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Test and Evaluation Plan: Interface and Usability Assessment for Trace Detector Portal Systems

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Test and Evaluation Plan

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16. Abstract Explosives may be concealed on one's person upon entering the airport security checkpoint or passenger. To assist screeners' ability to find hidden explosive threats on one's person or find trace explosives from someone who has either constructed or handled an explosive device, explosive detection portal devices are currently in development. This document describes a plan for collecting critical information about the interface and usability, and the efficiency and effectiveness of three explosive trace detection portals: Ion Track Instruments, Inc., Sandia National Laboratories, and Barringer Technologies, Inc. The assessment will proceed in two phases: a usability assessment (operator and passenger), and a laboratory effectiveness and efficiency assessment for all three portals. All interface and usability assessments of the portal technologies will be conducted at the FAA William J. Hughes Technical Center's Aviation Security Laboratory.			
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EXECUTIVE SUMMARY

To improve the detection of explosive threats on or handled by passengers, Portal Explosive Trace Detectors (PETDs) are currently in development. These PETDs will provide a mechanism for airport security personnel to examine passengers faster and more precisely than the current explosive trace detection equipment while maintaining a high level of confidence in their ability to identify explosive threats. To address these issues, Human Factors Engineers (HFEs) will assess PETDs manufactured by Ion Track Instruments, Inc., Sandia National Laboratories, and Barringer Technologies, Inc. This document describes a plan for assessing the interface and usability as well as the effectiveness and efficiency of the PETDs.

The assessment will proceed in two phases. The first phase is a usability assessment for all three system followed by the second phase, an effectiveness and efficiency assessment for the three portals. To evaluate system usability, HFEs will conduct interface and usability assessments at the Aviation Security Laboratory (ASL) at the FAA William J. Hughes Technical Center. The assessments will determine whether any part of the system software, hardware, or required procedures enhance or impede operator performance. They will focus on how the system displays information and on the compatibility of the user interface with the tasks of the operator as well as the compatibility of the passenger. The effectiveness and efficiency of these portals will be evaluated in a laboratory study at the ASL.

During the effectiveness and efficiency study, screeners will be trained in the use of the portal systems before they are deployed at a simulated checkpoint. HFEs will observe the operators using the PETDs with volunteer passengers. Passengers will wear patches with trace quantities of explosives. The effectiveness of the systems in detecting explosives will be recorded, and the efficiency with which screening is conducted will be recorded. Screeners and passengers will be interviewed to obtain their opinions about the usability of the portals at the conclusion of the test session.

All problems that arise with the use of the equipment will be recorded using standard data forms. This effort will help to identify factors that may enhance the effectiveness of PETD technology.

ACRONYMS

ASL	Aviation Security Laboratory
COIC	Critical Operational Issues and Criteria
ETD	Explosive Trace Detector
FAA	Federal Aviation Administration
HFE	Human Factors Engineer
ITI	Ion Track Instruments
MOP	Measure of Performance
P_d	Probability of Detection
PETD	Portal Explosive Trace Detector
P_{fa}	Probability of False Alarm

1. INTRODUCTION

Explosive materials may be concealed on one's person before entering the airport security checkpoint. Given the volume of passenger traffic and the fact that explosive materials are often elaborately packaged or sealed, manual inspection of a passenger is a difficult challenge for explosive threat detection. There are currently Explosive Trace Detectors (ETDs) deployed at dozens of U.S. airports that are used to analyze carry-on and checked baggage for explosive traces. Adaptation of these technologies to passenger screening would further enhance security against explosive threats. Such devices called Portal ETDs (PETDs) are currently in development to screen persons for trace amounts of explosive materials. These PETD systems will provide a mechanism for airport security personnel to examine passengers faster and more precisely while maintaining a high level of confidence in their ability to screen for explosive materials.

To address these issues, Human Factors Engineers (HFEs) will assess the operator interface and usability as well the passenger usability. Also, the effectiveness and efficiency of three PETDs will be assessed. This effort will help ensure that the PETD system is designed with the human operator and passenger in mind and that a high level of human-machine system performance is realized before the system is deployed at U.S. airports.

1.1 Background

Currently, airport security personnel examine passengers by metal detectors, hand wands, and physical search. However, passengers that have concealed explosive threats or passengers that have handled explosives, may have trace amounts on their clothing and person, which will not be detected with these methods. As part of the Federal Aviation Administration (FAA) effort to develop technology that facilitates screening for explosive materials, PETD systems are being developed that can analyze the contents of a plume of air surrounding a passenger. The goal of these devices is to quickly screen for explosive trace particles left on the clothing or person from a potential threat. Currently, there are three versions of PETDs being considered for evaluation.

1.2 Purpose

This document describes a plan for collecting critical information about the interface, usability, and laboratory assessment of three PETD systems. This effort will help to identify factors that may enhance or improve PETD technology development.

1.3 System Description

Three PETD systems are currently under consideration and are manufactured by Ion Track Instruments, Inc. (ITI), Sandia National Labs, and Barringer Technologies, Inc. All three PETD systems use similar technology. As a passenger enters the portal, optical sensors trigger a sampling device. Sampling is done through air jets that gently dislodge potential explosive particles from the clothing or person of a passenger. The dislodged particles are then directed into a preconcentrator which then go into the Ion Mobility Spectrometer for analysis. These portals are designed to sample passengers in a non-invasive manner.

2. CRITICAL OPERATIONAL ISSUES AND CRITERIA

The Critical Operational Issues and Criteria (COIC) and Measures of Performance (MOPs) are focused on different aspects of operational performance by trained screeners using PETD technology. These COICs need to be resolved with regard to trained operators using the equipment properly and passengers who will be screened using this methodology.

2.1 Issue 1 - Usability

Are there any software or hardware factors or procedures that affect system effectiveness?

Criterion 1-1. All system operations can be carried out smoothly and accurately by trained personnel.

MOP 1-1-1. Deficiencies reported with the usability checklist.

MOP 1-1-2. Deficiencies found in the laboratory evaluation.

MOP 1-1-3. Operators' evaluation through a questionnaire.

Criterion 1-2. All systems are designed to handle various passenger types.

MOP 1-1-1. Deficiencies reported with the usability checklist.

MOP 1-1-2. Deficiencies found in the laboratory evaluation.

MOP 1-1-3. Passenger' evaluation through a questionnaire.

2.2 Issue 2 - Training

Can personnel learn to use the system efficiently and effectively?

Criterion 2-1. Personnel are trained adequately before using the equipment.

MOP 2-1-1. Operators' evaluation of training through a questionnaire.

MOP 2-1-2. Number of system errors caused by the operator.

2.3 Issue 3 - Efficiency

How long does it take to screen a passenger?

Criterion 3-1. Investigative in nature.

MOP 3-1-1. Time from beginning to completion of screening.

MOP 3-1-2. Number of system failures.

2.4 Issue 4 - System Effectiveness

Can the system screen effectively without unacceptable numbers of false alarms?

Criterion 4-1. Investigative in nature.

MOP 4-1-1. Determine Probability of Detection (P_d) for portal system.

MOP 4-1-2. Determine Probability of False alarm (P_{fa}) for portal system.

MOP 4-1-3. Determine P_d for screener for explosive threat samples.

MOP 4-1-4. Determine P_{fa} for screener for explosive threat samples.

3. METHOD

The tests for the three PETDs will be carried out in two phases. Phase I will consist of a usability assessment. Phase II will be the efficiency and effectiveness laboratory study.

3.1 Phase 1: Portal Usability Assessment

3.1.1 Test Site

The usability assessment will be conducted in the FAA William J. Hughes Technical Center Aviation Security Laboratory (ASL) at the, Atlantic City International Airport, NJ.

3.1.2 Test Materials

Checklists based on human factors design standards will be utilized [1].

3.1.3 Test Participants

Test Participants for Phase I will be HFEs from Federal Data Corporation (FDC).

3.1.4 Test Procedure

HFEs will conduct tests to determine usability and interface issues for the three portals using the Human Factors Usability Checklists (see Appendix A). Deficiencies will be recorded and reported to each manufacturer of each system.

3.2 Phase II: Portal Laboratory Evaluations

This laboratory evaluation will concentrate on the efficiency and effectiveness of the three portal systems and the ability of trained screeners to properly use the equipment for which data will also be collected. Opinions about the usability and the proper use of the equipment will be examined using questionnaires given to screeners and passengers (appendix B) following their extended use of the systems. HFEs will directly observe the screeners as well as passengers while screeners are using the equipment.

3.2.1 Test Participants

3.2.1.1 Portal Operators - approximately 14 screeners who will be trained in the use of the PETD systems.

3.2.1.2 Trainers - vendor representatives or other parties authorized by the FAA.

3.2.1.3 Acting Passengers - approximately 10 to 20 test subject passengers will also be recruited to participate as passengers who will walk through each portal.

3.2.2 Test Site

The efficiency and effectiveness evaluation will be conducted in the ASL.

3.2.3 Test Materials

3.2.3.1 Patches - patches containing various trace concentrations of explosive material hidden on volunteered passengers.

3.2.3.2 Questionnaire - operator assessment of the trace detector portals will be surveyed by questionnaire (appendix B).

3.2.3.2 Data Collection Forms – forms utilized for data collection (appendix C).

3.2.4 Test Procedure

An efficiency and effectiveness assessment of the ITI, Barringer, and Sandia portal systems will be conducted in the following manner:

Each screener will monitor a minimum of 100 passengers through the portal. The passengers will consist of some volunteers walking through repeatedly in sequence. About 30% of the test passengers will wear patches with trace amounts of explosives. The remaining passengers will be innocent, not carry explosive traces. Screeners will be instructed to inform the HFEs when passenger alarms occur. HFEs will record the alarm and the screener responses. The HFEs will use data sheets that allow them to record portal and screener responses as hits or false alarms

based upon the trace explosive patch status of the test passengers. A second HFE will record simultaneously the processing time.

NOTE: Strict attention should be paid to keeping contaminated passengers isolated so that contamination will be contained.

3.3 Data Analysis

Screeners interviews, surveys, and errors will provide both qualitative and quantitative data about the portal trace detector technology usability. A list of screener errors and responses to usability questions will be compiled. Descriptive statistics will be used to analyze the questionnaires on a scale of (1) Strongly Disagree to (5) Strongly Agree. Summary statistics regarding the amount of time that trace detection screening requires will be collected, and mean times and variances will be reported.

HFEs will summarize the qualitative data from the questionnaires and interviews. Recommendations will be made to rectify any reported deficiencies. Any software, hardware, or procedural aspects that were marked as failures on the human factors checklist or received comments by the screeners or failures in operations will be reported and recommendations for improvements will be made.

4. REPORTING

A summary of the data analysis will be delivered first in a preliminary report of the main results. The final test and evaluation report will describe the entire process used to assess the three portal trace detector systems. It will also present the results of the laboratory testing in addition to the results of the screener interviews and surveys.

5. REFERENCES

1. Bailey, R. W., "Human Performance Engineering," Prentice Hall, NJ, 1989.

APPENDIX A
HUMAN FACTORS USABILITY CHECKLIST

USABILITY RATING SCALE

Severity	Description
I-Severe	There is a high probability of operational failure, severe damage, loss of equipment, and injury to operators.
II-Major	There is a high probability of degraded system performance, major damage to equipment, or discomfort to operators.
III-Moderate	There may be no measurable impact on system performance, though there is a measurable impact upon the performance of system components or subsystems (including the human subsystem). Operators try to compensate for or work around system defects.
IV-Minimal	There is no measurable impact on the performance of system components or subsystems (including the human subsystem), although operators' negative attitudes toward features to the system may be measurable.
V-Negligible	The problem has a negligible impact on short-term system performance. There may be no measurable impact on operator attitudes.
VI-None	No problem or negative factor related to system performance is noted.
NA	Not Applicable.

Human Factors Principle	Deficiency Rating	Comments
Data Entry		
1. Provide prompting for the required formats and acceptable values for data entries.		
2. Ensure that the computer will acknowledge entry of a designated position within an acceptable timeframe.		
3. Provide software for automatic data validation to check any item whose entry and/or correct format or content is required for subsequent data processing.		
4. If data validation detects a probable error, display an error message to the user at the completion of data entry; do not interrupt an ongoing transaction.		
5. Ensure that control actions for cursor positioning are compatible with movements of the displayed cursor, in terms of control function and labeling.		
6. An explicit action is required to initiate the processing of critical information.		
7. For position designation on the display, provide a movable cursor with distinctive visual features (blink, shape).		
8. Make labels consistent; always employ the same labels to indicate the same kind of information.		
9. Each function has a unique input device that is well marked with labels and/or icons.		
Data Display		
1. Reserve several lines of the screen of every display for status and error messages, prompts, and command entry.		
2. Use auditory displays, when appropriate, as a means of supplementing a visual display, or as an alternative means of data output in applications where visual displays are not feasible.		

Human Factors Principle	Deficiency Rating	Comments
3. Sufficient contrast shall be provided between displayed information and the display background to ensure that the required information can be perceived by the operator under all expected lighting conditions.		
4. Displays shall be located and designed so that they may be read by personnel in normal operation without requiring an uncomfortable, awkward, or unsafe position.		
5. Users should have control of the quality of the displays without degrading the displays.		
6. Glare shall be minimized by proper CRT placement and/or shielding.		
7. The preferred viewing distance from the eye reference point to a display should be at least 510mm (20 in).		
8. Users should be able to control the amount, format, and complexity of displayed data, as necessary to meet task requirements.		
Sequence Control		
1. Ensure that control actions are simple, particularly for real-time tasks requiring fast user response; control logic should permit completion of a transaction sequence with the minimum number of actions consistent with user abilities.		
2. Allow users to take initiative and control their interaction with the computer; try to anticipate user requirements and provide appropriate user control options and computer responses in all cases.		
3. Ensure that sequence control actions are consistent in form and consequences; employ similar means to accomplish ends that are similar from one transaction to the next and from one task to another throughout the user interface.		
4. Ensure that the computer acknowledges every control entry immediately; for every action by the user, there should be some apparent reaction from the computer.		

Human Factors Principle	Deficiency Rating	Comments
5. Ensure that the speed of computer response to user control entries is appropriate to the transaction involved; in general, the response should be faster for those transactions perceived by a user to be simple.		
6. Allow users to make control entries as needed; a sequence of control entries should not be delayed by delays in computer response.		
7. The user, not the computer, shall control the pace of control entries by explicit action.		
8. When a function is activated, the function name should appear on the screen.		
9. Each menu display should permit only one selection by the user.		
10. When multiple menu options are displayed in a list, display each option on a new line (i.e., format the list as a single column).		
11. Display an explanatory title for each menu, reflecting the nature of the choice to be made.		
12. List displayed menu options in a logical order; if no logical structure is apparent, then display the options in order of their expected frequency of use, with the most frequent listed first.		
13. Provide a general menu of basic options as the top level in a hierarchic menu structure, a "home base" to which a user can always return as a consistent starting point for control entries.		
14. Keys controlling frequently used functions should permit single key action and should not require double (control/shift) keying.		
15. When function key activation does not result in any immediately observable natural response, provide users with some other form of computer acknowledgement.		
16. If a function is assigned to a particular key in one transaction, assign that function to the same key in other transactions.		
17. A zoom capability should be provided to enlarge critical display areas.		
18. Ensure that alarm signals and messages are distinctive for each class of events.		

Human Factors Principle	Deficiency Rating	Comments
User Guidance		
1. Design standard procedures for accomplishing similar, logically related transactions.		
2. Design display formats so that user guidance material is readily distinguishable from displayed data.		
3. Adopt task-oriented wording for labels, prompts, and user guidance messages, incorporating whatever special terms and technical jargon may be customarily employed in the users' tasks.		
4. Allow users to switch easily between any information handling transaction and its associated guidance material.		
5. Provide some indication of system status to users at all times.		
6. Ensure that every input by a user will consistently produce some perceptible response output from the computer; when a terminal is in use, its display screen should never be blank.		
7. When computer processing of a user entry has been delayed, inform the user when processing is completed and provide appropriate guidance for further user actions.		
8. When the computer detects an entry error, display an error message to the user stating what is wrong and what can be done about it.		
9. Ensure that specific user guidance information is available for display at any point in a transaction sequence.		
10. In addition to explicit aids (labels, prompts, advisory messages) and implicit aids (cueing), permit users to obtain further on-line guidance by requesting HELP.		
Data Transmission		
1. Ensure that data transmission functions are integrated with other information handling functions within a system.		

Bailey, R. W., "Human Performance Engineering," Prentice Hall, New Jersey, 1989.

APPENDIX B
PORTAL TRACE DETECTOR OPERATOR SURVEY

OPERATOR SURVEY

Please take a few minutes to complete this survey. You may be operating this equipment in the future; therefore, your input is valued by the Federal Aviation Administration.

Portal Trace Detector System: ITI Sandia Barringer (Circle One)

1. How long have you worked as a screener? _____ years _____ months

2. Are you now or have you ever been a supervisor? ____ Yes ____ No

3. In what other screening positions have you worked?

X-ray? _____

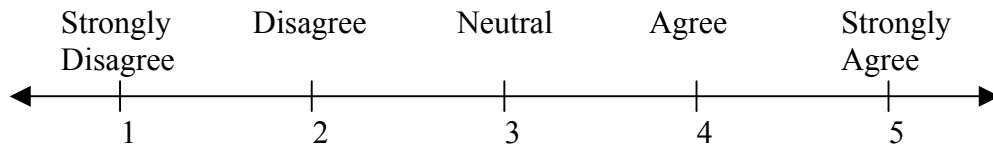
Exit Lane? _____

Entry Lane? _____

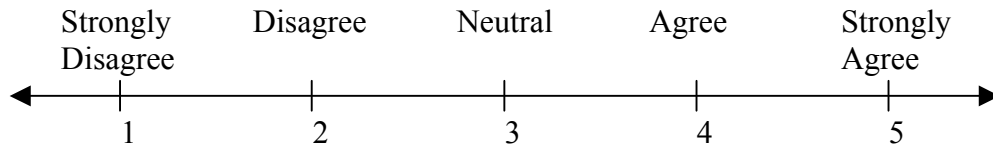
Trace Equipment? _____

Other, Please Specify _____

4. The portal trace detector system was easy to use.



5. The portal trace detector system would cause considerable delays at the checkpoint.



6. Approximately how many passengers did you screen with the portal trace detector?

1-5 _____

6-10 _____

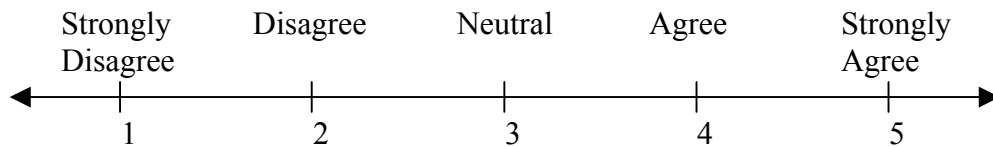
11-20 _____

20-50 _____

50+ _____

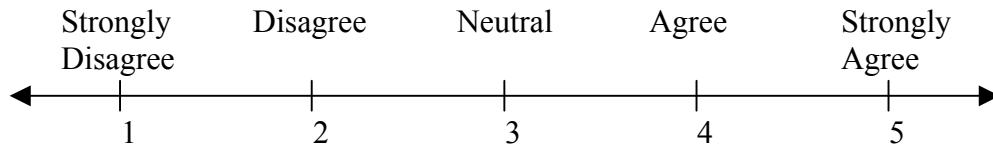
7. Please list any problems that caused a delay or made it difficult for you to perform this job.

8. The training I received for the portal trace detector system gave me enough knowledge to run the machine adequately.

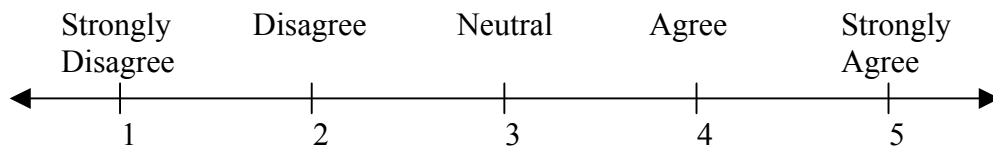


EQUIPMENT CONTROLS

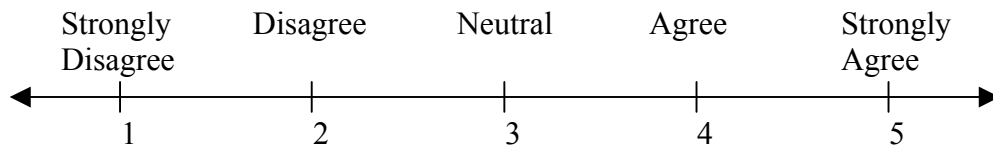
9. The controls for the portal trace detector system were easy to use.



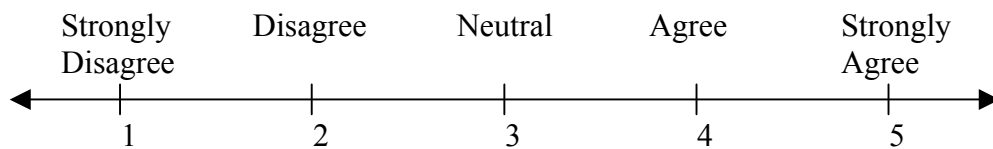
10. The controls were clearly labeled.



11. It was easy to perform the maintenance procedures.



12. I always knew the status of the device.



APPENDIX C
DATA COLLECTION FORM

SCREENER DATA COLLECTION FORM

Screeners Number_____

Passenger Number_____

Patch Concentration_____

Alarm Circle One	Total Screening Time	Operational Errors or External Problems
Yes No		
Yes No		
Yes No		
Yes No		
Yes No		
Yes No		

Comments:
