Description of Simulation Analysis Used to Determine the Proportion of Checkpoint Operating Costs Incurred to Screen Only Ticketed Passengers

BACKGROUND

The 2005 GAO Study estimated that airlines incurred costs of approximately $334 million in CY 2000 for screening related functions performed by third party screening companies at U.S. airports.[1] Employees of private screening companies staffed a variety of screening-related positions including checkpoint screeners, checkpoint supervisors, exit lane monitors, checked baggage screeners, and others. Several of these functions—checked baggage screeners, exit lane monitors, and checkpoint supervisors—and their associated costs were isolated from the overall $334 million cost estimate and analyzed separately, either because the function applied solely to property screening or because the function largely represented a fixed cost that did not vary, or varied to only a small degree, in response to fluctuations in traffic volume.

Separating these cost elements from the $334 million GAO estimate leaves approximately $258 million in costs associated with normal checkpoint screening operations. Based on results of the airport interviews, it is estimated that checkpoint screeners assigned to property screening functions represented 54% of the cost for normal checkpoint operations in CY 2000, and that screening of persons through the magnetometer (and follow-up hand wanding) accounted for 46% of checkpoint staffing and cost, or approximately $119 million.

We conducted a simulation analysis covering all 70 sample U.S. airports to estimate the portion of this $119 million that was attributable non-passengers who passed through security checkpoints in CY 2000.

[1] In some instances, airlines performed screening functions using their own employees, mostly at small airports. These costs are included in the $334 GAO estimate referenced above.

I. METHODOLOGY

We developed a checkpoint operations simulation model that estimated the number of checkpoint lanes required to screen passengers and non-passengers, on an hour-by-hour basis at the individual security checkpoints at all 70 of the sampled cross-section of U.S. airports. Using published airline schedules from the Official Airline Guide for a representative weekday in May, 2000[2], the model distributes daily screenings of passengers, meeter/greeters/well-wishers (MGWW), and employees over hourly periods and determines the number of lanes needed at each checkpoint to accommodate all screenings and only screened passengers in each hour. The difference between the two lane-hour totals represents the number of incremental lane hours needed for screening non-passengers. When summed by airport, weighted by the estimated number of screeners employed at each airport, and scaled to a national total, these figures represent the percentages of screener hours and costs attributable to passengers and non-passengers on a nationwide basis.

Exhibit 1: Inputs and Outputs for the Checkpoint Operations Simulation Model

Inputs	Outputs
■ Annual screened passengers, MGWW and employees ■ Scheduled departing and arriving seats ■ Screening time distribution relative to flight departure/arrival ■ Number of lanes at each sample airport checkpoint	■ Lanes needed for passenger screenings in each hour ■ Lanes needed for total screenings in each hour

Passenger Screenings

The number of screened passengers at each airport was based on the figures used in the 2005 GAO study, but adjusted to account for international arriving passengers who pre-cleared U.S. customs and immigration at their origin airport (Bahamas, Aruba, Bermuda and most Canadian cities). These pre-cleared passengers did not need to be re-screened before boarding a domestic connecting flight. Annual passenger screening totals at each sample airport were converted into average daily volumes.

[2] Schedules from the Official Airline Guide, Wednesday in May 2000. This day was chosen as the most representative day for analysis because May was the closest to average of any month that year in terms of seat departures (1% higher than the annual average) and traffic (2.8% higher than the annual average), and Wednesday was closest to the weekly average in terms of seat departures (2.6% higher than the average day of the week.)

Meeter/Greeter/Well-Wisher Screenings

The annual volume of screenings of meeter/greeters and well-wishers ("MGWW") was estimated based on the number of screened passengers and the estimated ratio of MGWW screenings to passenger screenings at each airport that was developed from the airport interviews and through airport passenger surveys that were conducted in the CY 2000 timeframe. Annual MGWW screening totals were also converted into average daily volumes.

Screenings of meeter/greeters and well-wishers were disaggregated into meeter/greeters (who met arriving passengers) and well-wishers (who accompanied departing passengers) under the following assumptions:

1. The ratio of domestic well-wishers to domestic meeter/greeters was 1:1
2. The ratios of international well-wishers to international passengers was the same as the ratio of domestic well-wishers to domestic passengers
3. The ratio of international to domestic well-wishers was the same as the ratio of international to domestic seats
4. There were no screened international meeter/greeters because international arriving passengers could not be met by meeter/greeters until they cleared customs/immigration and exited into the non-secure area of the terminal

For the two airports with the most highly detailed survey data, Atlanta and Minneapolis, the survey results were used to develop ratios of domestic and international meeter/greeters and well-wishers that were screened at security checkpoints.

Employee Screenings

Screenings of employees, including airline personnel, employees of the airport authority, and concession/vendor employees, were estimated at approximately 2.2% of total screenings based on analysis described in Part II, Section 2 of the main report.

Distribution of Screenings Across Day

For each airport, daily passengers and non-passengers were distributed across the day in 15-minute intervals based on published airline schedules and estimated screening time distributions relative to flight departure and arrival times.

To develop the time-of-day during which departing passengers, well-wishers, meeter/greeters and employees passed through screening checkpoints, we first calculated the percentage of total daily seats that departed or arrived in each 15-minute period in the sample day. Two separate seat

distributions were developed—one for total domestic and international departing seats and the other for domestic arriving seats.

These seat distributions were converted into screening distributions by applying the following curves to the seat distributions:

Exhibit 2: Time of Screening Relative to Flight Departure/Arrival

Minutes Before Flight Departure	Departing Pax & Wellwishers		Minutes Before Flight Arrival	Meeters/Greeters
	Domestic	International		Domestic
0-15	10%	2%	0-15	25%
15-30	20%	8%	15-30	45%
30-45	20%	20%	30-45	20%
45-60	15%	20%	45-60	10%
60-75	15%	15%	60-75	0%
75-90	10%	15%	75-90	0%
90-105	10%	10%	90-105	0%
105+	0%	10%	105+	0%

The distinct domestic and international time-before-flight distributions for departing passengers/well-wishers were weighted by the ratio of domestic to international seats at each airport to produce a single screening time distribution for both.[3]

After the screening distributions were applied to departing passengers and screened MGWW, these screenings were summed in each 15-minute period to create a single, combined distribution. This distribution was then applied to employee screenings, which were added to MGWW screenings to calculate total non-passenger screenings in each period.

Finally, the two separate distributions for passenger screenings and total (passenger plus non-passenger) screenings were converted from 15-minute intervals into one-hour periods to better correspond to screener scheduling patterns.

[3] At airports where checkpoints closed after the last departures, the domestic arriving seat distribution was adjusted so that meeter/greeter screenings were distributed only over the period in which the checkpoints were open.

Lane Calculations

Based on the hourly screening distributions, the peak-hour volume of total screenings was established at each sample airport. It was assumed that all checkpoint lanes were fully utilized during this peak hour. For each hourly period, the volume of total screenings and passenger screenings only were calculated as a percent of the daily peak volume. By multiplying these percentages in each hourly period to the total number of lanes at each checkpoint, the number of lanes needed for passengers and total screenings was calculated for each hour.[4] Because partial lanes could not be operated, fractional lanes were rounded up to the next whole lane. The rounding of partial lanes applied to both the number of lanes required to process total screenings (including non-passengers) and the lanes required to process ticketed passengers only.

In the example below (Exhibit 3), at Los Angeles International Airport the peak hour for total screenings on the sample day was 11:00am, when an estimated 7,259 people were screened airport-wide. Hourly passenger screenings and total screenings are expressed as percentages of this peak-hour total volume (when all lanes were needed) and these percentages are applied to the four lanes of the example checkpoint. The resulting lanes needed for passengers and total screenings during each hour are rounded up to the next whole lane, and the total lane hours for the checkpoint are summed across the 24-hour period.

In the second example below (Exhibit 4), at Minneapolis-St. Paul International Airport, the peak hour for total screenings on the sample day was 4:00pm, when an estimated 2,515 people were screened airport-wide. At this two-lane checkpoint, the number of lanes needed to screen passengers is the same as the number of lanes needed for total screenings during much of the day, and the percentage of lane hours assigned to passengers is much higher than the percentage of total screenings that passengers represent.

[4] During the peak hour, all lanes at individual airport checkpoints were assumed to be fully utilized. To test the impact of this assumption, we conducted sensitivity analysis with the peak hour utilization of the last lane (at multi-lane checkpoints) set at different levels—from 0% to 100%. This sensitivity analysis is described later in this memorandum.

Exhibit 3: Example of 4-Lane Checkpoint at LAX

	(Airport Total) Screenings		(Airport Total) Pct. of Total Peak		(Checkpoint) Unrounded Lanes		(Checkpoint) Whole Lanes	
Hour	Total	Psgr.	Total	Psgr.	Total	Psgr.	Total	Psgr.
0:00	1,817	1,385	25%	19%	1.00	0.76	2	1
1:00	382	303	5%	4%	0.21	0.17	1	1
2:00	0	0	0%	0%	0.00	0.00	0	0
3:00	23	18	0%	0%	0.01	0.01	1	1
4:00	797	515	11%	7%	0.44	0.28	1	1
5:00	3,475	2,715	48%	37%	1.91	1.50	2	2
6:00	6,126	4,725	84%	65%	3.38	2.60	4	3
7:00	6,753	5,154	93%	71%	3.72	2.84	4	3
8:00	5,233	3,843	72%	53%	2.88	2.12	3	3
9:00	5,721	4,077	79%	56%	3.15	2.25	4	3
10:00	6,180	4,349	85%	60%	3.41	2.40	4	3
11:00	**7,259**	5,304	**100%**	73%	**4.00**	2.92	4	3
12:00	7,080	5,297	98%	73%	3.90	2.92	4	3
13:00	6,161	4,464	85%	61%	3.40	2.46	4	3
14:00	6,197	4,655	85%	64%	3.42	2.57	4	3
15:00	5,790	4,177	80%	58%	3.19	2.30	4	3
16:00	5,457	3,956	75%	54%	3.01	2.18	4	3
17:00	4,983	3,456	69%	48%	2.75	1.90	3	2
18:00	4,162	2,857	57%	39%	2.29	1.57	3	2
19:00	3,900	2,462	54%	34%	2.15	1.36	3	2
20:00	4,907	3,217	68%	44%	2.70	1.77	3	2
21:00	5,671	4,032	78%	56%	3.13	2.22	4	3
22:00	3,295	2,301	45%	32%	1.82	1.27	2	2
23:00	1,860	1,357	26%	19%	1.03	0.75	2	1
Total	103,229	74,618			57	41	70	53
	100%	72%			100%	72%	100%	76%

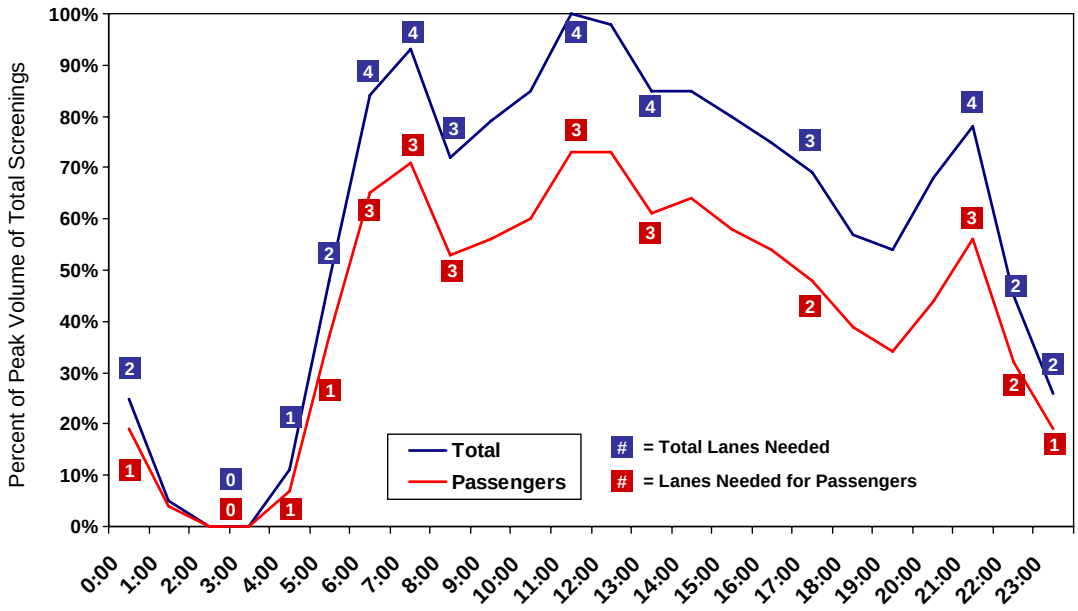
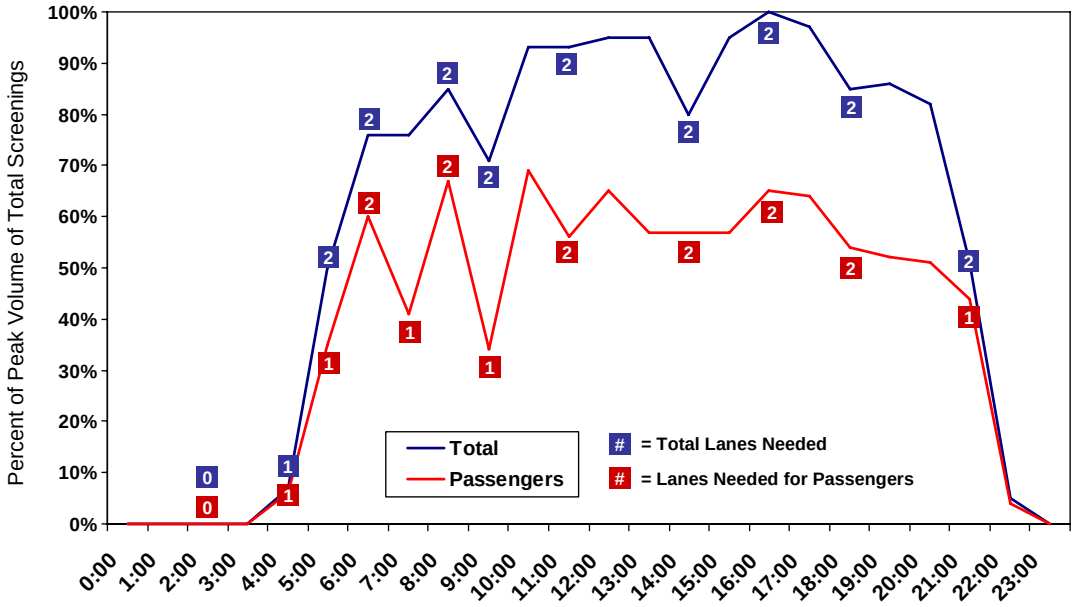


Exhibit 4: Example of 2-Lane Checkpoint at MSP

	(Airport Total) Screenings		(Airport Total) Pct. of Total Peak		(Checkpoint) Unrounded Lanes		(Checkpoint) Whole Lanes	
Hour	Total	Psgr.	Total	Psgr.	Total	Psgr.	Total	Psgr.
0:00	0	0	0%	0%	0.00	0.00	0	0
1:00	0	0	0%	0%	0.00	0.00	0	0
2:00	0	0	0%	0%	0.00	0.00	0	0
3:00	2	2	0%	0%	0.00	0.00	1	1
4:00	168	145	7%	6%	0.13	0.12	1	1
5:00	1,269	885	50%	35%	1.01	0.70	2	1
6:00	1,905	1,506	76%	60%	1.52	1.20	2	2
7:00	1,911	1,029	76%	41%	1.52	0.82	2	1
8:00	2,126	1,694	85%	67%	1.69	1.35	2	2
9:00	1,785	848	71%	34%	1.42	0.67	2	1
10:00	2,334	1,723	93%	69%	1.86	1.37	2	2
11:00	2,332	1,402	93%	56%	1.85	1.12	2	2
12:00	2,397	1,638	95%	65%	1.91	1.30	2	2
13:00	2,387	1,446	95%	57%	1.90	1.15	2	2
14:00	2,015	1,429	80%	57%	1.60	1.14	2	2
15:00	2,393	1,445	95%	57%	1.90	1.15	2	2
16:00	**2,515**	1,631	**100%**	65%	**2.00**	1.30	2	2
17:00	2,432	1,599	97%	64%	1.93	1.27	2	2
18:00	2,140	1,361	85%	54%	1.70	1.08	2	2
19:00	2,170	1,305	86%	52%	1.73	1.04	2	2
20:00	2,050	1,282	82%	51%	1.63	1.02	2	2
21:00	1,278	1,103	51%	44%	1.02	0.88	2	1
22:00	119	103	5%	4%	0.09	0.08	1	1
23:00	0	0	0%	0%	0.00	0.00	0	0
Total	35,728	23,575			28	19	37	33
	100%	66%			100%	66%	100%	89%



II. RESULTS

The simulation output in terms of lane hours (both total screenings and passenger screenings only) at each checkpoint was summed for each sample airport, and the percentages of lane hours attributable to passengers and non-passengers were weighted by the number of screeners at each airport to estimate the percentage of screening costs attributable to passengers and non-passengers in each stratum of airports.[5] The weighted percentages for each stratum were then combined for a national total by weighting each stratum's ratio by the percentage of screeners that it represented.

Exhibit 5: Screening Costs Assigned to Passengers/Non-Passengers

	Screening Costs		
Stratum	Psgr.	Non-Psgr.	Screeners
Stratum1	81.6%	18.4%	8,940
Stratum2	83.4%	16.6%	4,100
Stratum3	75.8%	24.2%	2,254
Stratum4	76.4%	23.6%	1,582
Stratum5	100.0%	0.0%	2,525
Weighted Total	**83.3%**	**16.7%**	

We also performed an alternative expansion based strictly on lane hours at each sample airport (i.e. no weighting by screener numbers.) This approach produced comparable results, but assigned a slightly higher share of checkpoint operating costs to the screening of passengers only, with a lower percentage of costs attributable to non-passengers.

Based on this simulation model, the percentage of total lane hours, screener hours, and costs attributable to passengers is significantly higher than the 60.9% of total screenings that passengers represented. This is due to the fact that checkpoint screening lanes could not be opened and closed to perfectly match demand. If airlines and their screening contractors could have precisely matched checkpoint screening capacity with fluctuations in passenger/non-passenger demand over the day, week and season, the costs of screening non-passengers would have been directly proportionate to their percentage share in the mix of persons screened. However, the throughput capacity of checkpoints could only be varied by opening (or closing) lanes, and the increments by which capacity could be added (or subtracted) were most often quite substantial. For example, in a two-lane checkpoint, the opening of the second lane would have increased checkpoint capacity by 100 percent, while closing the second lane would have reduced capacity by 50 percent. Similarly, for a three-lane checkpoint, opening the third lane would have

[5] Screener counts by airport are based on data developed by the FAA prior to 9/11/2001 when certification of screening companies was under consideration.

increased capacity by 50 percent, while closure of the third-lane would reduce capacity by 33 percent.

Because the great majority of U.S. airport checkpoints had four or fewer available lanes, this meant that the capacity of the checkpoint could not be precisely match the hour-by-hour flow of passengers and non-passengers through security. At single-lane checkpoints, no costs could have been saved by excluding non-passengers since the single lane had to open at all times to screen ticketed passengers. At multi-lane checkpoints, particularly those with 2-4 lanes, during many hours of the day the same number of lanes would have been needed to screen only ticketed passengers as was required to screen the total flow of passengers and non-passengers. As a result, the capacity and cost of operating the checkpoint could not have been reduced by a proportionate share if non-passengers had been eliminated from the flow of persons passing through the checkpoint.

Sensitivity Analyses

Various assumptions were applied in the simulation analysis used to estimate the CY 2000 checkpoint screening costs that were attributable to non-passengers. Several of the major assumptions were tested through sensitivity analysis to determine the impact of varying the baseline assumptions on the simulation analysis results. Three specific sensitivity analyses were performed to identify the impact of varying these assumptions:

- The baseline analysis assumed that all lanes at individual airport checkpoints were fully utilized at the peak time of the representative day. Alternative assumptions regarding the peak hour utilization of the last lane were identified and tested to determine the cost implications of the baseline assumption.
- The baseline analysis assumed that fractional lane requirements implied by the ratio of hourly demand to peak demand were rounded up to the next whole number of lanes, since partial lanes could not be operated. Alternative assumptions were tested that rounded up fractional lanes at different threshold values, and otherwise rounded the calculated lane requirement down.
- The baseline analysis expanded the simulation results from the 70 sample airports to a nationwide total using calculated lane hour requirements weighted by the estimated numbers of screening employees by airport. An alternative expansion approach that used only the calculated lane hour requirements at each sample airport was applied to determine the impact of the baseline approach.

The results of these sensitivity analyses are presented below.

To test the impact of the baseline assumption regarding the peak hour utilization of screening capacity at the last lane of multi-lane checkpoints, we ran a sensitivity analysis using different utilization levels. While the percentage of screener hours and costs attributable to passengers was much higher when the last lane was unused (0% utilization), the percentages calculated under intermediate utilization levels were very close to the percentage resulting from our base assumption of 100% utilization.

Exhibit 6: Sensitivity of Screener Hour Allocation to Last-Lane Utilization

Utilization of Last Lane at Multi-Lane Checkpoints	Screening Costs Assigned to Passengers
0%	89.9%
25%	84.2%
50%	82.4%
75%	82.7%
100%	**83.3%**

To test the impact of the baseline approach to the rounding from partial to whole lanes, we ran a sensitivity analysis in which we rounded at different lane increments from 0.1 to 0.5 lanes. Rounding up/down at these points, instead of simply rounding up to the next whole lane, would slightly reduce the percentage of screening costs assigned to passengers. If an additional checkpoint lane were only opened once the screening demand exceeded capacity by an amount equivalent to 50% of lane capacity, the percentage of screening costs assigned to passengers would be 1.8 percentage points lower than the percentage assigned in the baseline analysis.

Exhibit 7: Sensitivity of Screening Cost Allocation to Fractional Lane Rounding Point

Rounding Point for Lane Rounding	Screening Costs Assigned to Passengers
>0	**83.3%**
0.1	82.7%
0.2	81.7%
0.3	81.0%
0.4	81.1%
0.5	81.5%

We also tested the impact of expanding the results from our 70 sample airports to a nationwide total using only the estimated lane hours required to screen all persons (including non-passengers) and passengers only. Using this alternative approach, the percentage of costs assigned to screen only ticketed passengers would increase by approximately 0.9 percentage points, from 83.3% under the baseline analysis up to 84.2% using the alternative expansion approach.

These sensitivity analyses demonstrate the impact of applying alternative assumptions on the simulation analysis results. The first sensitivity analysis regarding the peak hour utilization of the last lane of multi-lane checkpoints indicates that alternative assumptions (excluding zero utilization) would change the baseline results either up or down, and by less than one percentage point, depending on the specific assumption utilized. The zero utilization assumption would assign a significantly higher share of checkpoint screening costs to passengers with a major reduction in the cost assigned to non-passengers.

The second sensitivity analysis regarding the rounding point for fractional lanes demonstrates that alternative assumptions would assign an 81.0% to 82.7% share of total costs to the screening of passengers only, compared to the baseline result of 83.3%. The associated share of costs attributable to non-passengers would increase by 0.6 to 2.3 percentage points depending on the specific rounding assumption.

The final sensitivity analysis concerning the method used to expand the results from the 70 sample airports to a nationwide total indicates that the alternative expansion approach would increase the passenger share of normal checkpoint operating costs (and reduce the portion of costs attributable to non-passengers) by 0.9 percentage points.

Considering the results of all three sensitivity analyses, we believe that the baseline assumptions provide a reasonable basis for estimating the shares of normal CY 2000 checkpoint operating costs attributable to passengers and non-passengers.