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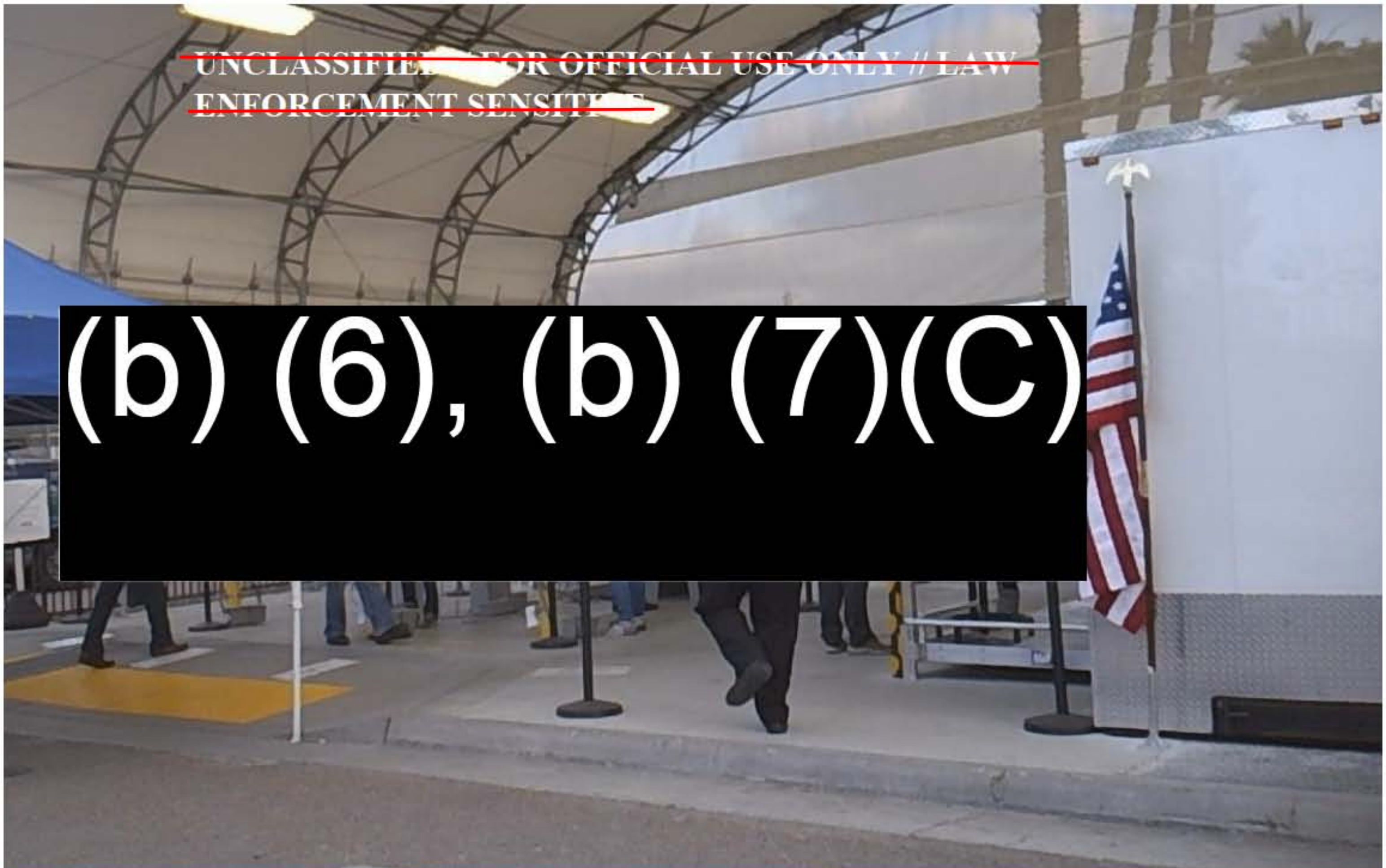

(b) (6), (b) (7)(C) [redacted]

Southern Border Pedestrian Field Test

Summary Report

December 2016

U.S. Customs and Border Protection

Office of Field Operations Entry/Exit Transformation Office

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1. Executive Summary

In May 2013, the Office of Field Operations (OFO) Entry/Exit Transformation Office (EXT) was formed with the mission of enhancing the integrity of the immigration system by providing assurance of traveler identity on departure matched with arrival. The Customs and Border Protection's (CBP) entry/exit strategy is focused on three efforts: closing biographic entry/exit gaps, near-term targeted biometric operations leveraging existing technology, and a long-term entry/exit transformation.

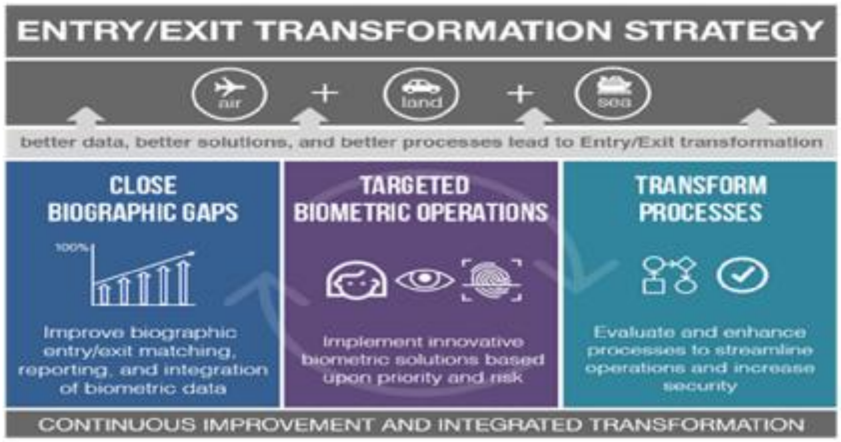

Figure 1.1 Entry Exit Transformation Strategy

The Pedestrian Exit Field Test (Field Test) conducted at the Otay Mesa Port of Entry (POE) is one of several targeted biometric operations that is part of the CBP's Entry/Exit Transformation Strategy. This Field Test was an "experiment of experiments" – designed to test non-customized commercial-off-the-shelf (COTS) technologies, capture methods, and scenarios to determine feasibility and usability of potential deployable biometrics solutions in an outdoor environment. Learning what worked well was equally as important as understanding what didn't work well.

The Field Test included three distinct stages: Inbound, Outbound, and a Post Fi eld Test Analysis:

- **Inbound** kiosks were setup immediately in front of Primary booths to collect biographic and biometric (face and iris) data from in-scope travelers[i] entering the U.S. (this process is referred to as "enrollment"). This process was designed expressly and exclusively to create the biometric gallery for matching against Field Test outbound biometric traveler images.
- **Outbound** operations were setup to collect biographic and biometric (face and iris) data from in-scope travelers leaving the U.S., so this data could be compared to inbound data. Three scenarios were tested for both face and iris capture: On-the-Move (OM), Pause-and-Look (PL), and Kiosks.
- **Post Field Test Analysis** included both a review of the data from the Field Test and the testing of several scenarios in a controlled environment to optimize the biometric analysis.

When analyzing biometric systems, it is important to review all components involved with the system. In the Field Test we found (1) the function of the technology chosen, (2) environment, and (3) traveler behavior were most critical. These Field Test results should not be considered in isolation, but rather, serve as inputs toward CBP's holistic biometric solution. In fact, ***the design and implementation of this Field Test system should only serve as an initial feasibility study of the chosen technology and associated biometric modalities, for the purpose of informing future test(s).***

[i] "in-scope travelers" for the Field Test were all non-U.S. Citizens between the ages of 14 and 79 who were neither exempt nor diplomats (*Southern Border Pedestrian Field Test Technical Report Final Draft*, page 15).

With this context in mind, the core findings of the Field Test are listed below, with details located in Section 3.1 of the report.

Core Findings

1. **Face OM showed the most promise of accuracy and speed for large traveler volumes. Kiosks showed potential for smaller traveler volumes.**

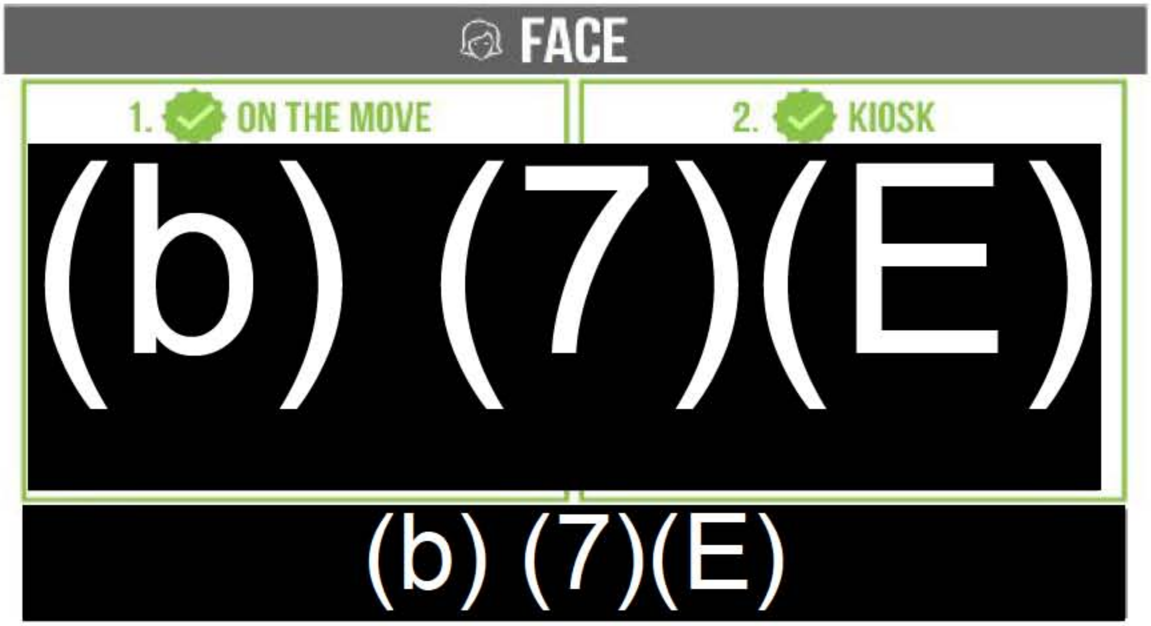

Figure 1.2 Face Summary

2. **Iris technology, as tested,** [redacted] **Based on this, the technology should be tracked as the industry evolves.**

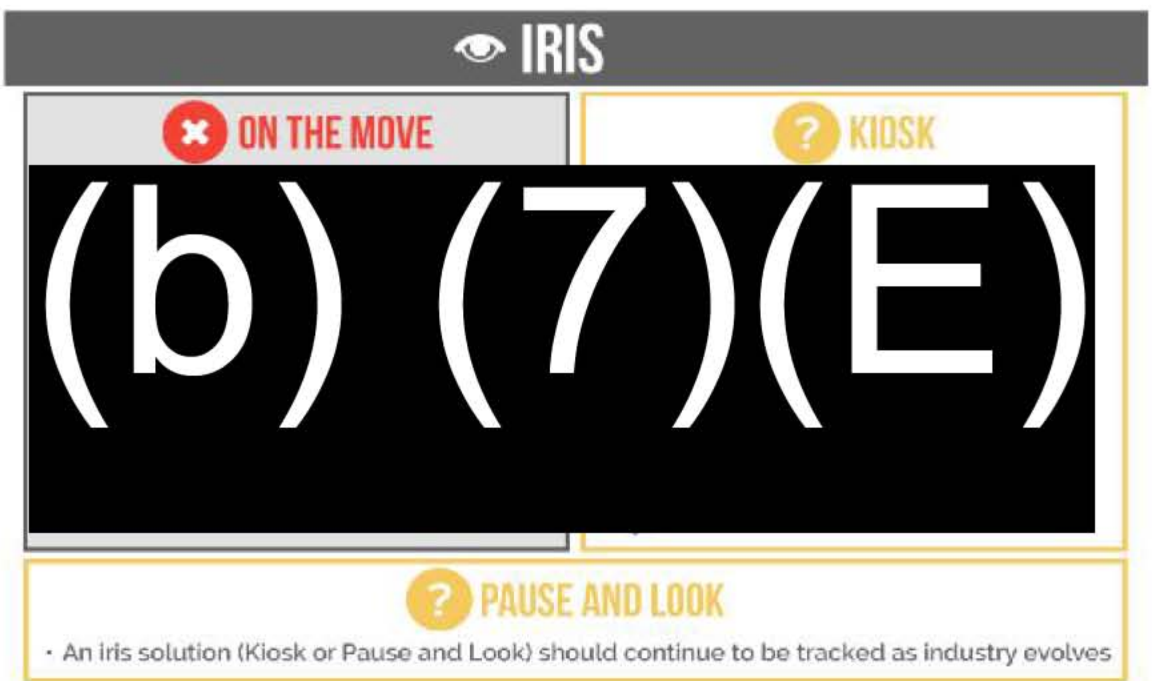

Figure 1.3 Iris Summary

Core Findings (Continued)

3. **Biometric capture** rates ranged from [redacted] Rates for face averaged [redacted] higher than iris, as shown in Figure 3.2, Scenario Comparison, shown below.

	OM		PL		Kiosk	
	Avg	**Range**	**Avg**	**Range**	**Avg**	**Range**
Face	[redacted]					
Iris						

4. **Processing speed** per individual lane (from document read until traveler left processing area) ranged from 1.9 to 4.6 travelers / minute[7]*. Figure 3.3, Traveler Processing Times, is shown below.

*Does not represent maximum throughput

5. **Biometric Effectiveness** at a constant False Acceptance Rate of [redacted] gets through the system)[8], Face Kiosk [redacted] of properly identified to wrongly rejected travelers, as represented by the green [redacted] rs in Figure 3.4, shown below.

FACE [redacted]

FACE

FACE

FACE

IRIS

IRIS

IRIS

[redacted]

Core Findings (Continued)	
6.	**Biometric gallery** of current CBP document photos on file provided [redacted] than the gallery of Field Test inbound images. In contrast, implementing an iris biometric solution would require some method of iris enrollment.
7.	**Port infrastructure**, including signage, requires construction and/or modification redesign to mitigate [redacted]
8.	**Even with biometric processing,** full enforcement and real-time adjudication of travelers is resource intensive and requires balancing of cost of labor and response timeliness.
9.	**Document compliance** - 10.8 % of the outbound population between the ages of 14 and 79 did not possess Western Hemisphere Travel Initiative (WHTI)-compliant documents, requiring manual processing. Manual processing required, on average, 51 seconds per traveler**.**
10.	**Outbound wait times** during the Field Test were infrequent for travelers possessing WHTI-compliant documents, and typically lasted less than two minutes when they did occur. This was due to sufficient resources and technology for the outbound volume.
11.	**COTS products** require technical adjustments to optimize biometric system performance. (e.g. COTS adaptation, tailoring, and user experience)

The Core Findings are interrelated. For example, [redacted]

Additional, CBP–wide considerations include, but are not limited to:

- Lack of industry standards for facial and iris image quality and cross-vendor interoperability,
- Higher bandwidth for facial video processing and increased image storage requirements, and
- Public apprehension associated with iris image capture.

The following table recommends next steps in preparing for and designing the next field test:

Recommended Next Steps
[redacted]

[ii] *A-B testing refers to a form of multivariate testing where solution iterations are tested simultaneously and the results compared. The better solution is then tested against another solution to successively improve results.*

2. Approach

The design, setup, and execution of the Southern Border Pedestrian Field Test required the close coordination of multiple stakeholder groups, including the Office of Field Operations (OFO) Entry-Exit Office (EXT) and the Office of Information Technology (OIT) Land Border Integration (LBI) Division. OFO leadership selected the location and timeframe for the Field Test and managed the operational aspects of the project. The OIT LBI Division managed the technical aspects of the project.

2.1 Design

The Field Test design consisted of three distinct stages: Inbound, Outbound, and Post Field Test Analysis. The objective of Inbound was to "enroll" in-scope travelers by collecting biometric data in a standalone system that served as a gallery for use in outbound processing in this Field Test.[11] Biometrics were captured during Primary processing, prior to traveler interaction with the CBP Officers (CBPOs). This approach limited the Field Test's impact on normal Inbound operations and data collection.

The objective of Outbound was to test and evaluate effectiveness and operational impact of selected biometric hardware and software. The hardware, which includes both the image capture equipment and physical lane configuration, along with the software, were tested in different combinations throughout the Field Test.

For the purposes of the Field Test, CBP recorded crossings at Outbound February 8, 2016–April 29, 2016, Monday–Friday, 1–9pm. Figure 2.1 is a simulated view of the exit processing area.

Figure 2.1 Exit Processing Area (Source: OIT)

The Field Test had two Outbound operational iterations:

- Iteration One, which ran for the first six weeks of the project, baselined system functionality and captured data on travelers unfamiliar with interacting with an exit solution.
- Iteration Two, which ran for the final six weeks of the field test, provided a steady state analysis of system processing with habituated users.

The objective of the Post Field Test Analysis was to perform a review of the data from the Field Test and test several scenarios in a controlled environment to optimize the biometric analysis.

2.2 Biometric Capture Scenarios

The biometric technology was installed on both inbound and outbound lanes at Otay Mesa. Inbound had only one physical configuration, Kiosks, while Outbound had three: On-the-Move (OM), Pause & Look (PL), and Kiosks.

- Six inbound Kiosks were deployed to enroll inbound travelers' biometric data into the biometric gallery.
- The one OM outbound lane allowed travelers to proceed at walking pace after scanning their Radio Frequency Identification (RFID)-readable document.
- The one PL outbound lane, which also only accepted travelers with RFID documents, required travelers to pause for a few seconds to look at the biometric capture device.
- The five outbound Kiosks were deployed for use by travelers with Machine Readable Zone (MRZ) or RFID documents and captured both face and iris images.
- A manual processing lane in outbound was setup where Officers checked the identity of travelers without either RFID or MRZ readable documents, whether due to the document not being compliant, or just not reading correctly.

2.3 Execution

A joint task force of 22 CBPOs and Border Patrol Agents supported the Field Test. A team of four bilingual Traveler Assistants instructed travelers how to interact with the technology. The biometric system integrator provided software integration and technical support. Observers also identified human behaviors potentially having an impact on the biometric capture success rate.

During Outbound's first operational iteration, OFO and OIT adjusted the physical setup and processes of the Field Test to better control for environmental and human factors that were reducing equipment effectiveness, such as:

Factor	Adjustment
[redacted] (b) (7)(E)	
Travelers not knowing how to act	- Arrow signs were installed on PL and OM units. - An attractor was placed in the OM lane to draw traveler attention to the camera. - Marks were placed on the ground for Kiosk and PL lanes to direct travelers where to stand.
[redacted] (b) (7)(E)	
Travelers with Disabilities	-One kiosk was configured to accomadate travelers with disabilities.

Figure 2.2 Field Test Adjustments for Environmental and Human Factors

Any future studies should incorporate these and other lessons learned as detailed in the findings below. Another key element in the success of a biometric exit solution is the ease with which travelers interact with the technology. Certain traveler behaviors, [redacted] Therefore, the Field Test included an observational analysis during Outbound's second iteration to collect information to assess whether these human factors played a role in the successful capture of biometric data. Additional observation details can be found in Section 5 of the Appendix.

3. Findings and Recommendations

After evaluating the system data, results of the observational analysis, and other observations from the staff on site, the Field Test team developed a list of core findings and recommendations. This section is divided into two parts: the first details the 11 core findings of the Field Test, and the second details recommendations that address each of the questions raised in the Field Test Concept of Operations (CONOPS). For detailed information on traveler demographics, law enforcement adjudications, and human factors, see the Appendix.

3.1 Core Findings

1. Face OM showed the most promise of accuracy and speed for large traveler volumes. Kiosks showed potential for smaller traveler volumes.

The overall recommendation from this Field Test incorporates both technical and operational considerations. Face images were captured and matched more consistently across all scenarios. OM allowed for the fastest processing of travelers. In contrast, Kiosks, while not as fast, had better accuracy than OM and PL, but required more maintenance in this test. When speed is not a factor, in lower traveler volume situations, Kiosks may be considered.

Comparison Factor	OM	Kiosk	PL
Capture Rate	[redacted]		
Throughput (travelers/min)	4.6	1.9	2.7
Traveler Assistance (Staff/per lane)	0.5	1	1
Traveler Experience	Easy	Hard	Medium
Maintenance Required	Low	High	Low

Figure 3.1 Scenario Comparison

2. Iris technology, as tested, [redacted] however it showed potential with PL and Kiosks. Based on this, the technology should be tracked as the industry evolves.

The iris technology vendor [redacted] Reasons for process failure include [redacted] Due to the proprietary technology being used, the specific cause of the failure could not be differentiated. However, as mentioned in Core Finding 1, iris technology provided the highest matching accuracy, once an image was captured. Due to its higher match rate and ongoing improvements in the industry, including a growing acceptance, iris technology should be tracked as the industry evolves.

3. Biometric capture rates ranged from [redacted] Capture rates for face averaged [redacted] higher than iris.

In the Field, no technology performed operational matching at a satisfactory level, primarily due to low capture rates. Operational matching[iii] requires a successful capture before the image can be compared (matched) to a gallery image. Capture rates varied greatly as the table below shows; the best average capture rate among all scenarios for face [redacted] approximately [redacted] higher than the equivalent iris capture rate across scenarios. Many factors contributed to lower and wide-ranging results, including environmental [redacted] and human (e.g. [redacted] factors, indicating the likely impact of these factors on the overall technology effectiveness.

	OM		PL		Kiosk	
	Avg	**Range**	**Avg**	**Range**	**Avg**	**Range**
Face	[redacted]					
Iris						

Figure 3.2 Capture Rates

4. Processing speed per individual lane (from document read until traveler left processing area) ranged from 1.9 to 4.6 travelers / minute*.

Processing times varied widely, with Kiosks requiring more than twice the amount of time to process a traveler compared to OM and nearly 50% more than PL. At a POE like Otay Mesa, which operates at high volumes, this additional processing time is significant, particularly when comparing OM to Kiosks. Based on the Field Test results, more than twice as many travelers could be processed through OM lanes as through Kiosks in the same amount of time.

Figure 3.3 Traveler Processing Times

The travelers per minute numbers are based on processing one traveler at a time with no overlap in the processing of multiple travelers. In an operational setting, multiple factors impact optimal throughput, including: resources, policies, infrastructure, and technology.

[iii] Operational Match Rate respresents the overall percentage of processed in-scope travelers who are biometrically matched. This percentage is inclusive of all issues that prevent a biometric match.

5. At a constant False Acceptance Rate of [redacted] gets through the system), Face Kiosk had the best ratio of properly identified/ wrongly rejected travelers, as represented by the green and orange travelers in Figure 3.4 below.

[redacted]

a. [redacted]

b.

c.

FACE

FACE

FACE

FACE

IRIS

IRIS

IRIS

[redacted]

Figure 3.4 Capture and Matching Results

Based on system sensitivity of [redacted] However, as mentioned in core Finding 4 above, OM processed ~4.6 travelers / minute compared to ~1.9 travelers / minute[7] for Kiosk at the same threshold (sensitivity). Because of this, as well as lower operating costs and physical deployment space requirements, Face OM offers a better candidate for future field tests.

Combining face and iris results together (multi-modal fusion) provided a minimum benefit and did not outperform individual results.[12] More specifically, there were two fusion types: score-based fusion, which combined the iris and face scores together; and decision-based fusion, which used results of each biometric operation together. Score-based fusion did worse than either face or iris images alone and decision-based fusion did not provide any benefit over using iris alone, but did show an improvement over using face alone.

6. Biometric gallery of current CBP document photos on file provided better face match scores than the gallery of the Field Test's inbound images. In contrast, implementing an iris biometric solution would require some method of iris enrollment.

Biometric verification requires existing biometric data (an image) against which to compare live-captured biometric data. As part of the Post Field Test Analysis, the images captured in outbound were matched against existing document photos on file. [redacted]

7. Port infrastructure, including signage, requires construction and/or modification redesign to mitigate the environmental [redacted] and human [redacted] etc.) factors that challenge biometric capture. 11.1% of outbound travelers crossed with [redacted]

Regardless of operational setting, the successful implementation of a biometric capture system requires infrastructure tailored to mitigate both environmental factors that degrade image quality and human factors that inhibit travelers from properly interacting with the biometric capture system. Overall, during the Field Test, environmental factors were mitigated more successfully than human factors, even in an outdoor environment.

[redacted] In the Field Test, the outbound infrastructure was built and adjusted throughout the Field Test in an attempt to improve biometric system performance. Changes to the outbound infrastructure to mitigate environmental factors included:

- [redacted]

Based on these mitigation strategies, weather did not cause statistically relevant issues. Day and night also didn't cause significant problems, [redacted]

Human factors observed during the Field Test included issues such as:

- [redacted]
- The systems deployed were limited to COTS hardware and software, and lacked user interface design and effective traveler engagement mechanisms.
- [redacted]
- [redacted]

[redacted] Changes to the outbound infrastructure to mitigate human factors were limited to adding small signs to help travelers unfamiliar with the capture process know where to look. Additionally, traveler assistants were deployed in outbound to help travelers and compensate for the lack of effective infrastructure.

In contrast to the changes made to the outbound infrastructure both prior to and during the field test to mitigate for environmental factors, inbound infrastructure was set-up in a space designed for standard inbound processing [redacted] This may have contributed to the average face capture rate at the end of the Field Test in inbound being [redacted] lower than identical technology deployed in outbound.[14]

8. Full Enforcement and real-time adjudication of travelers is resource intensive.

[redacted]

[redacted]

Figure 3.5 Projected Staffing and Secondary Requirements based on Enforcement Posture

9. Document compliance – 10.8% of the outbound population between the ages of 14 and 79 did not possess WHTI-compliant documents, and required manual processing. Manual processing required, on average, 51 seconds per traveler.[16]

Outbound travelers without documents or with documents that cannot be automatically processed using RFID chips or MRZ require manual processing, which, by its nature, is slower than automatic processing. Further, this processing requires additional spending on CBPOs, technology, and infrastructure. During this Field Test, nearly 11% of travelers required manual processing[9], which any solution must address. [redacted] Identifying ways to reduce manual processing could save costs.

10. Outbound wait times during the Field Test were infrequent for travelers possessing WHTI-compliant documents, and typically lasted less than two (2) minutes when they did occur. This was due to sufficient resources and technology for the outbound volume.

A concern that the Field Test would cause significant wait times at the port's outbound area did not occur. With normal operations in eight automated lanes (consisting of three Ready lanes and five Kiosks) and two manual processing lanes, wait times were never more than two minutes in automated lanes and 10 minutes in the manual lanes.[17] Wait times were actively managed, and were held down, in part, due to the short processing times in the OM lanes, as well as staffing that enabled the active management of travelers when volumes warranted active management. In addition, during the later weeks of the second outbound iteration, Mobile Query technology was used to further mitigate manual lane wait times.

---

iv [redacted]

11. COTS products require technical adjustments to optimize biometric system performance (e.g. COTS adaptation, tailoring, addressing latency issues, and user experience).

This Field Test used unmodified COTS technology that, as tested in the field, was unable to perform at the desired levels and would require technical modifications to optimize biometric system performance, including ensuring the user interface is designed for traveler engagement. [redacted]

3.2 Recommendations

To make recommendations from the findings of the Field Test, a group of interrelated (and sometimes conflicting) priorities must be balanced against one another. These competing priorities are driven by a need to control costs from staffing, technology, and port reconfiguration, while recognizing the importance of adjudicating every hit, deploying increasingly accurate technology, minimizing traveler wait time, and achieving the mandated biometric exit solution to close entry records. The recommendations laid out in this report were selected for their ability to best address these priorities. Critically, any change in these priorities has the potential to cause changes in resulting recommendations. (See Appendix)

Priorities	Source
Implement biometric solution to close entry records	**Statutory**
Identify overstays and EWIs	**Statutory**
Minimize impact on staffing levels	**Budget/ Statutory**
Limit physical alterations to Outbound space at POEs	**Budget**
[redacted] **and biometric mismatches and failures**	**CBP / Policy**
Minimize traveler wait times	**Stakeholders**
Achiev [redacted] **operational match (traveler verification) rate**	**CONOPS**

Figure 3.6 Priorities that Must be Balanced and Source of Influence

With these priorities in mind, the Field Test results led to the following recommendations that answer the four questions posed in the Field Test's CONOPS. These recommendations are listed below and then presented with additional details according to the CONOPS question addressed.

[redacted]

CONOPS Question 1: What is the best way to integrate a biographic and biometric exit processes for Pedestrians leaving the U.S. at a Southwest POE ensuring Officer safety and minimal impact to the traveling population?

Recommendation 1.1: [redacted]
[redacted]
Considerations
[redacted]

Recommendation 1.2: [redacted]
[redacted]
Considerations
[redacted]

Recommendation 1.3: [redacted]
[redacted]
Considerations
• [redacted] • [redacted]

[redacted]

Recommendation 2.1: [redacted]
Details
• [redacted]
Considerations
• [redacted]

CONOPS Question 3: [redacted]

Recommendation 3.1 [redacted]
• [redacted]
Considerations
• [redacted]

CONOPS Question 4: [redacted]

Recommendation 4.1: [redacted]
• [redacted]
Considerations
• [redacted]

Recommendation 4.2: [redacted]
• [redacted]
Considerations
• [redacted]

4. Recommended Next Steps

CBP and other DHS entities are conducting similar studies across various operational modes to analyze the feasibility of biometrics as part of a comprehensive exit solution. All the field tests should be analyzed and then the collective lessons learned used to inform the design of additional studies, to maximize the benefits of further refining technology and processes.

Additionally, the lessons from each field test should serve as an iteration within a larger process of creating a strategic, standardized offering across operational modalities (air, land, and sea). For example, [redacted] (b) (5)

Several gaps, detailed below, were identified during this Field Test that need to be addressed in any subsequent field test. This must start with clarifying policy guidance and priorities, as outlined in the first two recommendations.

Next Step 1: [redacted] (b) (5)
Gap
• [redacted] (b) (5)
Considerations
• [redacted] (b) (5), (b) (7)(E)   • [redacted] (b) (5)

Next Step 2: [redacted] (b) (5)
Gap
• [redacted] (b) (5), (b) (7)(E)
Considerations
• During this Field Test, [redacted] (b) (7)(E)   • [redacted] (b) (5), (b) (7)(E)   • [redacted] (b) (5)

The overall recommendation from this Field Test, which focused on COTS products, is to [redacted] (b) (5)

The goals of the next field test are:

- Optimize biometric operations based on lessons learned from this Field Test,
- Elevate the biometric capture and match rate to reach an operationally viable level, and
- Design the Land Exit solution to converge with Air Exit and other law enforcement initiatives.

These will be accomplished through the following steps:

Next Step 3: [redacted]
Gap
• Travelers are exiting ports at all hours of the day and it is not known if there is any significant difference between the population subset that leaves between 1-9PM and the population subset that leaves during the other 16 hours, including the pattern of any differences (e.g. immediate drop-off, or gradual), which would be valuable in determining the proper staffing. • [redacted]
Considerations
• [redacted]

Next Step 4: [redacted]
Gap
• [redacted]
Considerations
• [redacted]

Next Step 5: [redacted] (b) (5) (b) (5)
Gaps
• Travelers had difficulty understanding how to interact with the exit scenarios in the Field Test. This slowed traveler throughput and required the hiring of bilingual traveler assistants. • [redacted] (b) (5), (b) (7)(E)
Considerations
• [redacted] (b) (5), (b) (7)(E)

Next Step 6. [redacted] (b) (5)
Gaps
• [redacted] (b) (5)
Considerations
• Whatever solution is chosen / created will need to [redacted] (b) (5) • [redacted] (b) (5) • Also, see Recommendation 1.3, page 14.

[redacted] (b) (5)

5. Appendix:

The sections below provide information about the travelers who participated in the Field Test. For more details, refer to the Southern Border Pedestrian Field Test Technical Report.

5.1 Southern Border Pedestrian Field Test Summary Overview

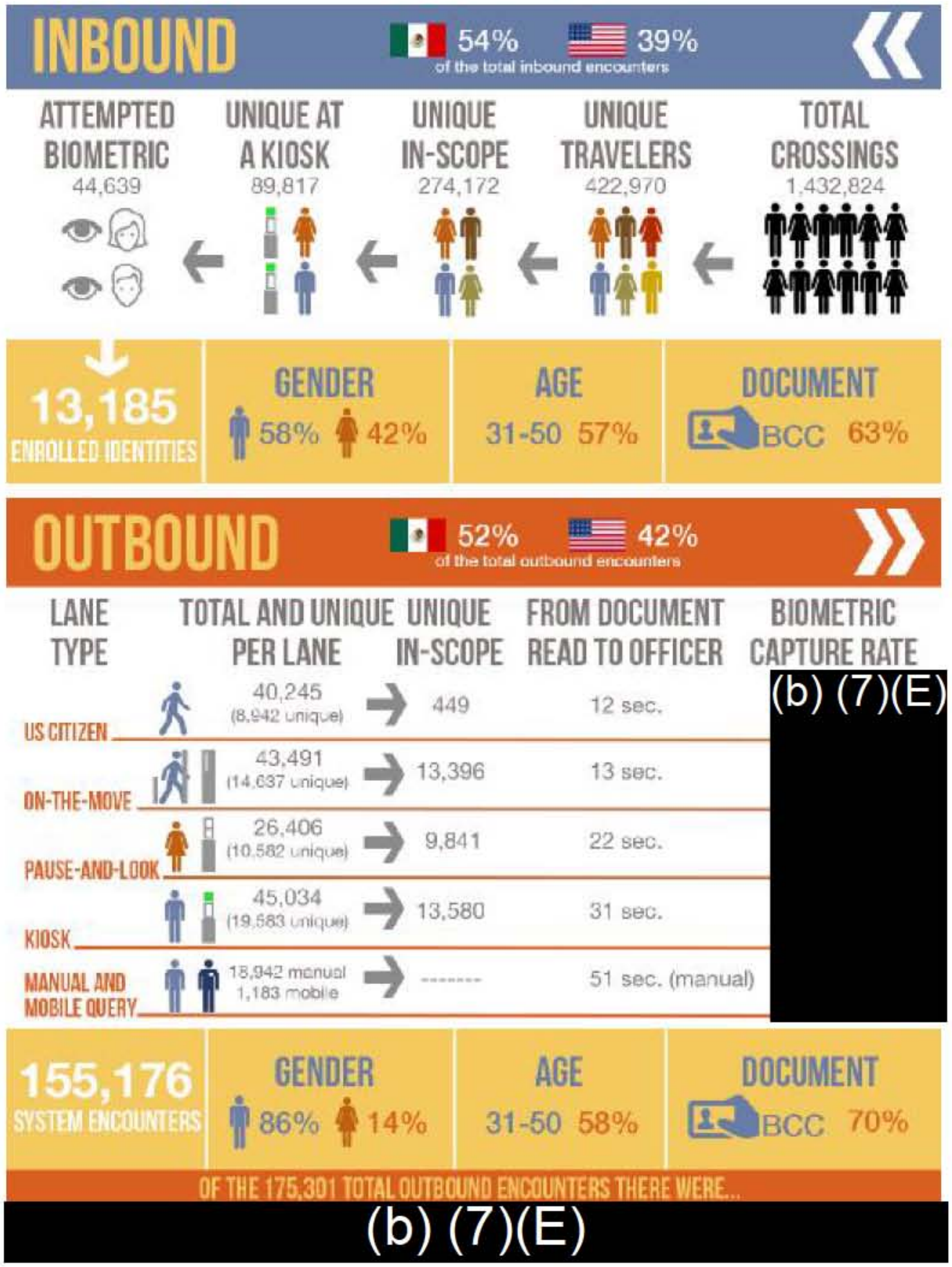

Figure 5.1: Southern Border Pedestrian Field Test Interim Summary Overview (Source: OIT)

5.2 Overstays, EWIs, Document Types, Hits, and Referrals

After travelers exited outbound, their time of departure was compared to the ADIS system to determine if they may have overstayed their allotted time within the U.S. The chart below depicts the number of overstays with a known class of admission (ie: B1/B2) from either Mexico or other/unknown countries. Similarly, individuals for whom no entry record could be located (Entry Without Inspection or "EWI") are shown in the figure to the right below.

[redacted] (b) (7)(E)

Figure 5.2 Outbound Potential Overstays (recorded February 8 -- April 29, 2016)

*Figure 5.3 Outbound Potential EWIs (recorded March 12 – April 29, 2016)***

**Dates: March 12 - April 29, 2015

\# of Travelers Country

[redacted] (b) (7)(E)

The document types used by Mexican citizens as they crossed Inbound and Outbound to the U.S. during the Field Test are shown below. BCC – Border Crossing Card; LPR – Legal Permanent Resident; DCL – Dedicated Commuter Lane

Figure 5.4 Inbound and Outbound Mexican Citizen Document

The charts below depict the reasons travelers were referred to Secondary Inspection (Left chart) and the database [redacted] Right Chart).

[redacted]

Figure 5.5 [redacted] *in Outbound*

5.3 Human Factors Observations

The charts below describe the objects that individuals were carrying as they traveled across the border, as well as the percentage who were using each type of lane, and where they were [redacted]

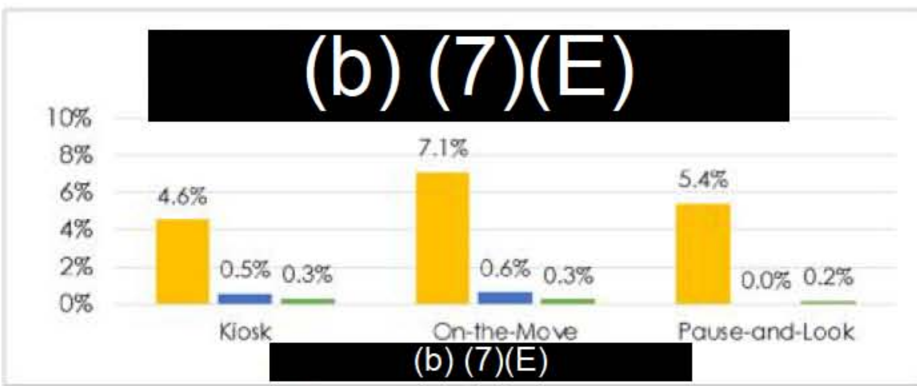

Figure 5.6 Items Worn by Travelers

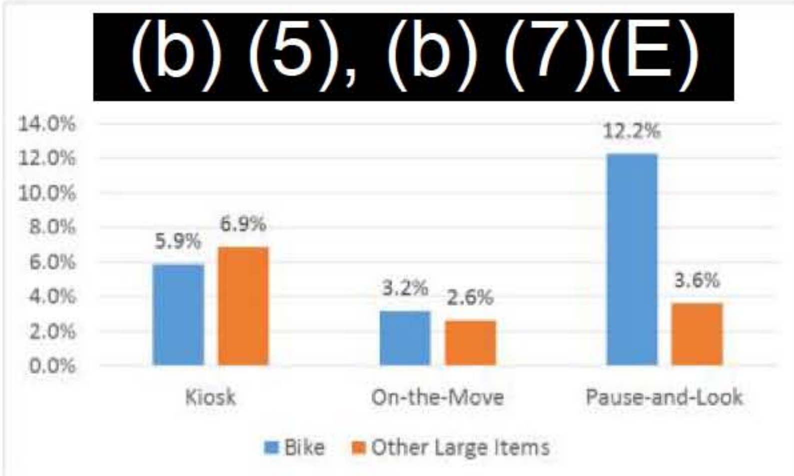

Figure 5.7 [redacted]

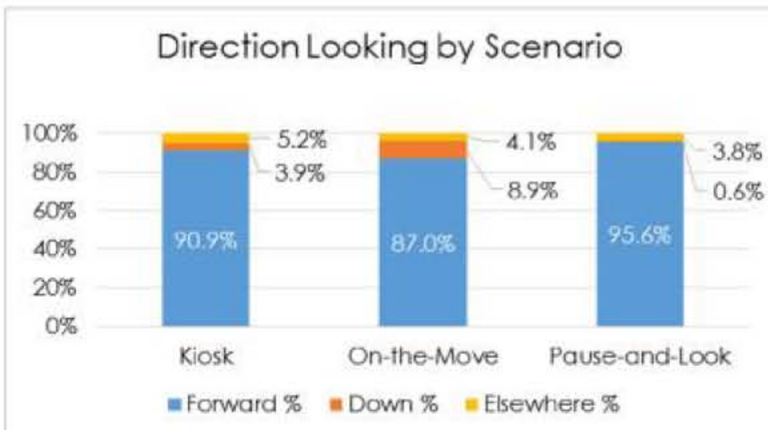

Figure 5.8 Direction Traveler Looking by Scenario

[1] Southern Border Pedestrian Technical Report, Section 7.3.3
[2] Ibid, Section 7.4.3
[3] Ibid, Section 7.5.3
[4] Ibid, Section 7.6.3
[5] Ibid, Section 7.7.3
[6] Ibid, Section 7.8.3
[7] Ibid, Section 7.12.7.1
[8] Ibid, Section 7.1.1
[9] Ibid, Section 8.5
[10] Ibid, Section 7.12.7.4
[11] Ibid, Section 6
[12] Ibid, Section 8.5
[13] Ibid, Section 8.6.1.3
[14] Ibid, Section 6 and 7
[15] Ibid, Section 4
[16] Ibid, Section 5.1
[17] Ibid, Section 5.1

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