



**NORMAN Y. MINETA SAN JOSE INTERNATIONAL AIRPORT
RUNWAY INCURSION MITIGATION/AIRFIELD DESIGN STANDARDS ANALYSIS**

DRAFT TECHNICAL MEMORANDUM

**SUMMARY OF UPDATED AVIATION
ACTIVITY FORECASTS**

Kimley Horn Associates
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Introduction

The current Airport Master Plan for the Norman Y. Mineta San Jose International Airport (SJC) was last updated in 2010 using aviation demand forecasts for a horizon year of 2027. Given the age of these demand projections, and the need to retain a long-term planning horizon, the preparation of an updated set of demand forecasts is a necessary component of the SJC Runway Incursion Mitigation/Design Standards Analysis Study (RIM). The new updated aviation activity forecasts will be used in the analysis of airfield incursion mitigation and design conformity alternatives, and in turn be incorporated into updates of the SJC Airport Master Plan and Airport Layout Plan along with the recommended RIM study alternative.

This technical memorandum summarizes an extensive and detailed demand forecasting analysis prepared by the study consultant team and documented in a technical report which is available as an appendix. The forecasts are presented in 5-, 10-, 15-, and 20-year time increments, with the year 2037 serving as a new 20-year planning horizon. Each major segment of aviation activity (e.g., air passenger, air cargo, and general aviation) is analyzed separately using the most appropriate assumptions and methodologies as described in the technical report. For reference, Table 3.1 below presents historical activity at SJC for the key activity components.

Table 3.1
Historical SJC Activity, 2000-2016

Year	Total Passengers	Cargo Tonnage	General Aviation Based Aircraft	Aircraft Operations				
				Passenger Airline	All-Cargo Airline	General Aviation	Military	Total
2000	13,097,196	163,096	316	141,880	5,986	139,000	206	287,072
2001	13,091,193	158,671	279	151,132	6,582	97,661	295	255,670
2002	11,115,778	154,522	218	136,466	5,103	65,836	105	207,510
2003	10,677,906	120,317	191	132,050	3,834	62,066	132	198,082
2004	10,733,532	119,914	175	133,056	3,610	61,523	125	198,314
2005	10,756,786	104,661	184	126,982	3,528	63,401	76	193,987
2006	10,708,065	101,045	172	127,030	3,452	57,883	97	188,462
2007	10,658,395	91,430	166	128,152	3,240	55,793	78	187,263
2008	9,717,717	81,222	151	118,366	2,884	51,253	73	172,576
2009	8,321,750	59,471	149	102,774	2,364	40,342	358	145,838
2010	8,249,136	49,363	136	90,542	1,984	30,691	273	123,490
2011	8,357,384	44,041	129	88,686	1,932	30,094	254	120,966
2012	8,296,174	41,817	123	86,314	1,540	31,324	251	119,429
2013	8,783,319	46,820	133	90,000	1,434	31,286	227	122,947
2014	9,385,212	53,286	133	91,604	1,546	30,796	192	124,138
2015	9,799,427	53,837	136	93,256	1,542	33,987	236	129,021
2016	10,796,725	60,360	137	103,280	1,616	33,743	276	138,915

Source: Norman Y. Mineta San Jose International Airport Activity Statistics

It should be noted that upon conclusion of the demand forecasting process, a subsequent analysis of airport capacity and facility requirements will be conducted to determine the extent to which the identified demand at SJC can be adequately accommodated.

Air Passenger Demand

Forecasts of commercial aviation activity begin with analysis of passenger enplanement demand, which includes domestic originations, international originations, and connecting passengers as separate elements of total enplanements. Forecast enplanements are then multiplied by two (to account for an assumed equal number of deplanements) to generate the forecast of total passengers.

Domestic Originating Passengers. The standard approach to forecasting domestic originations is to utilize regression analysis, a statistical method that tests the relationship of a range of socioeconomic variables to historical air passenger activity in order to develop a specific equation or model for forecasting future activity. Through this analysis, a regression model demonstrating the best statistical fit was selected, the key socioeconomic variables being:

- population and per capita income of a “SJC trade area” comprising Santa Clara County and adjacent Alameda, Monterey, San Benito, San Mateo, and Santa Cruz counties, using county population projections prepared by the State of California Department of Finance and county income projections prepared by the national economic forecasting firm of Woods & Poole;
- average air fares for SJC, using airline yield forecasts prepared by the FAA;
- U.S. unemployment rate, taken from an average of several sets of national forecasts.

In addition, given that SJC is one of three major airports serving the San Francisco Bay Area, an adjustment was made in the longer-term forecast horizon to account for some gradual spillover passenger demand from the greater Bay Area due to airfield capacity constraints at San Francisco International (SFO) and Oakland International (OAK) airports, as projected by FAA and as identified in regional studies.

International Originating Passengers. As international travel demand in the SJC trade area has historically been primarily served at SFO, the forecasting method for SJC international originations was based on a broader regression analysis that generated a regional demand for all three Bay Area airports combined, from which a percentage share was assigned to SJC. The model determined to be the best statistical fit for Bay Area international originations included world gross domestic product (GDP), dollar exchange rates, and average Bay Area international air fares as key variables. SFO is assumed to continue its role of a major international gateway airport for the Bay Area; however, SJC’s share of that projected regional international demand is expected to increase slightly, from an estimated 6.7% in 2016 to 8.0% over the forecast horizon, thereby continuing a trend that is evidenced by new international service to both Asian and European markets that has emerged over the past several years.

Connecting and Other Passenger Enplanements. Through most of SJC’s history, a small percentage of passenger activity has been connecting airline passengers, i.e., flying in on one flight and transferring to another flight, rather than originating at SJC. As SJC is expected to remain primarily an origin/destination airport without an airline hubbing operation, the forecasting analysis assumes that connecting passenger activity will remain at an estimated 4.1% of all SJC enplanements based on U.S. Department of Transportation data. In addition to connecting passengers, other enplanements include the relatively insignificant number of “non-revenue” airline passengers (approximately 1.4% of all enplanements).

Table 3.2 below presents the updated projections for air passenger demand at SJC, with actual activity in 2016 provided for reference. Key findings of the analysis are:

- Domestic originating passenger demand will increase from the almost 5.0 million served in 2016 to approximately 9.7 million in 2037, an annual compounded growth rate of 3.4%.
- International originating passenger demand will increase from just over the 0.5 million served in 2016 to more than 0.9 million in 2037, an annual compounded growth rate of 5.3%.
- Total passenger demand will increase from 10.8 million in 2016 to 22.5 million in 2037, an annual compounded growth rate of 3.6%.

**Table 3.2
Projected SJC Air Passengers**

Year	Domestic Originations	International Originations	Other*	Total Enplanements	Total Passengers
2016 Actual	4,955,062	334,713	87,658	5,377,433	10,796,725
2022	5,933,900	545,000	375,400	6,854,300	13,708,600
2027	6,762,700	655,000	429,900	7,847,600	15,695,200
2032	7,781,100	776,100	495,900	9,053,100	18,106,200
2037	9,735,800	913,100	617,100	11,266,000	22,532,000
* Connecting plus non-revenue passengers (approximately 5.5% of total enplanements).					

Source: San Jose RIM Consultant Team Analysis

Passenger Airline Operations Demand

Projecting the number of airline operations (takeoffs and landings) needed to accommodate the forecast passenger demand involves a series of assumptions and calculations that include:

- Load factors, i.e., the share of available aircraft seats that are filled, and dividing the passenger enplanement forecasts by the load factor percentages to derive total seat departures.
- Existing and future non-stop market destinations for SJC flights and allocating seat departures among those destinations.

- Types of aircraft and frequency of service that airlines would use to serve the projected non-stop destination seat departures.

Airline load factors at SJC in 2016 were 76.0% for domestic flights and 77.1% for international flights. Assuming that load factors at SJC would change at the same very slight rates projected on a national level by the FAA, the resulting load factor for SJC would increase to 77.3% in the year 2037 for domestic operations and stabilize at 77.0% for international operations through 2037.

The identification of projected new non-stop markets at SJC utilized an analysis of current thresholds of revenue (passenger originations multiplied by average fare), in combination with national level airline revenue projections based on FAA data, to determine potential new or additional SJC non-stop destinations. Seat departures by market were based on current SJC data for that market or the most similar existing market.

Aircraft types and frequencies were matched to seat departure projections for each market based on historical service patterns, current dominant carriers, aircraft currently in use, aircraft on order, length of flight, and announced plans of current and new entrant airlines. By 2037, the predominant aircraft for domestic service at SJC are projected to be current and new generation versions of the narrow-body Boeing 737-700/800/900, Airbus 319/320/321, and smaller Embraer 175 and the new Bombardier CS-100. Predominant aircraft for international service at SJC are projected to be the wide-body Airbus 330 and A350 and Boeing 787 800/900 for transoceanic destinations and the narrow-body Boeing 737-800/900 and Airbus 320 for North American destinations. The largest aircraft projected for scheduled service at SJC will be the Boeing 777-300.

Table 3.3 below presents the updated projections for passenger airline operations demand at SJC. The forecast analysis shows passenger airline operations increasing from a total of 103,280 scheduled passenger airline operations in 2016 to 183,920 in 2037, an annual compounded growth rate of 2.8%.

Table 3.3
Projected SJC Passenger Airline Operations

Year	Domestic Operations	International Operations	Total Operations
2016 Actual	98,249	5,031	103,280
2022	118,500	7,610	126,110
2027	132,930	9,100	142,030
2032	146,410	9,940	156,350
2037	172,300	11,620	183,920

Source: San Jose RIM Consultant Team Analysis

Air Cargo Demand

Air cargo includes air mail, express packages, and containerized freight carried by passenger airlines (as belly-cargo) and all-cargo airlines (currently Federal Express and UPS at SJC). Forecasting consists of projections of cargo tonnage demand, followed by an allocation of that tonnage demand between the passenger and all-cargo airlines, and the projection of cargo airline aircraft operations needed to accommodate its share of the tonnage demand. Historically at SJC, the all-cargo airlines have handled the majority of cargo tonnage (73% in 2016), although the small but growing volume of international cargo is almost totally handled by the passenger airlines with direct international flights.

Major structural changes have occurred in the air cargo industry over the last couple of decades (such as the replacement of overnight document packages with electronic transmittals and diversion of some traditional types of air cargo shipments to truck delivery) that disfavor use of regression analysis for forecasting cargo tonnage due to the lack of reasonably strong statistical relationships between activity and economic variables. Instead, an airport market share analysis approach was utilized based on applying a SJC share of the national level tonnage forecasts prepared by the FAA, Boeing, and Airbus (and averaged among the three). To account for local economic factors, the current SJC share of total domestic air cargo was adjusted for the future years by the projected ratio of SJC air trade area personal income to U.S. personal income.

The portion of the SJC cargo tonnage demand assumed to be carried by the passenger airlines as belly-cargo utilized the FAA's projected national ratio of revenue ton miles (RTMs) to available seat miles (ASMs) and applying that ratio to the SJC forecast of scheduled airline seat departures. The remainder of the SJC cargo tonnage is assumed to be carried by the all-cargo airlines. This allocation approach is consistent with the methodology used by Boeing and Airbus in their industry-wide projections.

The forecast of all-cargo airline aircraft operations was derived from the tonnage projections, historical load factors (tons/operation), and the anticipated cargo airline fleets. The Boeing 767-300 and Airbus A330-200 are expected to account for the majority of cargo airline operations by the year 2037.

Table 3.4 below presents the updated projections for air cargo demand at SJC. The forecast analysis shows cargo tonnage increasing at an annual compounded growth rate of 2.4%. The share of the tonnage demand handled by the passenger airlines are projected to increase from 27% in 2016 to 42% in 2037 as the number of airline operations, destinations served, and average size of aircraft increase. Aircraft operations by the all-cargo airlines are projected to increase at an annual compounded growth rate of 0.9%, reflecting its share of the tonnage demand and gradual use of higher-capacity aircraft.

Table 3.4
Projected SJC Air Cargo Tonnage and All-Cargo Airline Operations

Year	Passenger Airline Belly Tonnage	All-Cargo Airline Tonnage	Total Tonnage	All-Cargo Airline Operations
2016 Actual	16,534	43,826	60,360	1,616
2022	28,200	47,600	75,800	1,730
2027	32,900	50,500	83,400	1,830
2032	37,500	53,900	91,400	1,890
2037	42,900	57,300	100,200	1,960

Source: San Jose RIM Consultant Team Analysis

General Aviation Demand

General aviation, being all aviation activity that is not airline or military, ranges from small piston-powered aircraft operated for personal or recreational use to large jet aircraft used for the transport of corporate employees and executives, and also includes aircraft operations used for pilot training, law enforcement, emergency medical, and sports team transport purposes. General aviation activity forecasts are comprised of the number and type of aircraft expected to be based at SJC, and the number of general aviation aircraft operations, including “local” operations (aircraft operating in the traffic pattern or within sight of the air traffic control tower) and “itinerant” operations (aircraft arriving from, or departing to another airport).

General aviation activity has declined over time, both nation-wide and at SJC, for a myriad of economic, demographic, and regulatory factors, although this overall trend is primarily associated with personal/recreational aviation, whereas business/corporate activity has gradually increased over time. As with air cargo, regression analysis is not a viable methodology for forecasting general aviation activity due to the changes that have occurred over the previous few decades, plus the difficulty in accounting for SJC-specific factors such as landside facility limitations that may have constrained demand in the past. Therefore, an airport share analysis approach was again utilized based on FAA national level projections, with an adjustment to account for local economic factors as represented by the projected ratio of SJC air trade area personal income to U.S. personal income.

For based aircraft, a series of separate projections were generated for each of the five major types of general aviation aircraft: single-engine piston, multi-engine piston, turboprop, jet, and rotorcraft (helicopter). On a national level, the FAA forecasts show the total general aviation fleet growing at a relatively slight 0.2% annual rate over the next twenty years, with projected increases in turboprop, jet, and rotorcraft offsetting projected decreases in single and multi-engine piston aircraft. SJC has historically seen a much higher percentage of the based aircraft fleet comprised of jet aircraft than at most U.S. airports.

Table 3.5 below presents the based aircraft demand at SJC by type. Based aircraft are assumed to grow by an overall compounded annual growth rate of 0.9%. Consistent with the projected national trend, jet aircraft are expected to account for an increasingly larger percentage of SJC based aircraft.

**Table 3.5
 Projected SJC General Aviation Based Aircraft**

Year	Single Engine Piston	Multi Engine Piston	Turbo-prop	Jet	Rotor-craft	Total Based Aircraft
2016 Actual	62	9	8	53	5	137
2022	59	9	8	59	6	141
2027	56	8	8	66	6	144
2032	53	8	9	75	7	152
2037	51	8	11	86	8	164

Source: San Jose RIM Consultant Team Analysis

Forecasts of general aviation operations are typically derived through assumed ratios of operations per based aircraft. Available SJC data on operations for each type of general aviation aircraft was projected according to FAA national level forecasts of hours flown for each aircraft type.

Table 3.6 below presents the operations projections for general aviation demand at SJC. Total operations are projected to increase at an annual compounded growth rate of 2.0%. Consistent with national projections of higher rates of aircraft utilization in the future, operations per based aircraft at SJC would increase from 246 in 2016 to 315 in 2037. With almost all the growth being by higher-performance corporate aircraft, the share of local operations (i.e., flights that remain in the local airspace and primarily associated with training) will gradually decrease while itinerant operations increase.

**Table 3.6
 Projected SJC General Aviation Operations**

Year	Based Aircraft	Local Operations	Itinerant Operations	Total Operations
2016 Actual	137	4,363	29,380	33,743
2022	141	4,260	33,740	38,000
2027	144	4,070	37,350	41,420
2032	152	4,010	41,950	45,960
2037	164	4,020	47,560	51,580

Source: San Jose RIM Consultant Team Analysis

Military Aviation Demand

Military aviation activity at SJC has historically been insignificant and no military aircraft are stationed at SJC. The standard practice in forecasting military activity in such cases is to simply assume a constant annual number of operations. As military operations at SJC since 2010 have averaged approximately 250 a year (ranging from 192 in 2014 to 276 in 2016), this average was assumed for the forecast horizon years. The majority of military aircraft operations are by a mix of aircraft types similar to general aviation, with occasional larger troop movements conducted in airline narrow-body aircraft such as the Boeing 737-700.

Total Aviation Demand

Table 3.7 below presents a summary of the key demand projections. Total aircraft operations are projected to increase at a compounded annual growth rate of 2.6% over the next twenty years. Passenger airline activity will account for approximately 77% of all SJC operations by 2037 (compared to 74% in 2016).

Table 3.7
 Summary of Projected SJC Annual Activity Demand

Year	Total Passengers	Cargo Tonnage	General Aviation Based Aircraft	Aircraft Operations				
				Passenger Airline	Cargo Airline	General Aviation	Military	Total
2016 (Actual)	10,796,725	60,360	137	103,280	1,616	33,743	276	138,915
2022	13,708,600	75,800	141	126,110	1,730	38,000	250	166,090
2027	15,695,200	83,400	144	142,030	1,830	41,420	250	185,530
2032	18,106,200	91,400	152	156,350	1,890	45,960	250	204,450
2037	22,532,000	100,200	164	183,920	1,960	51,580	250	237,710

Source: San Jose RIM Consultant Team Analysis

Design Level Demand

For facility planning purposes, forecasts of annual aviation activity are used to derive peak period demand levels, two typical measures being “design day” and “design hour”. Design day is defined as the average day of the peak activity month, and design hour as the busiest 60-minute period of the design day.

At SJC, as at most air carrier airports, passenger airline activity usually peaks in July or August, with weekday volumes being approximately 6% higher than on a weekend. Cargo activity usually peaks in December, and general aviation activity can peak either in late spring, summer, or early fall. Thus, the design day for all operations combined tends to reflect passenger airline activity which accounts for the majority of all operations at SJC.

Design hour activity is based on recent and current operating characteristics which are assumed to remain relatively consistent over the forecast period. For air passenger activity at SJC, the design hour generally occurs during midday (roughly 12:30-1:30 p.m.), but with a departure peak also occurring in the early morning (6:30-7:30 a.m.) and an arrival peak also occurring in the late evening (10:00-11:00 p.m.).

Table 3.8 below presents the projected design day and design hour demand at SJC in the horizon year of 2037. Peak period air passenger volumes would roughly double by 2037, while passenger airlines operations would increase by approximately 80%. Peak activity for all types of aircraft operations combined would increase by about 75% in the design day and by two-thirds in the design hour.

**Table 3.8
Projected SJC Design Level Demand**

	Design Day		Design Hour	
	2016	2037	2016	2037
Air Passengers	34,200	71,400	2,900	5,700
Passenger Airline Operations	324	588	26	47
Cargo Airline Operations	8	11	4	6
General Aviation Operations	155	257	20	32
Military Operations	1	1	0	0
Total Operations*	487	856	43	72
* Note: Design Day and Design Hour operations for each type of aviation activity do not coincide, so total is not additive.				

Source: San Jose RIM Consultant Team Analysis

Operational Fleet Mix for 2037

Table 3.9 below provides a detailed fleet mix breakdown of projected aircraft operations for the year 2037. Key findings relevant to forthcoming tasks in the SJC Runway Incursion Mitigation/Design Standards Analysis Study are as follows:

- The narrow-body Boeing 737 series of aircraft (Aircraft Design Group III), will continue to dominate the commercial operational fleet at SJC and account for just over half of all commercial airline operations in 2037.
- Group V aircraft operations will increase (to a projected 6,100 annually by 2037) and, although remaining a relatively small share of all operations (2.5% in 2037), will continue to be the critical aircraft for the air carrier runways and associated taxiways and ramps on the east side of the Airport according to FAA airfield design criteria.

- Corporate/business jets will account for just over 75% of all general aviation operations by 2037 and approximately 17% of total SJC operations.
- The number of annual Aircraft Design Group III general aviation operations are projected to increase (to approximately 7,500 by 2037), and thus will be the critical aircraft for the west side of the Airport based on FAA airfield design criteria.

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UPDATED AVIATION ACTIVITY FORECAST SUMMARY

Table 3.9
Projected SJC Aircraft Fleet Mix for 2037

Aircraft Type	Operations		
	Annual	Average Daily	% of Total
Commercial Airline:			
Airbus 319, 319 Neo	3,990	11.0	1.7%
Airbus 320-100/200, 320 Neo	4,650	12.5	1.9%
Airbus 321, 321 Neo	11,290	31.0	4.8%
Airbus 330-200 (passenger)	1,060	3.0	0.5%
Airbus 330-200 (cargo)	480	1.5	<0.5%
Airbus 350-900	1,550	4.0	0.5%
Boeing 737-700/700LR, 737-7 Max	36,880	101.0	15.5%
Boeing 737-800, 737-8 Max	64,980	178.0	27.0%
Boeing 737-900/900ER, 737-9 Max	23,900	65.5	10.0%
Boeing 767-300/300ER (cargo)	1,440	4.0	0.5%
Boeing 777-200/200ER/300ER	770	2.0	0.5%
Boeing 787-800/900	2,190	6.0	1.0%
Bombardier CS100	14,210	39.0	6.0%
Embraer 175/190	17,750	48.5	7.5%
Other	740	2.0	0.5%
General Aviation:			
Beechcraft Bonanza 33/35/36	1,150	3.0	0.5%
Beechcraft 55/58 Baron	600	1.5	<0.5%
Beechcraft King Air 90/200/300/350	1,260	3.5	0.5%
Beechcraft Beechjet 400	350	1.0	<0.5%
Bombardier Challenger 300/350	4,000	11.0	2.0%
Bombardier Global 500/Global Express	2,620	7.0	1.0%
Canadair Bombardier CL600/610	800	2.0	0.5%
Cessna 172/182/206/210	2,070	5.5	1.0%
Cessna Citation 510/550/560/560XL	5,160	14.0	2.0%
Cessna Citation 680/750	5,600	15.5	2.5%
Cessna Citation CJ1/2/3	800	2.0	0.5%
Cirrus SR22	1,400	4.0	0.5%
Dassault Falcon 7X/50/900/2000	4,190	11.5	2.0%
Embraer EMB/ERJ-145, Phenom 100/300	5,900	16.0	2.5%
Gulfstream IV/V/VI	5,560	15.0	2.5%
Gulfstream G150/200/280	1,030	3.0	0.5%
Learjet 35/45/60	1,100	3.0	0.5%
Pilatus PC12	1,340	3.5	0.5%
Piper Cherokee/Malibu/Saratoga	520	1.5	<0.5%
Raytheon Hawker 800	580	1.5	<0.5%
Other - Single-Engine/Multi-Engine Piston	2,430	6.5	1.0%
Other - Turboprop	670	2.0	<0.5%
Other - Jet	1,930	5.5	1.0%
Other - Helicopter	520	1.5	<0.5%
Military	250	0.5	<0.5%
Total	237,710	651.5	