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Phase IIB Qualification Test Plan and Procedure of Commercially Available Radio Frequency Identification (RFID) Systems for Baggage Identification, Tracking and Security Applications

Continental Airlines Trial
San Antonio and Houston, Texas

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16. Abstract

This document describes the Qualification Test Plan/Procedures for the Phase IIB Qualification RFID Test to be conducted prior to the Operational RFID Test with Continental Airlines in San Antonio and Houston, Texas.

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EXECUTIVE SUMMARY

The increasing importance of commercial airline passenger and baggage security, combined with the need to sort and track ever larger numbers of passenger baggage quickly and accurately, have led to the search for more efficient methods of performing the baggage sortation, tracking and security functions. Any tool used to facilitate these functions must be able to rapidly and reliably process, reconcile and track passenger and baggage information. Without this capability, flight delays and increased operational costs are likely to result. Passenger inconvenience could lead to decreased tolerance of airline security regulations and loss of confidence in the air transport industry.

Phase I RFID Testing

In 1997, the FAA sponsored testing of commercially available RFID systems. Conducted in two stages, it began with Qualification Testing, which qualified vendor RFID products and systems, in a controlled laboratory environment, to:

- Operate within the physical and operational constraints associated with airline and airport environments, and

- Perform the functional requirements associated with baggage sortation and passenger/baggage match security objectives in the airline and airport environment, without causing degradation of existing electronic systems.

Operational Testing was subsequently conducted to examine and verify the operational validity and viability of candidate RFID systems for passenger/baggage match and sortation application in a live airport environment. This testing was conducted in conjunction with sponsor airlines and airports, as well as in cooperation with a Baggage Reconciliation System (BRS) provider.

Phase II RFID Testing

The primary objective of this second phase is to demonstrate the technical and operational feasibility of conducting baggage tracking in a complete, real-time end-to-end mode, using RFID, while adding overall value to baggage operations and management, to include the security function.

The Phase II programs will assess the feasibility of sorting and reconciling passenger boarding with baggage loading, beginning with the point of initial flight check-in, through all connecting flights, and ending with the final airport destination.

Additionally, this test program will provide valuable information (e.g., RF frequency, fixed and transportable reader performance, and operational efficiency) that will aid significantly in the evaluation and selection of an RFID system technology for application to the baggage identification, tracking and security functions.

Because of the more extensive scope of this Phase II testing, the tests will be conducted in several stages, each stage at different airports and with different carriers and technology systems.

Each operational test site will focus on specific portions of the end-to-end identification, tracking and security functions.

The first stage, Phase IIA, was conducted at the Frankfurt Airport (Germany) in cooperation with United Airlines, and with the participation of RFID vendors Texas Instruments and Omron Electronics, Inc. The tests encompassed the passenger baggage check-in process (bag tag encoding and printing) and the reconciliation of the baggage in the baggage make-up rooms (reading the encoded tags).

The second stage, Phase IIB, will be conducted in San Antonio and Houston, Texas in cooperation with Continental Airlines, and with the participation of the following:

Confidence International (Sweden) – System Integrator
Texas Instruments (Texas) – RFID Inlays
Philips (United Kingdom) – RFID Inlays
FEIG Electronic GmbH (Germany)– Belt/Ramp Readers
Flughafen Frankfurt am Main Aviation Ground Services (Germany) – BRS
IER (Texas, France)– Bag Tag Printers
idSystems (United Kingdom) – Printer read/write module
Moore Research Corporation (New York) – Bag Tag Labels
Sihl GmbH (Germany) – Bag Tag Labels

Phase IIB Operational Testing will expand upon the testing done in Phase IIA. It will include:

- Passenger baggage check-in (bag tag encoding and printing)
- Verification of proper RF tag programming and collection read data in the baggage make-up room (reading the encoded bag tags with a tethered handheld reader)
- Reading and data collection of the bag tag data on the delivery belt to the baggage make-up room using a belt reader
- Reading of the bag tag data and reconciliation of the data on the loading ramp to the aircraft using a ramp reader
- Transfer of the baggage to a connecting flight, which includes: reading the encoded bag tags on the ramp as the baggage is unloaded from the arriving flight; and reading them again with a handheld reader on the loading ramp as baggage is loaded onto the departing flight

The baggage will be checked in at the San Antonio airport and loaded onto Continental flights to Houston. At the Houston airport, the connecting bags will be transferred to the appropriate Continental flight departing from Houston.
This document addresses the Qualification Testing of the equipment prior to Operational Testing. The objective of the Qualification Testing is to ensure that the candidate RFID systems are qualified to enter the Phase IIB Integrated System Operational Test. This means that they:

- Are compatible with available airport space for installation and operation
- Are able to interface correctly with the test systems
- Demonstrate Electromagnetic Compatibility (EMC) with operational airline, airport and aircraft operations and systems
- Are compatible with communications restrictions for power and frequency in domestic and international countries
- Demonstrate a sound technical and operational approach to accomplishing baggage identification, tracking and security functions within operational environments

The Qualification Testing will be conducted at several locations. These locations will be determined based on availability of test equipment, and the availability of test personnel and supporting systems. Qualification Test sites may include the vendors' test facilities, the William J. Hughes Technical Center, Veridian Engineering, or the Operational Test site.

Specific Qualification Tests will be done to determine:

- The accuracy of the vendor's RF bag tag encoding process
- Read distances for the vendor's RFID readers
- RF bag tag read accuracy rates of the vendor's RFID readers
- Effect of bag tag orientation on the tag's readability
- Accuracy of the vendor's interface with the test equipment

ACRONYMS/ABBREVIATIONS

BRS ..... Baggage Reconciliation System
BSM ..... Baggage Sortation Message
CI..... Control Interface
CRC..... Cyclic Redundancy Check
DCS ..... Departure Control System
DOT..... Department of Transportation
EMC ..... Electromagnetic Compatibility
EMI..... Electromagnetic Interference
FAA..... Federal Aviation Administration
FAATC..... Federal Aviation Administration Technical Center
Ips..... Inches per Second
LAN..... Local Area Network
Mmps..... Millimeters per Second
OTP ..... Operational Test Plan/Procedure
PC..... Personal Computer
PPBM..... Positive Passenger Bag Match
QTP ..... Qualification Test Plan/Procedure
RF..... Radio Frequency
RFI..... Radio Frequency Interference
RFID..... Radio Frequency Identification
ROM..... Read Only Memory
RX ..... Receive
TX..... Transmit

1. INTRODUCTION

1.1 Background

The increasing importance of commercial airline passenger and baggage security, combined with the need to sort and track ever larger numbers of passenger baggage quickly and accurately, have led to the search for more efficient methods of performing the baggage sortation, tracking and security functions. Any tool used to facilitate these functions must be able to rapidly and reliably process, reconcile and track passenger and baggage information. Without this capability, flight delays and increased operational costs are likely to result. Passenger inconvenience could lead to decreased tolerance of airline security regulations and loss of confidence in the air transport industry.

Phase I Testing

In 1997, the FAA sponsored the initial phase of testing of commercially available RFID systems for the support of passenger/baggage match and baggage sortation functions. The initial phase had two stages. Stage one was Qualification Testing. Its objective was to qualify vendor RFID products and systems, in a controlled laboratory environment, to:

- Operate within the physical and operational constraints associated with airline and airport environments, and
- Perform the functional requirements associated with baggage sortation and passenger/baggage match security objectives in the airline and airport environment, without degradation of existing electronic systems.

The RFID systems which passed Qualification Testing subsequently entered Stage Two of initial testing, which consisted of Operational Testing in paired domestic/international airports. Of particular concern in initial Operational Testing were the following characteristics of the candidate systems:

- Performance
- Reliability
- Electromagnetic compatibility (EMC) with airline, airport and aircraft operations and systems
- Compatibility with airport communications restrictions (power, frequency)
- Technical and operational approach to supporting passenger/baggage matching and sortation functions

Operational Testing was conducted in conjunction with sponsor airlines and airports, as well as with the cooperation of a Baggage Reconciliation System (BRS) provider. The test results

clearly demonstrated the feasibility of using RF technology to support passenger/baggage match, tracking, and sortation functions. Several systems showed high levels of baggage identification performance, even in sub-optimal operational environments. In addition, there were a number of suggested approaches for improving system performance, which were identified during the first phase of testing.

Phase II Testing

The successful initial phase of feasibility testing of the candidate RFID systems led to this current (second) phase of testing – the Integrated System Test. The Operational Test for this second phase will be conducted in several stages at different airport sites. Each operational test site will focus on specific portions of the end-to-end identification, tracking and security functions.

The first stage, Phase IIA, was conducted at the Frankfurt Airport (Germany) in cooperation with United Airlines, and with the participation of RFID vendors Texas Instruments and Omron Electronics, Inc. The tests encompassed the passenger baggage check-in process (bag tag encoding and printing) and the reconciliation of the baggage in the baggage make-up rooms (reading the encoded tags).

The second stage, Phase IIB, will be conducted in San Antonio and Houston, Texas in cooperation with Continental Airlines, and with the participation of the following:

Confidence International (Sweden) – System Integrator
Texas Instruments (Texas) – RFID Inlays
Philips (United Kingdom) – RFID Inlays
FEIG Electronic GmbH (Germany)– Belt/Ramp Readers
Flughafen Frankfurt am Main Aviation Ground Services (Germany) – BRS
IER (Texas, France)– Bag Tag Printers
idSystems (United Kingdom) – Printer read/write module
Moore Research Corporation (New York) – Bag Tag Labels
Sihl GmbH (Germany) – Bag Tag Labels

Phase IIB Operational Testing will expand upon the testing done in Phase IIA. It will include:

- Passenger baggage check-in (bag tag encoding and printing)
- Verification of proper RF tag programming and collection read data in the baggage make-up room (reading the encoded bag tags with a tethered handheld reader)
- Reading and data collection of the bag tag data on the delivery belt to the baggage make-up room using a belt reader
- Reading of the bag tag data and reconciliation of the data on the loading ramp to the aircraft using a ramp reader

- Transfer of the baggage to a connecting flight, which includes: reading the encoded bag tags on the ramp as the baggage is unloaded from the arriving flight; and reading them again with a handheld reader on the loading ramp as baggage is loaded onto the departing flight

The baggage will be checked in at the San Antonio airport and loaded onto Continental flights to Houston. At the Houston airport, the connecting bags will be transferred to the appropriate Continental flight departing from Houston.

1.2 Purpose

The objective of the Qualification Testing is to ensure that the candidate RFID systems are qualified to enter the Phase IIB Integrated System Operational Test. This means that they:

- Are compatible with available airport space for installation and operation
- Are able to interface correctly with the test systems
- Demonstrate Electromagnetic Compatibility (EMC) with operational airline, airport and aircraft operations and systems
- Are compatible with communications restrictions for power and frequency in domestic and international countries
- Demonstrate a sound technical and operational approach to accomplishing baggage identification, tracking and security functions within operational environments

1.3 Scope

Qualification Testing will be conducted to insure that any equipment to be used or installed at an Operational Test site will perform as required and not cause any interference or delays with respect to current airport equipment and operations.

The Qualification Testing will be conducted at various locations which may include the vendors test facilities, the William J. Hughes Technical Center, Veridian Engineering, or at the Operational Test site. For equipment that will be custom configured for the Operational Test site, Qualification Testing will consist of testing a similar configuration at a test facility. Custom configured equipment will also undergo further testing at a pre-Operational Test checkout performed at the operational test site. This latter checkout testing is not addressed in this document.

2. REFERENCE DOCUMENTS

DOT/FAA/AR-97/39	Qualification Test Plan (QTP) of Commercially Available Radio Frequency Identification (RFID) Systems for Positive Passenger Baggage Match (PPBM) Applications, June 1997
DOT/FAA/AR-97/44	Qualification Test Procedures (QTP) of Commercially Available Radio Frequency Identification (RFID) Systems for Positive Passenger Baggage Match (PPBM) Applications, June 1997
DOT/FAA/AR-97/40	Operational Test Plan (OTP) of Commercially Available Radio Frequency Identification (RFID) Systems for Positive Passenger Baggage Match (PPBM) Applications, June 1997
DOT/FAA/AR-97/45	Operational Test Procedures (OTP) of Commercially Available Radio Frequency Identification (RFID) Systems for Positive Passenger Baggage Match (PPBM) Applications, June 1997
DOT/FAA/AR-98/2	Operational Test Report of Commercially Available Radio Frequency Identification (RFID) Systems for Potential Positive Passenger Baggage Match (PPBM) Applications – Results Not Correlated to Vendors, June 1997
DOT/FAA/AR-98/XX	Phase II Qualification Test Plan and Procedures (QTP) of Commercially Available Radio Frequency Identification (RFID) Systems for Baggage Identification, Tracking and Security Applications, October 1998
DOT/FAA/AR-98/102	Operational Test Report of Commercially Available Radio Frequency Identification (RFID) Systems for Potential Positive Passenger Baggage Match (PPBM) Applications, November 1997

3. SYSTEM DESCRIPTION

3.1 System Overview

The Phase IIB test system components are as shown in Figure 3.1. This figure shows the entire system as it will be tested in the Operational Tests to be conducted at the selected airports. This discussion is offered here merely to clarify the objectives of this phase of the testing program, the Integrated System Test.

The two airports which will be part of the operational test are located in San Antonio and Houston, Texas. During the Operational Tests, baggage will be checked in as usual for pre-determined test flights departing from San Antonio. The baggage for those flights will be tagged with test RF bag tags, and will be: a) read and identified by vendor RFID systems on the delivery belt to the baggage make-up room; b) read upon arrival in the baggage make-up room; and c) read, identified and reconciled again on the loading ramp into the aircraft cargo hold.

The designated aircraft(s) will then fly the passengers and their "tagged" bags to the Houston airport, where the test bags will be unloaded, read and identified by vendor RFID systems at the unloading ramp. As the appropriate test bags are loaded onto a connecting flight departing from Houston, they will be read and identified once more by vendor RFID equipment at the loading ramp. The data obtained in Houston will be collected for later analysis, but will not be reconciled with any airline/airport systems for this portion of the test.

With that as background, the objectives of the Qualification Test will be to qualify vendor RFID systems as satisfying the prerequisites (stated in Section 1.2) necessary to participate in the Operational Test program. All of the components of the vendor systems will be tested during these Qualification Tests. However, because of a limited capability to reproduce the operational environment during the Qualification Test, not all interfaces of the vendors' systems with the airline/airport systems (as shown in Figure 3.1) will be tested until the pre-Operational Test checkout.

The components that make up the total Operational Test system fall into four categories, as described below. The components that will be tested during Qualification Testing are identified here.

1. The candidate RFID systems under test – This includes each of the vendor RFID systems whose performance is being tested. Each candidate system may implement the RFID function by utilizing different elements. For the tests being conducted with Continental Airlines, the candidate RFID systems will consist of the following components, all of which will be tested during Qualification Test:

    - Modified Bag Tag Printer – The modified bag tag printer is a barcode label (bag tag) printer outfitted with an RF tag Reader/Programmer.

    - RFID Bag tags – The RFID bag tags consist of an RFID inlay laminated into a bag tag.

    - Handheld RFID Reader – A handheld unit that can be used in the baggage make-up area to manually read the RFID bag tags.

- Belt Reader – RFID antenna structure and reader designed to automatically read the RFID bag tags as they move along a conveyor belt.

- Ramp Reader - RFID antenna structure and reader designed to automatically read the RFID bag tags as they move up or down an aircraft ramp loader.

- Vendor Control - The vendor-supplied control system will control and record data (10-digit barcode number and time stamp) from the Belt and Ramp Reader. The vendor will supply this data, offline, to the FAA in electronic format.

2. The Control Interface test hardware and software – This includes all of the FAA-supplied hardware and software that has been customized to allow the test team to interface the RFID systems with the airline/airport systems, and to control the test processes and data collection. It consists of the Control Interface (CI) system. The CI is a computer (PC laptop) with software developed to provide an interface to the vendor systems, control the test operations and collect and manage the test data. The CI will interface with the vendor-supplied RFID handheld reader and the BRS. The CI will also interface to the vendor-supplied control system (Vendor Control) for the Ramp Reader and a wireless LAN in San Antonio for wireless communications to the BRS. The CI software controls the following test operations:

   - Storage of tag read results

   - Interface between the RFID handheld reader and the BRS

   - Interface between the Vendor Control and the wireless LAN

   - Automatic data reduction and analysis

   The CI and its interfaces to the vendor RFID system components will be tested during Qualification Testing.

3. Interfacing systems – These are the systems that must communicate information to/from the vendor RFID systems. These include:

   - Departure Control System (DCS)

   The DCS is the airline host computer, which records and manages the baggage data associated with the passenger check-in process. The DCS produces a formatted message for each checked bag containing passenger/baggage identification and departure/arrival information, which is sent to the Baggage Reconciliation System (BRS).

   The DCS will not be part of the Qualification Testing.

   - BRS

   The BRS is a database software system that supports tracking and reconciling of checked baggage to ensure a proper match between passengers and baggage and optimization of

aircraft baggage loading. This system can be used either in the baggage make-up area or at the ramp. The BRS interfaces with the DCS and the RFID systems under test.

The BRS and its interface to the DCS will be tested as part of the pre-Operational Test checkout and will not be part of the Qualification Testing.

- Wireless LAN

A wireless LAN system may be used to facilitate communications between the Ramp Reader and the BRS at the San Antonio site.

The wireless LAN and its interface to the CI will be tested as part of the pre-Operational Test and will not be tested during Qualification Testing.

4. Additional airport and airline systems – These are any other airport systems that are essential to the baggage processing sequence of events. They include:

   - Conveyor Belt

   A conveyor system will be used to duplicate the movement of the baggage from the check-in station to the baggage make-up areas. A conveyor belt will be available for use at a vendor facility for any testing done at that site. This component does not interface with any of the other test components.

   The conveyor belt will be part of the Qualification Test system to test both the Belt Reader and the Ramp Reader.

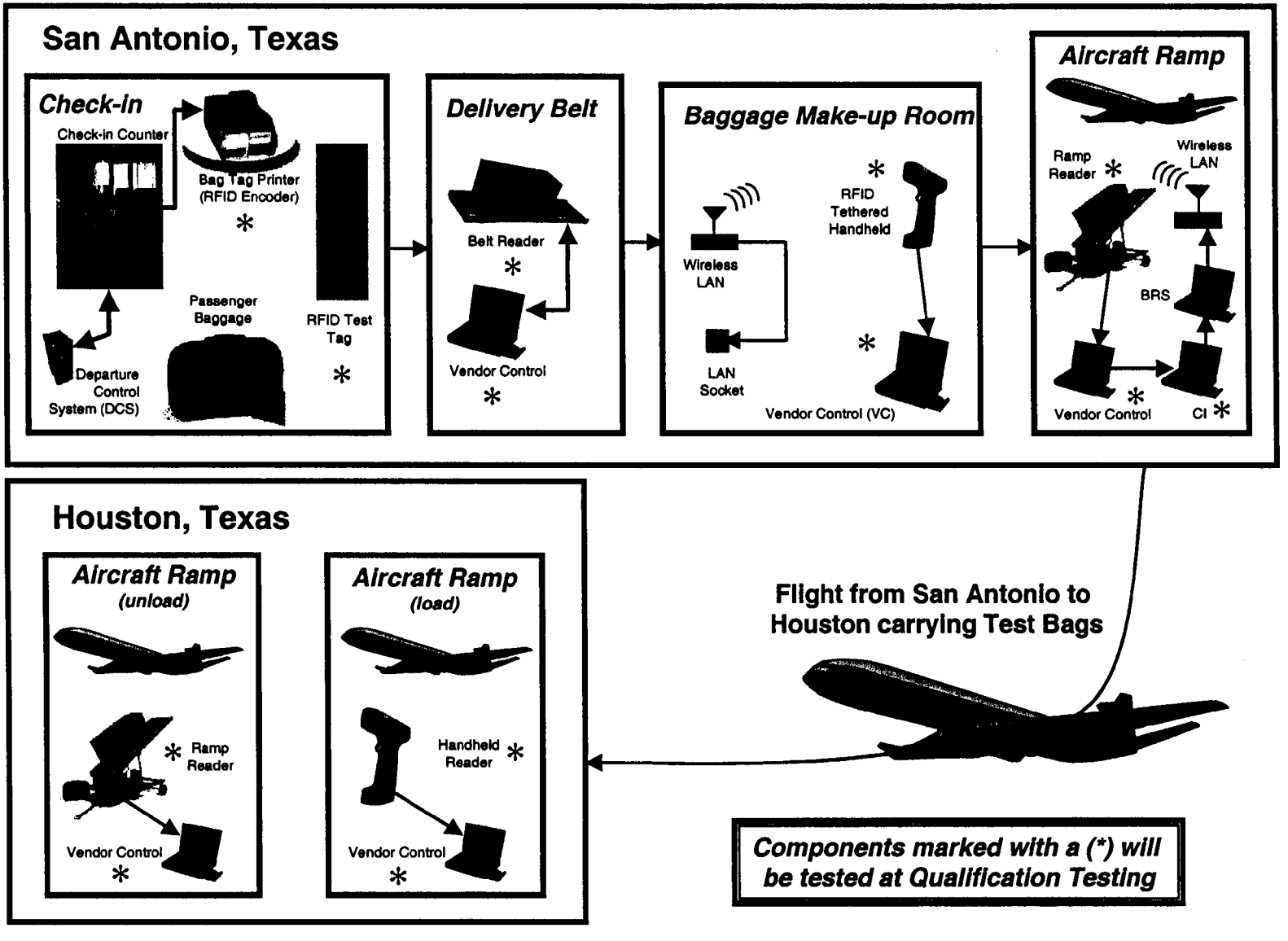

Figure 3.1 Portions of the Operational Test System To Be Tested at Qualification Test

3.2 Interfaces

The Qualification Test interfaces are summarized in Table 3.1. Refer to Figure 3.1 to see where these interfaces fit into the overall test system.

Table 3.1 Phase IIB Qualification Test System Interfaces

Interface	Description
Handheld RFID Reader ⇒ CI	The CI receives and records bag tag data from the Handheld RFID Reader.
Belt Reader ⇒ Vendor Control	A vendor-supplied control system will control and record data (10-digit barcode number and time stamp) from the Belt Reader. The vendor will supply this data, offline, to the FAA in electronic format.
Ramp Reader ⇒ Vendor Control	A vendor-supplied control system will control and record data (10-digit barcode number and time stamp) from the Ramp Reader. The vendor will supply this data, offline, to the FAA in electronic format.
Vendor Control ⇒ CI	The Vendor Control will transmit the 10-digit barcode number to the CI via RS-232 for transmission via wireless LAN to the BRS (San Antonio only).
CI ⇔ Wireless LAN	The CI acts as the interface to the BRS. The CI will transmit/receive the data from the BRS via wireless LAN (San Antonio only).

4. TEST PROGRAM DESCRIPTION

4.1 Approach and Concept

4.1.1 Evaluation Approach

The candidate system components will be tested prior to Operational Testing to verify that the systems will operate properly and not cause any interference with current airport operations or systems. The candidate systems will be tested in configurations and conditions as close as possible to those present at the actual Operational Test site.

4.1.2 Activities Leading to Test

4.1.2.1 Development of the Control Interface Software

The software for the CI will be developed by the FAA or a designated agent. It must be designed to accept and process bag tag data and a time stamp from each vendor's RFID reader components. This will require the development of a separate interface module for each vendor's equipment.

The CI software will also be developed to interface with the airport BRS. It will have to be capable of formatting passenger and baggage data read from the bag tags and sending it to the BRS.

In addition to its interface functions, the CI software will be developed to perform data collection and analysis of the data input from the vendor systems.

4.1.2.2 Operational Test Site Surveys

Surveys will be conducted by the FAA to determine the optimal sites for the Operational Tests. The factors to be used in choosing the test sites will be:

- Sites at which cooperating airlines are operating flights
- Sufficient space in the baggage processing areas of the airports for installation and operation of vendor RFID equipment without impacting normal airline/airport baggage processing functions
- Flight schedules with appropriate timing and connections to allow test functions to be completed without hampering normal airline schedules

4.1.2.3 Selection of Test Locations

The selection of the test locations will be made by the FAA with the collaboration of the cooperating airline.

4.2 Test Environment

The Qualification Testing will be conducted at several locations. These locations will be determined based on availability of test equipment, and the availability of test personnel and supporting systems. Qualification Test sites may include the vendors' test facilities, the William J. Hughes Technical Center, Veridian Engineering, or the Operational Test site.

4.3 Test and Analysis Tools

The test and analysis tool to be used in these tests is the FAA-supplied Control Interface (CI).

4.4 Test and Evaluation Descriptions

A description of each test is shown in Table 4.1.

Table 4.1 Test and Evaluation Descriptions

TEST	NAME	DESCRIPTION
1	Bag Tag Printer Test	This will test the following: 1. Bag tag encode rate 2. Printer functions, including verification of any built-in counters
2	Handheld Reader Test	This will test the following: 1. Minimum and maximum read distance 2. Read Orientation 3. Read Rate (this will test both the reader and the tag) 4. CI interface.
3	Belt Reader Test	This will test the read rate dependency on bag orientation.
4	Ramp Reader Test	This will test the read rate dependency on bag orientation.

5. TEST MANAGEMENT

5.1 Roles and Responsibilities

The system integrator (Confidence International) in conjunction with the FAA, or a designated agent, is responsible for conducting the actual Qualification Testing of the following:

- Belt Readers
- Ramp Readers
- Handheld Readers

The system integrator in conjunction with the FAA, and/or designated agent(s), will be responsible for conducting the actual test, managing the test data, analyzing the data, and reporting test results.

The printer manufacturer (IER) in conjunction with the FAA, and/or designated agent(s), is responsible for conducting the actual Qualification Testing of the printers and bag tag labels.

Personnel from the FAA, or a designated agent, will act as the Test Director and shall have full authority for all test decisions during all Qualification Testing, including the following:

- Authority to make a decision whether to allow the system to be included in any further testing after failure to meet the established criteria
- Authority to stop and cancel any further testing if it is deemed that the equipment may cause potential interference problems with any current airport or airline systems or operations
- Authority to change or include additional testing as required

5.2 QT Exit Criteria

Prior to Qualification Test a site survey will be performed at the Operational Test site. The success criteria for the Qualification test will be established based either on the results of the site survey, or upon existing specifications. If any of the systems fail to meet the established criteria, the Test Director shall make a decision whether to allow the system to be included in any further testing, and ultimately in the Operational Test.

5.3 QT Reports

Upon completion of the qualification testing, a Qualification Test Report will be issued. The report will discuss the results of the qualification testing and describe the systems tested, the test schedule and location, the participants, the test objectives, test configuration, the tests themselves, the hardware and software interfaces, and the data collection and analysis methods used.

5.4 System / Operational Deficiency Reports

Vendors will be notified and will be responsible for the repair, replacement, or maintenance of their respective systems should any deficiencies or failures occur. The occurrence of any failures/deficiencies will be recorded. The vendor will be notified and given the opportunity to investigate and correct the problem. The results of any additional testing or re-testing required will also be recorded. Any remaining performance deficiencies affecting the qualification of the systems, which are uncovered as a result of testing, will be documented in the Qualification Test Report.

APPENDIX A
TEST PROCEDURES

TEST 1 – Bag Tag Printer / Bag Tag Label Test

Objective

- Determine the bag tag encode rate (number of valid encoded tags)
- Verify printer functions, including any internal counters
- Determine the failure rate of the RFID inlays
- Verify the readability of the printed barcode label

Test Support Hardware, Software Documentation

- Bag Tag Printer
- 1000 Bag Tag Labels for each paper/RFID inlay combination
  (1000 Paper A/Inlay A, 1000 Paper A/Inlay B, 1000 Paper B / Inlay A, 1000 Paper B / Inlay B)
- Handheld Reader

Evaluation Criteria

- Printer Encode Rate: ≥95% (based on a minimum of 300 encoded tags for each RFID inlay)
- If available, internal counters indicate correct number of encoded tags
- RFID inlay Failure Rate: ≤5% (based on a minimum of 300 encoded tags for each RFID inlay)
- Barcode label readability: 100% (based on a minimum of 10 tags)

Procedures

- Connect a bag tag printer as per vendor instructions to emulate the data stream that will be present at the Operational Test site
- Reset all internal counters on the printer (if available) and record the initial value (normally 0) of each counter in the data sheet for TEST 1
- Encode 300 tags
- Enter the actual number of tags that the printer attempted to encode on the data sheet for TEST 1
- Count the number of RF void tags and record this number in the data sheet for TEST 1

- Using a Handheld Reader, read each bag tag and record the read results in the data sheet for TEST 1
- Calculate the encode rate and enter the value in the data sheet for TEST 1
- Calculate the RFID failure rate and enter the value in the data sheet for TEST1
- Record the final value of each counter (if available) in the data sheet for TEST 1
- If the results indicate the encode rate is below 95% then make any necessary adjustments or changes and repeat the test
- Randomly select 10 valid encoded tags and using a handheld device, read the printer barcode label. Record the total number of readable tags on the data sheet for TEST 1
- Repeat the test for each type of paper/RFID inlay combination

Data Analysis Methods

Comparison shall be made to values established in the criteria. If the comparison indicates a failure to meet the established criteria, the Test Director shall make a decision whether to allow the system to be included in any further testing.

TEST 2 – Handheld Reader Test

Objective

- Verify the Handheld Reader can read at a minimum distance of 1 inch and a maximum distance of 6 inches
- Determine the effects of read orientation
- Determine the read rate (i.e., the success rate of the read function)

Test Support Hardware, Software, and Documentation

- Handheld Reader
- 10 pre-encoded Bag Tag Labels for each paper/RFID inlay combination (10 Paper A/Inlay A, 10 Paper A/Inlay B, 10 Paper B/Inlay A, 10 Paper B/Inlay B)
- 10 Test Bags

Evaluation Criteria

- The Handheld Reader must be able to successfully read a Bag Tag Label when the distance between the reader and the label is anywhere from 1 to 6 inches and orientation of the reader with respect to the Bag Tag Label is at its optimum position as specified by the vendor
- Read Rate: ≥ 95% (based on the first attempt to read 100 Bag Tag Labels)

Procedures

- Connect the Handheld Reader to the CI and configure the CI to record the Handheld Reader output
- Attach pre-encoded Bag Tag Labels to 10 different pieces of test baggage
- Holding the Handheld Reader at a distance of 1 inch and at the optimum orientation as specified by the vendor, read the Bag Tag Label on 10 pieces of test baggage (only one read attempt per bag). Cycle through reading the 10 test bags to achieve a total of 100 read attempts. Attach the result from the CI to the data sheet for TEST 2. Determine the read rate and record the result in the data sheet for TEST 2
- Repeat step 3 with the Handheld Reader oriented 90 degrees relative to the optimum position as shown in Figure A-1, Position 2
- Repeat step 3 with the Handheld Reader oriented 180 degrees relative to the optimum position as shown in Figure A-1, Position 3

- Repeat step 3 with the Handheld Reader oriented 270 degrees relative to the optimum position as shown in Figure A-1, Position 4
- Holding the Handheld Reader at a distance of 6 inches and at the optimum orientation as specified by the vendor, read the Bag Tag Label on 10 pieces of test baggage (only one read attempt per bag). Cycle through reading the 10 test bags to achieve a total of 100 read attempts. Attach the result from the CI to the data sheet for TEST 2. Determine the read rate and record the result in the data sheet for TEST 2
- Repeat step 7 with the Handheld Reader oriented 90 degrees relative to the optimum position as shown in Figure A-1, Position 2
- Repeat step 7 with the Handheld Reader oriented 180 degrees relative to the optimum position as shown in Figure A-1, Position 3
- Repeat step 7 with the Handheld Reader oriented 270 degrees relative to the optimum position as shown in Figure A-1, Position 4
- Repeat the test for each paper / RFID inlay combination

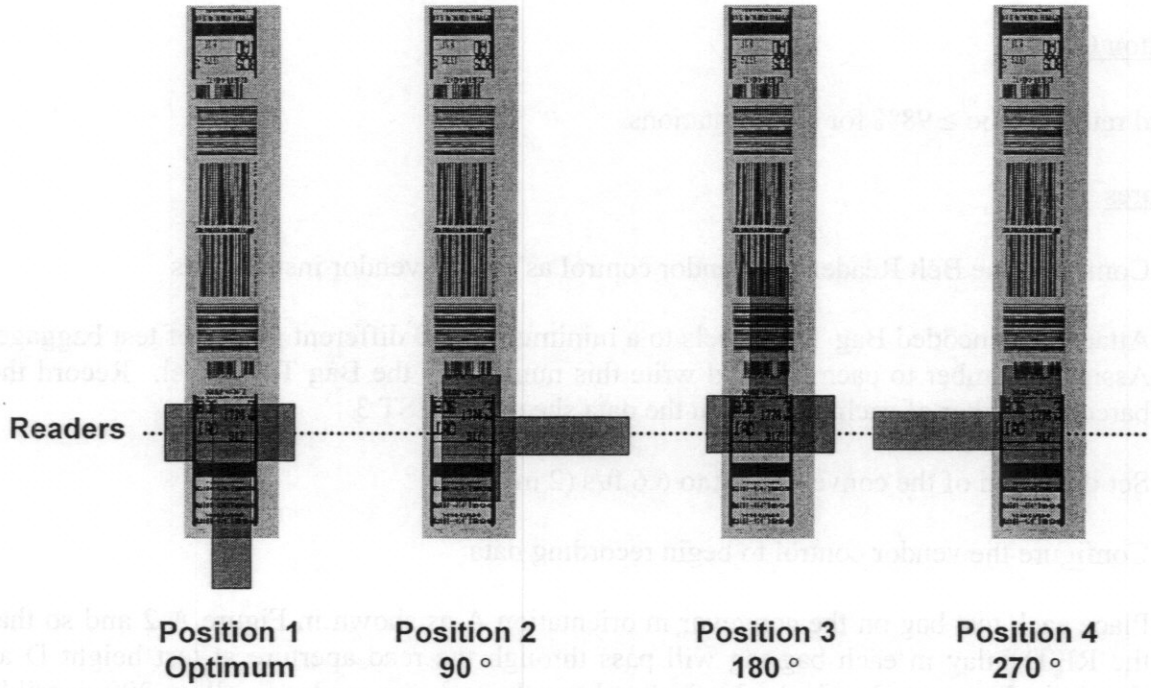

Figure A - 1 Handheld Reader Orientation

Data Analysis Methods

Comparison shall be made to values established in the criteria. If the comparison indicates a failure to meet the established criteria, the Test Director shall make a decision whether to allow the system to be included in any further testing.

TEST 3 – Belt Reader Test

Objective

The objective of this test is to determine the read rate dependency on bag orientation.

Test Support Hardware, Software, and Documentation

- Belt Reader/Vendor Control
- 20 Test Bags
- 20 pre-encoded Bag Tag Labels for each paper/RFID inlay combination
  (20 Paper A/Inlay A, 20 Paper A / Inlay B, 20 Paper B/Inlay A, 20 Paper B/Inlay B)

Evaluation Criteria

The read rate must be ≥ 98% for all orientations.

Procedures

- Configure the Belt Reader and vendor control as per the vendor instructions
- Attach pre-encoded Bag Tag Labels to a minimum of 20 different pieces of test baggage. Assign a number to each bag and write this number on the Bag Tag Label. Record the barcode number of each test bag on the data sheet for TEST 3
- Set the speed of the conveyor belt to 6.6 ft/s (2 m/s)
- Configure the vendor control to begin recording data
- Place each test bag on the conveyor in orientation A as shown in Figure A-2 and so that the RFID inlay in each bag tag will pass through the read aperture at test height D as shown in Figure A-3. Cycle the 20 test bags through the reader to allow 200 possible read attempts
- Attach a copy of the results to the data sheet for TEST 3. Calculate the read rate and record the value in the data sheet for TEST 3
- Repeat steps 5 and 6 for orientations B and C

- Raise the test bags so that the RFID inlay in each bag tag will pass through the read aperture at test height E as shown in Figure A-3. Repeat steps 5 through 7
- Raise the test bags so that the RFID inlay in each bag tag will pass through the read aperture at test height F as shown in Figure A-3. Repeat steps 5 through 7
- Repeat steps 5 through 9 for each paper / RFID inlay combination

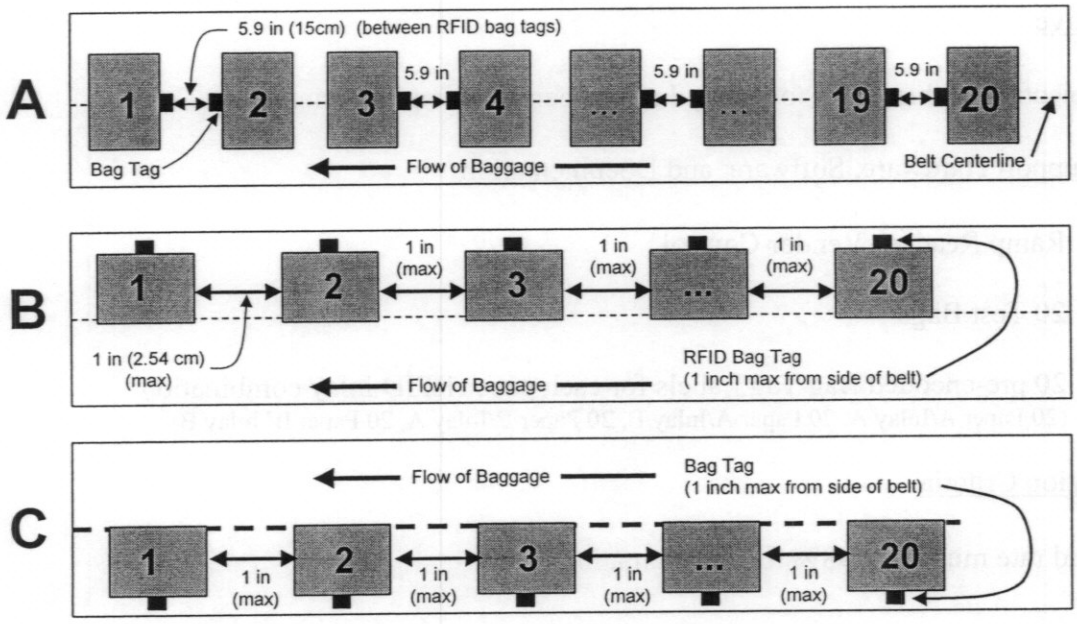

Figure A - 2 Test Bag Read Orientation

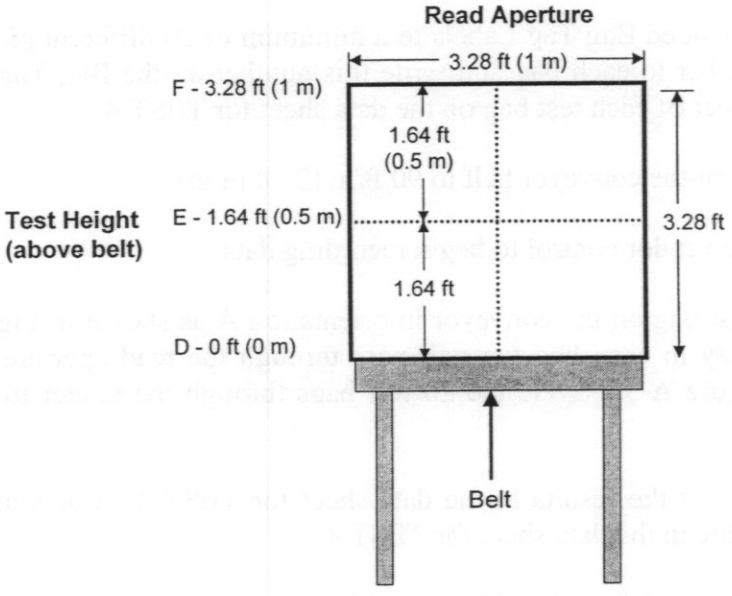

Figure A - 3 Read Aperature

Data Analysis Methods

Comparison shall be made to values established in the criteria. If the comparison indicates a failure to meet the established criteria, the Test Director shall make a decision whether to allow the system to be included in any further testing.

TEST 4 – Ramp Reader Test

Objective

The objective of this test is to the read rate dependency on bag orientation

Test Support Hardware, Software, and Documentation

- Ramp Reader / Vendor Control
- 20 Test Bags
- 20 pre-encoded Bag Tag Labels for each paper/RFID inlay combination
  (20 Paper A/Inlay A, 20 Paper A/Inlay B, 20 Paper B/Inlay A, 20 Paper B/ Inlay B)

Evaluation Criteria

The read rate must be ≥ 98% for all orientations.

Procedures

- Configure the Ramp Reader and vendor control as per the vendor instructions
- Attach pre-encoded Bag Tag Labels to a minimum of 20 different pieces of test baggage. Assign a number to each bag and write this number on the Bag Tag Label. Record the barcode number of each test bag on the data sheet for TEST 4
- Set the speed of the conveyor belt to 90 ft/m (27.4 m/m)
- Configure the vendor control to begin recording data
- Place each test bag on the conveyor in orientation A as shown in Figure A-4 and so that the RFID inlay in each bag tag will pass through the read aperture at test height D as shown in Figure A-5. Cycle the 20 test bags through the reader to allow 200 possible read attempts
- Attach a copy of the results to the data sheet for TEST 4. Calculate the read rate and record the value in the data sheet for TEST 4
- Repeat steps 5 and 6 for orientations B and C

- Raise the test bags so that the RFID inlay in each bag tag will pass through the read aperture at test height E as shown in Figure A-5. Repeat steps 5 through 7

- Raise the test bags so that the RFID inlay in each bag tag will pass through the read aperture at test height F as shown in Figure A-5. Repeat steps 5 through 7

- Repeat steps 5 through 9 for each paper / RFID inlay combination

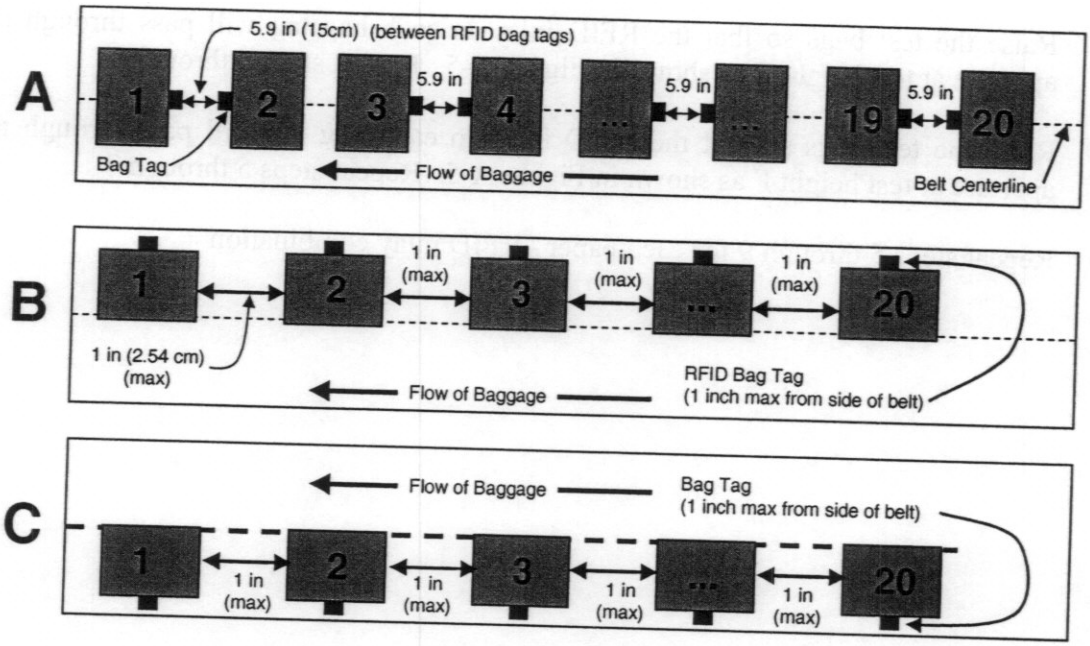

Figure A - 4 Test Bag Read Orientation

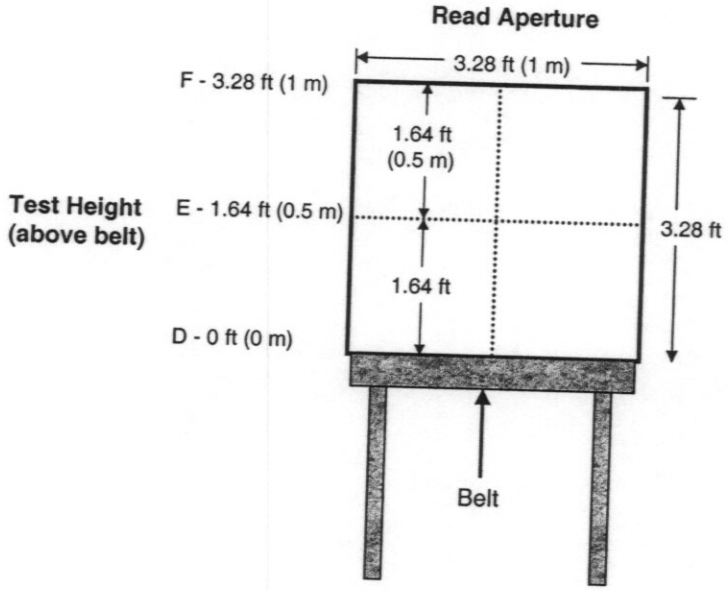

Figure A - 5 Read Aperature

Data Analysis Methods

Comparison shall be made to values established in the criteria. If the comparison indicates a failure to meet the established criteria, the Test Director shall make a decision whether to allow the system to be included in any further testing.

APPENDIX B
DATA SHEETS

TEST 1 – BAG TAG PRINTER / BAG TAG LABEL TEST

Date:	Paper:	RFID Inlay:

Counter Type	Initial Value	Final Value

A - Total number of tags printer attempted to encode	
B - Total number of RF Voids	

Tag Verification with Handheld Reader	
C - Partially Programmed	
D - Not Programmed	
E - Not Readable (Failed RFID Inlay)	
F - No Chip in Tag	
G – Other	

RFID Failure Rate (%): (E / A) * 100	RESULT (Spec: ≤ 5%)	PASS / FAIL

Encode Rate (%): (1 - ((B – E – F – G) / A)) * 100	RESULT (Spec: ≥ 95%)	PASS / FAIL

Barcode Readability: (Number read out of 10)	RESULT (Spec: 10)	PASS / FAIL

NOTES:

Test Director:	Test Operator:
Test Manager:	Other:

TEST 2 – HANDHELD READER TEST

Date:	Paper:	RFID Inlay:

Distance (inches)	Orientation	Read Attempts (A)	Valid Reads (B)	Read Rate (Spec: ≥ 95%) (B / A) * 100	PASS / FAIL
1	Optimum				
1	90°				
1	180°				
1	270°				
6	Optimum				
6	90°				
6	180°				
6	270°				

NOTES:

Test Director:	Test Operator:
Test Manager:	Other:

TEST 3 – BELT READER TEST

Date:	Paper:	RFID Inlay:

Test Bag Bar Code Numbers					
1		8		15	
2		9		16	
3		10		17	
4		11		18	
5		12		19	
6		13		20	
7		14			

Orientation (Figure A-2)	Test Height (Fig. A-3)	Total Test Bags (A)	Valid Reads (B)	Read Rate (%) (Spec: ≥ 98%) (B / A) * 100	PASS / FAIL
A	D				
B	D				
C	D				
A	E				
B	E				
C	E				
A	F				
B	F				
C	F				

NOTES:

Test Director:	Test Operator:
Test Manager:	Other:

TEST 4 – RAMP READER TEST

Date:	Paper:	RFID Inlay:

Test Bag Bar Code Numbers					
1		8		15	
2		9		16	
3		10		17	
4		11		18	
5		12		19	
6		13		20	
7		14			

Orientation (Figure A-4)	Test Height (Fig. A-5)	Total Test Bags (A)	Valid Reads (B)	Read Rate (%) (Spec: ≥ 98%) (B / A) * 100	PASS / FAIL
A	D				
B	D				
C	D				
A	E				
B	E				
C	E				
A	F				
B	F				
C	F				

NOTES:

Test Director:	Test Operator:
Test Manager:	Other:

Comments for document titled:

Phase IIB Qualification Test Plan and Procedure of Commercially Available Radio Frequency Identification (RFID) systems for Baggage Identification, Tracking and Security Applications.

Comment 1: Overall this is a very clear and concise document.

Comment 2: The chart on page 8 is beautiful

Comment 3: Appendix A: I recommend writing a one sentence introduction after each header before the bullets to clarify the information given.