Enhancing Air Cargo Security

- Congress tasked[1] DHS/S&T to conduct a pilot program in collaboration with TSA to test new Concepts of Operation for screening a significant percentage of air cargo above current levels
  - Current screening regime is random physical inspection and manifest matching by air carriers
  - Three airports to test different approaches to screening air cargo for explosives and stowaways
  - Assess effectiveness of employing *baggage-proven technology and TSA-approved screening protocols* in the air cargo environment
- Pilot data will provide baseline to inform national civil aviation security architecture and identify needed R&D to fill gaps

[1] Department of Homeland Security Appropriations Act, 2006

Three Operational Pilots and 3 Supporting Activities

- Pilot 1 – Dedicated cargo screeners and equipment
  - San Francisco International Airport (SFO)
- Pilot 2 – Shared screeners with passenger operations
  - Cincinnati/Northern Kentucky International Airport (CVG)
- Pilot 3 – Stowaways and explosives in freighter aircraft
  - Seattle-Tacoma International Airport (SEA)

- Technology Commodity Matrix
  - Targeting best technology for a given commodity
- Data Acquisition, Management and Assurance
  - Capturing and validating operational and technical data from field operations
- Enterprise Modeling and Analysis
  - Transforming the field data into knowledge, bounded understanding, and validated predictive capability
  - Assess, cost, risk, operational, and economic impacts
  - Develop security technology package that meshes with business requirements

LLNL (SFO), ORNL (CVG), PNNL (SEA)

ACEDPP addressed 3 key questions

- Is it feasible to screen significantly more air cargo (i.e., at least six times more than pre-ACEDPP levels)? What resources and CONOPS are required to do so?
- What are the costs associated with increased screening levels, and how are these costs distributed over system and operational elements?
- To what degree does increased screening enhance security? How effective are technologies and protocols developed for screening passenger-checked baggage at detecting explosives in air cargo?

Technologies employed by ACEDPP were EDS, ETD and Canine

Air Cargo Explosives Detection Pilot Program (ACEDPP) – Observations and Lessons Learned

ADSA10 - Explosives Detection in Air Cargo

May 6, 2014
Boston, MA

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ACEDPP addressed 3 key questions

- Can we screen more cargo than we do presently?
  - *Yes. However, breaking down and re-building ULD shipments for piece-level screening is very labor intensive. ULDs could be screened by air carriers using canines or another bulk screening method.*
- What would it cost?
  - *The cost of technology-based screening is on the order of $0.08-0.12 per pound, which is dominated by cargo handling and screening labor. Canine screening is much less expensive per pound – less than $0.01 per pound for the ACEDPP pilot at SEA-TAC airport.*
- How effective are present systems against threats?
  - *Limited operational efficacy assessments were conducted at SFO using explosives simulants, with positive results. Some efficacy data for ETD and canine screening have been reported elsewhere. There is still a need for system-level efficacy testing and analysis.*

Technologies employed by ACEDPP were EDS, ETD and Canine

Recommendations and Lessons Learned

- Most urgent need is for an effective method for screening bulk cargo tendered on pallets and in ULDs.
- Further efforts needed to identify specific causes of false and nuisance alarms.
- Additional efficacy testing for cargo screening systems is needed.
- Further testing also recommended for canine explosives detection teams in live cargo environments.
- Technologies other than those used in ACEDPP should be evaluated in live cargo environment.

Additional work remains to meet 100% screening mandate

7 Critical Scientific Questions defined data requirements

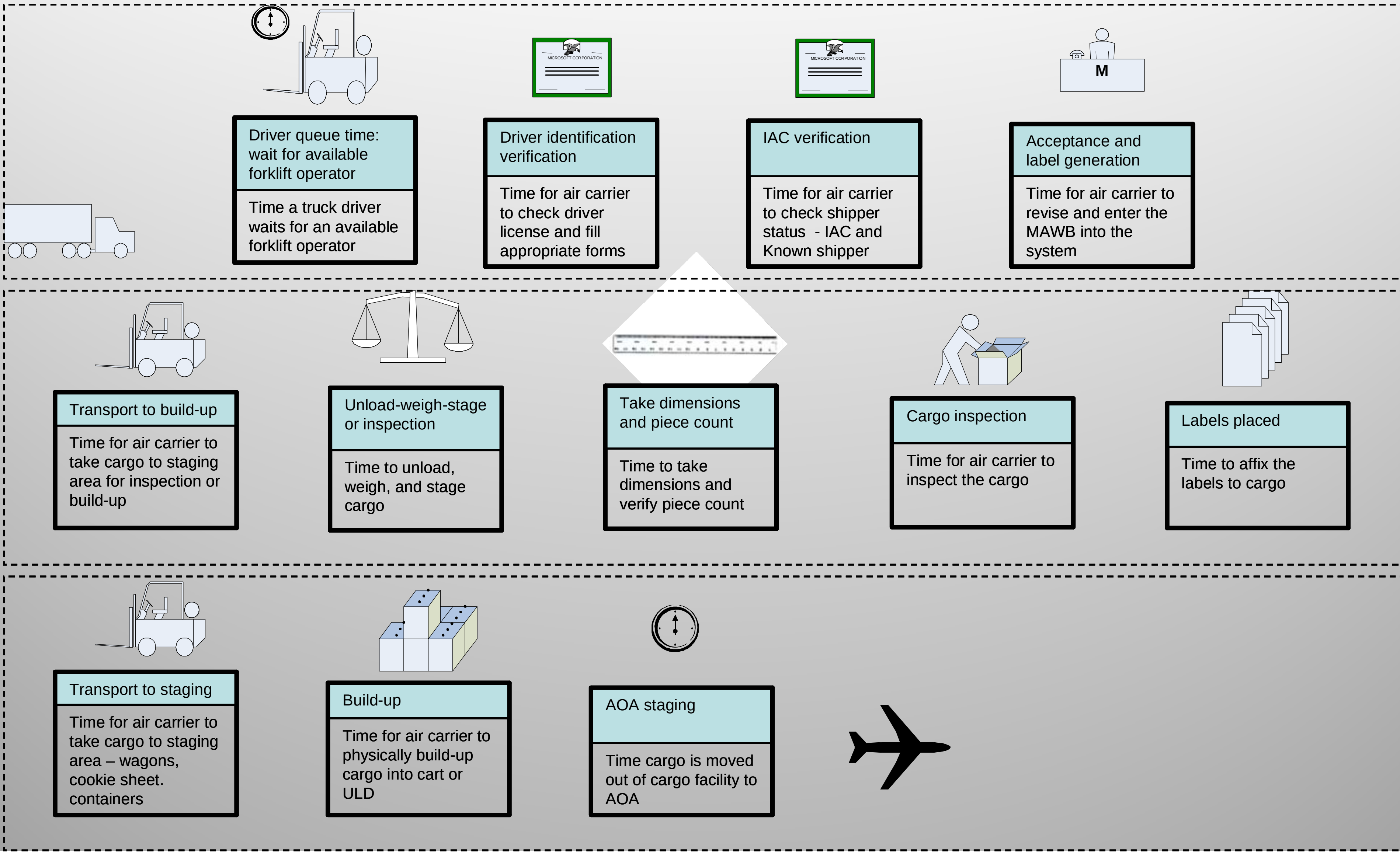
- **Q1 – *Impact*:** What is the impact on air cargo commerce and security policies of increased levels of cargo screening? In particular, what is the cost of significantly enhancing screening? What information is needed to determine who should bear those costs?
- **Q2 – *System RAM*:** What is the system/equipment Reliability, Availability, and Maintainability (RAM)?
- **Q3 – *Alarm Rate*:** What are the sources and causes of false alarms?
- **Q4 – *Process Effectiveness*:** How effective are the Concepts of Operations (ConOps) for increasing the level of air cargo security?
- **Q5 – *Baggage Equipment/Protocol Applicability*:** Can cargo screening protocols largely derived from checked baggage protocols and detection systems developed for passenger and baggage applications be deployed in a cargo environment and meet specified performance objectives?
- **Q6 – *Future R&D*:** What are the future Research and Development (R&D) needs for cargo management/handling and efficacious explosives detection systems as suggested by the results of the three pilots?
- **Q7 – *Data Limitations*:** What are the limits of ACEDPP data in regards to scalability and extrapolation to other airports?

Data from air carrier shipping records, CIMP system, targeted data sampling, interviews

ACEDPP data elements collected by and derived from pilot operations

Cargo Warehouse Operations Data	Cargo Load, Demand & Profile Data[a]	Screening & Effectiveness Data[b]	RAM Data	Cost Data
• Pilot operating hours • Pilot staff —no. per shift, hours spent in AC warehouse • AC cargo staff—no. of screeners, cargo handlers, supervisors per shift • Off-normal events—power outages, emergencies, VIP visits, et al. • Cargo processing stage times and rates, throughputs—unload, buildup, breakdown, transport, acceptance, et al. • Cargo volume processing stage—no. of AWBs, pieces, parcels • Staff training—per screening method, cargo-screening system operations, document processing	• Time distribution of cargo tendered (by AWBs, pieces, parcels) • Time distribution of commodity types tendered (by AWBs, pieces, parcels) • TSA exemption reasons used by shippers • Scheduled flight time • Shipments meeting scheduled flights, delayed or missed shipments • Cargo profile—weight, dimensions, no. of parcels per piece, packaging configurations & materials • Cargo destination—domestic, international, transient • Cargo service category—general, express, overnight, SPD, high-value • Cargo by aircraft size—narrow vs. widebody plane •	• Pilot test configu-ration—screening levels, numbers, and types of equipment used for primary, secondary, and tertiary screening • Screened AWBs, pieces, parcels counts by method • Cargo screened per time period; screening service times; screening throughput • Cargo screened per commodity type by method and affinity • Alarm type, mode, causes, by method • False-alarm rates by commodity and packaging types • True alarms by pieces and parcels • Screening times by method/affinity • CTX images—SP, CT, and raw data • ETD plasmagrams from alarms • Detection rates & false-alarm rates from explosives simulant testing	• Calibration times and modes per equipment item • Equipment up-time/downtime • Equipment failures—types, causes, service response time, and costs • Screening method utilization during peak/non-peak periods • Environmental factors and effects on equipment, system, and personnel performance • Equipment & system availability by peak/non-peak periods • Mean time between failures, by method • Mean time to repair, by method •	• Consumables & supplies • Cargo handling & screening systems, design, fabrication, installation, integration, parts, supplies • Labor costs—AC personnel, cargo handlers, screeners • Screening cost per parcel or lb. • On-the-job injuries • Training aides & user guides • Maintenance & repair costs • Utility costs • **Ancillary Data** • Data collected not in real time or inline with the cargo handling/screening system; these include daily logs of unusual events that disrupt operations, interviews with cargo handlers and screeners, sampling of time-in-motion events for cargo handling activities outside of pilot's cargo-handling system, et al.
	(a) in terms of number, quantity, weight, volume, percentage, as appropriate	(b) in terms of number, quantity, weight, volume, percentage, as appropriate		

Typical Air Carrier Cargo Process Flow

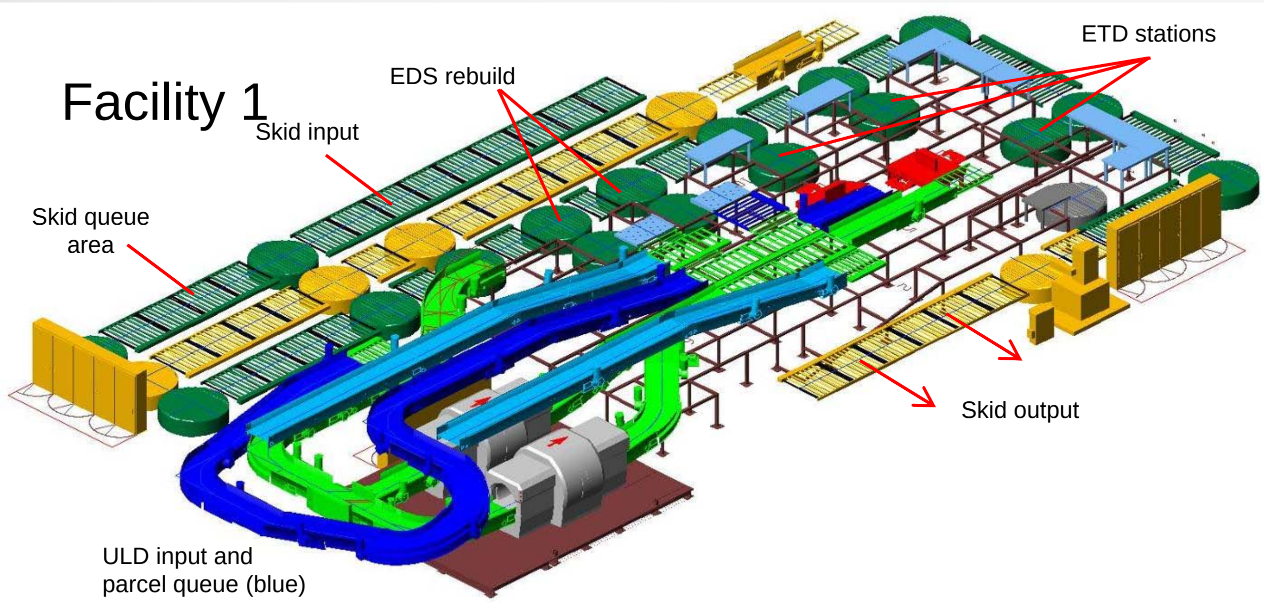


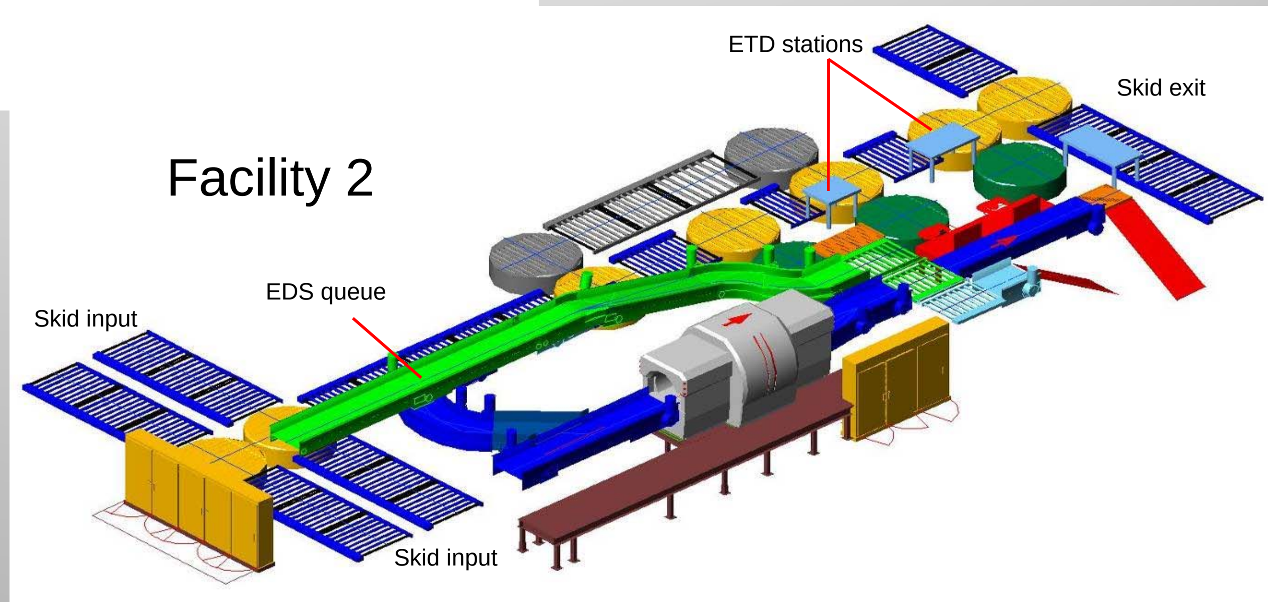
SFO pilot – commodity specific screening with dedicated technologies & personnel

- Pilot operations at 2 facilities, serving 9 airlines and handling just over half of air cargo originating at SFO
- Principle design requirement was to provide capability to screen at least 6 times more than pre-pilot
- Developed an integrated and partially automated system for cargo handling and screening
  - Systems were designed specifically for 2 facilities, based on cargo volumes, distribution of commodities, spatial constraints
- SFO and carriers also imposed requirements to minimize risk to the air carrier
  - 100% tracking and rebuild
  - No damage caused by CSS and have minimal claims
  - Robust ergonomics and safety features

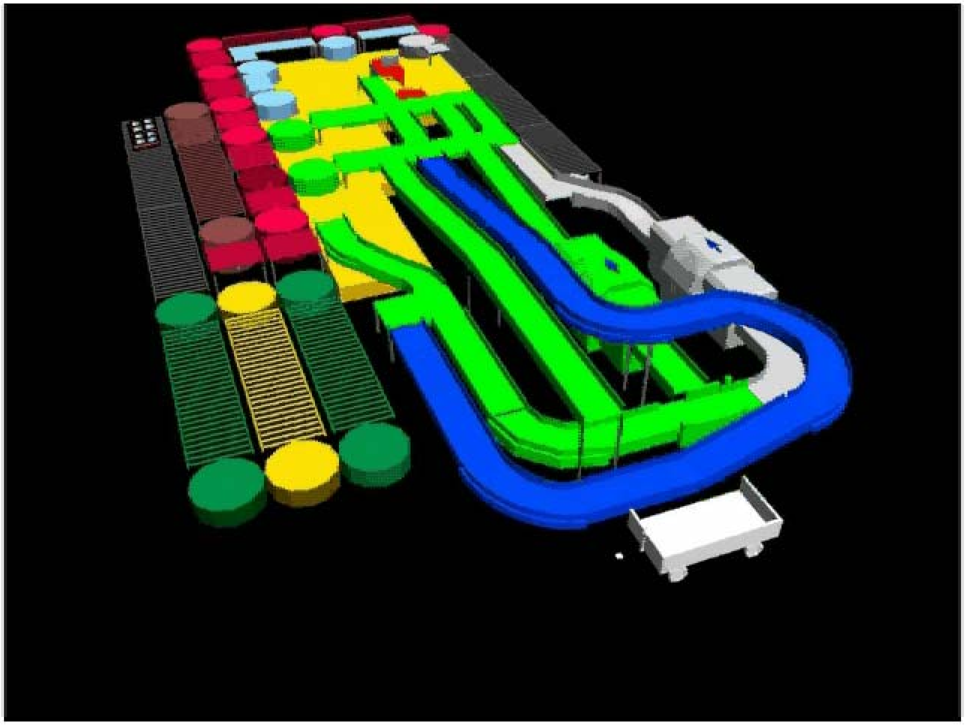
ACEDPP pilot operated at SFO from September 2006 through March 2008

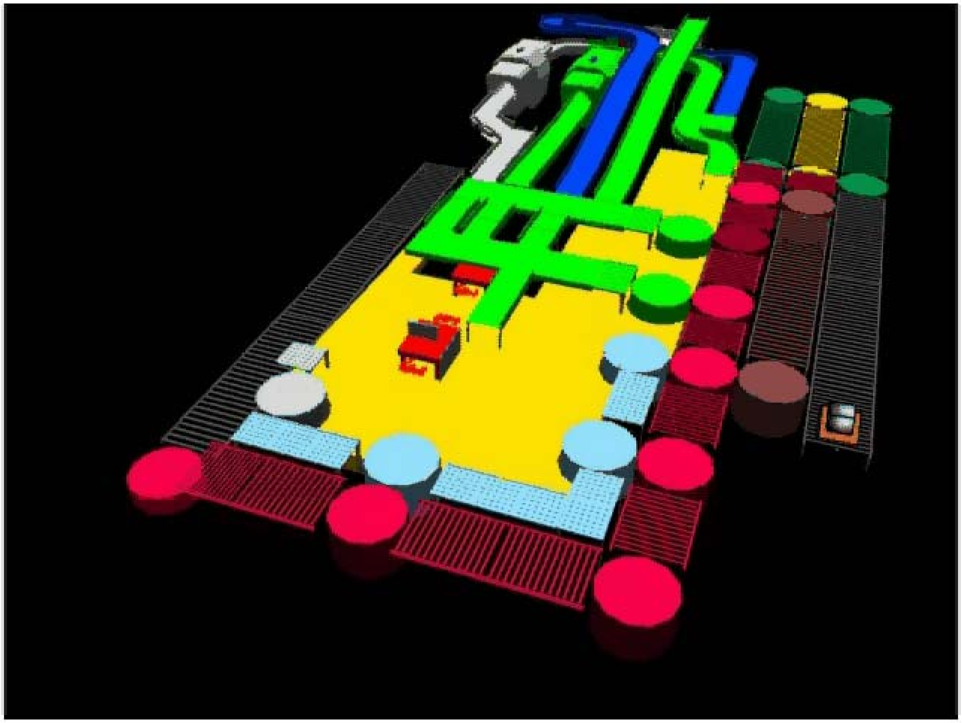
SFO Semi-Automated Cargo Handling Systems (CHS)





CHS included ETD or EDS screening, based on commodity type

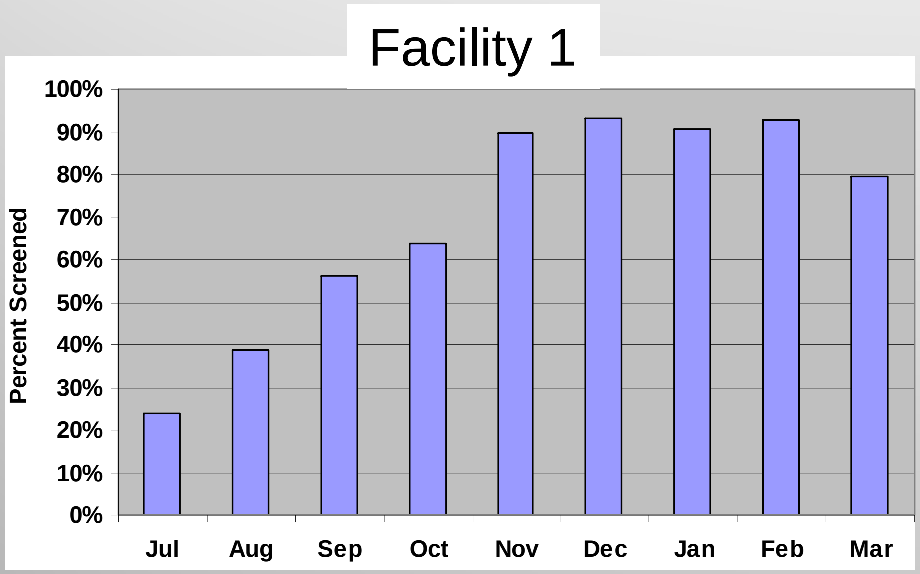


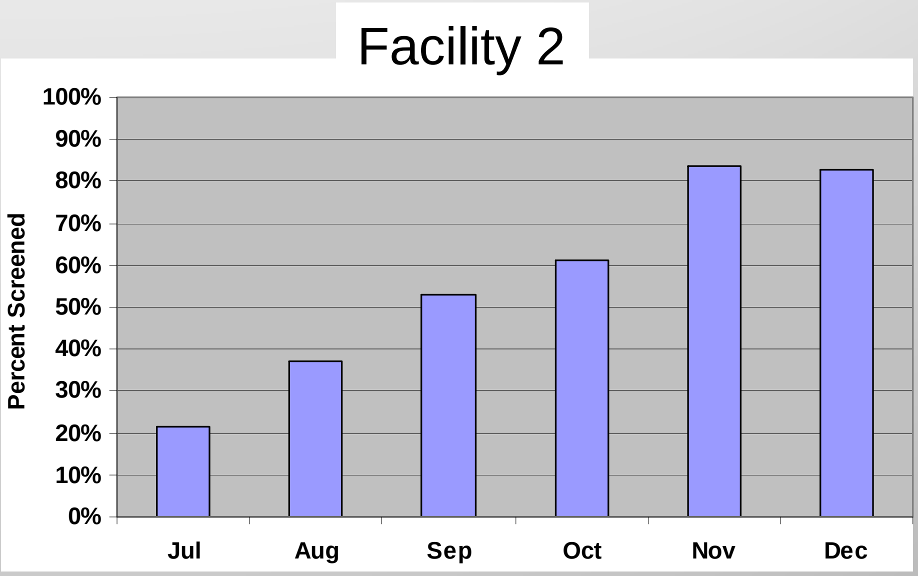


LEFT: EDS process flow

RIGHT: ETD process flow

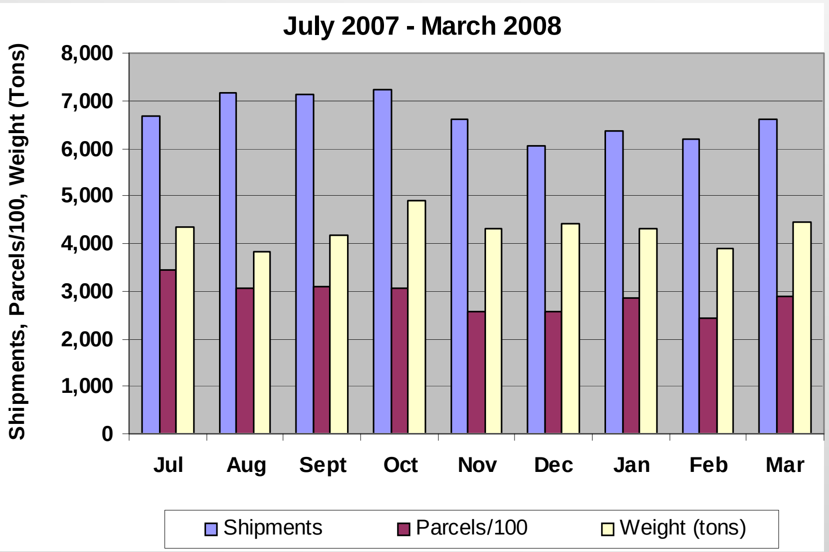
Screening at SFO was implemented in stages



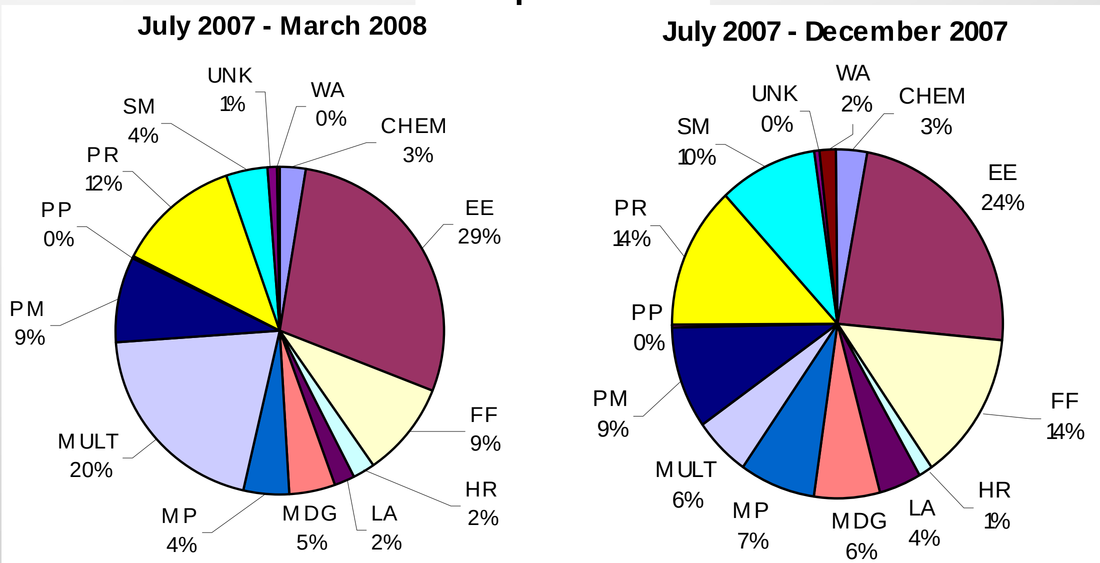


Facilities were screening 15% and 5% of total volume pre-pilot (mostly due to exemptions)

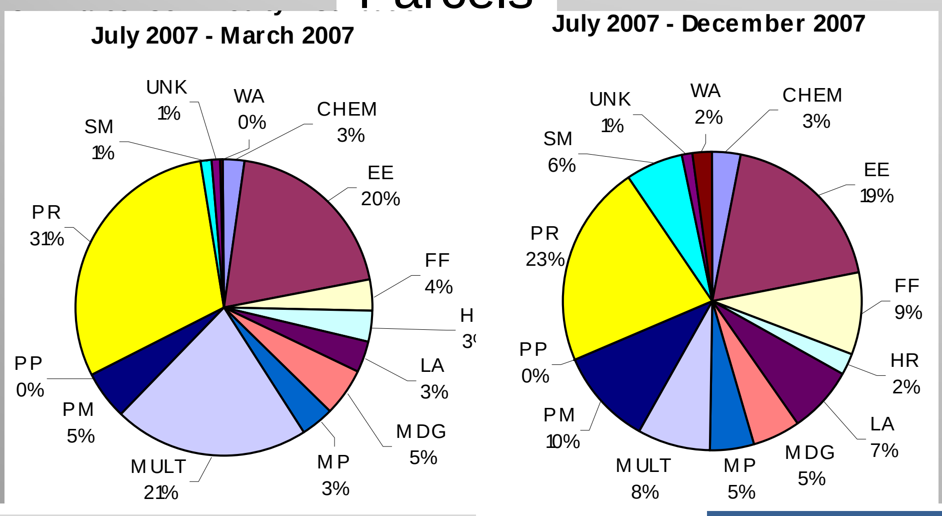
Shipments vary by commodity, by season and by airport



Shipments



Parcels



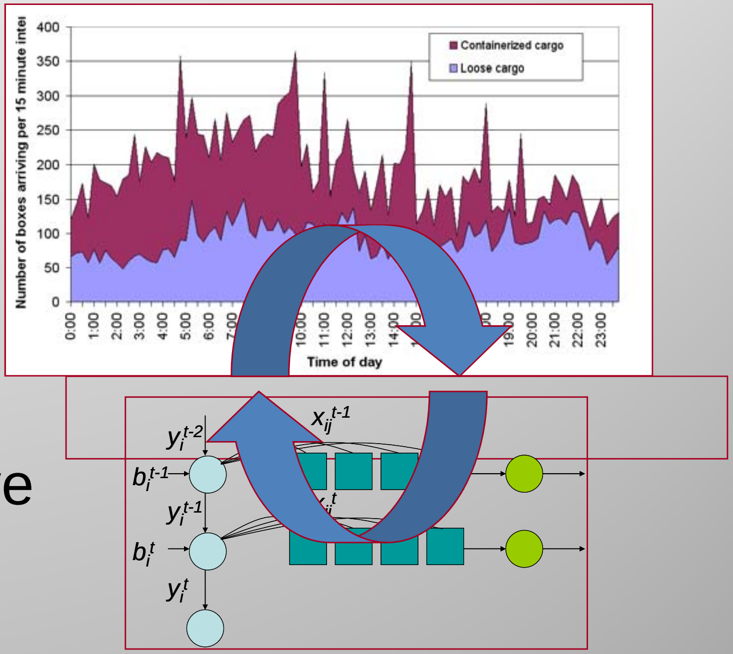
Commodity Code Key

CHEM=chemicals
EE= electronic equipment
FF=fresh flowers
HR=human remains
LA=live animals
MDG=miscellaneous durable goods
MP=machine parts
MULT=multiple commodities
PM=printed materials
PP=paper products
PR=produce
SM=seafood and meats
UNK=unknown
WA=wearing apparel

SFO - high-tech industry and agriculture

Modeling was used to evaluate a variety of topics

- Optimized system configuration (mix and number of technologies and staffing)
- Determination of costs and efficacy to drive decision making
- Determination of major cost drivers
- Calculation of system capacity
- Calculation of utilization levels
- Optimization of ConOps and policies
- Determination of critical parameters to drive requirements for data collection



ACEDPP utilized Optimization, Simulation, and Life Cycle Models

Life-Cycle Cost Modeling

- ACEDPP developed a life-cycle cost model with three main drivers
  - Time period over which costs are incurred
  - Discount rate applied to future costs
  - Pertinent cost element
- The following assumptions were used
  - Lifecycle of cargo-handling system assumed to be 20 years
  - Cargo volume over 20-year life cycle assumed constant
  - Imputed costs included
  - Inflation accounted for in future cost of goods and services
  - Discount rate used to calculate present value

Economics Working Group (EWG) formed to identify pilot cost categories

Pilot costs divided into 12 categories

1. Screening equipment costs (EDS, ETD, and PI)
2. Cargo handling system (CSS) costs
3. Business process modification costs including costs to expand capacity
4. Direct labor costs
5. Delay costs (given an alarm, impacts to time, labor, missed flights, et al.)
6. Performance testing costs
7. Utility costs
8. Liability (insurance) costs
9. Compliance/facility engineering costs
10. Incident costs
11. Taxes
12. Interest

All cost results presented in terms of the EWG cost components

Total costs calculated by Life Cycle Cost Model allocated to 7 categories

1. direct-labor costs in the warehouse
2. EDS equipment capital and maintenance costs
3. ETD equipment capital and maintenance costs
4. material-handling system equipment costs
5. utility costs
6. business process modification costs
7. performance testing costs

Total Life Cycle Cost

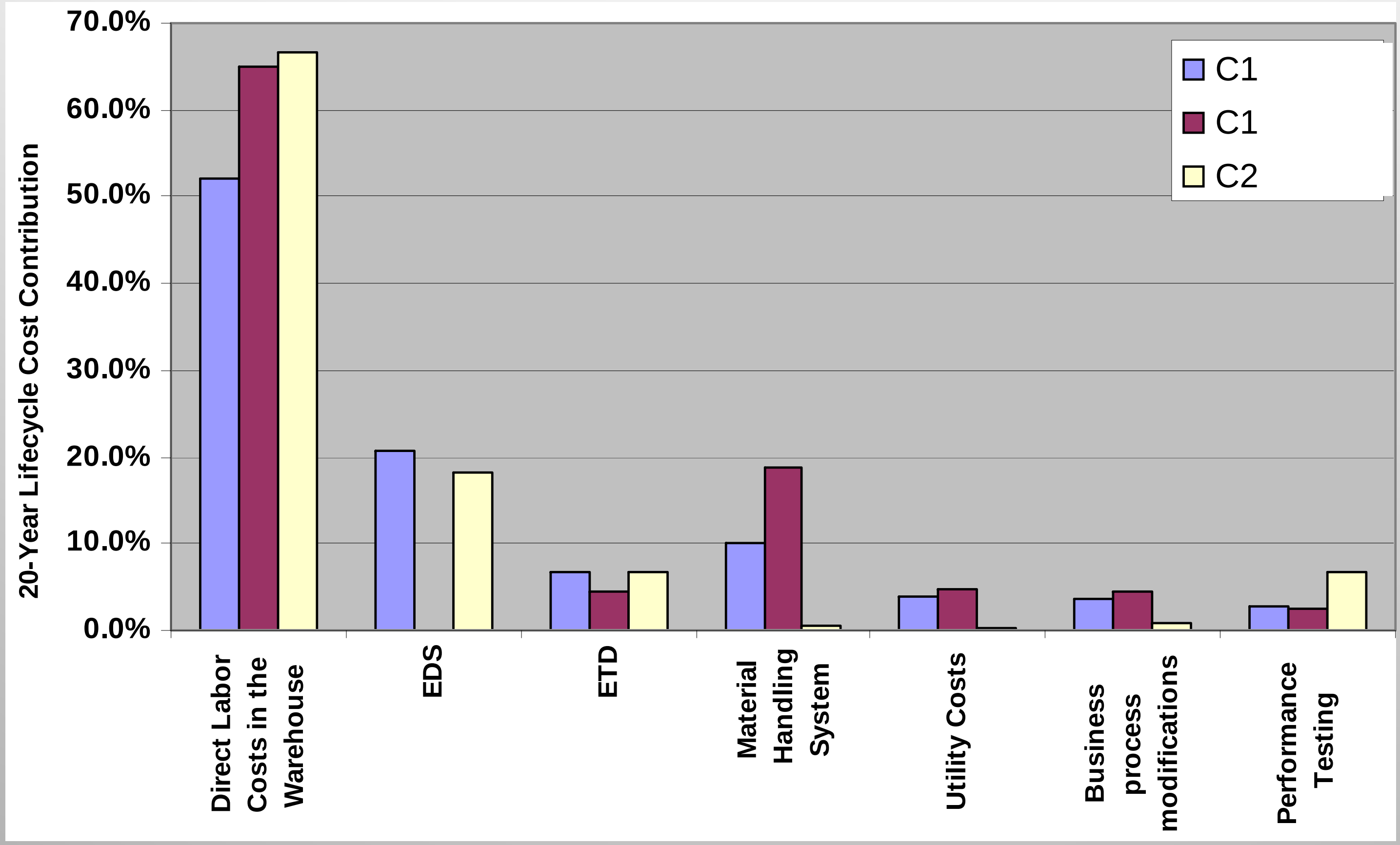
Cumulative and net present value of as-built and as-operated pilot costs			
	SFO Pilot		CVG Pilot
Cost Element	Facility 1	Facility 2	
20-year life-cycle cost	$81,402,000	$23,578,000	$33,530,402
present value of 20-year life-cycle cost	$46,821,000	$13,644,000	$18,184,601

Total Screening Cost

Screening cost comparison for SFO, CVG and SEA			
	SFO Pilot		CVG Pilot
Cost Element	Facility 1	Facility 2	
$/parcel	$4.35	$5.08	$8.55
NPV $/parcel	$2.50	$2.94	$4.64
$/pound	$0.15	$0.18	$0.15
NPV $/pound	$0.09	$0.10	$0.08

At SFO and CVG, labor is the major cost driver (more than 50% of costs)

Life Cycle Cost by Category

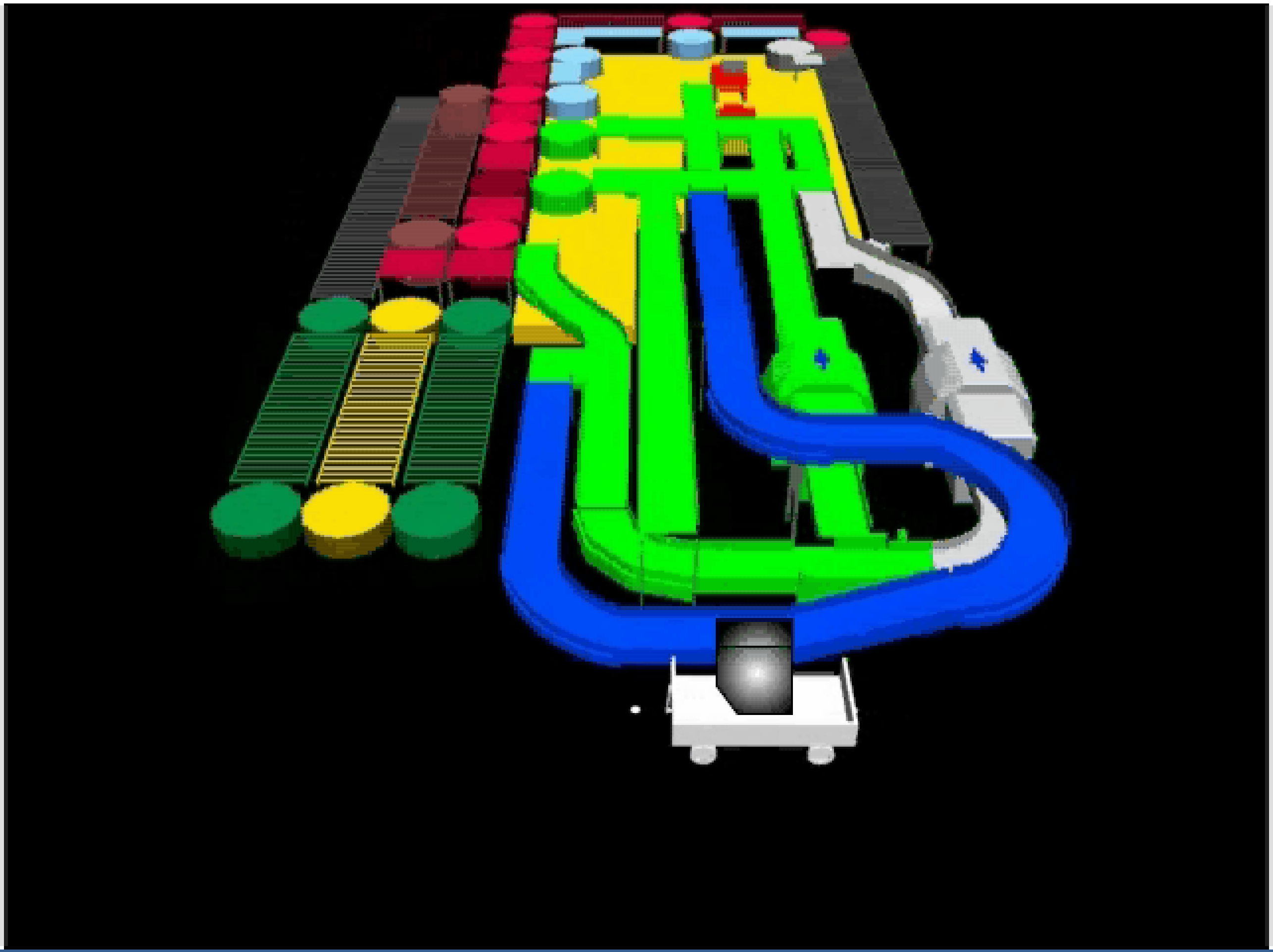


Major drivers of cost are labor, followed by EDS

ULDS are a significant challenge to screening operations

ULDs designated MULT commodity type

Cargo Handling System at SFO - ULD station



The Theory……

Unloading ULDs to conveyor extremely labor intensive

…versus reality.

Screening at parcel level remains significant issue

- Variety of shipping configurations (e.g. ULD) require intensive labor to break down, screen and reconstitute
  - Need effective solution for screening bulk cargo configurations
- Range of cargo commodity types shipped precludes a single technology approach
- Screening systems should be designed for high-capacity with low average utilization due to shipment bunching

Bulk-screening technologies would reduce operational impact, and decrease cost

Additional data would be useful as USG works to find optimal solution

- **True sources of alarms—What specific items cause false alarms when screening air cargo?**
- **Oversize/heavy cargo—What is the most appropriate method for screening this type of cargo?**
- **Minimum number of screeners—What is the maximum throughput that can be sustained by each screener, and what is the minimum number of screeners that are required to service a given cargo volume for difference screening ConOps?**
- **ULD screening—On average, how much labor is required to break down, screen, and rebuild ULDs of different sizes and types?**
- **X-ray screening—How effective is it, and what are its cost metrics?**
- **RAM—What would the reliability of ACEDPP-type systems be over an extended period of operations?**

Additional data (cont.)

- **Space requirements—What are the warehouse space requirements for an air-cargo screening operation as a function of cargo volume, commodity mix, and air carrier business rules?**
- **Industry elasticity—how would the volume of cargo shipped by air vary if the overall cost of shipping rises as the cost of increased screening is passed along to customers?**
- **Incident costs—What are the complete costs associated with evacuating a cargo warehouse facility in the event of a false alarm?**
- **Red teaming costs—what are the costs associated with establishing and maintaining the efficacy of air cargo screening?**
- **On-the-job injuries—What is the injury rate that can be expected for air-cargo screening operations?**
- **Centralized screening facilities—How well would a centralized screening approach work at airports of different sizes, and what new issues would it create? Is it cost effective?**

Acknowledgements

This work was funded and supported by the Department of Homeland Security, Science and Technology Directorate/Explosives Division.

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The specific language authorizing this program in the appropriations bill (Conference Report) is:

- Based on recommendations in Science and Technology's (S&T) system engineering study of civil aviation security, the conferees direct $30,000,000 be used to conduct three cargo screening pilot programs - one at an all cargo airport facility and two at passenger cargo airports (top twenty in size) - to test different concepts of operation, as described in the House report. The conferees expect S&T to utilize TSA airport management staff to manage the oversight and day-to-day operations of these pilot programs to the greatest extent possible. One of the pilots should test whether a significant amount of cargo can be screened in the terminal using existing checked baggage security infrastructure. The conferees also expect S&T to locate these pilots at airport or airline facilities willing to contribute both physical space and other resources to this effort. The conferees direct S&T to begin all pilots in fiscal year 2006, to report on the initial results of the pilots every six months after initiation of the first pilot, and to report on the final results four months after the last pilot is completed.

The language in the referenced House report is:

- **The Committee has provided $40,000,000 to the Science and Technology Directorate (S&T) within the explosive countermeasures appropriation to continue air cargo activities, previously funded under TSAs research and development program. Of this funding, $30,000,000 shall be used to conduct three cargo screening pilot programs - one at an all cargo airport and two at top ten passenger cargo airports. These pilots shall test different concepts of operation that TSA designs in coordination with the S&T. Testing shall consist of the following: (1) physically screening a significant percentage (e.g. six times more than today) of cargo at a passenger airport using TSA screeners during slack passenger and checked baggage screening periods; (2) physically screening a significant percentage (e.g. six times more than today) of cargo at a passenger airport using TSA or private screeners solely dedicated to cargo screening; and (3) using canine teams, supplemented as needed by technology, screening a similar percentage of cargo at an all cargo airport, specifically to detect explosives and hidden passengers. Based on results of each pilot, TSA will provide cost estimates (both non-recurring and recurring) of these different operational concepts if deployed to the top five air cargo only airports and top 10 passenger airports. The Committee expects each of these pilots to be no shorter than nine months in duration and all pilots to be completed by January 31, 2007. The Committee directs S&T to provide a comprehensive report on each pilot, two months after each is completed, and interim reports of progress and results no later than August 31, 2006.**

Final requirements for systems at SFO

- Requirements
  - Screening system must handle skids, ULDs, and individual parcels
  - Capacity at least 6X current screening throughput
  - Sufficient equipment redundancy
  - Integrate to the airlines air waybill (AWB) software
  - Incorporate on-screen resolution (OSR) in the future
  - No delayed cargo or missed flights
  - Scalable modular design for future growth
- Optimize the system for
  - Highest automation
  - Lowest processing time per skid/parcel
  - Maximize EDS/ETD equipment utilization and screening efficacy
  - Increased airline efficiency in the cargo area – minimize labor
  - Lowest possible square-foot usage
  - Minimize capital investments for peak and average demands
  - Lowest maintenance cost

Minimize cost per parcel screened

- Minimize risk to the air carrier through
  - 100% tracking and rebuild
  - No damage caused by CSS and have minimal claims
  - Robust ergonomics and safety features