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Operational Test and Evaluation Plan: Bottle Contents Tester Usability Assessment

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Test and Evaluation Plan

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16. Abstract
Explosives and flammable materials may be concealed in bottles in carry-on or checked baggage. Given the volume of passenger baggage and the fact that bottles are often elaborately packaged or sealed, manual inspection of a bottle's contents is a difficult challenge. To improve the screening of liquid containers, devices are currently in development to screen bottles. This document describes a plan for collecting critical information about the interface and usability of a bottle contents tester. The assessment will proceed in two stages: a laboratory assessment at the Aviation Security Laboratory at the Atlantic City International Airport in NJ and a field assessment. Usability of a bottle contents tester in the operational environment as well as screener and passenger acceptance of bottle contents screening will be assessed.

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EXECUTIVE SUMMARY

Explosives and flammable materials may be concealed in bottles in carry-on or checked baggage. Given the volume of passenger baggage and the fact that bottles are often elaborately packaged or sealed, manual inspection of a bottle's contents is a challenge. To improve the screening of liquid containers, devices are currently in development to screen bottles. These bottle contents testers will provide a mechanism for airport security personnel to examine liquids in bottles faster and more precisely while maintaining a high level of confidence in their ability to screen out hazardous materials. To address these issues, Human Factors Engineers (HFEs) will assess a bottle contents tester, particularly the operator interface and usability of the device. This document describes a plan for collecting critical information about the interface and usability of bottle contents tester.

The assessment will proceed in two stages: a laboratory assessment and a field assessment. For the lab assessment, HFEs will conduct an interface and usability assessment of a bottle contents tester at the Aviation Security Laboratory at the Atlantic City International Airport, NJ. The assessment will determine whether any part of the system software, hardware, or required procedures impede rather than enhance operator performance. This assessment will focus on how the system displays information and on the compatibility of the user interface with the tasks of the operator.

For the field test, which will be conducted at a U.S. airport, screeners will be trained in the use of a bottle contents tester before they are deployed at the checkpoint. HFEs will observe the operators using a bottle contents tester with volunteer passengers. All problems that arise with the use of the equipment will be recorded using standard data forms. Screeners will also be interviewed to obtain their opinions about the usability of a bottle contents tester at the conclusion of the test session. This effort will help to identify factors that may impinge on the effectiveness of a bottle contents tester.

ACRONYMS

COIC	Critical Operational Issues and Criteria
FAA	Federal Aviation Administration
HFE	Human Factors Engineer
MOP	Measure of Performance

1. INTRODUCTION.

Explosives and flammable materials may be concealed in bottles in carry-on or checked baggage. Given the volume of passenger baggage and the fact that bottles are often elaborately packaged or sealed, manual inspection of a bottle's contents is a challenge. To improve the screening of liquid containers, devices are currently in development to screen bottles. These bottle contents testers will provide a mechanism for airport security personnel to examine liquids in bottles faster and more precisely while maintaining a high level of confidence in their ability to screen out hazardous materials.

To address these issues, Human Factors Engineers (HFEs) will assess a bottle contents tester, particularly the operator interface and usability of the device. This effort will help ensure that a bottle contents tester is designed with the human operator in mind and that a high level of human-machine system performance is realized once the system is deployed in U.S. airports.

1.1 Background.

Currently, airport security personnel examine carry-on and checked baggage by X-ray screening and physical search. This baggage may include bottles such as liquor and shampoo bottles that can conceal a hazardous liquid. As part of the Federal Aviation Administration (FAA) effort to develop technology that facilitates screening for weapons and hazardous materials, bottle contents testers are being developed that can analyze the contents of a sealed container. These devices could quickly analyze liquids within glass and plastic containers to identify those that are hazardous.

Threats can be disguised as liquids commonly brought on board aircraft (e.g., soft drinks). This possibility has required developing unique technologies for detecting such potential threats. The goal of these efforts is to produce a simple, fast, accurate, and inexpensive instrument to detect the presence of flammable liquids or liquid explosives in self-contained bottles. No human performance evaluations have been completed in an airport or laboratory environment to evaluate bottle contents tester(s) currently available.

1.2 Purpose.

This document describes a plan for collecting critical information about the interface and usability of current bottle contents tester(s). This effort will help to identify factors that may impinge on the effectiveness of a bottle contents tester(s).

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 a bottle contents tester. These critical issues assess the performance of trained operators using the equipment and commercial airline passengers' acceptance of this screening method.

2.1 Issue 1 - Usability.

Are there any software or hardware factors or procedures that affect system usability by operators?

Criterion 1-1. All system operations show no deficiencies that could impact operation by trained personnel.

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

2.2 Issue 2 – Machine Performance

How does a bottle contents tester perform in a laboratory environment?

Criterion 2-1. Investigative in nature.

MOP 2-1-1. Machine false alarm rate.

MOP 2-1-2. Machine detection rate for hazardous material.

2.3 ISSUE 3 – Training.

Can personnel learn to use the system efficiently and effectively?

Criterion 3-1. Personnel are trained adequately before using the equipment.

MOP 3-1-1. Operator evaluation of training through questionnaires.

MOP 3-1-2. Number of system errors caused by the operator.

2.4 Issue 4- Throughput.

How long does it take to screen a bottle?

Criterion 4-1. Investigative in nature.

MOP 4-1-1. Time from beginning of bottle screening to the completion of bottle screening.

2.5 Issue 5 - Bottle Demographics.

How many and what types of bottles do passengers carry?

Criterion 5-1. Investigative in nature.

MOP 5-1-1. Number and types of bottles recorded (e.g., shampoo, wine)

Criterion 5-2. Size, shape, and composition of bottles are compatible with a bottle contents tester design.

MOP 5-2-1. Frequency of bottle contents tester problems caused by size, shape and composition of bottles.

MOP 5-2-2. The size and the percent full of all bottles greater than 4 ounces.

2.6 Issue 6 - Passenger Acceptability.

Can the system screen effectively without causing unacceptable levels of passenger discomfort, inconvenience, or embarrassment?

Criterion 6-1. Screened passengers report that screening is not unnecessarily inconvenient, invasive, or embarrassing.

MOP 6-1-1. Evaluation of perceived levels of inconvenience, invasiveness and embarrassment by passenger through questionnaires.

3. METHOD.

The study will concentrate on the usability of the equipment in the laboratory and the ability of trained screeners to properly use the equipment in the operational environment. Opinions about the usability and the proper use of the equipment will be examined via the questionnaires given (i.e., administered by HFEs) to screeners (see appendix A) following their extended use of a bottle contents tester and by direct observation using checklists while screeners are using the equipment. In addition, a second questionnaire will be given (i.e., administered by HFEs) to passengers (see appendix B) to elicit their opinions of a bottle contents tester equipment and procedures.

3.1 Test Participants.

Screeners will be trained in the use of a bottle contents tester before the device is deployed at the checkpoint. Trainers will be vendor representatives or other parties authorized by the FAA. A large number of passengers will also be asked to participate (i.e., volunteer) in the operational testing at the airport.

3.2 Test Sites.

The laboratory assessment will be conducted in the Aviation Security Laboratory at the FAA William J. Hughes Technical Center, Atlantic City International Airport, NJ. The field test will be conducted at a U.S. Airport.

3.3 Test Materials.

For the laboratory assessment, checklists based on human factors design standards will be used to assess the usability and interface of a bottle contents tester (see appendix C).

For the field assessment, questionnaires addressed to the operator and the passengers will elicit their opinions on inconvenience and /or invasiveness of a bottle contents tester.

3.4 Usability Assessment Procedure.

3.4.1 LABORATORY ASSESSMENT.

For the lab assessment, HFEs will conduct an interface and usability assessment of a bottle contents tester. The assessment will determine whether any part of the system software, hardware, or required procedures impede, rather than enhance, operator performance. This assessment will focus on how the system displays information and on the compatibility of the user interface with the tasks of the operator.

3.4.2 FIELD ASSESSMENT.

HFEs will observe operators using a bottle contents tester. All problems that arise with the use of the equipment will be recorded and evaluated against the usability checklist (appendix C). A sample size of 300 bottles will be obtained from the airport site (average of 2 bottles per passenger bag). The bottles will be those in the carry-on bags of airline passengers who volunteer to submit to bottle contents testing. Using a standard data collection form (see appendix D), information will be collected relevant to the COICs. These data will include the number and types of bottles that passengers carry, the amount of time that bottle screening requires, and any operational problems of performance or reliability that arise. Data will also be collected following screening using two questionnaires: an operator questionnaire to assess the use of the device and a passenger questionnaire to assess airline passenger acceptance of the screening method. These questionnaires can be found in appendices A and B.

3.5 Data Analysis.

Screener interviews, surveys, and errors will provide both subjective and objective data about a bottle contents tester usability. A list of screener errors and responses to usability questions as well as passenger responses will be compiled. Descriptive statistics will be produced for the questionnaires on a scale of (1) – Strongly Disagree to (5) – Strongly Agree. Summary statistics regarding the demographics of bottles in carry-on baggage and the amount of time that bottle screening requires will be collected, and averages 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, received negative comments by the screeners, or failures in operations will be reported. Recommendations for improvements will be made.

4. REPORTING.

The final test and evaluation report will describe the entire process used to assess a bottle contents tester. The final report will present the results of the laboratory and the airport testing in addition to the results of the screener interviews and passenger surveys.

5. REFERENCE.

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

APPENDIX A

BOTTLE CONTENTS TESTER 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.

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? _____

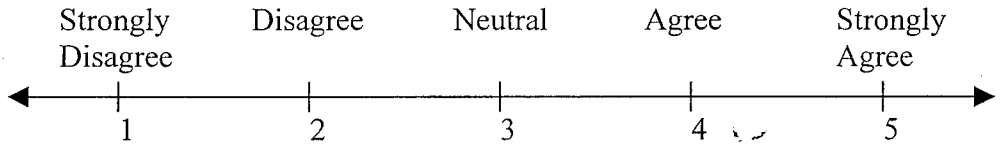
   Exit Lane? _____

   Entry Lane? _____

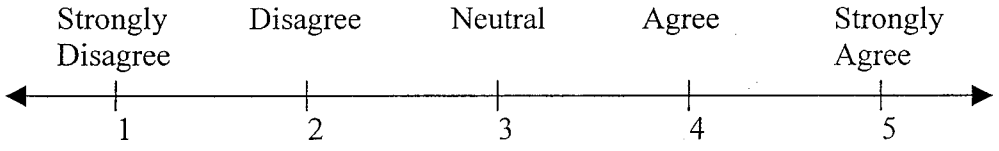
   Trace Equipment? _____

   Other, Please Specify _____

4. The bottle contents tester was easy to use.



5. The bottle contents tester would cause considerable delays at the checkpoint.



6. Approximately how long did you operate the bottle contents tester during your shift?

   _____Minutes

7. Approximately how many passengers did you screen with the bottle contents tester?

1-5 _____

6-10 _____

11-20 _____

20-50 _____

50+ _____

8. On average, how many bottles did you need to screen for each passenger?

Less than 1 _____

1 or 2 _____

More than 5 _____

9. On average, how long do you think it took to screen a bottle including the time it took to locate the bottle?

Less than 1 minute _____

1 or 2 minutes _____

3 to 5 minutes _____

More than 5 minutes _____

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

_____

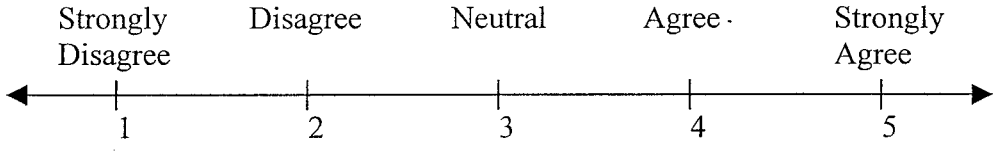
_____

_____

_____

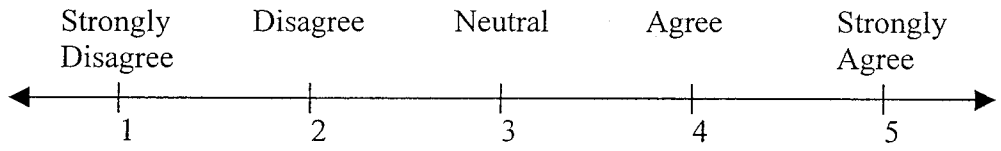
_____

11. The training I received for the bottle contents tester gave me enough knowledge to run the machine adequately.

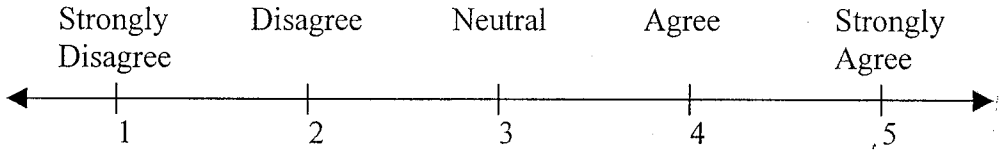


EQUIPMENT CONTROLS

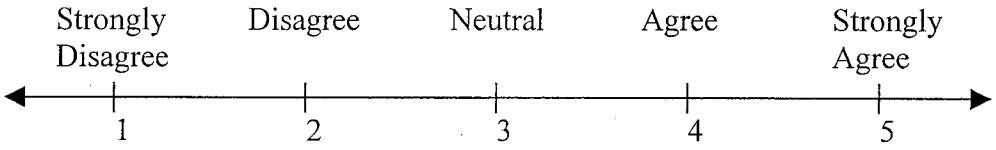
12. The controls for the bottle contents tester were easy to use.



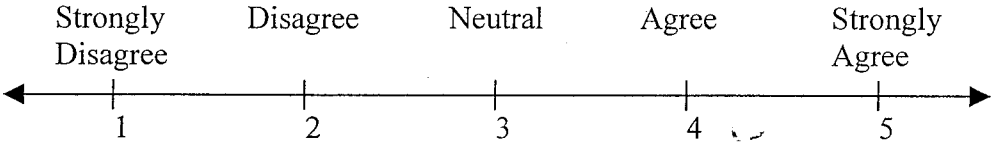
13. The controls were clearly labeled.



14. It was easy to perform the maintenance procedures.



15. I always knew the status of the device.



APPENDIX B

BOTTLE CONTENTS TESTER PASSENGER SURVEY

Thank you for participating in this assessment of the bottle contents tester. The Federal Aviation Administration is investigating its effectiveness in identifying hazardous materials carried by passengers. Please take a few minutes to complete this survey.

Please mark the appropriate space.

1. Gender

   Male_____ Female_____

2. Age Range

   under 21_____ 21–30_____ 31-40_____ 41-50_____ 51-60____ over 60 _____

3. Are you traveling for business or leisure?

   Business _____ Leisure_____

4. How many people are traveling with you?

   0 ____ 1____ 2____ 3+ _____

5. In an average year, how often do you fly?

   At least once weekly _____
   At least once monthly _____
   Once or twice a year _____
   Very Seldom _____

6. How many carry-on bags do you have with you?

   0 ____ 1____ 2____ 3+ _____

7. On average, how early do you arrive at the airport prior to your scheduled departure?

   Less than 30 minutes _____
   30 – 60 minutes _____
   1-2 hours _____

8. How many bottles (more than 4 oz) do you usually carry in your bags?

0_____ 1 or 2 _____ More than 5 _____

9. Did you find the bottle contents tester procedure to be inconvenient?

Yes_____ No_____

10. Did the procedure take too long?

Yes_____ No_____

11. How long would you be willing to wait for this procedure?

I would not want to wait at all _____
Less than 1 minute _____
1 or 2 minutes _____
2 to 5 minutes _____
As long as it takes _____

12. Do you feel that opening your bag and removing bottles is an invasion of privacy?

Yes_____ No _____

13. Which statement best describes you feeling about this procedure?

This procedure should be required to increase the security at our airports. _____
It makes me feel more secure when flying. _____
Current security procedures are sufficient. _____
I don't like it. It is one more intrusion at the checkpoint. _____

14. Do you have any other comments?

Thank you for taking the time and providing input to help improve security!

APPENDIX C

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 Bottle Contents Tester will acknowledge a data entry within an acceptable timeframe.		
3. Provide software for automatic data validation to check any item whose entry, 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. For position designation on the bottle contents tester, provide a movable cursor with distinctive visual features (i.e., blink, shape).		

Human Factors Principle	Deficiency Rating	Comments
Data Display		
1. 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.		
2. 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.		
3. Users should have control of the quality of the displays without degrading the displays.		
4. Glare shall be minimized by proper display placement and/or shielding.		
5. The preferred viewing distance from the eye reference point to a display should be at least 510mm (20 in.).		
6. 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 Bottle Contents Tester, try to anticipate user requirements and provide appropriate user control options and responses in all cases.		
3. Ensure that the Bottle Contents Tester acknowledges every entry immediately; for every action by the users there should be some apparent reaction from the Bottle Contents Tester.		

Human Factors Principle	Deficiency Rating	Comments
4. Ensure that the speed of Bottle Contents Tester 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.		
5. Keys controlling frequently used functions should permit single key action and should not require double (control/shift) keying.		
6. When function key activation does not result in any immediately observable natural response, provide users with some other form of system acknowledgement.		
7. If a function is assigned to a particular key in one transaction, assign that function to the same key in other transactions.		
8. Ensure that alarm signals and messages are distinctive for each class of events.		
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 bottle Contents Tester status to users at all times.		
6. Ensure that every input by a user will consistently produce some perceptible response output from the system.		
7. When Bottle Contents Tester processing of a user entry has been delayed, inform the user when processing is completed and provide appropriate guidance for further user actions.		

Human Factors Principle	Deficiency Rating	Comments
8. When the Bottle Contents Tester 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 the Bottle Contents Tester.		

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

APPENDIX D

DATA COLLECTION FORM

Bottle Screener Data Collection Form

Passenger Number	Number of Bags	Number of Bottles	Number of Alarms	Bottle Content, if Alarmed	Total Screening Time	Unusual Size?	Unusual Shape?	Unusual Container Material?	Operational Errors or External Problems

Comments: