are another venue to obtain relative data.

This information will serve as quantitative data for the current system (baseline) and provide further information associated with a design change to improve safety and enhance efficiency.

Section 10: Report Summary

The Safety Risk Assessment of the current North Airfield Complex identified several medium category hazards. The existing safety controls, such as the FAA separation standards and the Standard Operating Procedures (SOP's) within the scope of the airport user's and operators, resulted in mitigating these to an acceptable level of risk.

However, the efficiency of the North Airfield Complex is not at an acceptable level. This was clearly evident during the arrival and departure of the A380 on March 20, 2007. The aircraft required special procedures through-out its arrival, departure and taxi in the movement area.

The Safety Risk Management Panel (SRMP) reviewed quantifiable and historical data associated with both the North and South Airfield Complex. The previous configuration in the South Airfield Complex revealed numerous hazards. ***The Panel recognizes that these hazards relate to a high rate of system user's and runway crossings from airport tenants; however, the data also provides insight into the configuration complexities associated with an aircraft inadvertently proceeding into a flanking or parallel runway***.

Not surprisingly, extensive investigation of these unusual high incidents indicate a significant number of "hear-back - read-back" incidents, misunderstandings and latent practices where acceptable procedures lead to increasing risks.

The most recent runway incursion in the North Airfield Complex indicates that historical trends established in the previous South Airfield configuration are becoming more apparent and relate to the system design.

The Panel conducted a credible worst case scenario based upon current trends with communication errors, particularly at high risk locations in the present configuration. This scenario has a catastrophic outcome if the system state (poor visibility due to weather or evening operations), loss of technical tools and other control resources (such as untimely control instructions, frequency congestion or aircrew inability to respond) occur simultaneously.

The analysis of a credible worst case scenario occurrence was derived from subject matter experts using qualitative discussions; as such, the Panel feels increasing activity, complexities of the current system state and diversity of air traffic certainly have an impact on increasing the possibilities of a catastrophic event.

It is the recommendation of the Safety Risk Management Panel that the North Airfield Complex proposed configuration be adopted.

Appendix 1: Preliminary Hazard Analysis (PHA)

(1) Hazard #	(2) Hazard Description	(3) Causes	(4) System State	(5) Possible Effect	(6) Severity & Rationale	(7) Current Controls	(8) Likelihood	(9) Likelihood Rationale	(10) Current Risk	(11) Recommended Safety Requirements	(12) Residual Risk
LAX 001	Aircraft departing or arriving 24L with aircraft inadvertently crossing at taxiway Yankee or Zulu	Communication Error Equipment Malfunction Runway Hazard	Simultaneous use of Rwy24L & Rwy 24R Non-Heavy Aircraft	Near collision Hazardous with high severity operational error	2D Medium Risk Hazardous Severity Based on subject matter expertise	AMASS, ASDE, 7110.65, Visual Aids, Training Runway Guide Lights	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	2D Medium Risk Hazardous Severity	New center taxiway between Runway 24L/06R and 24R/06L eliminates the Complexity of aircraft immediately proceeding through the adjacent flanking runway	Eliminated
LAX 002	Same scenario as LAX 001	As Above	Simultaneous use of Rwy24L & Rwy 24R Heavy Aircraft	As Above	2D Medium Risk Hazardous Severity Based on subject matter expertise	As Above	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	2D Medium Risk Hazardous Severity	As Above	Eliminated
LAX 003	Aircraft departing or arriving 24L with aircraft inadvertently crossing at taxiway Alpha-Alpha or Bravo-Bravo	As Above	Simultaneous use of Rwy24L & Rwy 24R Heavy Aircraft	Reduction of ATC capabilities and increase of controller aircrew workload	4D Low Risk Minor Severity Based on subject matter expertise	As Above	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	4D Low Risk Minor Severity	As Above	4E Low Risk Minor severity
LAX 004	Same scenario as LAX 003	As Above	Simultaneous use of Rwy24L & Rwy 24R Non-Heavy Aircraft	Same as LAX 003 above	4D Low Risk Minor Severity Based on subject matter expertise	As Above	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	4D Low Risk Minor Severity	As Above	5E Low Risk No safety effect
LAX 005	Runway 24L & Runway 24R used for arrivals and departures at same time	As Above	Runway 24L arrival with a Runway 24L departure (Over flight)	Near collision Major with moderate severity operational error	3C Medium Risk Major Severity	As Above	Remote	Expected to occur several times in life cycle of an item	3C Medium Risk Major Severity	As Above	3D Low Risk Medium Severity
LAX 006	Same scenario as LAX 005	Communication Error Equipment Malfunction Runway Hazard	Runway 24R arrival with a Runway 24R departure (Over flight)	Reduction of ATC capabilities and increase of controller aircrew workload	3D Low Risk Major Severity Based on subject matter expertise	As Above	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	3D Low Risk Major Severity	As Above	3D Low Risk Medium Severity
LAX 007	Same scenario as LAX 005	As Above	Runway 24R arrival with a preceding arrival – Taxiway Alpha-Alpha or Bravo-Bravo	Near collision Hazardous with high severity operational error	2D Medium Risk Hazardous Severity	As Above	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	2D Medium Risk Hazardous Severity	As Above	4E Low Risk Minor Severity
LAX 008	Runway 24L and Taxiway Echo in use	As Above	Design Group V or VI aircraft using Taxiway Echo	Near collision Major with moderate severity operational error	3C Medium Risk Major Severity	As Above	Remote	Expected to occur several times in life cycle of an item	3C Medium Risk Major Severity	As Above	Eliminated
LAX 009	Increase complexity of fleet mix on North Airfield	As Above	Design Group V or VI aircraft using areas with restrictions and complex coordination	Near collision Major with moderate severity operational error	3C Medium Risk Major Severity	As Above	Remote	Expected to occur several times in life cycle of an item	3C Medium Risk Major Severity	As Above	3D Low Risk Major Severity
LAX 010	ARFF equipment using northeast end of LAX	Communication Error Equipment Malfunction	Runway 24R in use	Reduction of ATC capabilities and increase of controller aircrew workload	4D Low Risk Major Severity Based on subject matter expertise	As Above	Extremely Remote	Unlikely to occur, but possible in an item's life cycle	4D Low Risk Minor Severity	As Above	5E No safety effect

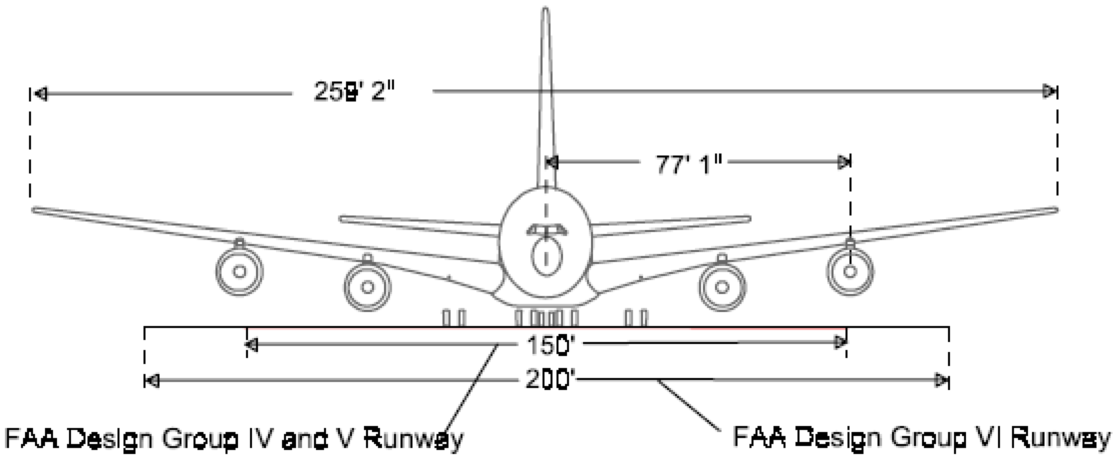
Appendix 2: Safety Management System – Safety Risk Management
SMS-SRM

DEFINITIONS

SAFETY	Freedom from unacceptable risk. Safety can be equated to some measurable goal (e.g., an accident rate less than an acceptable specified value)
ACCIDENT	An unplanned event that results in a harmful outcome; e.g., death, injury, occupational illness, or major damage to or loss of property
INCIDENT	An occurrence other than an accident that affects or could affect the safety of operations
RISK	The composite of predicted severity and likelihood of the potential effect of a hazard
ASSESSMENT	An estimation of the size and scope of risk or quality of system or procedure.
HAZARD	Any real or potential condition that can cause injury, illness, or death to people; damage to, or loss of, a system, equipment, or property; and/or damage to the environment. A hazard is a condition that is a prerequisite to an accident or incident
CAUSE	An event that leads to a hazard or hazardous condition
SOURCE (of a hazard)	Any potential origin of system failure, including equipment, operating environment, human factors, human machine interface, procedures and external services
SYSTEM	An integrated set of constituent pieces that are combined in an operational or support environment to accomplish a defined objective. These pieces include people, operational environment, usage, equipment, information, procedures, facilities, services, and other support services
ERROR TOLERANT SYSTEM	Total elimination of risk is an unachievable goal. Even in organizations with the best training programs and a strong safety culture, human operators will occasionally make errors. It is important that systems be designed and implemented in such a way that, to the maximum extent possible, errors and equipment failures do not result in an accident or incident
COMMON CAUSE FAILURE	A failure that occurs when a single fault results in the corresponding failure of multiple system components or functions

EFFECT	A description of the potential outcome of the hazard if it occurs in the defined system state
SYSTEM STATE	The system state refers to a variety of hazardous system conditions, including but not limited to location, system mode, velocity, operating rules in effect, type of operation, energy (power sourcing, electromagnetic environmental effects, etc.), operational environment and ambient environment. System state can be described in: *Operational and Procedure Terms* – Visual Flight Rules (VFR) vs. Instrument Flight Rules (IFR), Land and Hold Short Operations, etc. *Conditional Terms* – Instrument Meteorological Conditions (IMC) vs. Visual Meteorological Conditions (VMC), peak operating hours, etc. *Physical Terms* – Electromagnetic Environment Effects, precipitation, primary power source, back-up power source, etc. In addition, for any given hazard, not all system states have equal risk
WORST CREDIBLE OUTCOME	Assessment of hazards should make adequate allowance for worst-case conditions. However, it is also important that hazards included in the final analysis be *credible* hazards. *Worst* – Most unfavorable conditions expected (e.g., extremely high levels of traffic, extreme weather disruption) *Credible* – Implies that it is reasonable to expect the assumed combination of extreme conditions will occur within the operational lifetime of the system
DESIGN DIVERSITY	Independent generation of different implementations of the same logic function

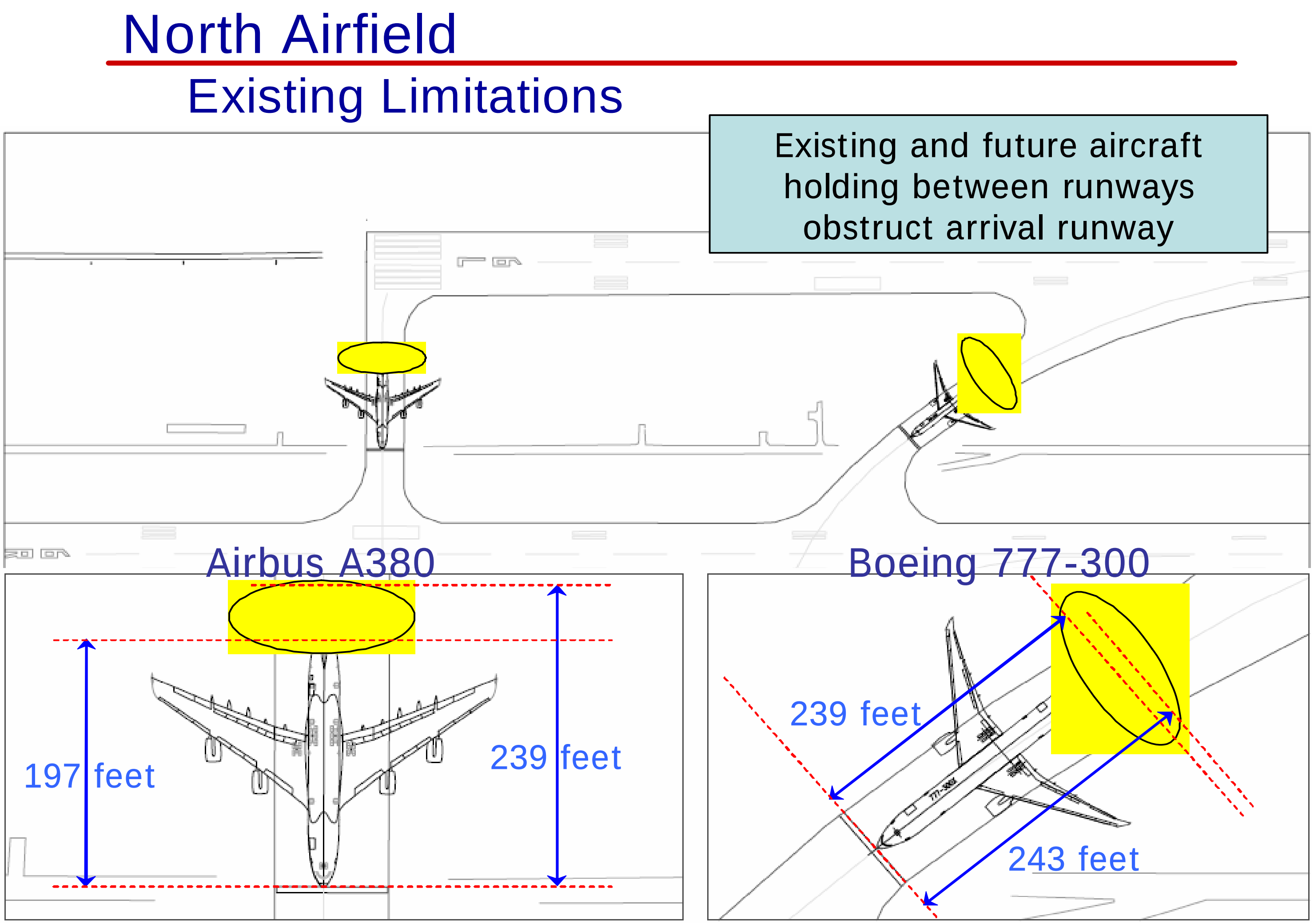
Appendix 3: Description of Design Group Aircraft



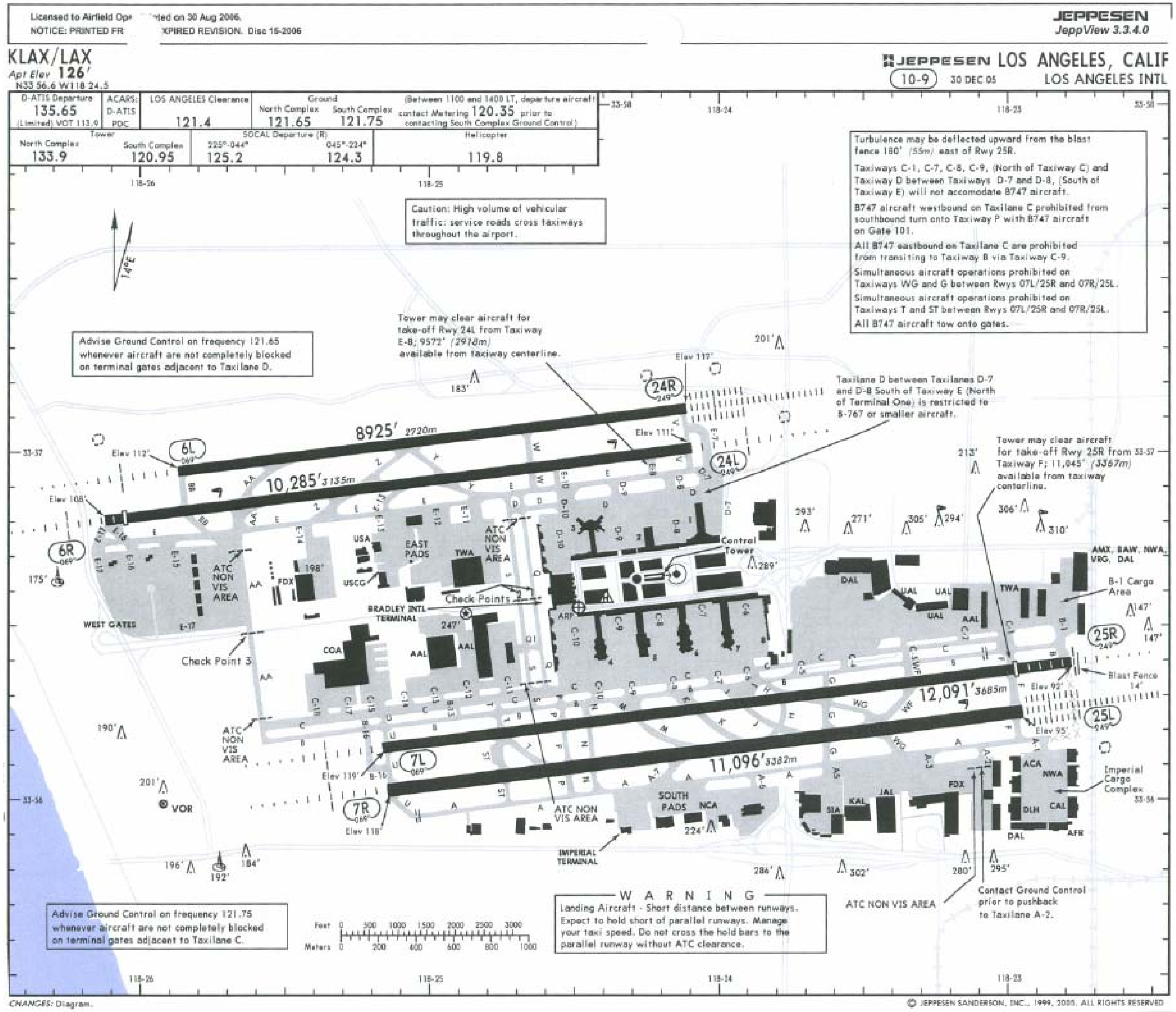
Airport Reference Code (ARC) Determination

Aircraft Approach Category	Aircraft Approach Speed (stall speed x 1.3 in knots)
A	0 to 90
B	91 to 120
C	121 to 140
D	141 to 165
E	166 or more
Airplane Design Group	Aircraft Wingspan in Feet (Meters)
I	0 up to but not including 49 (15)
II	49 (15) up to but not including 79 (24)
III	79 (24) up to but not including 118 (36)
IV	118 (36) up to but not including 171 (52)
V	171 (52) up to but not including 214 (65)
VI	214 (65) up to 262 (80)

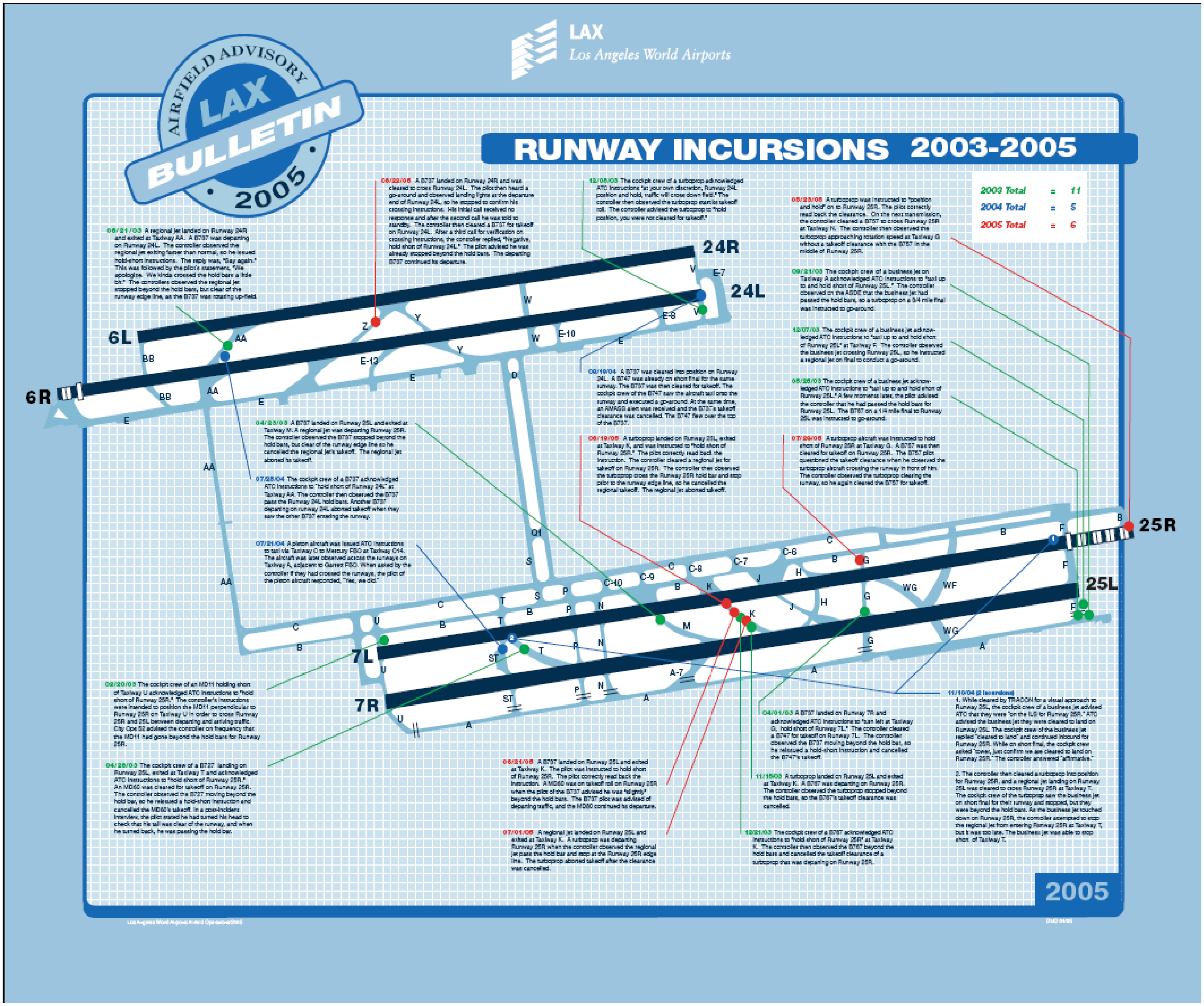
Appendix 4: North Airfield Limitations for Design Group V and VI



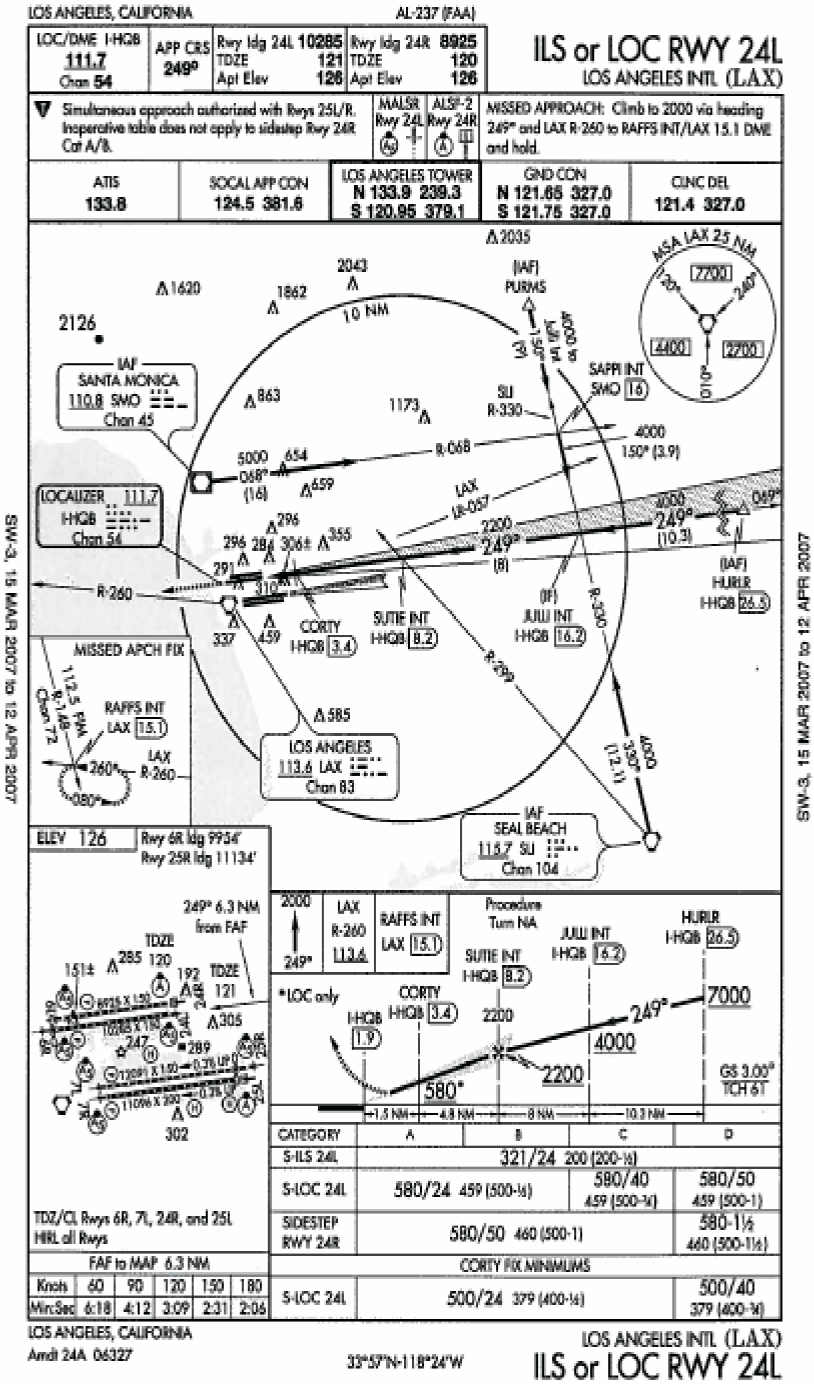
Appendix 5: Jeppesen Airport Diagram Listing Restrictions

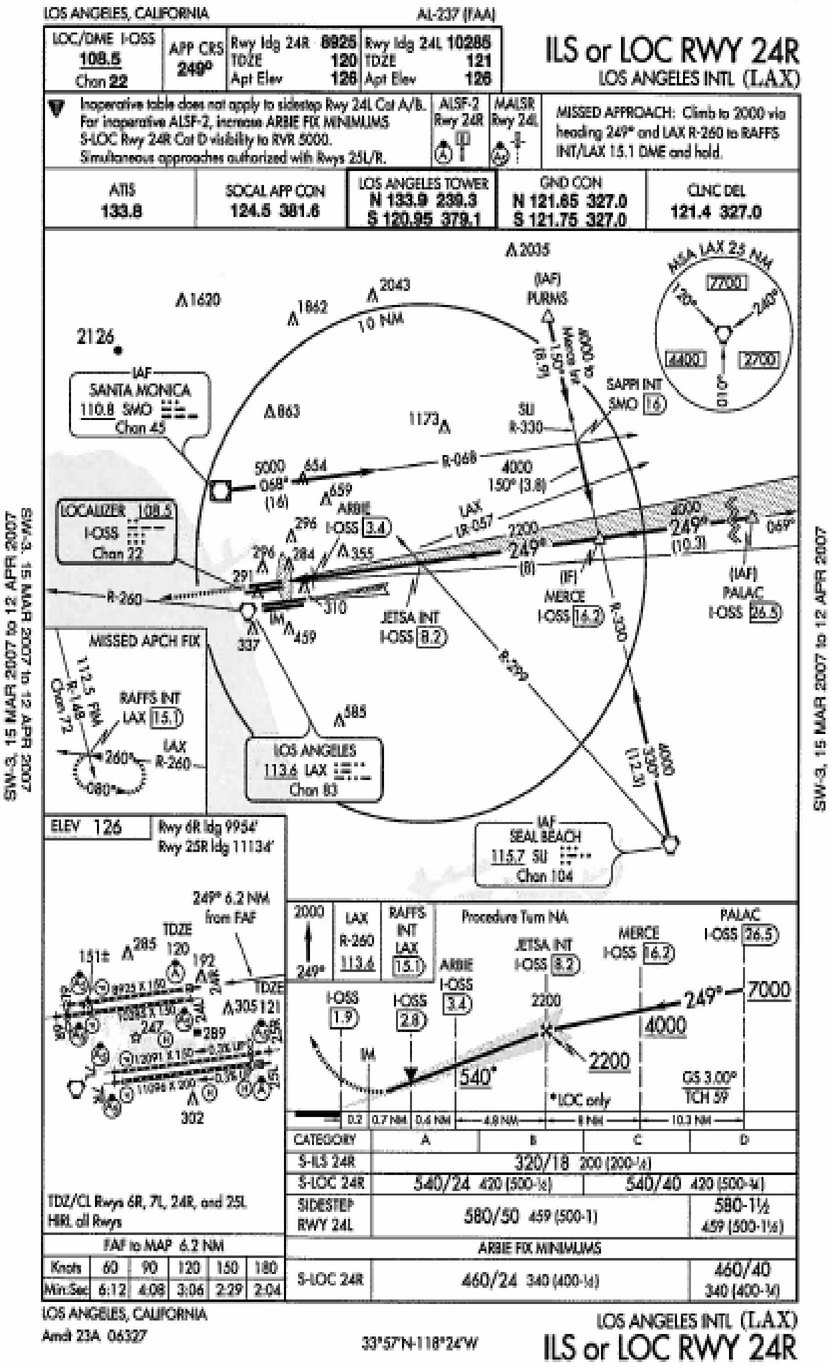


Appendix 6: LAWA Historical Data of System Errors and Incidents (03-2005)



Appendix 7: Jeppesen ILS Approach Charts Runway 24L and 24R





Appendix 8: LAX Class B Airspace

Appendix 9: FAA Advisory Circular AC 150-5200-37 SMS for NAS Airports

U.S. Department of Transportation

Federal Aviation Administration

Advisory Circular

Subject: INTRODUCTION TO SAFETY MANAGEMENT SYSTEMS (SMS) FOR AIRPORT OPERATORS

Date: February 28, 2007
Initiated by: AAS-300

AC No: AC 150/5200-37
Change:

1. PURPOSE. This Advisory Circular (AC) introduces the concept of a safety management system (SMS) for airport operators.

BACKGROUND. The application of a systematic, proactive, and well-defined safety program (as is inherent in a SMS) allows an organization producing a product or service to strike a realistic and efficient balance between safety and production. The forecast growth in air transportation will require new measures and a greater effort from all aviation producers—including airport operators—in order to achieve a continuing improvement in the level of aviation safety. The use of SMS at airports can contribute to this effort by increasing the likelihood that airport operators will detect and correct safety problems before those problems result in an aircraft accident or incident. In November 2005, the International Civil Aviation Organization (ICAO) amended Annex 14, Volume I (Airport Design and Operations) to require member States to have certificated international airports establish an SMS. The FAA supports harmonization of international standards, and has worked to make U.S. aviation safety regulations consistent with ICAO standards and recommended practices. The agency intends to implement the use of SMS at U.S. airports to meet the intent of the ICAO standard in a way that complements existing airport safety regulations in 14 CFR Part 139.

The following actions are being taken in conjunction with the implementation of SMS at commercial airports in the United States:

Rulemaking. The FAA has opened a rulemaking project to consider a formal requirement for SMS at certificated airports. In the United States, about 570 airports are certificated under 14 CFR Part 139, *Certification of Airports*. The agency anticipates issuing a notice of proposed rulemaking (NPRM) for public comment in 2008. A decision on a final rule will not be made until the agency has considered all of the public and industry comments received on the NPRM. We will also take into account the experience of airports that have already implemented an SMS. In any decision to issue a final rule to have airport operators implement SMS, the FAA would:

- Consider the benefits and costs of the rule and tailor the rule to impose the minimum burden and costs necessary for effective implementation
- Consider whether the requirement should apply to all certificated airports or only to airports above a certain activity level