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Gannett Fleming

Common Acronyms and Terms

Acronyms

ACP	access control point
ACSIM	Assistant Chief of Staff for Installation Management
ADA	Americans with Disabilities Act
AIE	automated installation entry
AT	antiterrorism
ATR	automated traffic recordings
AVB	active vehicle barrier
BRAC	Base Realignment and Closure
CAC	common access card
CCTV	closed circuit television
DBIDS	Defense Biometric Identification System
DHV	design hourly volume
DoD	Department of Defense
ECF	entry control facility
FPCON	force protection condition
FY	fiscal year
HCM	Highway Capacity Manual
IACS	USAREUR Installation Access Control System
LOS	level of service
OPMG	Army Office of Provost Marshal General
PA	program amount
PHF	peak hour factor
POV	privately owned vehicle (vehicles other than trucks, such as sedans)
RAM	random antiterrorism measures
RFID	Radio-frequency identification
SDDCTEA	Military Surface Deployment and Distribution Command, Transportation Engineering Agency
SMART	Security, Manpower, Automation, Roads and lanes, Traffic and safety
UFC	Unified Facilities Criteria
USACE-COS	U.S. Army Corps of Engineers – Center of Standardization
USACE-ESC	U.S. Army Corps of Engineers – Electronic Security Center
USACE-PDC	U.S. Army Corps of Engineers – Protective Design Center
USAREUR	United States Army in Europe
VOC	volatile organic compounds
VPH	vehicles per hour
VPHPL	vehicles per hour per lane

Terms

Automation - the use of technology to provide permanent automated credentialing (ID checks) through an access control point (ACP). This is commonly referred to as automated installation entry (AIE).

Handheld technologies - the use of electronic scanners to provide credentialing (ID checks) through an ACP. Handheld technologies are commonly referred to as Defense Biometric Identification System (DBIDS) or USAREUR Installation Access Control System (IACS).

Manual processing – the use of visual inspection only by guards to provide credentialing (ID checks) through an access control point.

Single processing – when only one guard is stationed in an ID check lane.

Tandem processing - when two guards are stationed in an ID check lane.

Disclaimer

The ACP/ECF SMART Decision Evaluator was developed utilizing common engineering, security and economic resources. Engineering judgment was applied where appropriate. The results may vary from actual and future conditions.

All defaults should be validated and adjusted as appropriate as part of the evaluation process. Due to periodic changes in regulations, procedures, design guides, and policies, the content contained herein is subject to change without notice.

While SDDCTEA and Gannett Fleming, Inc. exercise good faith efforts to provide information that is accurate, by using the information contained herein, user assumes all risks and liabilities in connection with such use. SDDCTEA and Gannett Fleming, Inc. shall not be held responsible for errors or omissions in information provided herein or conclusions reached as a result of using this material.

1 Background and Purpose

1.1 Background

The Unified Facilities Criteria 4-022-01 Security Engineering: Entry Control Facilities/ Access Control Points (2005), states that the objective of an Access Control Point (ACP) or an Entry Control Facility (ECF) is "to secure the installation from unauthorized access and intercept contraband (weapons, explosives, drugs, classified material, etc.) while maximizing vehicular traffic flow." The perimeter of the ACP/ECF consists of both passive and active barriers arranged to form a contiguous barrier to pedestrians and vehicles. ACP/ECF guards control the active barriers to deny or permit entry into the Installation.

ACPs/ECFs shall be designed to prevent an unauthorized vehicle or pedestrian from entering the Installation, to ensure safety of innocent ACP users, and to maximize throughput of vehicular and pedestrian traffic. The overarching priorities are[1]:

Security	The first objective of an ECF is to maintain perimeter security and establish the demarcation line between the controlled and uncontrolled perimeter of the installation. An ECF must accommodate RAM and must be able to operate at all FPCONs protecting against illegal entry.
Safety	Safety measures shall be incorporated so that persons and vehicles entering and leaving the facility do so in a safe and orderly manner to protect themselves, security personnel, and pedestrians from harm. Security Forces safety includes provisions for personnel protection against attack, errant drivers, and considerations for climate, location, and orientation.
Capacity	The ECF needs to maximize the flow of traffic without compromising safety, security, or causing undue delays that may affect installation operations or off-installation public highway users.
Sustainability	The ECF should reduce energy costs, facility maintenance and operations costs through sustainable design where appropriate.

Throughout the planning of an ACP/ECF, it should be remembered that these priorities often conflict with one another. For example, an increase in force protection condition (FPCON) procedures may result in more delays and congestion, which in turn may lead to congestion-related crashes. A change in one condition requires that the impact to other priorities is considered, and where appropriate, corrective action is taken.

[1] SDDCTEA Pamphlet 55-15, *Traffic and Safety Engineering for Better Entry Control Facilities*

In practice, ACP/ECF practitioners are charged with maximizing security and limiting impacts to traffic while minimizing resource needs such as manpower and infrastructure expansion costs. Automation is viewed as a tool that may offer manpower benefits and enhance security, but it must be implemented in the context of other considerations.

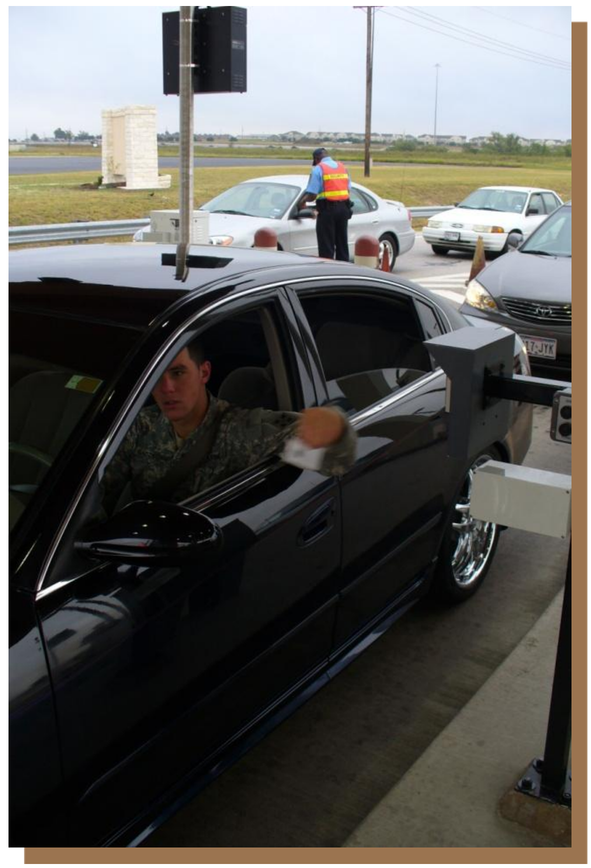
When considering automation, ACP/ECF designers must ask the appropriate questions concerning manpower and infrastructure issues in order to properly assess the impacts of their decisions.

Security	▪ What AT measures are required? ▪ How do these requirements impact traffic (processing) and will that impact necessitate additional manpower or lanes? ▪ Can automation enhance security? ▪ Is the system providing positive access control?
Manpower	▪ Is manpower utilized efficiently? ▪ Would additional lanes allow for more efficient processing thus reducing manpower demands? ▪ Will automation help reduce manpower costs?
Automation	▪ Will automation provide a manpower cost savings? ▪ Will automation provide a security benefit? ▪ Will automation be able to achieve comparable processing rates to manual processing? ▪ Can the infrastructure (lanes) support automation initiatives? ▪ Are there policy decisions that need to be implemented to support efficient automation?
Roads & Lanes	▪ Are there sufficient lanes to accommodate manual processing? ▪ Are there sufficient lanes to accommodate automation? ▪ If additional lanes were constructed, could manpower be reduced?
Traffic & Safety	▪ How do security decisions impact processing (traffic)? ▪ How do manpower decisions impact processing (traffic)? ▪ How do automation decisions impact processing (traffic)?

All of these issues are inter-related. The SMART approach is to consider all the short-term and long-term ramifications of these decisions and their impacts on manpower, safety, security, and traffic.

The ACP/ECF SMART Decision Evaluator was initially developed by Gannett Fleming and SDDCTEA in 2008 in coordination with, and through funding provided by the Army Office of the Provost Marshal General (OPMG). This revision allows the software to be run from the web (rather than from a CD), adds a level-of-service computation for a gate, expands the user's guide, captures lessons learned over the last several years, and identifies the benefits of reducing congestion and delay at gates and in reducing automobile pollutants and climate change.

1.2 Purpose



The purpose of the ACP/ECF SMART Decision Evaluator software is to help decide the best configuration for an ACP: to provide different scenarios that help right-sizing the number of ID check lanes, with the optimal number of guards in order to minimize construction and operating costs, minimize risk, minimize environmental effects, obtain an acceptable maximum vehicle queue length, and obtain the greatest reasonable level of service in terms of overall delay to entering vehicles.

The ACP/ECF SMART Decision Evaluator aims to assist ACP/ECF planners in assessing the impacts of their decisions by:

- Providing a comprehensive perspective of various ACP/ECF issues
- Providing the ramifications of different scenarios

The ACP/ECF SMART Decision Evaluator uses common engineering, security and economic principals and compares various metrics for different processing methods and ID check lanes.

The purpose of this user guide is to outline and describe the capabilities and requirements of the ACP/ECF SMART Decision Evaluator as well as the background calculations used. Please contact SDDCTEA with questions.

1.3 Representative Examples

The ramifications of these decisions are best illustrated through examples.

Example 1

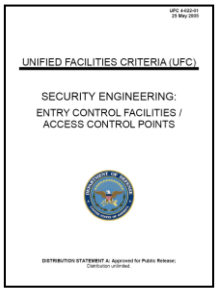
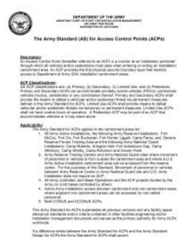
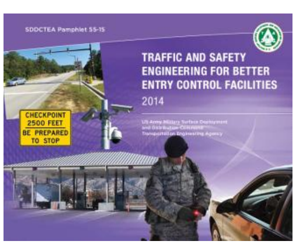
Existing Conditions	▪ An ACP has four ID check lanes. ▪ The morning peak hour exceeds 1,500 vehicles. ▪ To accommodate morning peak hour demands, the ACP utilizes two guards per lane (tandem processing) resulting in a total manpower requirement of eight guards during peak periods.
Direction	▪ The installation wants to implement automated installation entry (AIE) to enhance security and because it is believed that it may reduce manpower requirements.
Blind Decisions	▪ The installation implements AIE without assessing the impacts. ▪ Prior to implementation, Command is notified that manpower will be reduced and security enhanced. ▪ While manpower is reduced, on the day the system is implemented it is realized that no one considered that AIE processes at a slower rate than tandem processing and as a result, a half-mile backup of traffic occurs. ▪ Command is infuriated and is under pressure from local authorities to address the "back-up" issue. ▪ As a result, the AIE system is temporarily shut down.
Corrective Actions	▪ Eventually, the installation consults with experts to develop a plan. ▪ An assessment is conducted and it is concluded that an additional lane is needed during peak periods to support the AIE system. ▪ The installation concludes that adding a fifth lane is an option, but design and construction will take two years. ▪ In the interim, three temporary options are considered: 1. The installation could run manual tandem processing to alleviate traffic impacts; however, security needs will not be addressed and manpower needs will not be reduced. 2. The installation could utilize handheld technologies to alleviate traffic and to address security, however manpower needs will not be reduced. 3. The installation could utilize AIE, but not utilize traffic arms (for each transaction). This option would address manpower and traffic needs as well as provide some security benefits. ▪ While all agree that it would be preferred to utilize traffic arms for each transaction, it is agreed that Option 3 provides the most benefits and fewest drawbacks.

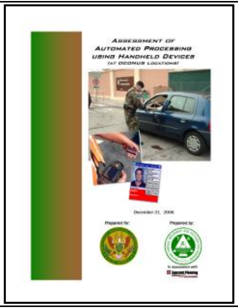
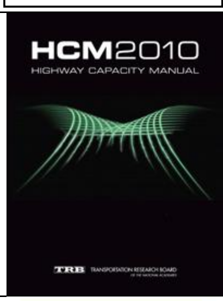
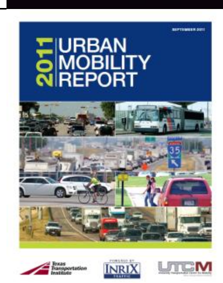
Example 2

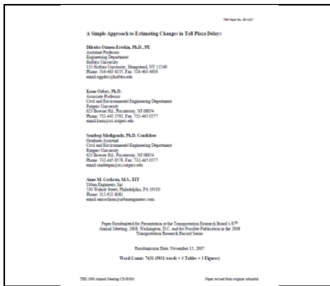
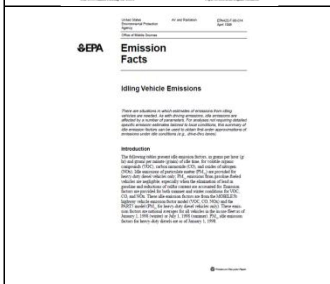
Existing Conditions	▪ An ACP has two ID check lanes. ▪ The morning peak hour exceeds 700 vehicles. ▪ To accommodate morning demands, the ACP utilizes one guard per lane (single processing) resulting in a total manpower requirement of two guards during peak periods.
Direction	▪ The installation wants to implement handheld technologies to enhance security.
Blind Decisions	▪ The installation implements handheld technologies without assessing the impacts. ▪ On the day the system is implemented it is realized that no one considered that handheld automation processes at a slower rate than manual, single processing. ▪ As a result, tandem processing is required in one lane while single processing occurs in the other lane. The total resulting manpower requirement increases from two guards to three guards during peak periods.
Corrective Actions	▪ An assessment is conducted and it is concluded that AIE can provide similar security benefits without requiring additional manpower. ▪ However it concluded that implementation of AIE requires additional funding and will take two years. ▪ In the interim, three temporary options are considered: 1. The installation could increase staffing during peak periods and utilize handheld technologies until AIE is implemented. 2. The installation could abandon handheld technologies and return to manual processing with two guards. 3. The installation could utilize handheld technologies for every vehicle during non-peak periods, and could use handheld technologies only on random vehicles during peak periods. This operation would not require additional guards. ▪ The installation implements option 3 as a temporary measure while AIE is funded and implemented.

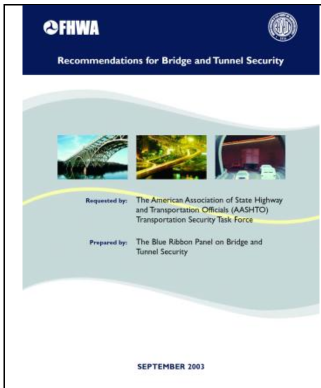
2 References and Resources

In the development of the *ACP/ECF SMART Decision Evaluator*, the following references and resources were utilized:

 UFC 4-022-01 25 May 2005 UNIFIED FACILITIES CRITERIA (UFC) SECURITY ENGINEERING: ENTRY CONTROL FACILITIES / ACCESS CONTROL POINTS DISTRIBUTION STATEMENT A: Approved for Public Release; Distribution unlimited.	Unified Facilities Criteria (UFC) 4-022-01, *Security Engineering: Entry Control Facilities/ Access Control Points,* May 2005	✓ Produced by the Department of Defense (DoD). ✓ Presents a unified approach between military service branches regarding the design features necessary to ensure that infrastructure constructed today will have the flexibility to support future technologies, a changing threat environment, and changes in operations. ✓ http://www.wbdg.org/ccb/DOD/UFC/ufc_4_022_01.pdf ✓ https://pdc.usace.army.mil/library/ufc/4-022-01
 ARMY ACCESS CONTROL POINTS (ACPs) STANDARD DESIGN VARIOUS LOCATIONS (CONUS AND OCONUS) MAY 2013 Prepared By: US Army Corps of Engineers Omaha District	Department of the Army, *Army Access Control Points (ACPs) Standard Design*, May 2013	✓ Produced by the Department of the Army. ✓ The design procedures and drawings included in the document provide flexibility to designers in meeting the Army's baseline physical security requirements and the full range of Force Protection Conditions on Army installations. ✓ http://mrsi.usace.army.mil/cos/Omaha/SitePages/acp.aspx
 DEPARTMENT OF THE ARMY The Army Standard (AS) for Access Control Points (ACPs)	Department of the Army, *The Army Standard (AS) for Access Control Points (ACPs),* April 2012	✓ Produced by the Department of the Army. ✓ Provides design guidance for ACPs. ✓ http://mrsi.usace.army.mil/cos/Omaha/SitePages/acp.aspx
 SDDCTEA Pamphlet 55-15 TRAFFIC AND SAFETY ENGINEERING FOR BETTER ENTRY CONTROL FACILITIES 2014 CHECKPOINT 2500 FEET BE PREPARED TO STOP	SDDCTEA Pamphlet 55-15, *Traffic and Safety Engineering for Better Entry Control Facilities,* 2014 *(referred to as 55-15)*	✓ Produced by Military Surface Deployment and Distribution Command, Transportation Engineering Agency. ✓ Supplements other existing criteria and guidance. ✓ Referenced in UFC and in the Army Standard Definitive Design. ✓ Per regulation AR 55-80. ✓ http://www.tea.army.mil/pubs/dod.asp

	***Assessment of Automated Processing Using Handheld Devices,*** **December 2006**	✓ Produced by Military Surface Deployment and Distribution Command, Transportation Engineering Agency. ✓ Evaluated the efficiency of automated ACP processing using handheld devices. ✓ Evaluated the impact of automated ACP processing using handheld devices.
	***Assessment of Phantom Express Automated Installation Entry At Fort Hood Texas,*** **February 2008**	✓ Produced by Military Surface Deployment and Distribution Command, Transportation Engineering Agency. ✓ Evaluated the efficiency of Phantom Express processing. ✓ Evaluated the impact of Phantom Express processing.
	***Highway Capacity Manual,*** **2010**	✓ Produced by the Transportation Research Board. ✓ Presents methodology for calculating traffic delay and level of service.
	***2011 Urban Mobility Report,*** **September 2011**	✓ Written by David Schrank, Tim Lomax and Bill Eisele. ✓ A yearly report published by the Texas Transportation Institute. ✓ Discusses congestion, travel time, and the cost due to increased delay in cities across the United States. ✓ Provides an updated value for the average cost of time per person hour.
	***Assessment of the Impact of Electronic Toll Collection on Mobile Emissions in the Baltimore Metropolitan Area,*** **February 2002**	✓ Written by Anthony A. Saka, Ph.D., P.E., PTOE and Dennis K. Agboth, Ph.D. ✓ Offers a method to measure vehicle queues at a toll plaza (ACP/ECF) using a modified version of the vehicle queue at a two-way stop controlled intersection from the Highway Capacity Manual.

 A Simple Approach to Estimating Changes in Toll Plaza Delays	*A Simple Approach to Estimating Changes in Toll Plaza Delays,* November 2007	✓ Written by Diluraba Ozmen-Ertekin, Ph.D., P.E.; Kaan Ozbay, Ph.D.; Sandeep Mudigonda; Anne M. Cochran, M.S., EIT. ✓ The reviewed document offers a way to calculate toll plaza (ACP/ECF) delay using methods from the Highway Capacity Manual.
 EPA Emission Facts Idling Vehicle Emissions Introduction	*Idling Vehicle Emissions,* April 1998	✓ Produced by the U.S. Environmental Protection Agency ✓ Presents tables to determine volatile organic compounds, carbon monoxide, and particulate matter emissions due to idling time for winter and summer conditions.
 Argonne To Idle or Not To Idle: That Is the Question	*To Idle or Not To Idle: That Is the Question*	✓ Produced by Argonne National Laboratory. ✓ Discusses wasted fuel values for every ten minutes of idle time for various size engines.
 A Risk Assessment Methodology (RAM) for Physical Security	*A Risk Assessment Methodology (RAM) for Physical Security*	✓ Produced by Sandia National Laboratories. ✓ Provides a method for calculating relative risk.

	***Recommendations for Bridge and Tunnel Security***	✓ Produced by the American Association of State Highway and Transportation Officials (AASHTO) Transportation Security Task Force and Federal Highway Administration. ✓ Provides a method for calculating relative risk.

3 Development Team

The development of the *ACP/ECF SMART Decision Evaluator* was commissioned and supervised by SDDCTEA:

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This does not constitute endorsement by TEA, SDDC, the U.S. Army, the Department of Defense, or any of its components.

4 ACP/ECF Assessment Process

4.1 Overview

Even though the *ACP/ECF SMART Decision Evaluator* provides the total cost of manpower, infrastructure, technology, traffic delay, and wasted fuel, it does not eliminate the need for practical knowledge or detailed engineering assessments.

UFC 4-022-01 places strong emphasis on traffic considerations including the capacity and an adequate number of ID check lanes in the planning of an ECF. Please consult this UFC for background information on ECFs, their purpose, classification, planning and site selection criteria, components, and design guidelines.

Additionally, the Army Standard for ACPs requires that a traffic engineering study shall be performed and completed prior to planning, design or construction of a new ACP or prior to modification of an existing ACP. ACP Criteria from the Army Office of Provost Marshal General (OPMG) also supports the need for a traffic engineering study.

4.2 Traffic Overview and Perspective

A proper evaluation of ACP/ECF needs must consider future demand requirements and the existing infrastructure. If congestion occurs at the gate and there is inadequate queuing distance, the queue may extend into adjacent intersections or cause congestion on feeder roads. Additionally, the queue of stopped vehicles becomes an additional target for attack. Renovating an existing ACP/ECF should improve the throughput of the ACP/ECF, but at a minimum not reduce it.[2]

Design capacity is the maximum volume or throughput of traffic that a proposed ACP/ECF would be able to serve without an unreasonable level of congestion occurring. Capacity is used at the design criteria in assessing the adequacy of ACPs/ECFs to serve current and future traffic demands. Vehicles arriving at an ACP/ECF faster than they can be processed causes congestion. During the design process, properly sizing the ACP/ECF will be the key element in providing an efficient facility. The goal of the ACP/ECF should be to cause little or no delay under the design force protection conditions.[3]

4.3 Standard Scope of Work

The cost of a traffic engineering assessment of an ACP/ECF is approximately one percent of the cost of a new ECF/ACP. Ultimately, whether an installation is conducting a self assessment or contracting the work, a standard scope of work will provide consistency in the

[2] SDDCTEA Pamphlet 55-15, *Traffic and Safety Engineering for Better Entry Control Facilities*
[3] SDDCTEA Pamphlet 55-15, *Traffic and Safety Engineering for Better Entry Control Facilities*

data that is collected and the products or outcomes that are produced, which will allow for side-by-side comparisons as work is prioritized.

A standard scope of work for a gate study should include the following elements:

- Assess ACP user concerns and evaluate origins and destinations.
- Perform an assessment of compliance of existing/proposed facilities with the UFC, SDDCTEA Pamphlet 55-15 and all applicable service standards and guidance.
- Conduct a safety review.
- Perform an inventory of existing infrastructure and operational procedures.
- Conduct traffic data collection activities, to include 24-hour automated traffic recordings, as well as morning peak-period visual observations.
- Conduct a comprehensive review of overall ACP/ECF needs (number of gates, locations, total lanes) at each installation.
- Calculate lane requirements with consideration of growth (BRAC, etc), as well as single or tandem lane processing and automation (AIE, etc).
- Identify short-term recommendations to enhance safety and/or traffic operations.
- Review current designs for standards compliance issues.
- Identify long-term recommendations.
- Calculate manpower requirements for all short-term and long-term concepts.
- Calculate threat requirements including AVB strategy.

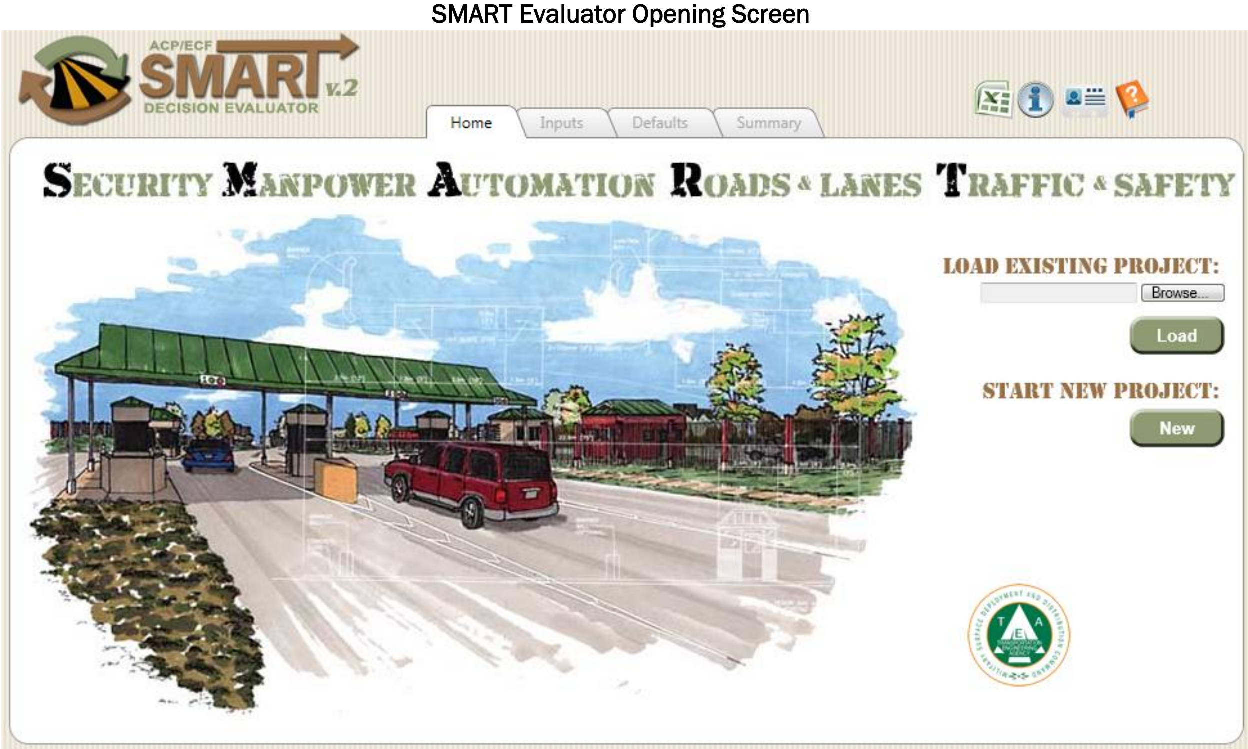
5 Using the ACP/ ECF SMART Decision Evaluator

5.1 Introduction

The *ACP/ECF SMART Decision Evaluator* has been designed to require a minimal amount of data entry. The formulas and equations used in the program are derived from military standards, national transportation engineering practices and economic principals. Results from the *ACP/ECF SMART Decision Evaluator* can be exported to an Excel template for inclusion in other documents or for additional analyses.

The *ACP/ECF SMART Decision Evaluator* should be used under direct supervision and/or in close coordination with SDDCTEA.

SMART Evaluator Opening Screen



5.2 Navigation

When the user opens the program, the Home tab is displayed. From here, the user can either load a previous project or start a new project. There are four tool buttons in the upper-right corner of the Home tab. On all subsequent tabs, five tool buttons are shown in the upper right corner.

To download a preliminary ACP/ECF cost estimator, click the EXCEL button.

To save the project and any entered information, click the SAVE button. This button does not appear in the upper-right corner of the Home tab.

To view background information about SMART, click the INFORMATION button.

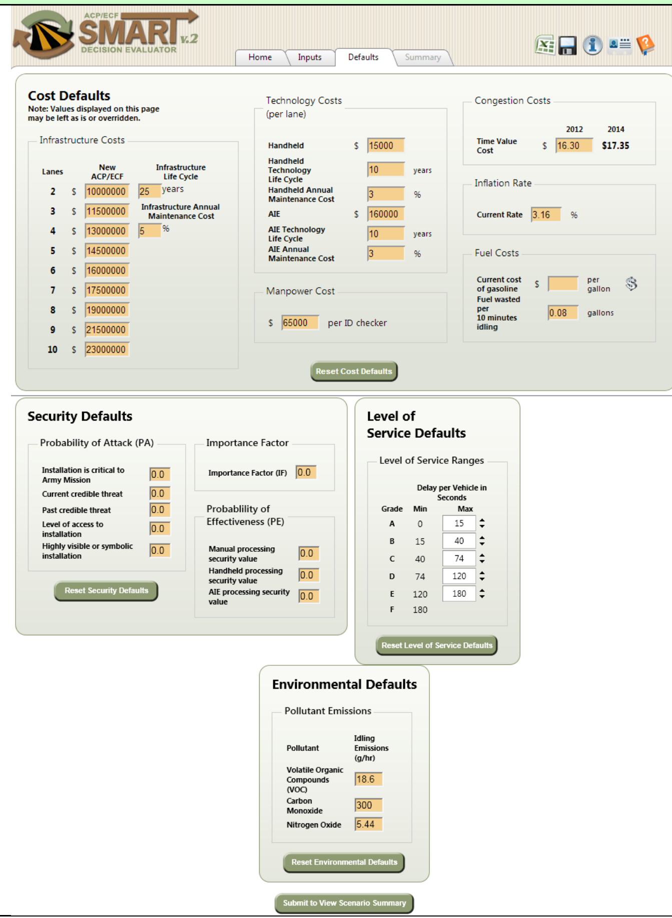
To contact members of the development team, click the CONTACTS button.

To open the user's guide, click the REPORT button.

The following table briefly describes the other tabs shown along the top tool bar. Detailed discussions of each tab are presented in the following sections.

Tab	Functions	Reference
Inputs	• Enter traffic data • Enter existing conditions	

Tab	Functions	Reference

Defaults	The Defaults tab has four sub-tabs:
	• Cost
	    ○ Infrastructure
	    ○ Technology
	    ○ Congestion
	    ○ Manpower
	    ○ Fuel
	    ○ Inflation Rate
	• Security
	    ○ Probability of Attack
	    ○ Probability of Effectiveness
	    ○ Importance Factor
	• Level of Service
	• Environmental
	    ○ Pollutant Emissions
		

Tab	Functions	Reference
Summary	• Display results • Export results to MS Excel	(see tables below)

Design Demand 400 vph	Existing Conditions	User-Defined Conditions (Select / Clear)	Methods Applied to Existing Lanes: Handheld Processing	AIE Processing: No Arms	AIE Processing: With Arms
Number of Lanes	**1**		**1**	**1**	**1**
Traffic Queue (vehicles)	16		25	10	20
Additional Manpower Needed					
Infrastructure Cost					
Annualized Infrastructure Cost					
Annualized Infrastructure Maintenance Cost	$21,921		$21,921	$21,921	$21,921
Annualized Congestion Cost	$574		$1,400	$187	$941
Annualized Manpower Cost	$69,173		$69,173	$69,173	$69,173
Technology Cost	$0		$15,000	$160,000	$160,000
Annualized Technology Cost	$0		$1,773	$18,910	$18,910
Annualized Technology Maintenance Cost	$0		$53	$567	$567
Annualized Cost of Wasted Fuel	$48		$116	$16	$78
Annual Carbon Monoxide Emissions (g)	1,586,489		3,865,796	516,420	2,600,379
Annual Nitrogen Oxide Emissions (g)	28,768		70,100	9,364	47,154
Annual Volatile Organic Compound Emissions (g)	98,362		239,679	32,018	161,223
Crash Reduction Benefit to Cost Ratio	N/A		N/A	N/A	N/A
Traffic Benefit to Cost Ratio	0		0	0.02	0
Traffic Level of Service	F		F	C	F
Total Annual Costs	**$91,716**		**$94,436**	**$110,774**	**$111,590**
Risk Score	0.000		0.000	0.000	0.000
Select Scenario					

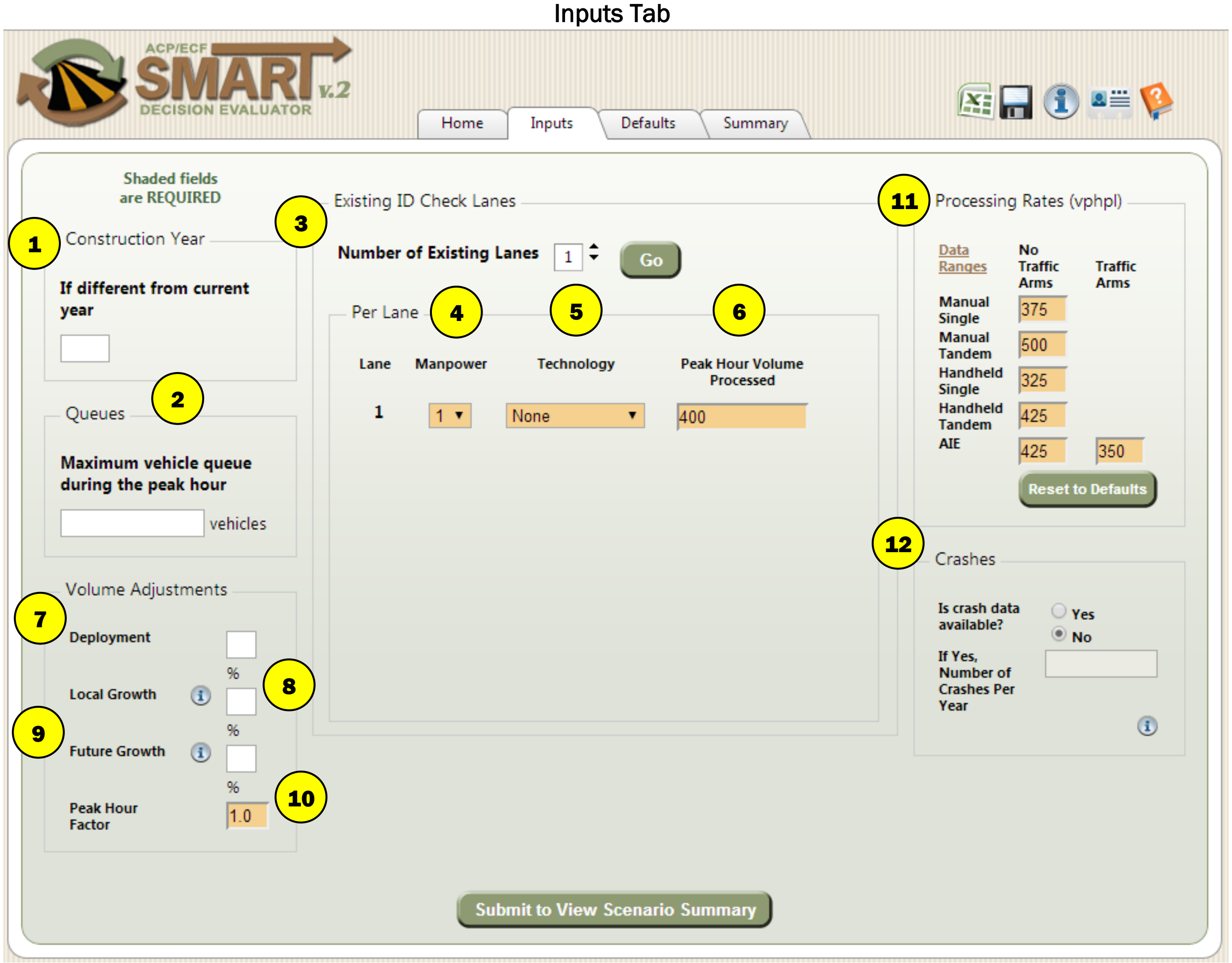
Methods Applied with Needed Lanes to Achieve LOS D

	Manual Processing: Single	Manual Processing: Tandem	Handheld Processing: Single	Handheld Processing: Tandem	AIE Processing: No Arms	AIE Processing: With Arms
Total Lanes Needed	**1**	**1**	**1**	**1**	**1**	**1**
Traffic Queue (vehicles)	3	5	4	10	10	4
Additional Manpower Needed	1	1	1	1	0	1
Infrastructure Cost	$10,000,000	$0	$10,000,000	$0	$0	$10,000,000
Annualized Infrastructure Cost	$584,565	$0	$584,565	$0	$0	$584,565
Annualized Infrastructure Maintenance Cost	$29,228	$0	$29,228	$0	$0	$29,228
Annualized Congestion Cost	$8,934	$13,175	$10,462	$29,860	$29,860	$9,597
Annualized Manpower Cost	$814	$814	$814	$814	$407	$814
Technology Cost	$0	$0	$30,000	$15,000	$160,000	$320,000
Annualized Technology Cost	$0	$0	$1,754	$1,754	$18,706	$37,412
Annualized Technology Maintenance Cost	$0	$0	$106	$53	$567	$1,135
Annualized Cost of Wasted Fuel	$742	$1,094	$868	$2,479	$2,479	$797
Annual Carbon Monoxide Emissions (g)	154,509	227,858	180,933	516,420	516,420	165,977
Annual Nitrogen Oxide Emissions (g)	2,802	4,132	3,281	9,364	9,364	3,010
Annual Volatile Organic Compound Emissions (g)	9,580	14,127	11,218	32,018	32,018	10,291
Crash Reduction Benefit to Cost Ratio	N/A	N/A	N/A	N/A	N/A	N/A
Traffic Benefit to Cost Ratio	0	0.15	0	0.36	0.44	0
Traffic Level of Service	B	B	B	C	C	B
Total Annual Costs	**$624,283**	**$15,083**	**$627,797**	**$34,960**	**$52,019**	**$663,548**
Risk Score	0.000	0.000	0.000	0.000	0.000	0.000
Select Scenario						

5.3 Inputs Tab

On this tab, the user enters traffic data and existing conditions information so that design demand, costs and other metrics can be calculated.

Inputs Tab



Traffic Inputs Descriptions			
Field	**Name**	**Description**	**Unit of Measure**
1	Construction Year	Enter the anticipated year of gate construction, if different from the current year.	Year
2	Maximum vehicle queue during the peak hour	The maximum number of vehicles queued (backed up) approaching the ID check area during the peak hour.	Vehicles
3	Number of Existing Lanes	The number of existing lanes used for ID checks during the peak hour. The user must click the “Go” button after entering the number of existing lanes to update the screen and enter values for Fields 4-6.	Lanes
4	Manpower	The number of guards (ID checkers) in that lane during the peak hour.	People
5	Technology	This is technology utilized during ID checks in order to enhance security and/ or reduce manpower. Typical technologies deployed include AIE (also known as trusted traveler, phantom express, smart gate, etc.) and Handheld (also known as DBIDS, IACS, etc.)	NA
6	Peak Hour Volume Processed	The busiest one-hour volume of traffic processed in that lane.	Vehicles
7	Deployment	Percent of total base population deployed and not part of normal traffic conditions during the time of peak hour volume data collection. Example: If 20 percent of the installation's population is deployed away from the installation, enter 20.	Percent
8	Local Growth	Total planned development outside the installation that may affect the traffic demand utilizing the ACP/ECF, given as a percentage of the total existing gate volume. Example: a proposed off-base shopping center is expected to generate 5 percent more traffic through the ACP/ECF.	Percent
9	Future Growth	Total planned installation growth (BRAC, mission changes, etc) that will increase the total installation traffic, given as a percentage of the total existing gate volume. Example: due to BRAC, the installation traffic is expected to increase by 12 percent in the next seven years.	Percent
10	Peak Hour Factor	The peak hour factor represents the distribution of the traffic volume during the peak hour based on 15-minute intervals. A peak hour factor of 1.00 means that the volumes are evenly distributed throughout the four 15-minute intervals, while a factor of 0.25 means that all of the hourly traffic arrived within one 15 minute interval.	Number between 0.25 and 1.00
11	Processing Rates	The maximum volume of traffic per ID check lane that can be accommodated during the peak hour. The processing rates vary depending on the type of processing. Click “Data Ranges” to see a table of the ranges of processing values for various processing techniques from Pamphlet 55-15. The default values should be used if you are not sure, or consult SDDCTEA.	Vehicles per hour per lane (vphpl)

Traffic Inputs Descriptions			
Field	**Name**	**Description**	**Unit of Measure**
12	Crashes	Is crash data available for the approach inbound lanes of the ACP/ECF? If yes, enter the total number of crashes per year.	Number

After entering the traffic input data, the settings for security, cost, and environmental factors can be changed in the Default tab. If the default settings do not need to be adjusted, click the SUBMIT TO VIEW SCENARIO SUMMARY button Submit to View Scenario Summary.

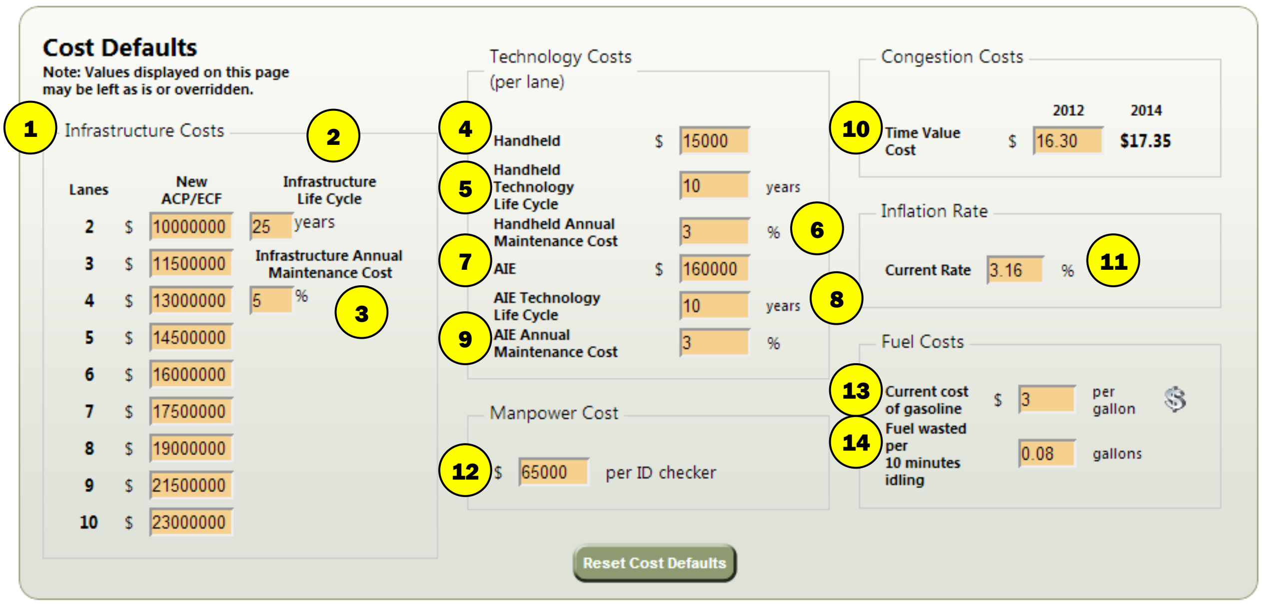
5.4 Defaults Tab

On the Defaults tab, these default costs are retrieved from the software's host site, and may be update periodically by SDDCTEA. You may override these defaults as necessary based on the installation’s specific conditions.

5.4.1 Cost Defaults

The Cost Defaults are located at the top of the Defaults tab. These factors affect the calculation of all costs, both annual and total, shown on the Summary tab.

Cost Defaults (Part of Defaults Tab)



Cost Defaults Descriptions			
Field	**Name**	**Description**	**Unit of Measure**
1	Infrastructure Costs	The average cost for a new ACP/ECF as a function of ID check lanes. Default values were generated using the ACP/ECF cost estimate template developed by USACE-PDC (October 2010). ACP/ECF costs may vary greatly depending on site-specific conditions.	U.S. Dollars
2	Infrastructure Life Cycle	Estimated life of infrastructure improvements at an ACP/ECF to be used to annualize costs and benefits.	Years
3	Infrastructure Annual Maintenance Cost	Estimated annual maintenance costs stated as a percent of infrastructure costs.	Percent

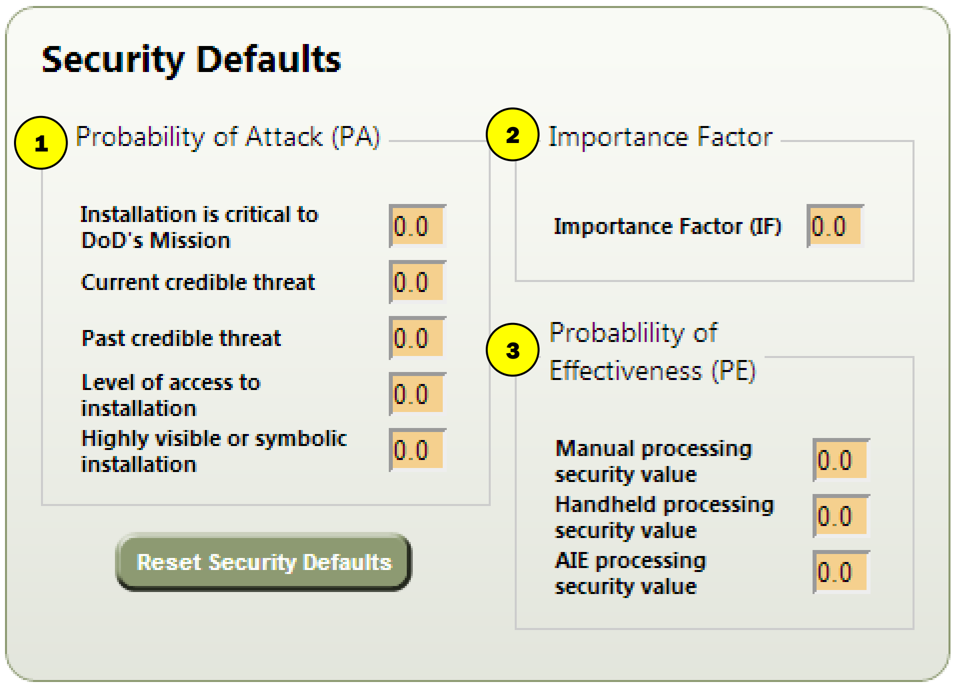
Cost Defaults Descriptions			
Field	**Name**	**Description**	**Unit of Measure**
4	Handheld Costs	The average cost per lane to equip an ACP/ECF with handheld technologies.	U.S. Dollars
5	Handheld Life Cycle	Estimated life of handheld technologies at an ACP/ECF.	Years
6	Handheld Annual Maintenance Cost	Estimated annual maintenance costs stated in percent of handheld technology capital costs.	Percent
7	AIE Costs	The average cost per lane to equip an ACP/ECF with AIE technologies.	U.S. Dollars
8	AIE Life Cycle	Estimated life of AIE technologies at an ACP/ECF.	Years
9	AIE Annual Maintenance Cost	Estimated annual maintenance costs stated in percent of AIE technology capital costs.	Percent
10	Time Value Cost	The estimated value of a motorist's lost productivity due to time spent in congestion.	U.S. Dollars per hour
11	Inflation Rate	A persistent, substantial rise in the general level of prices related to an increase in the volume of money and resulting in the loss of value of currency.	Percent
12	Manpower Costs	The yearly cost per guard assigned to ID checks at an ACP/ECF.	U.S. Dollars per year
13	Current Cost of Gasoline	Nationwide average cost of gasoline, which can be obtained by clicking on $. This icon links to http://fuelgaugereport.aaa.com/.	U.S. Dollars per gallon
14	Fuel Wasted per 10 Minutes Idling	Amount of fuel wasted, in gallons, for every 10 minutes of idling.	Gallons per 10 minutes

The RESET COST DEFAULTS button Reset Cost Defaults can be used at any time to reset all the cost variables to their default values. This will change all the factors in the cost section and cannot be undone, expect by re-entering the overrides.

5.4.2 Security Defaults

The Security Defaults are located at the bottom left of the Defaults tab. These factors are used to calculate the risk score that is shown in the Summary tab.

Security Defaults (Part of Defaults Tab)



Security Defaults Descriptions			
Field	**Name**	**Description**	**Range of Values**
1	Probability of Attack	A measure of the relative probability or likelihood of the threat of person(s) attempting to use a false credential to gain access to the installation occurring. **The calculations of the default factor are detailed in Appendix A. It is acceptable to override these values, if more detailed and specific information is available.**	Between 0.0 and 1.0
2	Importance Factor	Importance Factor is defined as a measure of the magnitude of importance of the installation's operation to the DOD's mission and of the consequences if the installation's operations were compromised due to a security breach. It is equivalent to the concept of "Consequence" in standard risk calculation methodologies. **The calculation of the default factor is detailed in Appendix A. It is acceptable to override this value, if more detailed and specific information is available.**	Between 0.0 and 1.0
3	Probability of Effectiveness	A measure of the effectiveness of various credential validation strategies at recognizing the use of false credentials. **The calculations of the default factors are detailed in Appendix A. It is acceptable to override these values if more detailed and specific information is available.**	Between 0.0 and 1.0

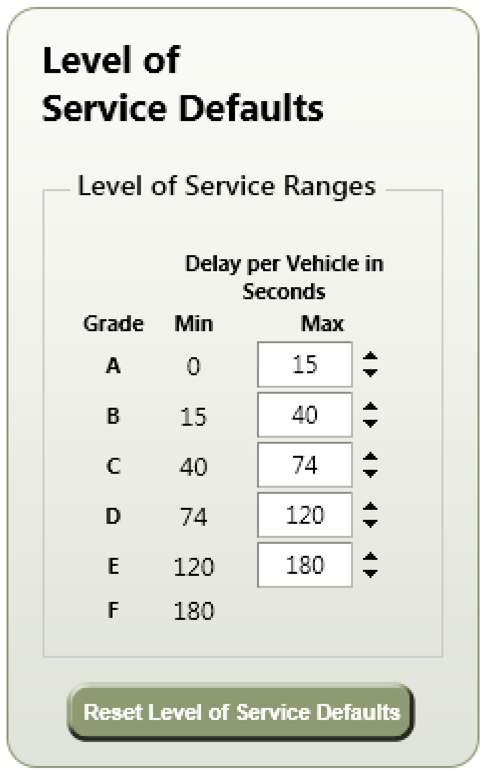
The RESET SECURITY DEFAULTS button 

can be used at any time to reset all the security factors to their default values. This will change all the factors in the security section and cannot be undone, expect by re-entering the overrides.

5.4.3 Level of Service Defaults

The Level of Service Defaults are located in the middle of the Defaults tab. These factors are used to determine the traffic level of service that is shown in the Summary tab.

Level of Service Defaults (Part of Defaults Tab)



The level of service defaults allows the user to adjust the delay per vehicle threshold values for each letter grade.

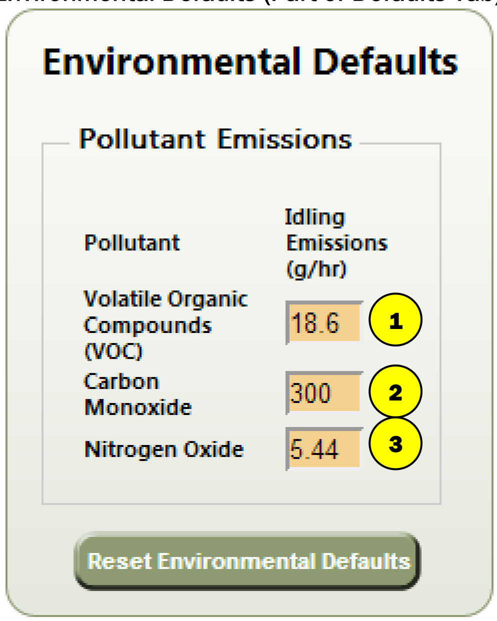
The RESET LEVEL OF SERVICE button 

can be used at any time to reset all the level of service ranges to their default values. This will change all the factors in the level of service section and cannot be undone, expect by re-entering the overrides.

5.4.4 *Environmental Defaults*

The Environmental Defaults are located at the bottom right of the Defaults tab. These factors affect the calculation of annual emissions shown on the Summary tab.

Environmental Defaults (Part of Defaults Tab)



Environmental Defaults Descriptions			
Field	**Name**	**Description**	**Unit of Measure**
1	Volatile Organic Compounds (VOC) Idling Emissions	Volatile organic compound emission rate, in grams, per hour of vehicle idling time.	Grams per hour of idling
2	Carbon Monoxide Idling Emissions	Carbon monoxide emission rate, in grams, per hour of vehicle idling time.	Grams per hour of idling
3	Nitrogen Oxide Idling Emissions	Nitrogen oxide emission rate, in grams, per hour of vehicle idling time.	Grams per hour of idling

The RESET ENVIRONMENTAL DEFAULTS button 

can be used at any time to reset all the environmental variables to their default values. This will change all the factors in the environmental section and cannot be undone, expect by re-entering the overrides.

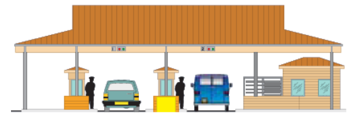
5.5 Summary Tab

The Summary tab is intended to provide a comprehensive summary based on the data input. The Summary tab returns results for four key conditions:

1. Existing conditions
2. User-defined conditions
3. Implementation of technologies (handheld or AIE) under existing lane conditions
4. Ideal operating conditions for manual, handheld and AIE conditions.

User-defined conditions allow the user to select the number of ID check lanes, manpower and type of processing technology used at the ACP/ECF. By entering the user-defined conditions, the user can study the costs and consequences of providing processing conditions that are less-than-ideal. Ideal operating conditions show the number of lanes and manpower required for the ACP/ECF to operate at a level of service D during the peak hour. Per the 2012 Army Standard for ACPs, the required traffic engineering study to be completed prior to planning, design or construction of a new ACP/ECF, or prior to modification of an existing ACP/ECF, must identify the number of ID check lanes associated with LOS D.

By providing results for these conditions, practitioners can forecast ideal operating conditions, and consider the ramification of implementing technologies under existing conditions or a user-defined scenario. The values shown in the Summary tab are briefly described starting on Page 31. Detailed methodologies for calculating the results are discussed in Section 6.



Summary Tab

Design Demand 400 vph	Existing Conditions	User-Defined Conditions	Methods Applied to Existing Lanes		
		Select / Clear	Handheld Processing	AIE Processing	
				No Arms	With Arms
Number of Lanes	**1**		**1**	**1**	**1**
Traffic Queue (vehicles)	16		25	10	20
Additional Manpower Needed					
Infrastructure Cost					
Annualized Infrastructure Cost					
Annualized Infrastructure Maintenance Cost	$21,921		$21,921	$21,921	$21,921
Annualized Congestion Cost	$574		$1,400	$187	$941
Annualized Manpower Cost	$69,173		$69,173	$69,173	$69,173
Technology Cost	$0		$15,000	$160,000	$160,000
Annualized Technology Cost	$0		$1,773	$18,910	$18,910
Annualized Technology Maintenance Cost	$0		$53	$567	$567
Annualized Cost of Wasted Fuel	$48		$116	$16	$78
Annual Carbon Monoxide Emissions (g)	1,586,489		3,865,796	516,420	2,600,379
Annual Nitrogen Oxide Emissions (g)	28,768		70,100	9,364	47,154
Annual Volatile Organic Compound Emissions (g)	98,362		239,679	32,018	161,223
Crash Reduction Benefit to Cost Ratio	N/A		N/A	N/A	N/A
Traffic Benefit to Cost Ratio	0		0	0.02	0
Traffic Level of Service	F		F	C	F
Total Annual Costs	**$91,716**		**$94,436**	**$110,774**	**$111,590**
Risk Score	**0.000**		**0.000**	**0.000**	**0.000**
Select Scenario					

Summary Tab (continued)

	Methods Applied with Needed Lanes to Achieve LOS D					
	Manual Processing		Handheld Processing		AIE Processing	
	Single	Tandem	Single	Tandem	No Arms	With Arms
Total Lanes Needed	**1**	**1**	**1**	**1**	**1**	**1**
Traffic Queue (vehicles)	3	5	4	10	10	4
Additional Manpower Needed	1	1	1	1	0	1
Infrastructure Cost	$10,000,000	$0	$10,000,000	$0	$0	$10,000,000
Annualized Infrastructure Cost	$584,565	$0	$584,565	$0	$0	$584,565
Annualized Infrastructure Maintenance Cost	$29,228	$0	$29,228	$0	$0	$29,228
Annualized Congestion Cost	$8,934	$13,175	$10,462	$29,860	$29,860	$9,597
Annualized Manpower Cost	$814	$814	$814	$814	$407	$814
Technology Cost	$0	$0	$30,000	$15,000	$160,000	$320,000
Annualized Technology Cost	$0	$0	$1,754	$1,754	$18,706	$37,412
Annualized Technology Maintenance Cost	$0	$0	$106	$53	$567	$1,135
Annualized Cost of Wasted Fuel	$742	$1,094	$868	$2,479	$2,479	$797
Annual Carbon Monoxide Emissions (g)	154,509	227,858	180,933	516,420	516,420	165,977
Annual Nitrogen Oxide Emissions (g)	2,802	4,132	3,281	9,364	9,364	3,010
Annual Volatile Organic Compound Emissions (g)	9,580	14,127	11,218	32,018	32,018	10,291
Crash Reduction Benefit to Cost Ratio	N/A	N/A	N/A	N/A	N/A	N/A
Traffic Benefit to Cost Ratio	0	0.15	0	0.36	0.44	0
Traffic Level of Service	B	B	B	C	C	B
Total Annual Costs	**$624,283**	**$15,083**	**$627,797**	**$34,960**	**$52,019**	**$663,548**
Risk Score	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Select Scenario	○	○	○	○	○	○

Export to Excel

Evaluation Summary Descriptions		
Name	**Description**	**Unit of Measure**
Design Demand	Future traffic volume used in determining the results for existing, user-defined, existing with technologies implemented and ideal conditions.	Vehicles per hour
Number of Lanes	The number of existing lanes at the ACP/ECF as entered on the Input tab or the number of lanes as entered for the user-defined scenario.	Lanes
Total Lanes Needed	Equal to the number of lanes needed at the ACP/ECF to achieve ideal operating conditions.	Lanes
Traffic Queue	The calculated total number of vehicles queued approaching the ID check area.	Vehicles
Additional Manpower Needed	The additional amount of guards (ID checkers) needed during the peak hour to support the scenario being evaluated.	People
Infrastructure Cost	Estimated capital costs for constructing the infrastructure.	Dollars
Annualized Infrastructure Cost	Estimated annualized costs for constructing the infrastructure.	Dollars per year
Annualized Infrastructure Maintenance Cost	Annual cost of maintenance for infrastructure based on percentage of capital costs. Percentage is defined on the Defaults tab.	Dollars per year
Annualized Congestion Cost	The cost of delay incurred by the future design demand during the morning peak hour over the course of a work year.	Dollars per year
Annualized Manpower Cost	The annualized cost of the total manpower needed.	Dollars per year
Technology Cost	Estimated capital cost to implement technology.	Dollars
Annualized Technology Cost	Estimated annualized cost to implement technology.	Dollars per year
Annualized Technology Maintenance Cost	Annual costs of maintenance for technology based on percentage of capital costs of technology. Percentage is defined on the Defaults tab.	Dollars per year
Annualized Cost of Wasted Fuel	Annual cost of wasted fuel due to idling caused by delay.	Dollars per year
Annual Carbon Monoxide Emissions	Annual carbon monoxide emissions, in grams, due to idling caused by delay.	Grams per year
Annual Nitrogen Oxide Emissions	Annual nitrogen oxide emissions, in grams, due to idling caused by delay.	Grams per year

Evaluation Summary Descriptions		
Name	**Description**	**Unit of Measure**
Annual Volatile Organic Compound Emissions	Annual volatile organic compound emissions, in grams, due to idling caused by delay.	Grams per year
Crash Reduction Benefit to Cost Ratio	The anticipated cost savings of a reduction in crashes due to a properly designed ACP/ECF, divided by the additional cost to implement the scenario compared to the cost to operate the existing scenario. A value greater than 1.0 means the scenario is beneficial to implement strictly from a safety aspect.	NA
Traffic Benefit to Cost Ratio	The cost savings of implementing the scenario (savings in the cost of wasted fuel and congestion cost compared to the existing scenario) divided by the additional cost to implement the scenario compared to the cost to operate the existing scenario. A value greater than 1.0 means the scenario is worthwhile to implement, because the savings in the cost of wasted fuel and delay is greater than the additional cost to implement the scenario.	NA
Traffic Level of Service	Measure used to determine the effectiveness of the infrastructure. LOS describes the operational condition of the ACP/ECF and falls into one of six categories, A through F. LOS A represents operating conditions with relatively little congestion, while LOS F represents operating conditions with extreme delay with queuing and driver discomfort.	NA
Total Annual Costs	Sum of annual infrastructure maintenance, congestion, manpower, technology, technology maintenance, wasted fuel, and construction costs.	Dollars per year
Risk Score	Risk score is the relative risk of using manual, handheld, and automated processing techniques to verify credentials. Relative risk is the risk of an event occurring relative to exposure. It is a ratio of the probability of the event occurring in one group versus a control group. In this case, the control group is manual credential checking by a guard.	NA
Select Scenario	Radio button that allows the user to choose the preferred scenario to be displayed on the Executive Summary tab when the project is exported to Excel. The Export to Excel button is displayed at the bottom of the page once a scenario is selected.	NA

5.6 Exporting Data

After the information is calculated, it can be exported to an Excel template. The user must select a preferred scenario by clicking its associated radio button and then the EXPORT TO EXCEL button Export to Excel will appear. The user can download the Excel file by clicking on the EXPORT TO EXCEL button. When the file is opened, message boxes will appear asking the user to fill in the gate name, installation, and location. After all information is exported, the user can save the Excel file and print the report.

6 Methodology

This section provides detailed explanations of the equations and methodology used in the *ACP/ECF SMART Decision Evaluator*.

6.1 Design Demand

The design demand is the expected volume of traffic during times of peak demand for the design year of the ACP/ECF. Usually, the time of peak demand is during the morning peak hour, but other events at the installation may dictate using a different basis.

The design demand is calculated using the existing peak hour volume processed, existing maximum vehicle queue during the peak hour and volume adjustments, all of which are entered by the user on the Inputs tab.

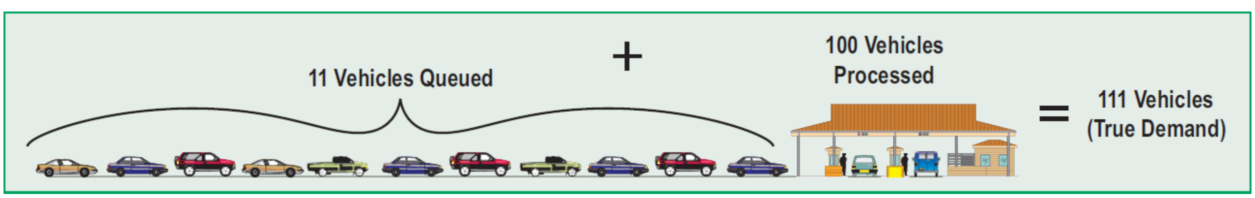
6.1.1 Peak Hour Volume Processed

The number of vehicles processed during the peak hour is used as the baseline volume for determining the design demand. If vehicle volumes are recorded in 15-minute intervals, the peak hour factor (PHF) should be taken into account to provide a conservative design. Peak hour factor is explained in Section 6.1.3.

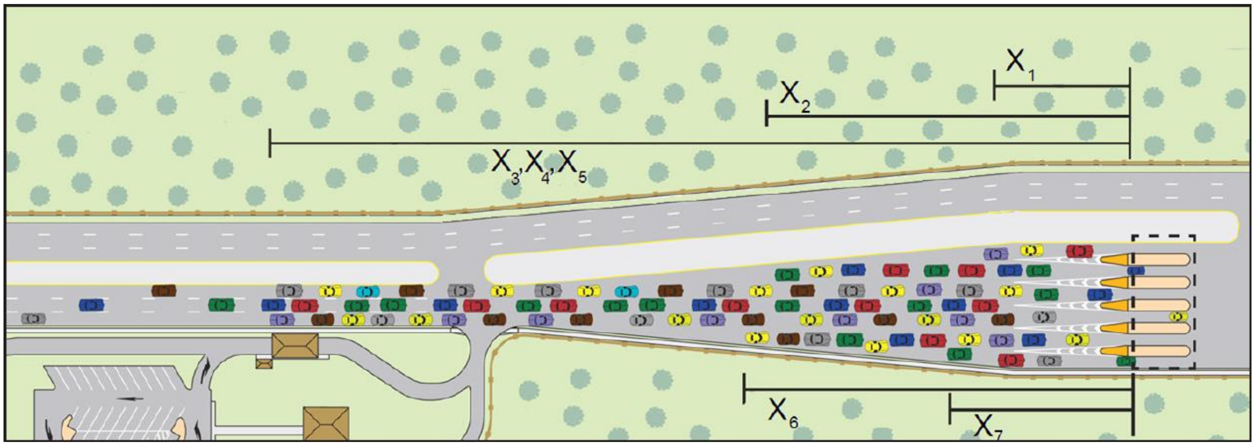
6.1.2 Maximum Vehicle Queue

Due to the nature of random arrivals of vehicles, traffic queues at an ACP/ECF will always be anticipated. The ACP/ECF designer's job is to account for traffic queues based on field observations in order to provide a future ACP/ECF design that allows the queued vehicles to gain secure and safe access without excessive delays.

To determine the existing vehicle queue, count the number of vehicles that were not processed for each 15-minute increment during the peak hour and add the maximum queue to the number of vehicles that were processed to determine the true demand.



If the 15-minute increment vehicle queue extends beyond the limit of sight and cannot be counted by field personnel, note an object in the field where the vehicle queue begins. Measure the distance from the ID check point to the object noted in the field remembering to add the distance of additional lanes and transitions where appropriate. (Note: Distance can be measured in the field or on aerial mapping). Divide the summation of each 15-minute queue distance by 25 feet (approximate length of POV and space between queued vehicles) to determine the approximate number of vehicles in the queue.



$$Number\ of\ Queued\ Vehicles = \frac{Total\ Length\ of\ Queue}{25\ feet}$$

6.1.3 Volume Adjustments

<u>Deployment</u>

Traffic data should be collected when the installation population is at a “normal” condition. Periods of significant deployments should be avoided, but military missions may make it unavoidable. When there are significant deployments, normal demand can be calculated if the deployment percentage is known.

<u>Local Growth</u>

Local growth is the total planned development outside the installation that may affect the traffic demand using the ACP/ECF.

<u>Future Growth</u>

Future growth is the total planned installation growth that will increase traffic demand at the ACP/ECF.

<u>Peak Hour Factor (PHF)</u>

The peak hour factor represents the distribution of traffic volume during the peak hour based on 15-minute intervals. The closer the PHF is to 1.00 means that the traffic volumes are constant throughout the peak hour. A peak hour factor of 0.25 means that traffic was inconsistent during the hour. The PHF is calculated using the following formula.

$$PHF = \frac{V}{4 * V_{15}}$$

Where,

V = peak hour volume (vph)
V_{15} = highest peak 15-minute volume (veh/15 min)

If traffic data is not available to calculate the PHF, the *ACP/ECF SMART Decision Evaluator* assumes a value of 1.00.

6.1.4 Calculating Design Demand

The table below shows a detailed example of calculating the design demand.

Line	Field	Calculation	Example Calculation	Example Value
1	Total Peak Hour Volume Processed			1200
2	Peak Hour Factor	See 6.1	1200 / (4 *300)	1.00
3	Maximum 15-minute Queue in Peak Hour			150
4	TOTAL EXISTING DEMAND	Line 1 / Line 2 + Line 3	1200 /1.00 + 150	1350
5	Deployment Adjustment [DA] *Percent of Total Base Population Deployed*	100% / (100% - DA%)	100% / (100% - 10%)	10% deployment = 1.11
6	TOTAL ADJUSTED EXISTING DEMAND	Line 4 * Line 5	1350 * 1.11	1498
7	Local Growth at ECF [LG] *Percent of Estimated Local Growth*	(100% + LG%) / 100%	(100% + 5%) / 100%	5% local growth = 1.05
8	Future Growth [FG] *Percent of Estimated Future Growth*	(100% + FG%) / 100%	(100% + 8%) / 100%	8% future growth = 1.08
9	DESIGN DEMAND	Line 6 * Line 7 * Line 8	1498 * 1.05 * 1.08	1699

The following equation is used by the *ACP/ECF SMART Decision Evaluator* to calculate design demand:

$$Design\ Demand = \left(\frac{\sum_{j=1}^{All\ Lanes} Lane\ j\ Peak\ Hour\ Volume}{Peak\ Hour\ Factor} + Max\ Queue\right) * \frac{100}{100 - Deployment\ \%} * \frac{100 + Local\ Growth\ \%}{100} * \frac{100 + Future\ Growth\ \%}{100}$$

6.2 Needed Lanes

To accurately size an ACP/ECF, a lane-processing rate must be assumed. SDDCTEA has collected significant data from over 200 ACP/ECF assessments, which has been used to establish criteria regarding capacity and processing rates at ACPs/ECFs.

The *ACP/ECF SMART Decision Evaluator* considers three processing/credentialing techniques:

1. Manual Checks
2. Handheld Device Checks
3. Automated Lanes (AIE)

Each processing/credentialing technique is influenced by several variables, which are described in the following table:

<table>
<tr><th>Influences</th><th>Manual Checks</th><th>Handheld Device Checks</th><th>Automated Lanes (AIE)</th></tr>
<tr><td>Manpower</td><td colspan="2">▪ Under Manual and Handheld Device Checks, additional guards can be added per lane to increase design processing rates (throughput).
▪ SDDCTEA has concluded that providing more than three guards per lane provides little if any benefit and may be a misuse of resources.
▪ In general, it is more efficient to use two guards with one in each lane versus using two guards in one lane; however, the cost of additional infrastructure needs to be compared with the efficiency of processing and best use of manpower.
▪ In summary, the best use of manpower to gain efficiency is to add lanes if possible, but infrastructure constraints may dictated that tandem processing be utilized.</td><td>▪ Automated processing may reduce manpower requirements.</td></tr>
<tr><td>Signage</td><td colspan="3">▪ Lane use signing can improve processing and operations by clearly defining what type of processing is used at each lane. This is especially true at locations where there is a mix of manual/handheld lanes and automated lanes.
▪ ACPs/ECFs with proper (MUTCD/SDDCTEA compliant) signs will be more efficient since there will be less driver confusion.</td></tr>
<tr><td>Card Scanning</td><td>▪ Not applicable</td><td colspan="2">▪ Card reading/authentication delays can have a negative impact on processing.
▪ Driver education can assist in promoting awareness of card care, as well as to increase driver readiness and understanding on how to interact with the automated systems.
▪ Next generation CAC card systems should authenticate in equal or less time than existing systems if possible; otherwise, future card types may disrupt processing efficiency.</td></tr>
<tr><td>Traffic Arm Utilization</td><td colspan="2">▪ While it is acceptable to assume that traffic arms may be utilized for non-peak periods, design assumptions should be based on non-arm usage for peak periods.
▪ The use of traffic arms during peak periods should not be justification for constructing additional lanes.</td><td>▪ While the use of traffic arms provides a level of active traffic control, their usage adds approximately 2 seconds of processing time per vehicle.
▪ “Open-arm” operations may reduce the ability to control traffic (thus possibly reducing security benefits), but would promote more efficient processing.
▪ Consider “up/down” operations at locations where congestion is not an issue and where there are sufficient lanes, but consider “open-arm” operations at installations where congestion exists and there are limited expansion possibilities.</td></tr>
<tr><td>FPCON</td><td colspan="3">▪ FPCON can have a significant impact on processing rate due to the variations in processing.
▪ The goal of the ACP/ ECF should be to result in little or no delay under FPCON Bravo+ conditions.
▪ It is not practical to design for FPCON Delta. It should be assumed that under FPCON Delta, that only mission essential personnel will be permitted to enter and that alternative travel measures may be required.</td></tr>
</table>

The data presented below shows a range of values that were used to establish the default processing rates used in the *ACP/ECF SMART Decision Evaluator*.

PROCESSING TECHNIQUE	MANUAL CHECKS		CHECKS USING HANDHELD DEVICES		AUTOMATED LANES	
	SINGLE LANE CHECKS	TANDEM LANE CHECKS	SINGLE LANE CHECKS	TANDEM LANE CHECKS	WITHOUT TRAFFIC ARMS	WITH TRAFFIC ARMS (UP/DOWN FOR EACH VEHICLE)
	vphpl	vphpl	vphpl	vphpl	vphpl	vphpl
Vehicle identification only	800 to 1,400	NA	NA	NA	800 to 1,400	550 to 800
Vehicle and occupant identification[4]	300 to 450	400 to 600	275 to 375	350 to 475	400 to 450	325 to 350
Inspection of mission essential vehicles only	20 to 120	NA	20 to 120	NA	NA	NA

Design Conditions

It is not uncommon to experience rates outside these ranges; however, these rates are often affected by influences described previously. Measured rates greatly exceeding those shown are often associated with a generally relaxed posture that typically includes only vehicle identification. It should be remembered that the design basis for ACPs/ECFs should be vehicle and occupant identification.[4]

SDDCTEA has concluded that providing more than three ID checkers per lane provides little, if any benefit, and may be a misuse of resources. Furthermore, it is more efficient to use two ID checkers with one in each lane versus using two ID checkers in one lane. Still, the *ACP/ECF SMART Decision Evaluator* allows a user to choose triple or quadruple processing. In general, the program assumes triple processing is equal to 1.167 times the tandem processing rate and quadruple processing is 0.875 times the tandem processing rate.

The following equation is used by the *ACP/ECF SMART Decision Evaluator* to calculate the number of lanes needed for ideal operating conditions (lanes needed to achieve LOS D).

$$Lanes\ Needed = \frac{Design\ Demand}{\sum_{j=1}^{All\ Lanes} Lane\ j\ Processing\ Rate}$$

Normally, the calculated number of needed lanes will not be a whole number, and in most cases, the number should be rounded up. Sometimes, the number can be rounded down,

[4] SDDCTEA Pamphlet 55-15, *Traffic and Safety Engineering for Better Entry Control Facilities*

as long as the traffic level of service will be a "D" or better. Traffic level of service is discussed in more detail in Section 6.4.2. The *ACP/ECF SMART Decision Evaluator* automatically performs this determination when calculating the number of needed lanes.

6.3 Manpower

An ACP/ECF must have adequate manpower to support efficient processing in ID check lanes. The best use of manpower to gain efficiency is to add lanes, if possible, but infrastructure constraints may dictate that more than one guard be utilized in a lane.

In the Summary Tab, the program displays "Additional Manpower Needed" for a given scenario, which is the amount of manpower required, in addition to or less than, the manpower required to support existing conditions. The equation to calculate additional manpower needed is:

$$Additional\ Manpower\ Needed = \sum_{i=1}^{All\ Lanes} Scenario\ Lane\ i\ Manpower - \sum_{j=1}^{All\ Lanes} Existing\ Lane\ j\ Manpower$$

6.4 Delay per Vehicle and Traffic Level of Service

The most comparable civilian infrastructure to a military ACP/ECF is a tollbooth. Both have approach zones with traffic queues during peak periods. Also, both require driver interaction with a guard or operator, unless an automated technology, such as AIE or EZPass, is utilized. Researchers have already created methods to calculate delay and queues at tollbooths, and these same methods can be applied to ACPs/ECFs.

6.4.1 Peak Hour Delay per Vehicle

In *A Simple Approach to Estimating Changes in Toll Plaza Delays*, Dilruba Ozmen-Ertekin, Kaan Ozbay, Sandeep Mudigonda and Anne Cochran identify a way to calculate toll plaza delay using methods from the Highway Capacity Manual. The research determines that delay per vehicle can be calculated by adding the incremental delay, deceleration delay, service time, acceleration delay and initial queue delay, as expressed in the equation below.

$$\begin{aligned} Delay\ per\ vehicle & \\ &= incremental\ delay + deceleration\ delay + service\ time + acceleration\ delay \\ &+ initial\ queue\ delay \end{aligned}$$

The following sub-sections explain each portion of the delay per vehicle equation, as identified in *A Simple Approach to Estimating Changes in Toll Plaza Delays*. Each quantity is described using ACP/ECF terminology and the equations used to calculate each quantity are presented in each section.

Incremental Delay

Incremental delay is a modified version of the incremental delay equation taken from the Highway Capacity Manual. It represents the incremental delay experienced by each vehicle due to random variations in processing times and vehicle arrivals. Incremental delay is calculated using the following equation:

$$Incremental\ Delay = 900 * \left[(X-1) + \sqrt{(X-1)^2 + \frac{4*X}{\sum_{j=1}^{k} Lane\ j\ Processing\ Rate}}\right]$$

Where,

$$X = \frac{Design\ Demand}{\sum_{j=1}^{All\ Lanes} Lane\ j\ Processing\ Rate}$$

Deceleration Delay

Deceleration delay is the extra travel time incurred for drivers to decelerate from free flow speed, assumed to be 25 mph (11.18 m/s) at ACPs/ECFs, to a stop at the ID check. According to the following calculation, deceleration delay is equal to 2.33 seconds.

$$Deceleration\ Delay = \frac{(Free\ flow\ speed - speed\ at\ ID\ check)^2}{2 * deceleration\ rate * free\ flow\ speed} = \frac{(11.18-0)^2}{2*2.4*11.18} = 2.33\ s$$

The deceleration rate was assumed as 7.87 ft/s^2 (2.4 m/s^2), per *A Simple Approach to Estimating Changes in Toll Plaza Delays*.

Service Time

Service time is the time required for a vehicle to be processed. It is calculated using the following equation.

$$Service\ time = \frac{\sum_{j=1}^{All\ Lanes}\left(3600/_{Lane\ j\ Processing\ Rate} * Lane\ j\ Peak\ Hour\ Volume\right)}{\sum_{i=1}^{All\ Lanes} Lane\ i\ Peak\ Hour\ Volume}$$

Acceleration Delay

Acceleration delay is extra travel time incurred while drivers accelerate back to free flow speed (25 mph or 11.18 m/s) after being stopped at the ID check. According to the following calculation, acceleration delay is equal to 3.77 seconds.

$$Acceleration\ Delay = \frac{(Free\ flow\ speed - speed\ at\ ID\ check)^2}{2 * acceleration\ rate * free\ flow\ speed} = \frac{(11.18-0)^2}{2*1.5*11.18} = 3.77$$

The acceleration rate was assumed as 4.92 ft/s^2 (1.5 m/s^2), per *A Simple Approach to Estimating Changes in Toll Plaza Delays*.

Initial Queue Delay

Initial queue delay is delay due to the presence of initial queues at the ACP/ECF at the start of the peak hour. For simplicity, this value is assumed to be zero in the *ACP/ECF SMART Decision Evaluator.*

Delay per Vehicle Calculation

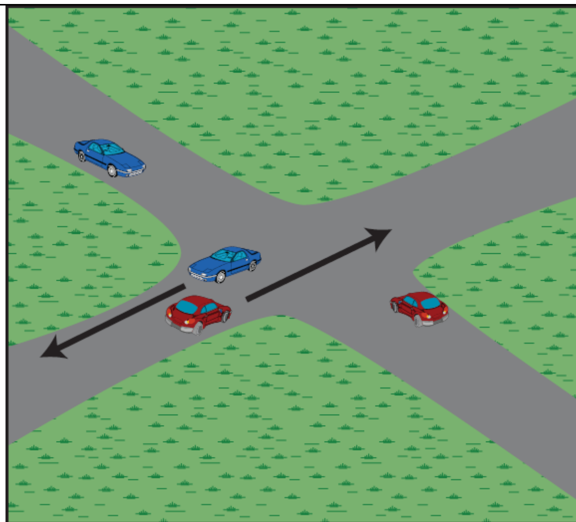
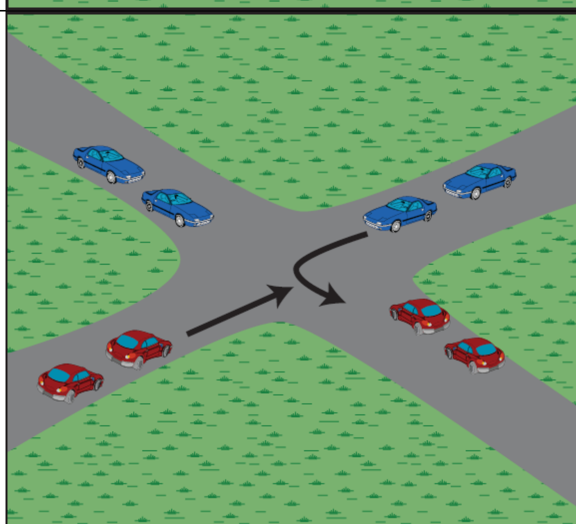
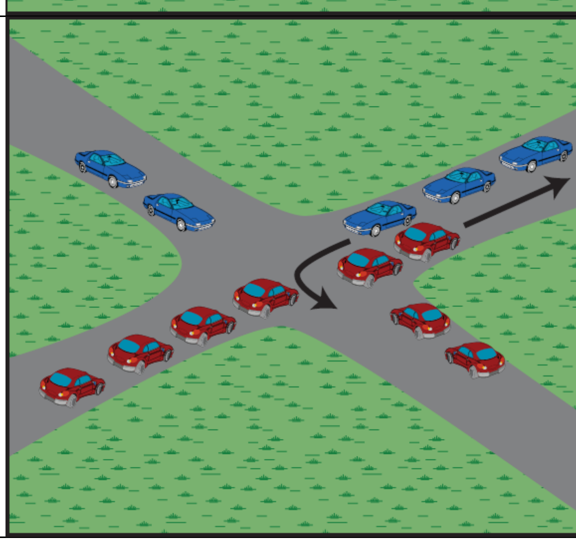
Summing each of the previously described terms gives the following equation, which is used to calculate delay per vehicle in the *ACP/ECF SMART Decision Evaluator.*

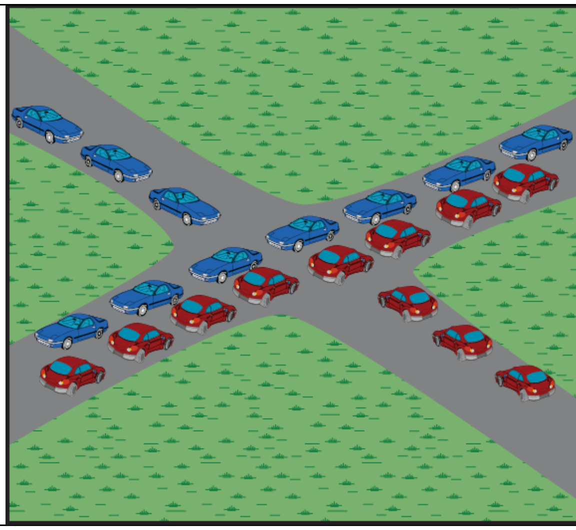
$$Delay\ per\ Vehicle = 6.06 + 900 * \left[(X-1) + \sqrt{(X-1)^2 + \frac{4 * X}{\sum_{j=1}^{All\ Lanes} Lane\ j\ Processing\ Rate}}\right] + \frac{\sum_{j=1}^{All\ Lanes} \left({}^{3600}/_{Lane\ j\ Processing\ Rate} * Lane\ j\ Peak\ Hour\ Volume \right)}{\sum_{i=1}^{All\ Lanes} Lane\ i\ Peak\ Hour\ Volume}$$

The delay per vehicle is not explicitly shown in the Summary tab of the program. Instead, traffic level of service, a letter grade expressing the amount of delay per vehicle, is shown.

6.4.2 Traffic Level of Service

Level of service (LOS) is a concept used to rate the effectiveness of some element of transportation infrastructure. The most prevalent use for LOS is in defining intersection operations. In this instance, level of service is a letter grade expressing how much delay drivers experience during peak hours of traffic. There are six LOS classifications, “A” through “F.” LOS “A” and “B” are considered good. LOS “C” and “D” are considered acceptable. LOS “E” and “F” are considered unacceptable. The following chart explains and depicts different levels of service for intersections.

LOS	Depiction	Signalized	Unsignalized
A		▪ Very low delay ▪ Most vehicles arrive during green phase ▪ Most vehicles do not need to stop	▪ Little or no delay to minor street traffic
B		▪ More vehicles stop than LOS A	▪ Short traffic delays to minor street traffic
C		▪ Number of vehicles stopping is significant ▪ Cycle failures may begin to appear	▪ Average traffic delays to minor street traffic
D		▪ Congestion more noticeable ▪ Many vehicles stop ▪ Cycle failures noticeables	▪ Long traffic delays to minor street traffic

LOS	Depiction	Signalized	Unsignalized
E		▪ Cycle failures frequent	▪ Very long delays to minor street traffic
F		▪ Delay unacceptable to most drivers ▪ Many cycle failures	▪ Extreme delays with queuing ▪ Congestion affects other intersections ▪ Warrants improvement to intersection

The *ACP/ECF SMART Decision Evaluator* reports level of service in terms of how well the ACP/ECF ID check operates. It is based on the calculated amount of delay encountered by each driver at the gate, and the thresholds for LOS and corresponding delay can be adjusted in the defaults tab. Again, LOS "A" and "B" represent good operations and "E" and "F" are unacceptable.

At a typical ACP/ECF, deficient LOS can usually be improved by adding processing lanes, adding manpower, or by changing to a method that processes vehicles at a faster rate. As stated previously in this manual, the *ACP/ECF SMART Decision Evaluator* calculates the number of lanes needed at a gate in order to achieve a level of service D. Calculating for level of service D is in accordance with the Army Standard for ACPs.

6.5 Traffic Queue

Version 1 of the *SMART Evaluator* utilized Poisson's Queue Theory to assume a random arrival rate and calculate the expected queue, but this yielded unreliable results as the arrival rate approached the processing rate. Recognizing the limitation of Poisson's Queue Theory, the study team investigated other methods to determine the expected traffic queue. In *Assessment of the Impact of Electronic Toll Collection on Mobile Emissions in the Baltimore Metropolitan Area*, Anthony Saka and Dennis Agboh offer a method to measure vehicle queues at a toll plaza (ACP/ECF) using a modified version of the vehicle queue at a two-way stop controlled intersection from the Highway Capacity Manual.

As shown in the following equation, the expected traffic queues depend on the design demand and the total processing capability (capacity) of the gate.

$$Queue = 450 * \left[(X-1) + \sqrt{(X-1)^2 + \frac{\left(3600 * Number\ of\ Lanes \Big/ \left(\sum_{j=1}^{All\ Lanes} Lane\ j\ Processing\ Rate \right) \right) * X}{150}} * \frac{\sum_{j=1}^{All\ Lanes} Lane\ j\ Processing\ Rate}{3600} \right]$$

Where,

$$X = \frac{Design\ Demand}{\sum_{j=1}^{All\ Lanes} Lane\ j\ Processing\ Rate}$$

6.6 Costs

6.6.1 Cost Overview and Perspective

Costs are a major issue in ACP/ECF construction and operations. When comparing scenarios, all decisions should consider not only the immediate (capital) costs, but also the recurring operational and maintenance costs. Additionally, the costs associated with congestion and wasted fuel due to idling should be considered. While these costs are directly absorbed by drivers, they are often indirectly transferred to the installation through lost productivity of the work force and through safety issues associated with congestion.

There are two types of costs:

1. Capital costs – the costs of deploying infrastructure and technology.
2. Annual costs – the recurring costs associated with operations, maintenance, manpower, congestion, and wasted fuel.

The best method to compare capital and annual costs for features with different life cycles is through the *Equivalent Uniform Annual Cost* (EUAC) method, which is the cost per year of owning and operating an asset over its entire lifespan.

In order to convert capital costs to annual costs, it must be annualized over the life of the infrastructure. The general equation for converting capital costs to annual costs is:

$$A = Pv\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$$

Where,

A = Annual cost
Pv = Capital cost present value
i = Interest/inflation rate
n = Lifetime of the infrastructure

In cases where annual costs increase due to inflation (e.g., manpower cost), the cost is a “gradient” that increases at the end of each year. In order to compare the costs between scenarios, the gradient must be converted to a uniform annual cost using the following equation:

$$A = \frac{A_1 * n * i * (1+i)^{n-1}}{(1+i)^n - 1}$$

Where,

A = Annual cost
A_1 = First year annual cost
i = Interest/inflation rate
n = Lifetime of the infrastructure

6.6.2 Infrastructure Cost

The infrastructure cost is taken from the default values. The default values were generated using the ACP/ECF cost estimate template developed by USACE-PDC (October 2010). These costs assumed a generic ACP/ECF that does not have a visitors center or truck inspection area. If more accurate costs are needed, the default values can be adjusted.

Note that the *ACP/ECF SMART Decision Evaluator* includes a downloadable Excel file that the user can use to estimate the cost of an ACP/ECF. Based on the preliminary estimates, the user can change the default cost of construction values. In addition, for ACPs/ECFs that need more than ten lanes, the cost of construction is the cost of construction for a ten-lane gate, plus an additional 10% for each lane over ten. For example, if a scenario requires 14 lanes, the cost of construction equals the cost of construction for ten lanes times 1.4. Finally, the cost of a one-lane ACP/ECF is ¾ the cost of a two-lane gate.

6.6.3 Annualized Infrastructure Cost

The annualized infrastructure cost is the cost of the ACP/ECF infrastructure annualized over the assumed life of the gate. The equation to calculate annualized infrastructure cost is:

$$Annualized\ Infrastructure\ Cost = Scenario\ Infrastructure\ Cost * \frac{\mathrm{i} * (1+\mathrm{i})^{\text{Infrastructure Life Cycle}}}{(1+\mathrm{i})^{\text{Infrastructure Life Cycle}} - 1}$$

6.6.4 Annualized Technology Cost

The annualized technology cost is the yearly cost of technology (handheld or AIE) implemented at the ACP/ECF, annualized over the project life of the gate. It considers the need to replace the technology during the life of the gate. The equation to calculate annualized technology cost is:

$$Lane\ j\ Annualized\ Technology\ Cost = Round\left(\frac{Infrastructure\ Life\ Cycle}{Lane\ j\ Technology\ Life\ Cycle}\right) * Lane\ j\ Technology\ Cost * \frac{i * (1+i)^{Infrastructure\ Life\ Cycle}}{(1+i)^{Infrastructure\ Life\ Cycle} - 1}$$

$$Total\ Annualized\ Technology\ Cost = \sum_{j=1}^{All\ Lanes} Lane\ j\ Annualized\ Technology\ Cost$$

6.6.5 Annualized Infrastructure Maintenance Cost

The yearly infrastructure maintenance cost for an ACP/ECF is assumed as a percentage of the total infrastructure cost. The annualized infrastructure maintenance cost is the yearly maintenance cost annualized over the assumed life of the ACP/ECF, as shown below:

$$\begin{aligned}&\mathit{Annualized\ infrastructure\ maintenance\ cost}\\&= \#\ \mathit{Lane\ Infrastructure\ Cost} * \frac{\mathit{Infrastructure\ Annual\ Maintenance\ Cost}}{100}\\&* \frac{\mathrm{i} * (1+\mathrm{i})^{\text{Infrastructure Life Cycle}}}{(1+\mathrm{i})^{\text{Infrastructure Life Cycle}} - 1}\end{aligned}$$

6.6.6 Annualized Technology Maintenance Cost

The yearly technology maintenance cost is assumed as a percentage of the gate technology cost. Again, the annualized cost is the yearly cost annualized over the life of the gate.

$$\begin{aligned}&\mathit{Lane\ j\ Annualized\ Technology\ Maintenance\ Cost}\\&= \mathit{Lane\ j\ Technology\ Cost} * \frac{\mathit{Technology\ Annual\ Maintenance\ Cost}}{100}\\&* \frac{i * (1+i)^{\mathit{Lane\ j\ Technology\ Life\ Cycle}}}{(1+i)^{\mathit{Lane\ j\ Technology\ Life\ Cycle}} - 1}\end{aligned}$$

$$\begin{aligned}&\mathit{Total\ Annualized\ Technology\ Maintenance\ Cost}\\&= \sum_{j=1}^{\mathit{All\ Lanes}} \mathit{Lane\ j\ Annualized\ Technology\ Maintenance\ Cost}\end{aligned}$$

6.6.7 Annualized Manpower Cost

The annualized manpower cost is the yearly cost of all ID checkers at the ACP/ECF, annualized over the assumed life of the gate.

$$\begin{aligned}&\mathit{Annualized\ manpower\ cost}\\&= (1+i)^{\mathit{Construction\ Year} - \text{Current year}} * \mathit{Manpower\ Cost} * \left[\sum_{j=1}^{\mathit{All\ Lanes}} \mathit{Lane\ j\ Manpower}\right]\\&* \frac{\text{Infrastructure Life Cycle} * \mathrm{i} * (1+\mathrm{i})^{\text{Infrastructure Life Cycle} - 1}}{(1+\mathrm{i})^{\text{Infrastructure Life Cycle}} - 1}\end{aligned}$$

6.6.8 Annualized Congestion Cost

The annualized congestion cost is the time value cost of the peak hour delay for all vehicles projected over a year, assuming 252 workdays. The assumed time value cost is based off the *2011 Urban Mobility Report*, by David Schrank, Tim Lomax and Bill Eisele. The *Urban Mobility Report* is a yearly report published by the Texas Transportation Institute. The report discusses congestion in cities across the United States, travel time and the cost due to increased delay. The equation to calculate annualized congestion cost is:

$$\begin{aligned}&\mathit{Annualized\ Congestion\ Cost}\\&= 252 * \frac{\mathit{Delay\ Per\ Vehicle} * \mathit{Design\ Demand}}{3600} * \mathit{Study\ Year\ Time\ Value\ Cost}\\&* \frac{\text{Infrastructure Life Cycle} * \text{i} * (1+\text{i})^{\text{Infrastructure Life Cycle}-1}}{(1+\text{i})^{\text{Infrastructure Life Cycle}} - 1}\end{aligned}$$

6.6.9 Annualized Cost of Wasted Fuel

The annualized cost of wasted fuel utilizes the current cost of gasoline, the peak hour delay for all vehicles projected over a year (assuming 252 workdays), and the assumed rate of fuel wasted per ten minutes of idling. The cost is inflated to the construction year, if applicable, and then annualized over the life of the infrastructure.

The assumed rate of fuel wasted per ten minutes of idling is obtained from *To Idle or Not to Idle – That is the Question*, by Linda Gaines, Terry Levinson and Steve McConnell, from Argonne National Laboratory. The assumed rate of 0.08 gallons wasted per ten minutes of idling is based off a 3-liter engine.

$$\begin{aligned}&\mathit{Annualized\ Cost\ of\ Wasted\ Fuel}\\&= \mathit{Fuel\ Wasted\ per\ 10\ Minutes\ Idling} * \frac{\mathit{Delay\ per\ Vehicle}}{60 * 10} * \mathit{Design\ Demand}\\&* \mathit{Current\ Cost\ of\ Gasoline} * (1+i)^{\mathit{Construction\ Year}-\mathit{Current\ Year}} * 252\\&* \frac{\text{Infrastructure Life Cycle} * \text{i} * (1+\text{i})^{\text{Infrastructure Life Cycle}-1}}{(1+\text{i})^{\text{Infrastructure Life Cycle}} - 1}\end{aligned}$$

6.7 Risk Score

The risk score portion of the *ACP/ECF SMART Decision Evaluator* provides a methodology for evaluating how one type of credential checking strategy may be different from another in terms of security risk. The ACP/ECF strategies addressed in this manual provide three different methods of checking the validity of a credential:

1. the manual verification of a credential by a guard,
2. the use of a handheld device by the guard in order to verify the credential with a personnel database, and
3. the use of multiple vetting processes contained in an automated processing system.

The score is the relative risk of using manual, handheld, and automated processing techniques to verify credentials. Relative risk is the risk of an event occurring relative to exposure. It is a ratio of the probability of the event occurring in one group versus a control group. In this case, the control group is manual credential checking by a guard. The risk score methodology considers the following:

1. Likelihood of the attempted use of a false credential to gain admittance to the installation, termed the ***Probability of Attack*** **(P_A).**
2. Consequences to the installation and operations given a successful attack, defined as ***Importance Factor*** **(I_F).**
3. Effectiveness of the particular entry control/credential verification strategy being utilized or considered, defined as ***Probability of Effectiveness*** **(P_E).**

Due to the lack of data available regarding risk analysis for validating credentials, the risk score defaults to zero for each credentialing method. Appendix A provides more information explaining the risk score methodology. If the user wishes to analyze the credentialing methods in terms of security risk, he/she should contact SDDCTEA for more guidance.

6.8 Annual Carbon Monoxide/Nitrogen Oxide/Volatile Organic Compound Emissions

The annual emissions calculations utilize idling vehicle emissions tables published by the Environmental Protection Agency. The default emission rates were calculated by averaging the winter and summer emission rates for light-duty gasoline-fueled vehicles. The default emission rates are:

- Volatile Organic Compounds (VOC) – 18.6 grams per hour
- Carbon Monoxide – 300 grams per hour
- Nitrogen Oxide – 5.44 grams per hour

As shown below, the annual emissions are calculated using the design demand, the default hourly emissions rate and the peak hour delay for all vehicles to project the emissions over the course of a year (assuming 252 workdays).

$$Annual\ Carbon\ Monoxide\ Emissions = Carbon\ Monoxide\ Idling\ Emissions\ Rate * \frac{Delay\ per\ Vehicle}{3600} * Design\ Demand * 252\ work\ days$$

$$Annual\ Nitrogen\ Oxide\ Emissions = Nitrogen\ Oxide\ Idling\ Emissions\ Rate * \frac{Delay\ per\ Vehicle}{3600} * Design\ Demand * 252\ work\ days$$

$$Annual\ Volatile\ Organic\ Compound\ Emissions = VOC\ Idling\ Emissions\ Rate * \frac{Delay\ per\ Vehicle}{3600} * Design\ Demand * 252\ work\ days$$

6.9 Total Annual Cost

The total annual cost is the sum of all annualized costs for a particular scenario, as shown in the following equation.

$$\begin{aligned}\mathit{Total\ Annual\ Costs}\\ &= \mathit{Annualized\ Infrastructure\ Maintenance\ Cost} + \mathit{Annualized\ Congestion\ Cost}\\ &+ \mathit{Annualized\ Manpower\ Cost} + \mathit{Annualized\ Technology\ Cost}\\ &+ \mathit{Annualized\ Technology\ Maintenance\ Cost} + \mathit{Annualized\ Cost\ of\ Wasted\ Fuel}\\ &+ \mathit{Annualized\ Cost\ of\ Construction}\end{aligned}$$

6.10 Traffic Benefit to Cost Ratio

Traffic benefit to cost ratio (B/C) is the difference in annual congestion cost and cost of wasted fuel between the proposed scenario and the existing conditions (the benefit), divided by the cost to implement the scenario.

$$Traffic\ B/C = \frac{A}{B - C}$$

Where,

$$\begin{aligned}A = \mathit{Existing}(\mathit{Annualized\ Congestion\ Cost} + \mathit{Annualized\ Cost\ of\ Wasted\ Fuel})\\ - \mathit{Scenario}(\mathit{Annualized\ Congestion\ Cost} + \mathit{Annualized\ Cost\ of\ Wasted\ Fuel})\end{aligned}$$

$$B = \mathit{Scenario}(\mathit{Total\ Annual\ Costs} - \mathit{Annualized\ Congestion\ Cost} - \mathit{Annualized\ Cost\ of\ Wasted\ Fuel})$$

$$C = \mathit{Existing}(\mathit{Total\ Annual\ Costs} - \mathit{Annualized\ Congestion\ Cost} - \mathit{Annualized\ Cost\ of\ Wasted\ Fuel})$$

A traffic B/C exceeding 1.0 indicates that the benefit, by way of reduced congestion and wasted fuel costs, of implementing the scenario is greater than the cost to implement the scenario. When evaluating scenarios, the traffic benefit to cost ratio should be used in conjunction with other factors.

6.11 Crash Reduction Benefit to Cost Ratio

In order to determine the crash reduction benefit of properly designing an ACP/ECF, a crash reduction factor must be utilized. A crash reduction factor is an estimate of the percent reduction in crashes after a countermeasure is implemented. The Crash Modification Factors Clearinghouse (http://www.cmfclearinghouse.org) presents hundreds of factors for a variety of safety related countermeasures. Unfortunately, the Clearinghouse does not have any factors for countermeasures specific to toll plazas or ACPs/ECFs. Therefore, the *ACP/ECF SMART Decision Evaluator* uses the crash reduction factor for traffic calming modifications (0.32). This means that if the ACP/ECF is redesigned, it is assumed that crashes will be reduced by 32%.

If the user enters the number of crashes at the inbound approach lanes of an ACP/ECF, the *ACP/ECF SMART Decision Evaluator* calculates and displays a crash reduction benefit to cost ratio for scenarios that require gate reconstruction (i.e., addition of new lanes). The ratio is calculated assuming crashes at the ACPs/ECFs are property-damage-only crashes, which cost an average of $8,900, per the National Safety Council[5].

Specifically, the equation to calculate the crash reduction benefit to cost ratio is:

$$Crash\ Reduction\ Benefit\ to\ Cost\ Ratio = \frac{0.32 * Crashes\ per\ Year * \$8{,}900}{D - E}$$

Where,

$$D = Scenario(Total\ Annual\ Costs - Annualized\ Congestion\ Cost - Annualized\ Cost\ of\ Wasted\ Fuel\ )$$

$$E = Existing(Total\ Annual\ Costs - Annualized\ Congestion\ Cost - Annualized\ Cost\ of\ Wasted\ Fuel)$$

A crash reduction B/C exceeding 1.0 indicates that the benefit, by way of the reduction in the costs associated with property-damage-only crashes, of implementing the scenario is greater than the cost to implement the scenario. As with the traffic benefit to cost ratio, when evaluating scenarios, the crash reduction benefit to cost ratio should be used in conjunction with other factors.

[5] http://www.nsc.org/news_resources/injury_and_death_statistics/Pages/EstimatingtheCostsofUnintentionalInjuries.aspx

7 Applying SMART Decisions

7.1 AIE versus Handheld Technologies

When considering AIE, remember:

- Though unproven, AIE processing appears to improve security through verification of drivers and vehicles, and the Army OPMG is encouraging the implementation of AIE.
- AIE processing rates (with traffic arms) are slightly lower than manual (single) processing rates.
- AIE processing rates (without traffic arms) are comparable or more efficient than manual (single) processing rates.
- AIE programs that allow "open-arm" operations may realize greater manpower benefits and may also require less processing lanes.
- AIE processing may reduce manpower requirements.
- Other factors (driver understanding of gate operations, traffic arms, rejections, inspections) have an impact on processing.

When considering handheld technologies, remember:

- Handheld automated processing appears to improve security through verification of occupants (and vehicles).
- Handheld automated processing lowers processing capabilities versus manual processing rates, but not significantly.
- Handheld automated processing has limited impact on manpower requirements.
- Other factors (traffic arms, in-lane inspections) have more impact on processing than the use of handheld automated processing.

7.2 Summary

In summary,

- Manual processing offers the most efficient use of manpower and in many cases the most efficient processing; however, security benefits may be limited.
- AIE processing improves security; however, automation costs are a significant consideration. If traffic arms are not utilized, AIE processing is comparable to manual processing in terms of throughput.
- Handheld processing offers some security enhancements at a lower cost than AIE; however, processing efficiency and manpower are impacted. Handheld processing may be a good interim solution where automation is desired, but constraints may require tandem processing.

When planning for short-term changes to processing methods or long-term ACP/ECF construction projects, utilize the *ACP/ECF SMART Decision Evaluator* to assist in decision-making. Consider AIE at locations where there are sufficient lanes to support its implementation and where funding allows. Consider handheld technologies at locations with insufficient lanes to support AIE, at locations where units must be transportable and at locations with limited funding.

Appendices