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# Phase IID Operational Test Plan and Procedures of Commercially Available Radio Frequency Identification (RFID) Systems for Baggage Identification, Tracking and Security Applications

**Alaska Airlines / Singapore Airlines Trial**

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16. Abstract
The Operational Test for the Alaska and Singapore Airlines Trial will be used to evaluate those RFID systems that have the potential to accomplish baggage identification, tracking and security requirements in an operational environment, utilizing RFID handheld, belt and ramp readers, and with interline baggage transfers.

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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 the initial phase of testing of commercially available RFID systems for the support of passenger/baggage match tracking and baggage sortation functions. Vendor RFID systems underwent Qualification Testing; those that passed this level of testing entered 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 match 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 and sortation functions. Several systems showed high levels of baggage identification performance, even in sub-optimal operational environments.

## Phase II RFID Testing

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

The first stage, Phase IIA, was conducted at the Frankfurt Airport (Germany) in April of 1999 in cooperation with United Airlines, and with the participation of RF vendors Texas Instruments and Omron Electronics, Inc. The tests there encompassed the passenger baggage check-in process (bag tag encoding) and the reconciliation of the baggage in the baggage make-up rooms (reading the encoded tags).

The second stage of tests, Phase IIB, took place jointly at the San Antonio, Texas airport and the Houston, Texas airport in cooperation with Continental Airlines. In this stage, the tests expanded to include belt readers and ramp readers, and involved tail-to-tail baggage transfers. For designated test flights from San Antonio to Houston, the RFID bag tags were read in the baggage make-up room prior to departure from San Antonio, at the departure ramp in San Antonio, at the arrival ramp in Houston, and at the departure ramp of connecting flights out of Houston.

The third stage of testing, Phase IIC, took place at two domestic airports: New York John F. Kennedy International (JFK) Airport and the Miami International (MIA) Airport in Florida. This stage expanded to include: interface with a Baggage Reconciliation System (BRS), and the test of a reusable container tracking system with RF "seals". These tests were done in conjunction with Tower Airlines. RFID bag tags were read with both a fixed belt reader and handheld readers. Baggage containers were electronically sealed, then tested for "tamper" detection as they were routed between JFK and MIA. The containers' locations were also tracked by an automatic logging system during all test periods.

This fourth stage of testing, Phase IID, will include the test of two types of RFID bag tags: disposable and reusable; and multiple types of RFID readers: handheld, fixed belt, and ramp readers. It will also involve international interline transfer of baggage. This stage of testing will be conducted simultaneously at airports in six different cities: Penang, Malaysia; Madras, India; Singapore, Singapore; Hong Kong, China; San Francisco, USA; and Vancouver, Canada. This stage will be performed in cooperation with both Alaska Airlines (San Francisco, Vancouver) and Singapore Airlines (Penang, Madras, Singapore, Hong Kong, San Francisco, and Vancouver).

Phase IID Testing

This document addresses only the plan and procedures for the fourth stage of Operational Testing in cooperation with Alaska Airlines and Singapore Airlines. It addresses specific tests to determine:

- The capability of RFID systems to reliably and consistently encode bag tags with baggage RFID information in an operational airport environment
- The capability of RFID systems to reliably and consistently read RFID data from encoded bag tags in an operational airport environment
- The ability of RFID bag tags to withstand the normal rigors of baggage handling without deterioration or failure
- The capability of RFID systems to reliably and consistently identify and track passenger baggage in an operational airport environment

## ACRONYMS AND ABBREVIATIONS

BRS ..... Baggage Reconciliation System
C ..... Centigrade
cm ..... centimeter
DOT ..... Department of Transportation
Dpi ..... Dots per Inch
Dpmm ..... Dots per Millimeter
EMC ..... Electromagnetic Compatibility
EMI ..... Electromagnetic Interference
FAA ..... Federal Aviation Administration
F ..... Fahrenheit
gm ..... gram
GHz ..... Gigahertz
HKG ..... Hong Kong
Hz ..... Hertz
ID ..... Identification
In ..... Inches
Ips ..... Inches per Second
ISM ..... Industrial, Scientific, and Medical
JFK ..... John F. Kennedy International Airport
kb ..... Kilobits
KHz ..... Kilohertz
lb ..... pound
LCD ..... Liquid Crystal Display
m ..... meter
mA ..... milliamps
MAA ..... Meenambarkkam, Madras, India
MB ..... Megabyte
MHz ..... Megahertz
MIA ..... Miami International Airport
mm ..... millimeters
Mmps ..... Millimeters per Second
ms ..... millisecond
OTP ..... Operational Test Plan/Procedure
PC ..... Personal Computer
PEN ..... Penang International Airport
PPBM ..... Positive Passenger Bag Match
PVC ..... Polyvinylchloride
QTP ..... Qualification Test Plan/Procedure
RF ..... Radio Frequency
RFI ..... Radio Frequency Interference
RFID ..... Radio Frequency Identification
SCS ..... Single Chip Systems
SFO ..... San Francisco International Airport
SEL ..... Kimpo International, Airport, Seoul South Korea

SIN ..... Changi International Airport, Singapore, Singapore
ULD..... Unit Loading Device
VAC ..... Volts alternating current
VC ..... Vendor Control
YVR ..... Vancouver International Airport

# 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 Radio Frequency Identification systems for the support of passenger/baggage matching 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
- 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 match 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 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 four stages at different combinations of airport sites. Each test stage will focus on specific portions of the end-to-end baggage 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 RF vendors Texas Instruments and Omron Electronics, Inc. The tests there encompassed the passenger baggage check-in process (bag tag encoding) and the reconciliation of the baggage in the baggage make-up rooms (reading the encoded tags).

The second stage of tests, Phase IIB, took place jointly at the San Antonio, Texas airport and the Houston, Texas airport in cooperation with Continental Airlines. In this stage, the tests expanded to include belt readers and ramp readers, and involved tail-to-tail baggage transfers. For designated test flights from San Antonio to Houston, the RFID bag tags were read in the baggage make-up room prior to departure from San Antonio, at the departure ramp in San Antonio, at the arrival ramp in Houston, and at the departure ramp of connecting flights out of Houston.

The third stage of testing, Phase IIC, took place at two domestic airports: New York John F. Kennedy International (JFK) Airport and the Miami International (MIA) Airport in Florida. This stage of testing included the use of belt readers and handheld RFID readers, and expanded to include the test of a reusable container tracking system with RF "seals". These tests were done in conjunction with Tower Airlines.

This fourth stage of testing, Phase IID, will include the test of two types of RFID bag tags: disposable and reusable; and multiple types of RFID readers: handheld, fixed belt, and ramp readers. It will also involve international interline transfer of baggage. This stage of testing will be conducted simultaneously at airports in six different cities: Penang, Malaysia; Madras, India; Singapore, Singapore; Hong Kong, China; San Francisco, USA; and Vancouver, Canada. This stage will be performed in cooperation with both Alaska Airlines (San Francisco, Vancouver) and Singapore Airlines (Penang, Madras, Singapore, Hong Kong, San Francisco, and Vancouver).

This document addresses only the plan and procedures for the fourth stage of Operational Testing at the Penang, Madras, Singapore, Hong Kong, San Francisco and Vancouver Airports. Subsequent test stages will be addressed individually in separate documents.

## 1.2 Purpose

The objective of the Operational Test of the RFID systems is to demonstrate the technical and operational feasibility of using RFID technology to perform baggage identification, tracking and security functions in a complete, real-time end-to-end implementation. The specific Operational Test areas of concern are:

- Compatibility with available physical space for installation
- Ability to interface with test systems
- RFID systems' electromagnetic compatibility (EMC) demonstrated with operational airline, airport and aircraft operations and systems
- Compatibility with communications restrictions for power and frequency both domestically and internationally
- RFID systems' technical and operational approach to support the passenger/baggage identification, tracking and security functions within operational environments

## 1.3 Scope

The Operational Test of vendor provided, commercially available RFID systems will be conducted at selected domestic and international airports in cooperation with sponsor airlines. Candidate RFID systems will be installed and tested at these sites under normal operational conditions. Operational requirements demand not only that the candidate RFID systems perform specific communications functions, but that these systems also possess the capability to:

- Withstand repetitive cycles of sustained operations with little to no maintenance
- Perform in a physically demanding environment
- Not degrade the existing operational electronic environment with additional Radio Frequency Interference (RFI)/Electromagnetic Interference (EMI)

As candidate RFID systems are installed at the test sites, all control and interface functions will be exercised to assure that the RFID systems communicate properly with the test equipment and that they are able to function satisfactorily within the operational constraints of the test environment.

## 2. REFERENCE DOCUMENTS

| | |
|---|---|
| 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-98/102 | Operational Test Report of Commercially Available Radio Frequency Identification (RFID) Systems for Potential Positive Passenger Baggage Match (PPBM) Applications, November 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 |
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| DOT/FAA/AR-99/XX | Phase IIB Qualification Test of Commercially Available Radio Frequency Identification (RFID) Systems for Baggage Identification, Tracking and Security Applications; Continental Airlines Trial; San Antonio and Houston, Texas; July, 1999 |
| DOT/FAA/AR-99/XX | Phase IIB Operational Test of Commercially Available Radio Frequency Identification (RFID) Systems for Baggage Identification, Tracking and Security Applications; Continental Airlines Trial; October, 1999 |
| DOT/FAA/AR-99/XX | Phase IIC Operational Test Plan and Procedures of Commercially Available Radio Frequency Identification (RFID) Systems for Baggage Identification, Tracking and Security Applications; Tower Airlines Trial; November, 1999 |

## 3. SYSTEM DESCRIPTION

### 3.1 Test Approach overview

Two different RFID systems will be tested, each system using a different type of RFID bag tag. Single Chip Systems' (SCS) RFID system uses "single use" paper tags. Magellan Technology's RFID system uses reusable plastic tags.

### SCS Approach

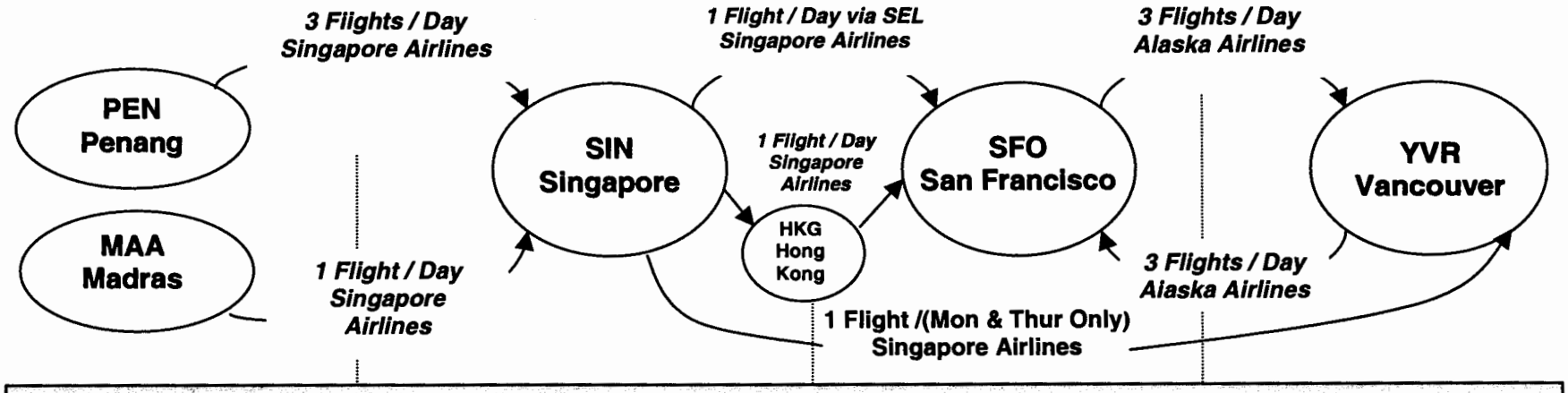
Figure 3.1 shows the overall approach to be used with the SCS equipment (single use bag tag). At the Penang (PEN) and Madras (MAA) Airports, baggage checked on the Singapore Airlines test flights departing for Singapore will have SCS RFID bag tags attached at the check-in stations. When these bags are sent to the baggage make-up room for sortation, their bag tags will be read with an SCS handheld RFID reader. The bags will then be loaded on the test flight to Singapore. The equipment setup for PEN and MAA is shown in Figure 3.2.

The equipment setup for the Singapore Airport (SIN) is shown in Figure 3.3. At SIN, baggage being checked on Singapore Airlines test flights to Hong Kong (HKG), San Francisco (SFO), and Vancouver (YVR) will be tagged with SCS RFID bag tags. A fixed SCS RFID reader will be used to read the tags on these bags in the baggage delivery/sortation area. Additionally, the transfer bags from PEN and MAA destined for Hong Kong, will have their tags read by another fixed RFID reader in the baggage transfer area. In the baggage make-up room, the bag tags on the test bags will be read once more via SCS RFID handheld readers. The bags will be sorted, then loaded on the test flights from SIN to HKG, SFO, and YVR.

The testing at Hong Kong will take place in the baggage arrival area. The test setup is shown in Figure 3.4. All test bags arriving from Singapore and terminating in Hong Kong will be read with an SCS handheld reader.

The majority of the testing activity will take place at SFO. The equipment setup for SFO is shown in Figure 3.5. Bags being checked on Alaska Airlines test flights to Vancouver (YVR) will be tagged with SCS RFID bag tags. These bags will then be placed on the delivery belt to the baggage make-up room. On the belt, the bag tags on these bags will be read by a fixed SCS RFID reader. Once the outgoing bags arrive in the baggage make-up room, their tags will be read again with an SCS RFID handheld reader before they are loaded onto the test flight.

Test bags arriving in SFO from SIN and YVR will have their SCS bag tags read by fixed SCS RFID readers. One of these readers will be mounted on the belt in the domestic arrivals area to read the bag tags on bags from the Alaska Airlines test flights from YVR. The other reader will be mounted on the belt in the international arrivals area to read the bag tags on bags coming from the Singapore Airlines test flights from SIN.




- Check-in Encoding, Transfers to SIN only, 2 RFID Printers PEN and 2 RFID Printers MAA
- Read bags in Make-up Room (PEN), 1 RFID Handheld
- Read bags in Make-up Room (MAA), 1 RFID Handheld

- Check-in Encoding, Originating Passengers, 6 RFID Printers
- Read originating bags on tilt tray, 1 RFID Fixed Reader
- Read transfer bags from Penang and Madras on tilt tray, 1 RFID Fixed Reader
- Read bags in Make-up Room, 3 RFID Handhelds

**Hong Kong (HKG)**

- Read terminating bags at arrival, 1 RFID Handheld

- Check-in Encoding, originating passengers, 2 RFID Printers
- Read originating baggage on delivery belt, 1 RFID Fixed Reader
- Read originating bags in Make-up Room, 2 RFID Handhelds
- Read arriving baggage from SIN on international arrival belt, 1 RFID Fixed Reader
- Read arriving baggage from YVR on domestic arrival belt, 1 RFID Fixed Reader

- Check-in Encoding, originating passengers, 4 RFID Printers
- Read originating baggage on delivery belt, 1 RFID Fixed Reader
- Read bags in Make-up Room, 2 RFID Handhelds
- Read arriving baggage from SFO and SIN on arrival belt, 1 RFID Fixed Reader

**Figure 3.1 Test Operations and Test Flights for SCS RFID System**

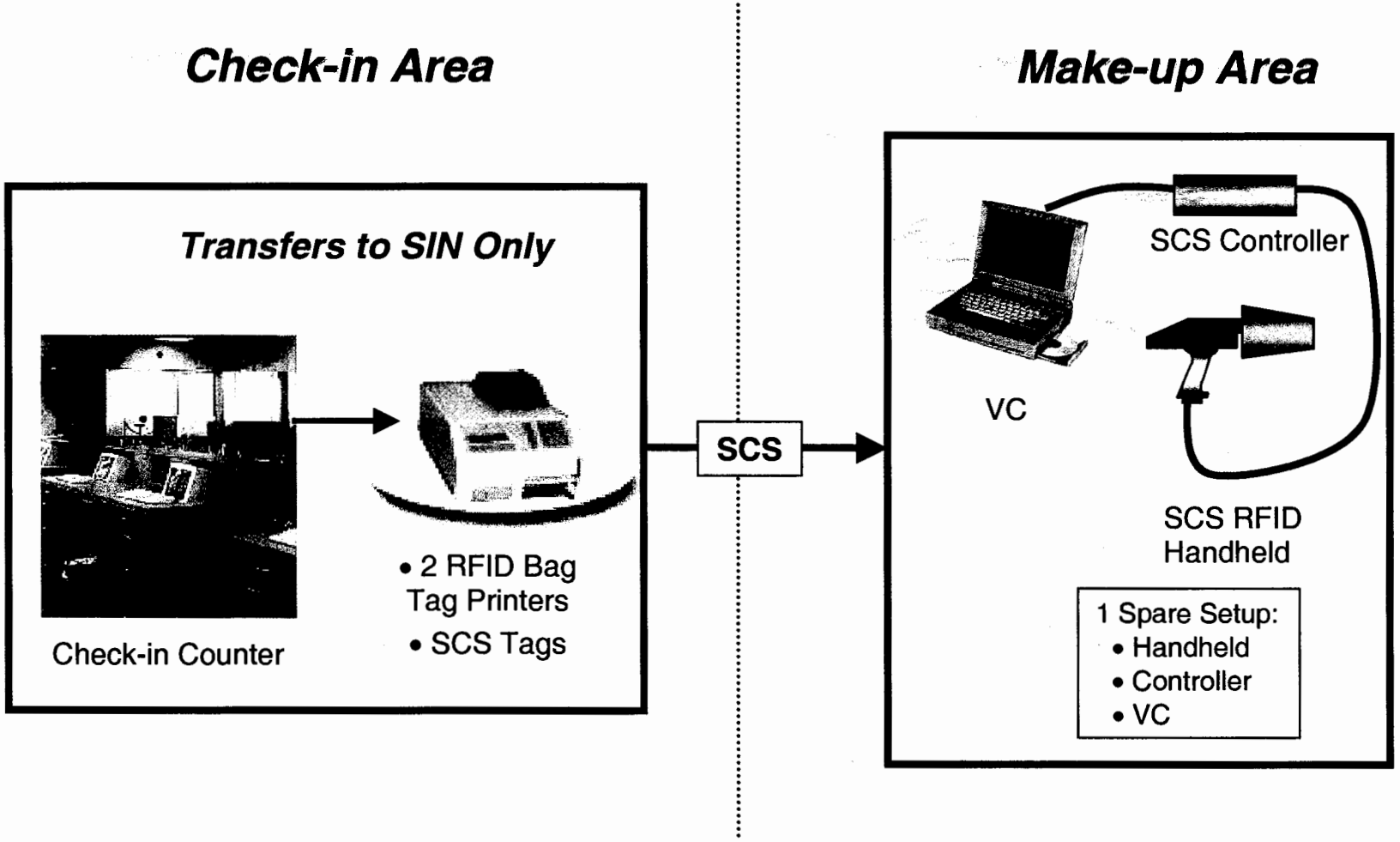



**Figure 3.2 Test Equipment Setup – Penang (PEN) and Madras (MAA)**

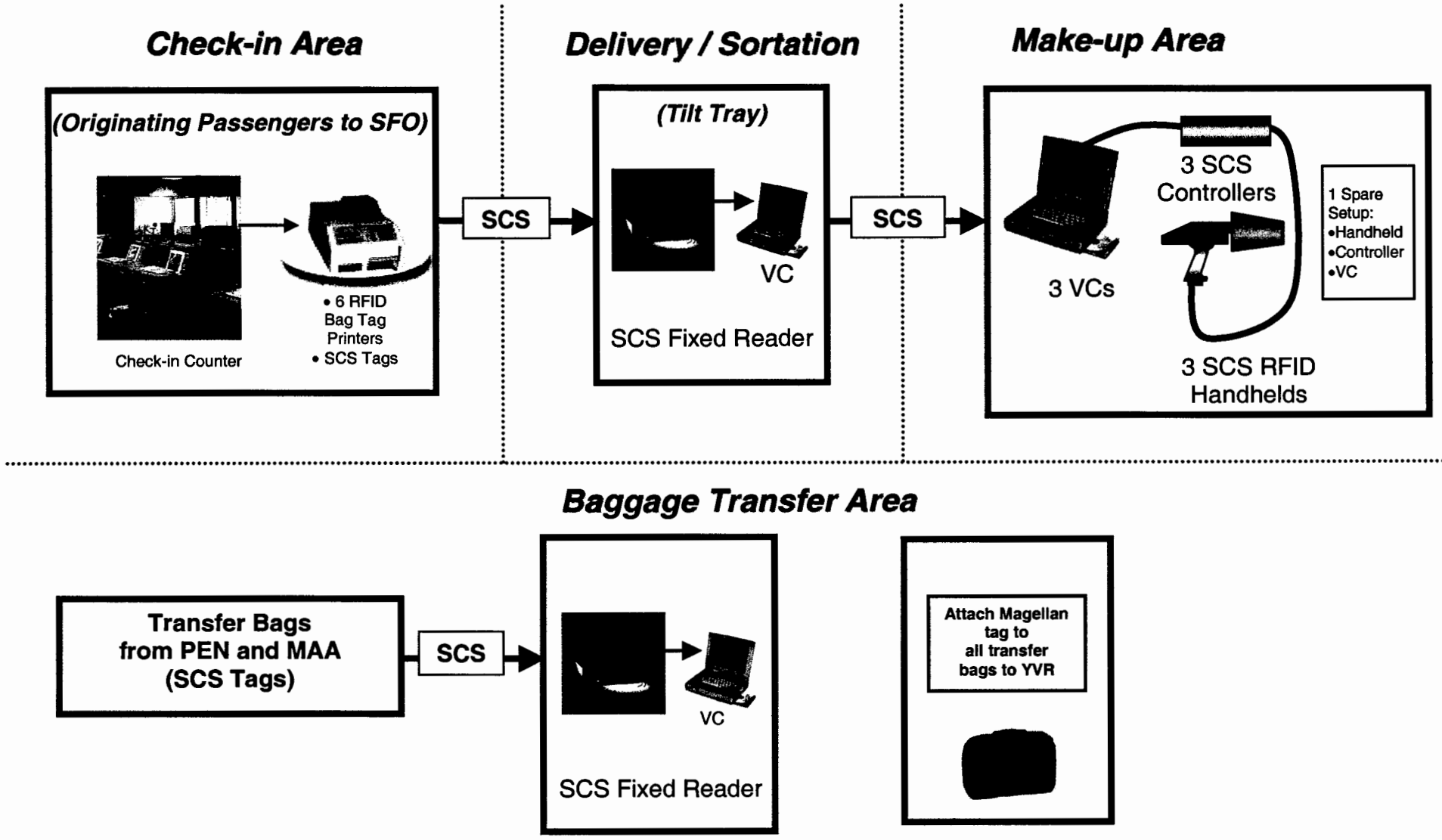



**Figure 3.3 Test Equipment Setup – Singapore (SIN)**

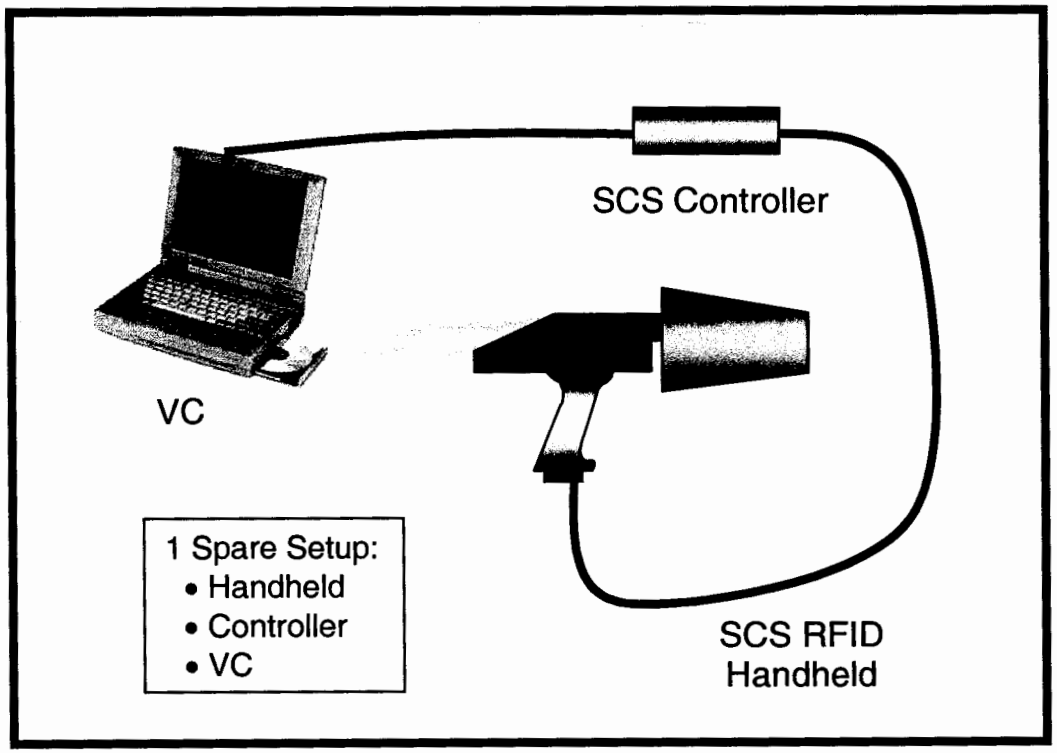



**Figure 3.4 Test Equipment Setup – Hong Kong (HKG)**

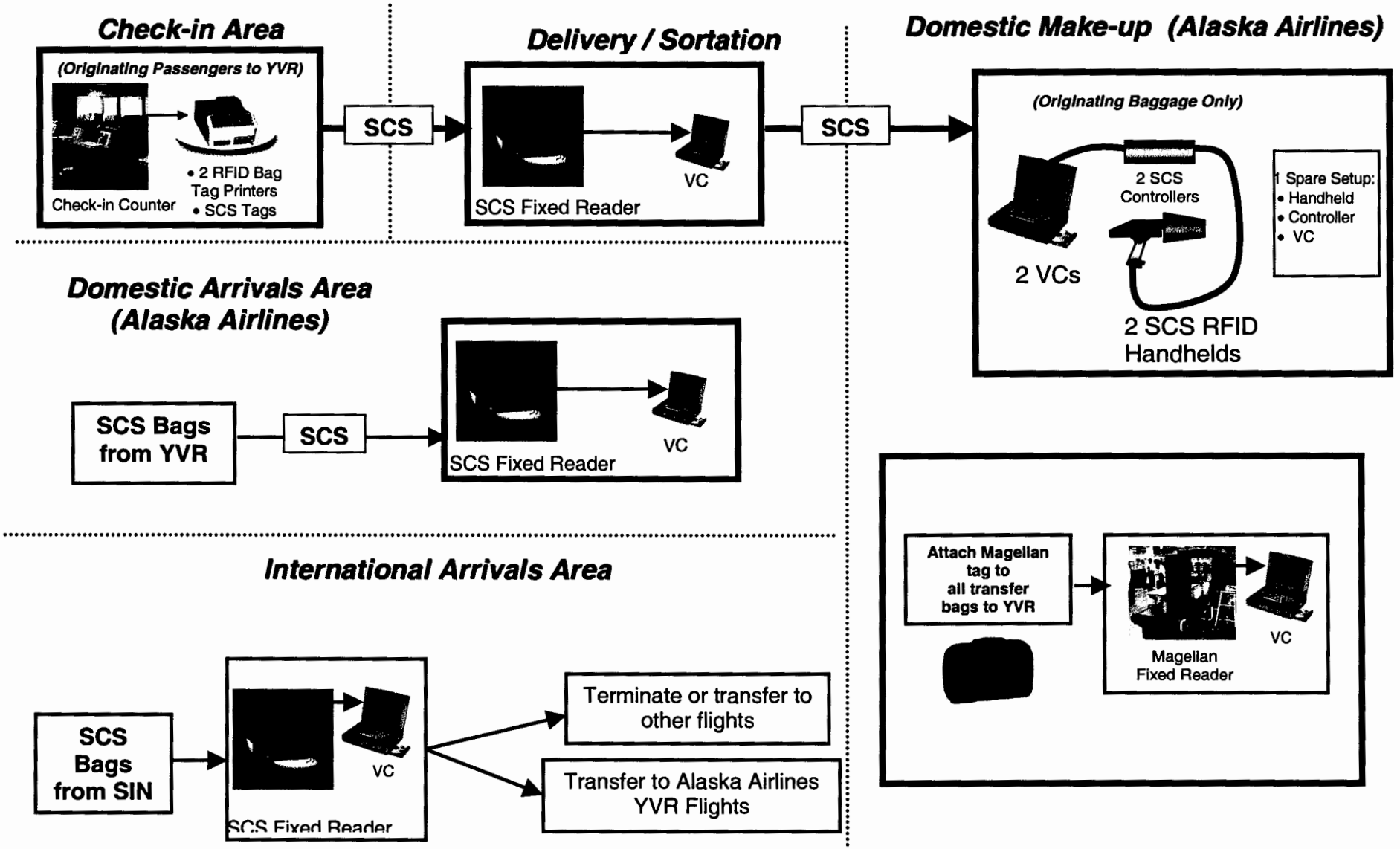



**Figure 3.5 Test Equipment Setup – San Francisco (SFO)**

Testing activities in YVR will be similar to those in SFO. The equipment setup for YVR is shown in Figure 3.6. Bags being checked on Alaska Airlines test flights to SFO will have SCS RFID bag tags attached at the check-in stations. On the delivery belt to the baggage make-up room, these bag tags will be read by a fixed SCS RFID reader. In the baggage make-up room, SCS RFID handheld readers will be used to read these bag tags again. In the international arrivals area, a fixed SCS RFID reader will read the SCS bag tags of bags arriving on Alaska Airlines test flights from SFO and SIN.

**Magellan Approach**

Figure 3.7 shows the overall test approach that will be used for the Magellan Technology RFID system (reusable bag tags). No Magellan equipment will be used in PEN, MAA or HKG. Refer to Figure 3.3 for a diagram of the SIN Magellan equipment setup and Figure 3.5 for a diagram of the SFO Magellan equipment setup. At SIN and SFO, Magellan RFID bag tags will be attached to all bags destined for YVR on the Singapore and Alaska Airlines test flights. This will be done in the baggage transfer area in SIN and the baggage make-up room in SFO. In SFO, after the tags have been attached, they will be read by a Magellan fixed RFID reader (also in the baggage make-up room). The bags will then be loaded onto the test flight to YVR.

The YVR setup for the Magellan system can be seen in Figure 3.6. At YVR, the bags arriving on the test flights from SFO and SIN will be passed through a Magellan RFID reader mounted on a belt-loader as they are unloaded from the aircraft on the ramp. After these test bags have reached the international arrivals area in the airport, a Magellan fixed RFID reader will be used to read the bag tags a second time.

3.2 System Overview

This section provides an overview of the entire complement of equipment that will be used to conduct the Phase IID Operational Test. Different portions of these systems will be used at the various test sites, as described in Section 4.1, Test Approach. Detailed information on each component within these system categories is provided in Section 4.2.2, Test Resources Required. Refer to Figures 3.2 through 3.6 for the diagrams of these components and their interfaces. The components that make up this test system fall into three categories:

<u>System under test</u>

- This includes the vendor RFID system whose performance is being tested. For these tests an RFID system will consist of the following components:

<u>SCS System</u>

- RFID Bag Tags (Singapore Airlines: 10000 for Operational Test/1000 for pre-test. Alaska Airlines: 5000 for Operational Test/1000 for pre-test.) – The RFID bag tags will consist of an RFID inlay laminated into a paper bag tag.

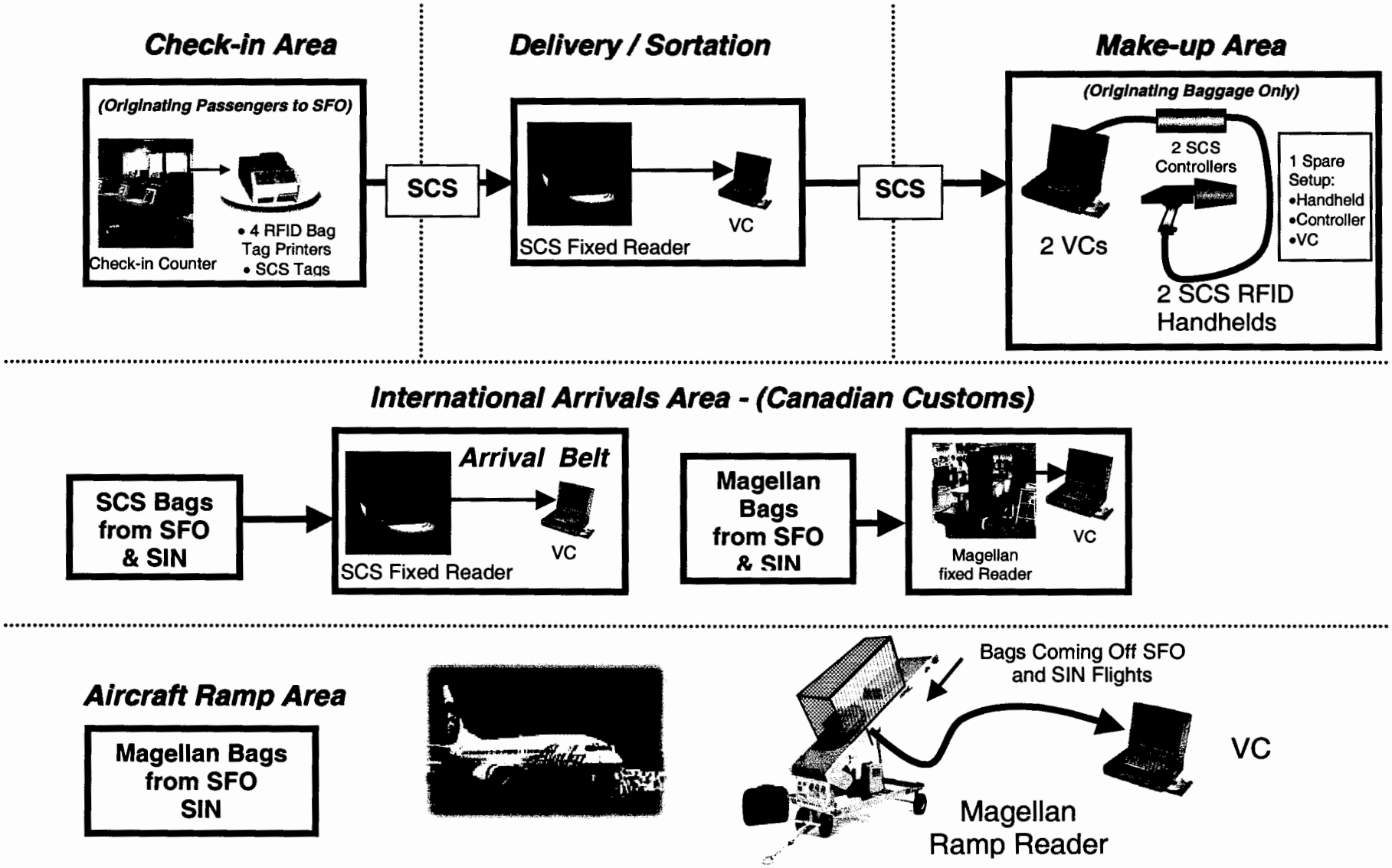



**Figure 3.6 Test Equipment Setup – Vancouver (YVR)**

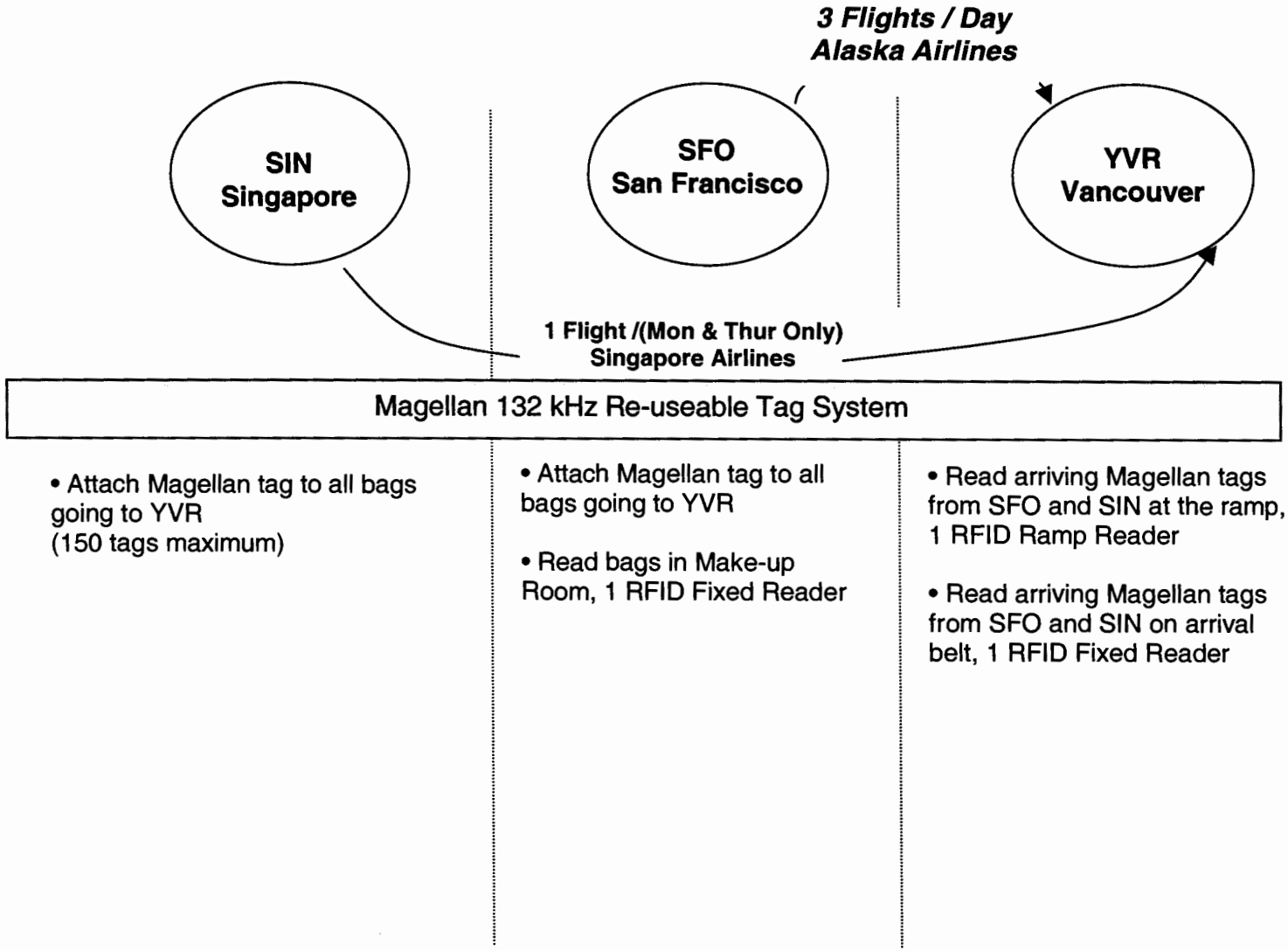



**Figure 3.7 Phase IID Test Approach - Magellan System**

- Modified Bag Tag Printers (16 + 2 backups) – The modified bag tag printer is a barcode label (bag tag) printer outfitted with an internal RFID antenna and an external RFID scanner.
- RFID Handheld Readers (8 + 4 backups) – This is a handheld unit that will be used in the baggage make-up room and in the arrivals area to manually read the RFID bag tags.
- RFID Fixed Readers (7) – This is a fixed reader that is mounted around the delivery belt in the following locations: a) the baggage delivery/sortation area, b) the baggage transfer area, and c) the domestic and international arrivals area. It enables automatic reading of the RFID bag tags as the bags move along the belt through the reader.

Magellan System

- RFID Bag Tags (1000 for Op. Test) – The Magellan RFID bag tags will consist of a plastic card with an embedded RF chip that is pre-encoded.
- RFID Fixed Readers (2) – In SFO this will be a self-contained tunnel reader belt system installed in the baggage make up room. In YVR, the tunnel reader will be installed inline on the international arrivals belt.
- RFID Ramp Reader (1) – This is a tunnel reader that is mounted around the belt of a mobile baggage loader used on the aircraft ramps to load/unload baggage to/from the aircraft.

Test Support System

This includes all of the hardware and software that has been customized to allow the test team to control the test processes and data collection. It consists of the following components:

- Vendor Control (VC) (SCS: 24 + 6 backups. Magellan: 3) -- This consists of a laptop PC which hosts test data control software. It is used to interface to the various RFID readers, and to collect and store the read results from the tests. The SCS handheld readers require a separate controller that interfaces the PC to the reader. The VC performs the following test functions.
- Controls the RFID reading process
- Stores tag read results from the RFID system

Airport and Airline Systems

These are the systems that comprise the airport environment within which the RFID system must operate. These include:

- Conveyor Belt System – This is the delivery belt system regularly used to transport baggage throughout the various airports. These delivery belts will be used in the normal manner in these tests.

- Ramp Loader/Unloader – This is a moveable motorized loading device which transports the baggage to or from the aircraft cargo hold via a moving conveyor belt. It is used at the aircraft ramp areas.

# 4. TEST PROGRAM DESCRIPTION

## 4.1 Test Approach

### 4.1.1 Activities Leading to Test

The following activities will be completed before the start of operational testing:

Manufacture of RFID Bag Tags. Two bag tag manufacturers will produce a number of color-coded paper tags specifically for the operational tests. Global Ventures supplies paper bag tags to Alaska Airlines, and General Labels & Labelling Pte.Ltd. supplies tags to Singapore Airlines. These manufacturers will produce the required number of paper tags and provide these to SCS. SCS will embed the RF inlays in the tags, and will test a portion of the resulting RFID bag tags in a modified bag tag printer at their plant. This testing will be done to ensure that the tags will not hamper the normal tag-printing and check-in process. After FAA representatives have approved the results of the tag tests, the remaining RFID bag tag stock will be shipped to all of the test sites. Before the operational tests begin, the bag tags will be tested with the printers at the test site.

Magellan RFID bag tags will be attached to baggage only at SIN and SFO. Magellan will produce the quantity of reusable RFID bag tags needed to conduct the tests.

FAA test personnel will be responsible at each of the five test sites for verifying that the RFID bag tag supplies are sufficient for conducting the tests. This will be confirmed before any operational tests are begun.

Bag Tag Printer Modifications. The printers normally used by Alaska Airlines and Singapore Airlines at the check-in counters to print the bag tags will be replaced by Genicom BT302 and BT201E printers that have been modified for this test. These bag tag printers will be used only with the SCS system and will be installed at five of the test sites. The hardware modifications for the printers will be done by SCS. Genicom, the printer manufacturer, will develop the software modifications.

Genicom will supply printers to SCS for modification. SCS will add an internal antenna and an external scanner to each one, which will allow the printer to encode the RFID inlays in the test bag tags. Meanwhile, Genicom will develop the software modifications necessary to control the encoding process. The printers will then be shipped to all of the test sites.

At the test sites, the printers will be installed and tested to ensure that they will print and encode the test tags without hindering normal check-in operations. These tests will be overseen and approved by the FAA test team.

Fixed Reader Development. SCS will provide a number of its fixed readers for use in these tests. They will be configured to be mounted on the delivery belts and tilt tray sortation systems at the various test sites. They will be factory tested and the results approved by FAA representatives before they are shipped to the appropriate test sites: SIN, SFO and YVR.

Magellan will also provide two fixed readers and a ramp reader for these tests. Two fixed readers will be configured for mounting on a section of conveyor belt for use in the SFO baggage make-up room and the YVR international arrivals area. The ramp reader will be configured for mounting on a moveable ramp loader for use on the aircraft ramp area at the YVR test site. These readers will also be thoroughly factory tested before the operational tests, and FAA representatives will approve the results before the readers are shipped to SFO and YVR.

At the test sites, each vendor will be responsible for conducting an on-site pre-operational qualification test of its readers. After each reader has been installed, a minimum of 500 test tags must be run through each reader to ensure that the reader is working properly and that it has been optimized as necessary for this application. Each reader's interface to its VC unit must also be tested after installation at the test site. These tests will be overseen and approved by FAA test personnel before testing begins.

Handheld Reader Testing. The RFID handheld readers to be used by SCS for this test have been developed and used in a previous RFID test stage. SCS will be responsible for testing each of these readers at the factory with the new test bag tags (both the Global and the General tags). The results of the factory tests will be approved by FAA representatives before any of the handheld readers are shipped to the six test sites where they will be used (PEN, MAA, SIN, HKG, SFO and YVR).

At the test sites, SCS will have responsibility for testing the readers and their connections to the VC/controller units; the tests will be conducted in the locations (within the airports) where the readers will be used. FAA test personnel will oversee and approve these on-site tests.

Vendor Control Modifications. Both SCS and Magellan will be using VC PCs interfaced to the handheld and the fixed RFID readers to collect and record the read data being produced. Each vendor is responsible for making the VC software and hardware changes necessary to interface their respective units to the appropriate reader and to process and store the RFID read results being passed from the readers. The VC units will be factory tested and the test results approved by FAA representatives before they are shipped to the six test sites where they will be used (PEN, MAA, SIN, HKG, SFO and YVR).

Installation of Test Control Equipment at Test Sites. Both SCS and Magellan will work under the supervision of the respective cognizant airport/airline personnel to install the necessary test equipment at the six test sites. The installations will be approved by FAA test personnel before operational testing will begin. SCS will be installing equipment at all six sites; Magellan will be installing only at the SFO and YVR sites.

4.1.2 Test Events

**Penang and Madras.** There are only two areas in PEN and MAA where test equipment will be used: the check-in counters, and the baggage make-up room. The equipment to be used in these areas is shown in the diagram in Figure 3.2.

Check-In. There will be two Singapore Airline check-in stations (supported by two printers) to be used for the test flights destined for Singapore. As passengers check in for these test flights, their checked baggage will be tagged with the SCS RFID bag tags. These test tags will be color-coded so that they will be readily identifiable as test tags by the FAA test teams and the airline/airport personnel. Each of these bag tags will have its unique ten-digit license plate number printed on it, along with the barcode representation. In addition, the RFID chip will be encoded with that same License Plate. This will be accomplished in the same tag-printing process. If RF encoding fails, a visual indication such as "RF VOID" will be printed on the bag tag and the encoding will be attempted on the next bag tag. Test personnel monitoring the check-in stations will retrieve all failed bag tags for later analysis, and will record the time and location (printer number) of the failure as well as a description of the circumstances of the failure.

Baggage Make-up Room. As the test bags enter the baggage make-up room via the delivery belt, they will be read by an FAA test team member using an SCS handheld RFID reader connected to a VC unit. If the bag tag is not read correctly, the baggage will be processed as usual, and the test team member will cite the RFID bag tag as a "Failed RF Read", noting the date and time, the barcode number of the bag tag, and the circumstances. All RFID data read from the bag tags will be automatically sent to the VC, which will record the results of the read. At the end of each test day, this data will be downloaded for later analysis, and the date of the readings will be recorded.

**Singapore.** There are four areas in the SIN airport that will be used in these tests: the check-in area, the baggage delivery/sortation area, the baggage make-up room, and the baggage transfer area. The equipment setup to be used in these areas is shown in Figure 3.3.

Check-In. There will be six Singapore Airlines check-in stations (supported by six modified bag tag printers) in the SIN airport used for the test flights to SFO. The check-in process for these tests will be the same as that used in PEN and MAA.

Baggage Delivery/Sortation Area. The test bags will enter this area via the tilt tray sortation system used in the baggage sortation process. An SCS fixed RFID reader will be mounted around this tilt tray sortation system, and will automatically read the test bag tags as the bags pass through the reader. The reader will be connected to a VC, which will collect and record the results of all of the RFID readings; i.e., the assigned 10-digit license plate number. FAA test personnel will monitor this reader at intervals throughout the day and will record the date, time and circumstances of any problems or discrepancies in the reading process. At the end of each test day, the data from the VC will be downloaded to a file so that the date of collection of that data will be preserved.

Baggage Transfer Area. Test bags coming from PEN and MAA for transfer to other SQ flights will go through this area. As in the Baggage Delivery/Sortation Area, there will be an SCS fixed RFID reader mounted around the tilt tray sortation system that is used to transport and sort the bags. As the test bags pass through the reader, their bag tags will be automatically read. The VC unit supporting the reader will receive and record the RFID readings. FAA test personnel will monitor the reading process, and will record any problems or discrepancies, along with the date, time and circumstances. At the end of each test day, the data from the VC will be downloaded to a file so that the date of collection of that data will be preserved.

Test personnel will also attach Magellan tags to all transfer bags destined for YVR and record the tag numbers used each day.

Baggage Make-up Room. Baggage will be delivered to the make-up area from the delivery/sortation system where each bag will be read/scanned by FAA personnel using SCS RFID handheld readers. There will be three test team members, each equipped with a handheld reader. As the test bags arrive in this area, each test bag tag will be read by one of the test team members. If the bag tag is not read successfully, the test team member will cite the RFID bag tag as a "Failed RF Read", and will note the date, time, the barcode number of the bag tag, and the circumstances of the failure.

**San Francisco**. There are five areas of the SFO airport that will be used for these tests: the international arrivals area for the SQ flights; for Alaska Airlines, the check-in area, the baggage delivery/sortation area, the baggage make-up room, the domestic arrivals area. The equipment setup to be used in these areas is shown in Figure 3.5.

Check-In. There will be three Alaska Airlines check-in stations (supported by two modified bag tag printers) that will be used for the flights to YVR. The check-in process for these tests will be the same as that used in PEN, MAA, and SIN.

Baggage Delivery/Sortation Area. As the bags enter this area via the conveyor belt, they will pass through an SCS fixed RFID reader that will be mounted around the belt. The bag tags will be read automatically as the bags pass through the reader. The reader will be connected to a VC, which will collect and record the results of all of the RFID readings; i.e., the assigned 10-digit license plate number. FAA test personnel will monitor this reader at intervals throughout the day and will record the date, time and circumstances of any problems or discrepancies in the reading process. At the end of each test day, the data from the VC will be downloaded to a file so that the date of collection of that data will be preserved.

Alaska Airlines Domestic Make-up Room. The bags that were checked in at SFO will pass from the Delivery/Sortation Area to this area via the delivery belt system. Before being loaded for transport to the appropriate aircraft, the bag tags will be read by FAA test personnel using SCS handheld RFID readers. There will be two test team members, each equipped with a handheld reader, performing the read operation. The process will be similar to that used in the baggage make-up room in SIN.

In addition to the reading of the SCS test bag tags, an FAA test team member will attach Magellan reusable bag tags to all baggage for the YVR flights. After the Magellan tags are attached, the bags will pass through a Magellan fixed reader where they will pass through the reader where the pre-encoded tag will be read. The reader will be mounted around a self-contained section of conveyor belt. The interfacing VC unit will receive and record the results of the RFID readings. At the end of each test day, the data from the VC will be downloaded to a file so that the date of collection of that data will be preserved. Test personnel will also record the RFID tag numbers used each day.

Alaska Airlines Domestic Arrivals Area. Bags arriving bags from the YVR flights will be placed on the delivery belt. A fixed SCS RFID reader will be mounted around the belt so that bags passing through it will have their RFID bag tags read automatically. The equipment setup will be the same as in the SFO baggage delivery/sortation area. FAA test personnel will monitor this reader at intervals throughout the day and will record the date, time and circumstances of any problems or discrepancies in the reading process. At the end of each test day, the data from the VC will be downloaded to a file so that the date of collection of that data will be preserved.

International Arrivals Area. Bags arriving on flights from SIN will be transported to this area and placed on the delivery belt. A fixed SCS RFID reader will be mounted around this belt, and the reading and data collection process will be identical to that in the Alaska Airlines domestic arrivals area.

**Vancouver**. There are five areas of the YVR airport that will be used for these tests: the check-in area, the baggage delivery/sortation area, the baggage make-up room, the aircraft ramp area and the international arrivals area (Canadian Customs). The equipment setup to be used in these areas is shown in Figure 3.6.

Check-In Area. There will be four check-in stations (supported by four modified bag tag printers) that will be used for the test flights to SFO. The check-in process for these tests will be the same as that used at the other test sites.

Baggage Delivery/Sortation Area. Baggage will enter this area from the check-in counters, transported on the delivery belt. A fixed SCS RFID reader will be mounted around this belt and will automatically read the RFID bag tags as the bags pass through. The reader will be connected to a VC, which will collect and record the results of all of the RFID readings; i.e., the assigned 10-digit license plate number. FAA test personnel will monitor this reader at intervals throughout the day and will record the date, time and circumstances of any problems or discrepancies in the reading process. At the end of each test day, the data from the VC will be downloaded to a file so that the date of collection of that data will be preserved.

Baggage Make-Up Room. The bags for the SFO flights will be transported to this area after check-in and sortation. Before these bags are loaded for transport to the designated aircraft, their SCS RFID bag tags will be read by FAA test personnel in this room. There will be two test team members, each equipped with an SCS handheld RFID reader. The test procedures will be the same as those used in the baggage make-up room in SIN.

Aircraft Ramp Area. Baggage arriving on the flights from SFO and SIN will be offloaded onto a ramp loader with a Magellan RFID reader mounted on it. The bags will pass through the reader which will read the contents of the pre-encoded Magellan RFID bag tags. An FAA test team member will monitor this process, and record the date, time and circumstances of any reading problems or discrepancies. The results of the readings will be collected and recorded by the interfacing VC unit. At the end of each test day, the test data will be downloaded to a file so that the date of the data collection will be preserved.

International Arrivals Area (Canadian Customs). Bags arriving from SIN and SFO will come to this area on the arrival delivery belt. A fixed SCS RFID reader will be mounted around this belt to automatically read the SCS RFID bag tags attached to these bags as they pass through the reader. FAA test personnel will monitor this reader at intervals throughout the day and will record the date, time and circumstances of any problems or discrepancies in the reading process. At the end of each test day, the data from the VC will be downloaded to a file so that the date of collection of that data will be preserved.

In addition to the SCS fixed reader, a Magellan fixed reader will be used in this area. Bags from SIN and SFO will also have Magellan tags attached to them. The FAA test personnel will pass these bags through the fixed reader where the tags will be read automatically. The test personnel will record the date, time and circumstances of any problems or discrepancies in the reading process. After all the arriving bags have been read, the read results will be downloaded from the interfacing VC so that the date of the data collection will be preserved.

4.2 Test Environment

4.2.1 Test Facilities

4.2.1.1 Penang and Madras Airports

4.2.1.1.1 Check-In Stations

Two bag tag printers at the Singapore Airlines check-in counter will be replaced one-for-one with modified Genicom printers. The modified bag tag printers will be a direct substitution for the current printers. The affected agents' terminals will remain the same, and the printers will be used in the normal way. The test personnel monitoring the tests at this location will be located behind the counters, so that they are able to observe the actions of the check-in agents and the functioning of the printers.

4.2.1.1.2 Baggage Make-up Room

There will be one SCS RFID handheld reader, tethered to a VC and controller unit, which will be set up in the baggage make-up room. There will also be one backup handheld unit with supporting components (VC and controller) in this area. No installation of this equipment is required.

4.2.1.2 Singapore Airport

4.2.1.2.1 Check-In Stations

Six bag tag printers at the Singapore Airlines check-in counter will be replaced one-for-one with modified Genicom printers. The installation of the printers and the placement of the test personnel within this test area will be the same as that for PEN and MAA.

4.2.1.2.2 Baggage Delivery/Sortation Area

One SCS fixed reader will be installed on the tilt tray sortation system in this area. The fixed reader will interface to a VC unit. There will be no other interfaces to this reader or VC.

4.2.1.2.3 Baggage Make-Up Room

There will be three SCS handheld RFID readers used in the baggage make-up room to read the RFID bag tags. Each handheld reader will be tethered to its own VC and controller unit. There will be one backup handheld reader assembly (the reader unit and its supporting data collection/control components) in this area. No installation of this equipment is required.

4.2.1.2.4 Baggage Transfer Area

The test equipment and installation in this area will be the same as that in the SIN delivery/sortation area. One SCS fixed reader will be installed on the tilt tray sortation system in this area. The fixed reader will interface to a VC unit. There will be no other interfaces to this reader or VC.

4.2.1.3 Hong Kong Airport

4.2.1.3.1 Baggage Arrivals Area

There will be one SCS handheld RFID reader used in the baggage arrivals area to read the RFID bag tags on baggage terminating in HKG. Each handheld reader will be tethered to its own VC and controller unit. There will be one backup handheld reader assembly (the reader unit and its supporting data collection/control components) in this area. No installation of the equipment is required.

4.2.1.4 San Francisco Airport

4.2.1.4.1 Check-In Stations

Two bag tag printers at the Alaska Airlines check-in counter will be replaced one-for-one with modified Genicom printers. The installation of the printers and the placement of the test personnel within this test area will be the same as that for the check-in stations at MAA, PEN and SIN airports.

4.2.1.4.2 Baggage Delivery/Sortation Area

One fixed SCS RFID reader will be installed on the delivery belt leading into this area. The reader will interface to a VC unit. There will be no other interfaces to this reader or VC.

4.2.1.4.3 Alaska Airlines Domestic Make-Up Room

In this baggage make-up room, there will be two SCS handheld RFID readers. The equipment configuration will be the same as that in the baggage make-up room at SIN. There will be one backup handheld reader assembly (the reader unit and its supporting data collection/control components) in this area. No installation of this equipment is required.

There will also be a Magellan fixed reader in this baggage make-up room. The fixed reader (a unit consisting of a fixed reader with its own section of moving conveyor belt) will be placed in the make-up room so that it does not interfere with normal baggage handling operations. The reader will interface to a VC. There will also be a supply of Magellan RFID bag tags. FAA test personnel will be located in this area in such a way that they can attach Magellan tags to all bags destined for YVR, and then pass these bags through the Magellan mobile reader without impacting the usual baggage handling process.

4.2.1.4.4 Alaska Airlines Domestic Arrivals Area

One SCS fixed reader will be installed on the delivery belt leading into this area, so that all arriving bags from YVR (bearing SCS RFID bag tags) will pass through this reader. The equipment configuration and monitoring by test personnel will be the same as in the SFO baggage delivery and sortation area.

4.2.1.4.5 International Arrivals Area

One SCS fixed reader will be installed on the delivery belt leading into this area, so that all arriving bags from SIN (bearing SCS RFID bag tags) will pass through this reader. The equipment configuration and monitoring by test personnel will be the same as in the SFO baggage delivery and sortation area.

4.2.1.5 Vancouver Airport

4.2.1.5.1 Check-In Stations

Four bag tag printers at the Alaska Airlines check-in counter will be replaced one-for-one with modified Genicom printers. The installation of the printers and the placement of the test personnel within this test area will be the same as that for the check-in stations at the PEN, MAA, SIN, and SFO airports.

4.2.1.5.2 Delivery/Sortation Area

One fixed SCS RFID reader will be installed on the delivery belt leading into this area. The reader will interface to a VC unit. There will be no other interfaces to this reader or VC.

4.2.1.5.3 Baggage Make-Up Room
In this baggage make-up room, there will be two SCS handheld RFID readers. The equipment configuration will be the same as that in the baggage make-up rooms at SIN and SFO. There will be one backup handheld reader assembly (the reader unit and its supporting data collection/control components) in this area. No installation of this equipment is required.

4.2.1.5.4 Aircraft Ramp Area

Magellan will install one of their fixed tunnel readers on a mobile ramp loader used on the aircraft ramp. This loader will be dedicated to the arriving test flights from SIN and SFO. The reader will be installed around the conveyor belt of the ramp loader. It will interface to a VC, which will be mounted on the loader.

4.2.1.5.5 International Arrivals Area (Canadian Customs)

One fixed SCS RFID reader will be installed on the delivery belt leading into this area. The reader will interface to a VC unit. There will be no other interfaces to this reader or VC.

In addition to the SCS fixed reader, a Magellan fixed reader will be placed in this area. A Magellan tunnel reader will be installed on the delivery belt leading into this area. The reader will interface to a VC. FAA test personnel will be positioned in this area so that they monitor the reader as the bags pass through it.

4.2.2 Test Resources Required

4.2.2.1 Systems Under Test

4.2.2.1.1 SCS

4.2.2.1.1.1 Bag Tag Printers (Modified)

The bag tag printers used in these operational tests will be modified versions of the standard Genicom BT201e printer currently used by the airline industry. In SFO the new Genicom 302 bag tag printer will be deployed. These units will be modified to incorporate an external SCS RFID scanner and internal antenna that will enable the printer to encode/read the SCS RFID inlays in the test tags.

The Genicom printer is a direct thermal printer for self-adhesive labels, tickets and tags. Table 4.1 contains details of the printer characteristics.

**Table 4.1 Technical Specifications for Genicom Printers**

| Genicom BT201e | |
|---|---|
| **Characteristic** | **Specification** |
| Print Speed | 4.9 ips maximum (125 mmps) |
| Print Modes | Prints text, bar codes, and dot-addressable graphics in all four directions |
| Print Resolution | 203.2 dpi (8 dpmm) |
| Memory | 1 MB standard; optional additional memory |
| Software | Fingerprint programming language; UBI LabelShop (Windows label program); Windows and Macintosh printer drivers |
| User Interface | Numeric keyboard (0-9) plus 9 function keys; LCD display 2 X 16 |
| Interfaces | RS232C or 20 mA Current Loop; 1200-19200 baud rate |
| Connectivity | XON/XOFF; ENC/ACK; RTS/CTS protocols |
| Voltage | 115 or 230 VAC, 50 or 60 Hz (switchable) |
| **Genicom BT302** | |
| Print Speed | 8 ips (200 mmps) |
| Print Modes | Prints text, bar codes, and dot-addressable graphics in all four directions |
| Print Resolution | 203.2 dpi (8 dpmm) |
| Memory | 6 MB standard; optional additional memory |
| User Interface | Numeric keyboard (0-9) plus function keys; LCD display 2 X 16 |
| Interfaces | RS232 and USB ports |
| Voltage | 90 or 264 VAC, 45 - 65 Hz (auto sensing) |
| **Characteristic** | **Specification** |
| Print Speed | 4.9 ips maximum (125 mmps) |
| Print Modes | Prints text, bar codes, and dot-addressable graphics in all four directions |
| Print Resolution | 203.2 dpi (8 dpmm) |
| Memory | 1 MB standard; optional additional memory |
| Software | Fingerprint programming language; UBI LabelShop (Windows label program); Windows and Macintosh printer drivers |
| User Interface | Numeric keyboard (0-9) plus 9 function keys; LCD display 2 X 16 |
| Interfaces | RS232C or 20 mA Current Loop; 1200-19200 baud rate |
| Connectivity | XON/XOFF; ENC/ACK; RTS/CTS protocols |
| Voltage | 115 or 230 VAC, 50 or 60 Hz (switchable) |

The printers will be modified so that they can cleanly replace the normal bag tag printers; i.e., their installation will not require any modifications to any other interfacing equipment.

4.2.2.1.1.2 Bag Tags

4.2.2.1.1.2.1 RFID Inlays

The SCS RFID inlay is a very thin, flexible RFID inlay containing an integrated circuit on which data is stored. It is read from or written to using an RF scanner, and receives its power from the transmission signal eliminating the need for a separate power source. Reading from and writing

to the RFID inlay does not require line-of-sight transmission, and the design enables near simultaneous reading of several RFID inlays at a time. Its technical specifications are summarized in Table 4.2.

**Table 4.2 Technical Specifications for the SCS RFID Inlay**

| Characteristic | Specification |
|---|---|
| RF Characteristics | ISM band (no license required), 2.45 GHz Passive RF Back-scatter |
| Read Distance | Nominal 14 inches* (35 cm) |
| Average Read Times | 1 Word (16 bits) in less than 10 ms |
| Memory | Reserved – 1 Word (16 bits), Unique Serial Code – 5 Words (16 bits)<br>User Defined – 1 Word (16 bits)<br>Factory Programmable |
| Physical Characteristics | Flexible, durable<br>Length 2.25 in (5.7 cm) Width 0.4 in (1 cm) Thickness 0.05 in (1.3 mm) |
| Operating Temperature | -5° to 176° F (-20° to 80° C) |
| Storage Temperature | -22° to 212° F (-30° to 100° C) |

* Obstructing metals, other conducting material such as water, and label orientation may significantly affect read distance. Read distance measured while material is dry using FCC Part 15 certified scanner.

4.2.2.1.1.2.2 Paper Tags

Paper bag tags manufactured by Global Ventures will be used in the testing with Alaska Airlines and paper bag tags manufactured by General Labels & Labeling Pte. Ltd. will be used in the testing with Singapore Airlines. SCS RFID inlays will be incorporated into both types of paper tags to produce self-adhesive barcode bag tags with RFID inlays embedded in them.

4.2.2.1.1.3 Handheld RFID Readers

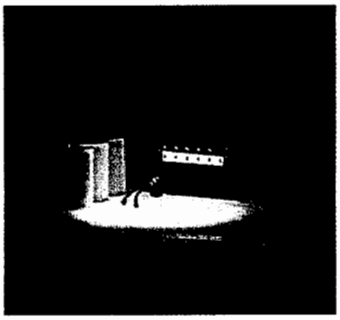
Handheld readers manufactured by SCS will be used for the testing. These handheld readers have the capability to interrogate 2.45 GHz RFID bag tags.

4.2.2.1.1.4 Fixed RFID Readers

Automatic RFID bag tag readers, supplied by SCS, will be installed on the baggage delivery and arrival systems at test sites in Singapore, San Francisco, and Vancouver. The fixed readers will consist of a scanner, which contains the reader electronics, and a series of antennas that will be placed both under and around the belts to enable reading of the bag tags in different orientations. Three types of scanners will be used during the testing. Their characteristics are shown in Figures 4.1 through 4.3.

# SCS S416 Scanner

## Location Used: Underneath Belts



| | |
|---|---|
| Nominal Physical Dimensions: | Length: 13 in (33 cm)Width: 7 in (18 cm) Height: 4.5 in (11 cm) Weight: 4.5 lbs. (2 kg) |
| Operating Temperature: | 32° F - 122° F (0° - 50° C) (non-condensing) |
| Power Requirements: | Internal Power Supply, External Cable provided 85-264 VAC, 47-63 Hz, less than 0.5 Amps |
| External Environment: | Protection from relative moisture and humidity |
| Certification: | FCC Part 15 |
| Serial Interface: | 9-pin Female RS-232 connector |
| Antenna Ports: | 6 |
| Application Program Interface: | Allows interface with host applications. Standard C interface; currently supports DOS or Windows applications. Facilitates optimized label read and write operations and provides macros for frequently used command scripts |

## System Specifications

| | |
|---|---|
| RF Characteristics: | ISM band (no license required) 2.400 - 2.483 GHz @ +28 dBm (0.7 W), using frequency-hopping spread spectrum (FHSS) |
| Read Distance: | Nominal 14 inches (35 cm)* |
| Write Distance: | Nominal 1 inch (2.5 cm)* |
| Host Interface: | RS-232 at up to 19,200 baud |
| *Obstructing metals, other conducting material and label orientation may significantly affect read and write distance. | |

## Protocol Specifications

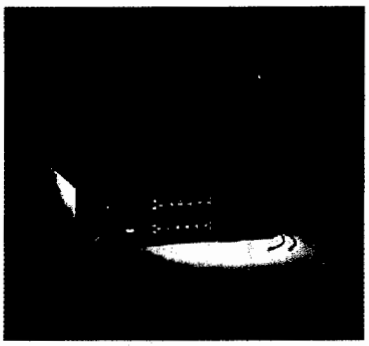
Average Read/Write Times:

| | Read | Write |
|---|---|---|
| 1 Word (16 bits) | 10ms | 200ms |
| Unique Serial Code (32 bits) | 20ms | (preprogrammed) |
| Multiple label identification (per label, 2 words): 84 ms | | |

**Figure 4.1 SCS S416 Scanner**

# SCS S456 Scanner

## Location Used: Belt Top & Sides, Tilt Tray Sortation System



| | |
|---|---|
| Nominal Physical Dimensions: | Length: 14.5 in (36.8 cm)Width: 16 in (40.6 cm) Height: 5.5 in (14.0 cm) Weight: 12 lbs. (5.5 kg) |
| Operating Temperature: | 32° F - 110° F (0° - 43° C) (non-condensing) |
| Power Requirements: | Internal Power Module, External Cable provided US: 110-125 VAC, 60 Hz |
| External Environment: | Protection from relative moisture and humidity |
| Certification: | FCC Part 90 Requires Site License |
| Serial Interface: | 9-pin RS-232 connector |
| Application Program Interface: | Allows interface with host applications. Standard C interface; currently supports DOS or Windows applications. Facilitates optimized label read and write operations and provides macros for frequently used command scripts |

## System Specifications

| | |
|---|---|
| RF Characteristics: | ISM band, 2.450-2.485GHz |
| Read Distance: | Single tag, nominal 50 inches (127 cm)* |
| Write Distance: | Nominal 3 inches (7.6 cm)* |
| Host Interface: | RS-232 at up to 19,200 baud |
| *Obstructing metals, other conducting material and label orientation may significantly affect read and write distance. | |

## Protocol Specifications

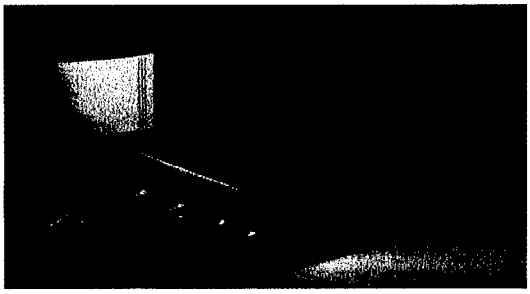
Average Read/Write Times:

| | Read | Write |
|---|---|---|
| 1 Word (16 bits) | 10ms | 200ms |
| Unique Serial Code (32 bits) | 20ms | (preprogrammed) |
| Multiple label identification (per label, 2 words): 84 ms | | |

**Figure 4.2 SCS S456 Scanner**

# SCS S512 Scanner

## Location Used: Printer



| | |
|---|---|
| Physical Dimensions: | Length: 8.0 in (20.3 cm) Width: 7.0 in (17.8 cm) Height: 2 in (5.1 cm) Weight: 2.6 lbs (1.2 kg) |
| Operating Temperature: | 32° F - 122° F (0° - 50° C) (non-condensing) |
| Power Requirements: | 7.5 Volt DC @ 2 Amp max Modular Power Supply provided for local AC |
| External Environment: | Protection from moisture and humidity |
| Certifications: | FCC Part 15 (no license required) |
| Interface: | RS-232 Serial Communication, 9-pin Female DB-9 connector, up to 57,600 baud |
| Application Program Interface: | Allows interface with host applications. Standard C interface; currently supports Windows® applications. Facilitates optimized tag read and write operations and provides macros for frequently used command scripts. |

## System Specifications

| | |
|---|---|
| RF Characteristics: | ISM band 2.400 - 2.483 GHz, Frequency-hopping Spread Spectrum (FHSS) |
| Antennas: | Supports 1 or 2 pairs of external transmit and receive antennas |
| Read Distance: | Nominal 18 inches (45 cm)*+ |
| Write Distance: | Nominal 4 inches (10 cm)*+ |
| *Obstructing metals, other conducting material and label orientation may significantly affect read and write distance.<br>+Measured using DL-100 Dura-label® | |

## Protocol Specifications

Average Read/Write Times:

| | Read | Write |
|---|---|---|
| 1 Word (16 bits) | 10ms | 200ms |
| Unique Serial Number (48 bits) | 30ms | (pre-programmed) |
| Multiple tag identification (per tag, 2 words): 40 ms | | |

**Figure 4.3 SCS S512 Scanner**

4.2.2.1.2 Magellan

4.2.2.1.2.1 Bag Tags

The Magellan RFID bag tag used in these tests will consist of their RTK-1 chip embedded in a rigid polyvinylchloride (PVC) tag. The tag is suitable for operation on high-speed conveyor belts. It can be read from or written to in the presence of multiple tags and the read/write process is not sensitive to tag orientation. The tag does not require a power source and can be read without direct contact by the reader. The characteristics of the Magellan bag tag are described in Table 4.3.

**Table 4.3 Magellan RFID Bag Tag Description**

| Characteristic | Specification |
|---|---|
| Command data rate | 8.25 kb/sec |
| Reply data rate | 33.0/16.5 kb/sec |
| Memory size | 1 kb |
| Operating Range | 1 m (max) |
| Size | 85.0 mm (3.3 in) x 54.0 mm (2.1 in) |
| Material | Rigid Laminated PVC |
| Weight | 10 gm |
| Color | white |

4.2.2.1.2.2 Magellan Fixed Readers

The Magellan Fixed Reader is an RFID read/write device that can handle multiple simultaneous tags and is not sensitive to tag orientation. Three different configurations of fixed readers will be used. The first configuration, used in the San Francisco baggage make-up area, will be the Self Check-in Tunnel Reader Programmer (SCITRP). This is a self-contained reader and belt system. The second configuration, used in the Vancouver aircraft ramp area, will be the Belt Loader Tunnel Reader Programmer (BLTRP). The BLTRP will essentially be the SCITRP turned on its side mounted on a mobile ramp loader/unloader that is used to transfer baggage between the aircraft cargo hold and the ground. The third configuration, used in the Vancouver international arrivals area, will be the Slimline Tunnel Reader Programmer (SLTRP). This reader will be installed in-line on the arrival belt. The performance characteristics of the readers are shown in Tables 4.4 and 4.5.

**Table 4.4 Magellan SCITRP and BLTRP Characteristics**

| Characteristic | Specification |
|---|---|
| Powering Field | 132 kHz |
| Reply Frequency | 2.7 – 4.7 MHz |
| Command Data Rate | 16.5/8.25 kb/sec |
| Reply Data Rate | 33/16.5 kb/sec |
| Number of Reply Channels | 8 |
| Conveyor Belt Speed | >2m/sec |
| Aperture | 0.50m x 0.80m |
| Size | 1.2m L x 0.72m W x 1.14m H |

**Table 4.5 Magellan SLTRP Reader Characteristics**

| Characteristic | Specification |
|---|---|
| Powering Field | 132 kHz |
| Reply Frequency | 2.7 – 4.7 MHz |
| Command Data Rate | 16.5/8.25 kb/sec |
| Reply Data Rate | 33/16.5 kb/sec |
| Number of Reply Channels | 8 |
| Conveyor Belt Speed | >2m/sec |
| Aperture | 1.0m x 1.0m |
| Size | 1.6m L x 1.22m W x 1.34m H |

4.2.2.2 Airport/Airline Systems

4.2.2.2.1 Conveyor Belt System

The standard conveyor belt systems that are currently used at the Singapore, San Francisco, and Vancouver Airports will be used for these tests. These belts transport the bags from the check-in stations to the baggage make-up areas in Singapore, San Francisco, and Vancouver, and to the Domestic and International Arrivals areas in San Francisco, and the International Arrivals area in Vancouver. An SCS fixed RFID Reader as described in paragraph 4.2.2.1.1.4, will be added to each of these belts to automatically read the SCS RFID bag tags.

4.2.2.2.2 Ramp Loader/Unloader

The ramp loader/unloader is a vehicle mounted conveyor belt system that can be driven to an aircraft and raised or inclined so that baggage can be transferred between the aircraft and the ground. The standard ramp loader/unloader that is currently used at the Vancouver airport will be used for these tests. A Magellan Ramp RFID Reader as described in paragraph 4.2.2.1.2.2, will be added to the ramp loader/unloader to automatically read the Magellan RFID bag tags.

4.2.2.3 Test Support System

4.2.2.3.1 Vendor Controls (VCs)

The VCs are laptop PCs with specialized software for controlling RFID readers and for data logging. Except for the Check-in Areas, the VCs will be used at all of the test sites, at the Penang, Madras, Singapore, Hong Kong, San Francisco, and Vancouver airports. SCS will develop VC software for control of the readers and logging of data for their RFID tag system, and Magellan will develop VC software for control of the readers and logging of data for their RFID tag system. Data logged by each of the VCs consists of the RFID tag's 10-digit license plate number, date, and time.

4.2.2.4 Test Personnel

4.2.2.4.1 Penang Airport

Personnel from Singapore Airlines, the FAA, and FAA support contractors will be required to perform the testing. The following criteria will be used to establish the number of each type of personnel required.

1. Check-in Site Testing
    a. Airline Personnel - Singapore Airlines will provide the number of check-in agents that are needed and would normally be used for passenger/baggage check-in for the designated flights.
    b. FAA and FAA Support Contractor Personnel - The FAA or FAA Support Contractor Personnel will act as an observer at the check-in positions, to monitor the process and record data.
2. Baggage Make-up Area Testing
    a. Airline Personnel – Singapore Airlines will provide the number of baggage handlers that are normally needed for loading the baggage onto the designated flights.
    b. FAA and FAA Support Contractor Personnel - FAA or FAA Support Contractor Personnel will perform the reading of the SCS tags using the RFID Handheld readers. The FAA or FAA Support Contractor Personnel will monitor the process and record any necessary data.

4.2.2.4.2 Madras Airport

Personnel from Singapore Airlines, the FAA, and FAA support contractors will be required to perform the testing. The following criteria will be used to establish the number of each type of personnel required.

1. Check-in Site Testing
    a. Airline Personnel - Singapore Airlines will provide the number of check-in agents that are needed and would normally be used for passenger/baggage check-in for the designated flights.
    b. FAA and FAA Support Contractor Personnel - FAA or FAA Support Contractor Personnel will act as an observer at the check-in positions, to monitor the process and record data.
2. Baggage Make-up Area Testing
    a. Airline Personnel – Singapore Airlines will provide the number of baggage handlers that are normally needed for loading the baggage onto the designated flights.
    b. FAA and FAA Support Contractor Personnel - FAA or FAA Support Contractor Personnel will perform the reading of the SCS tags using the RFID Handheld readers. The FAA or FAA Support Contractor Personnel will monitor the process and record any necessary data.

4.2.2.4.3 Singapore Airport

Personnel from Singapore Airlines, the FAA, and FAA support contractors will be required to perform the testing. The following criteria will be used to establish the number of each type of personnel required.

1. Check-in Site Testing
    a. Airline Personnel - Singapore Airlines will provide the number of check-in agents that are needed and would normally be used for passenger/baggage check-in for the designated flights.
    b. FAA and FAA Support Contractor Personnel - The FAA or FAA Support Contractor Personnel will act as observers at the check-in positions, to monitor the process and record data.
2. Delivery/Sortation Area Testing
    a. FAA and FAA Support Contractor Personnel - The FAA or FAA Support Contractor Personnel will monitor the automatic tag reading done by the Fixed RFID reader on the delivery/sortation belt, at intervals throughout the test periods, and record any necessary data.
3. Baggage Make-up Area Testing
    a. Airline Personnel – Singapore Airlines will provide the number of baggage handlers that are needed for loading baggage onto the designated flights. If needed, they will also assist in performing the reading of the SCS tags using the RFID Handheld readers.
    b. FAA and FAA Support Contractor Personnel - FAA or FAA Support Contractor Personnel will perform the reading of the SCS tags using the RFID Handheld readers. The FAA or FAA Support Contractor Personnel will also monitor the process and record any necessary data.
4. Baggage Transfer Area Testing
    a. FAA and FAA Support Contractor Personnel - The FAA or FAA Support Contractor Personnel will monitor the automatic tag reading done by the Fixed RFID reader in the baggage transfer area, at intervals throughout the test periods, and record any necessary data.

4.2.2.4.4 Hong Kong Airport

Personnel from the FAA or FAA support contractors will be required to perform the testing. They will perform the reading of the SCS tags using the RFID Handheld reader in the baggage arrivals area. They will also monitor the process and record any necessary data.

4.2.2.4.5 San Francisco Airport

Personnel from Alaska Airlines, the FAA, and FAA support contractors will be required to perform the testing. The following criteria will be used to establish the number of each type of personnel required.

1. Check-in Site Testing
    a. Airline Personnel - Alaska Airlines will provide the number of check-in agents that are needed for passenger/baggage check-in for the designated flights.
    b. FAA and FAA Support Contractor Personnel - The FAA or FAA Support Contractor Personnel will act as observers at the check-in test site, to monitor the check-in process and record data.
2. Delivery/Sortation Area Testing
    a. FAA and FAA Support Contractor Personnel - The FAA or FAA Support Contractor Personnel will monitor the automatic tag reading done by the Fixed RFID reader on the delivery/sortation belt, at intervals throughout the test periods, and record any necessary data.
3. Domestic Baggage Make-up Area Testing
    a. Airline Personnel – Alaska Airlines will provide the number of baggage handlers that are needed and would normally be used for baggage loading for the designated test flights.
    b. FAA and FAA Support Contractor Personnel - FAA or FAA Support Contractor Personnel will perform the reading of the SCS RFID tags using the RFID Handheld readers. They will also attach the Magellan RFID tags to the appropriate baggage and pass the baggage through the Magellan Fixed Reader. The FAA or FAA Support Contractor Personnel will monitor the reading of both the SCS and the Magellan RFID tags and record any necessary data.
4. Domestic Arrivals Areas Testing
    a. Personnel from the FAA, or FAA Support Contractor Personnel will monitor the automatic tag reading process of incoming bags in the Domestic Arrivals area, at intervals throughout the test periods, and record any necessary data.
5. International Arrivals Area
    a. Personnel from the FAA or FAA Support Contractor Personnel will monitor the automatic tag reading process of incoming bags in the International Arrivals Area at intervals throughout the test periods, and record any necessary data.

4.2.2.4.6 Vancouver Airport

1. Check-in Site Testing
    a. Airline Personnel - Alaska Airlines will provide the number of check-in agents that are needed for passenger/baggage check-in for the designated flights.

b. FAA and FAA Support Contractor Personnel - The FAA or FAA Support Contractor Personnel will act as observers at the check-in positions, to monitor the check-in process and record data.

2. Delivery/Sortation Area Testing

   a. FAA and FAA Support Contractor Personnel - The FAA or FAA Support Contractor Personnel will monitor the automatic tag reading done by the Fixed RFID reader on the delivery/sortation belt, at intervals throughout the test periods, and record any necessary data.

3. Baggage Make-up Area Testing

   a. Airline Personnel – Alaska Airlines will provide the normal number of baggage handlers used for loading for loading of baggage onto the designated flights.

   b. FAA and FAA Support Contractor Personnel - FAA or FAA Support Contractor Personnel will perform the reading of the SCS tags using the RFID Handheld readers. The FAA or FAA Support Contractor Personnel will also monitor the process and record data.

4. International Arrivals Area

   a. Personnel from the FAA, or FAA Support Contractor Personnel will monitor the automatic tag reading process of incoming bags, from San Francisco and Singapore, for both the SCS RFID tags and the Magellan RFID tags.

5. Aircraft Ramp Area

   a. Personnel from the FAA, or FAA Support Contractor Personnel will monitor the automatic tag reading process performed by the Magellan ramp reader as the incoming baggage from Singapore and San Francisco is unloaded from the aircraft.

### 4.3 Test and Evaluation Desc ription

The objective of this testing is to verify that RFID technology can be successfully introduced into an actual airport operational environment to perform the baggage identification, tracking and passenger match functions. This testing will incorporate:

- RFID integration with check-in systems
- RFID reading/tracking of baggage on delivery/arrival belts
- RFID reading/tracking of baggage using handheld readers
- RFID reading/tracking of baggage within the airport and on the aircraft ramp
- RFID reading/tracking of interline/transfer baggage

### 4.3.1 Evaluation Criteria

Evaluation of the RFID systems under test will be based on the following factors:

- Read rate of success
- Operator Impact

#### 4.3.1.1 Read Rate of Success

The read rate of success is a measure of the RFID system's capability to correctly read the RFID bag tags. The effective use of the RFID bag tags requires that they are able to be accurately read during normal baggage handling without slowing or hindering normal procedures in any way. Bag tag failure, or the inability to read the bag tag, could result in delays in baggage routing, misdirected baggage or lost baggage based on the integrated system concept of operation. The read rate of success will be based on the percentage of successful tag reads during the baggage sorting and tracking process. The percentage will be determined by dividing the number of successful bag tag reads by the total number of readable tags passing by the reader. The read rate will be calculated separately for each individual type of RFID reader (i.e., handheld, fixed belt, and ramp), and for each test location.

#### 4.3.1.2 Operator Impact

The operator impact is a measure of any additional functions or operations that must be performed, or any additional time that must be spent in performing the normal operations in order to accomplish RF baggage identification, tracking and reconciliation. To be successful, the RFID system should be able to effectively perform the baggage reconciliation function with minimal or no impact to the functions performed by the airline check-in and the baggage handling personnel. The extent of operator impact will be based on observations made by test personnel during the baggage check-in process, the baggage sortation process, and the RF identification of baggage during the usual baggage handling process.

### 4.3.2 Data Analysis Methods

To calculate the **read rate of success**, the test team needs the number of bag tags successfully read, in addition to the number of bag tags not successfully read. The number of bag tags (and their barcode numbers) successfully read will come from the data recorded by each RFID reader's interfacing VC. The number of bag tags (and their barcode numbers) not successfully read will come from the manual records of the test personnel indicating the number of encoded tags on bags not placed on the belt (e.g., animal containers, oversize bags, etc.), and the number of tags not read correctly by the readers. These numbers will be used to determine the read rate of success for each different read event in the test (e.g., reading with the fixed reader vs. reading with the handheld reader). The data and read rate of success for each RFID reader used will be compared to determine if there is consistency in the data. Any inconsistencies or anomalies in the data will be investigated.

RFID bag tag encoding and reading errors will be investigated in an attempt to determine the cause of the errors. The encoding errors would prove less difficult to investigate since the failed tags from the check-in site will be available for analysis. Any SCS RFID bag tags that did not read properly would not be available since the bag tags cannot be removed, and the cause of the read errors would be more difficult to ascertain.

As a final point of analysis, the test personnel's observations concerning any difficulties with system operation, delays, errors, or other factors that impacted airline/airport personnel and operations will be reviewed and analyzed in an attempt to determine their cause, and to identify possible corrective measures.

## 5. TEST MANAGEMENT ORGANIZATION

The Operational Test of vendor provided, commercially available RFID systems is to be conducted by the FAA and support contractor personnel with additional support from RFID system component vendors, and commercial airline and airport personnel.

### 5.1.1 Roles and Responsibilities

Personnel from the FAA William J. Hughes Technical Center will be responsible for conducting the testing of the RFID systems, including monitoring of the actual tests, test data acquisition, data analysis, and reporting of test results. The FAA will also supply the bag tag printers.

Vendors will provide the VC PCs required for testing, the VC software for reader control and data logging, the SCS RFID inlays for the paper bag tags, the paper bag tags, modifications to the bag tag printers to encode/print the integrated paper RFID bag tags with data, the handheld and fixed RFID bag tag readers for the SCS RFID tags, the Magellan PVC RFID bag tags, and the fixed and ramp RFID readers for the Magellan tags. Vendors will be responsible for the proper operation and maintenance of their corresponding system components, and will also provide assistance in any required troubleshooting, should system component failures occur.

Singapore and Alaska Airlines personnel will provide any information and support necessary for the interface of equipment to their systems, and for installation of the modified bag tag printers. They will perform passenger/baggage check-in functions, baggage handling functions and when required assist with gathering test data.

### 5.1.2 Test Conduct Teams

The Test Conduct Team* will consist of:

- FAA and support contractor personnel
- Singapore Airline personnel
- Alaska Airline personnel

* RFID vendor personnel will be available at the test sites to provide assistance only in the event of equipment failure or malfunction.

The roles and responsibilities of the test conduct team are as described in paragraph 5.1.1.

## 5.2 System Configuration Management

Any modifications that may be required to the RFID system under test from its original configuration, prior to completion of all testing for that system, will be documented. Portions of the testing affected by the modifications may be repeated to verify any changes in the test data that may have resulted from those modifications.

## 5.3 Operational Test Entry Criteria

Prior to the start of operational testing, the following items must be operational and qualified for operational test:

- RFID Bag Tags, both SCS and Magellan
- Modified Bag Tag Printers
- RFID Handheld Readers for the SCS RFID bag tags
- Fixed RFID Readers for the SCS RFID bag tags
- Fixed RFID readers for the Magellan RFID bag tags
- Ramp RFID reader for the Magellan RFID bag tags
- VC software

Each vendor must supply sufficient quantities of these items, along with information describing system installation and operation. Insufficient quantities of system hardware, non-operational hardware or software, or the lack of system installation and operation information may result in insufficient or incorrect test data or failure of the system to meet operational requirements.

## 5.4 Operational Test Execution

All test personnel shall review the test procedures so that they understand the tests that will be performed, how they will be performed, and what data will be collected. The vendor-supplied RFID system components will be installed as directed in the system installation and operation information provided by each vendor, and their operation verified.

Airline and airport personnel who participate in the testing will be briefed on their roles as well as on the operation of that portion of the RFID system that they will be using.

Testing will be performed in accordance with test procedures described in Appendix A. Any apparent abnormalities observed in data recording, test operation, or the recorded data will be investigated to determine the cause, and a determination will be made by the Test Coordinator as to whether a re-test is required.

## 5.5 Operational Test Exit Criteria

The criteria for successfully completing the operational test will be the determination, based on the test results, that the RFID systems under test are able to effectively and reliably accomplish the baggage identification and tracking functions in the airport environment. If any of the systems fail to meet the established criteria, the Test Coordinator shall make a decision as to whether to allow the system to be included in any further testing (if re-testing is needed) or whether the system failed and cannot meet the criteria.

## 5.6 Operational Test Reports

Upon completion of the operational testing, an Operational Test Report will be developed. The report will detail the results of the operational tests and describe the systems tested, the test schedule and location, the participants, the test objectives, test configuration, the test execution, the hardware and software interfaces, and the data collection and analysis methodology.

## 5.7 System/Operational Deficiency Reports

Should any system deficiencies or failures occur, the vendors will be notified and will be responsible for the repair, replacement, or maintenance of their respective systems. 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 operation of the systems, which are uncovered as a result of testing, will be documented in the Operational Test Report.

## 5.8 Operational Test Schedule

The following test schedule is in effect at the time of publication of this document.

| Event | Start Date |
|---|---|
| Begin equipment modification, software development, and qualification testing | 2/14/2000 |
| Begin equipment installation | 4/4/2000 |
| Begin Operational Test | 4/8/2000 |
| Complete Operational Test | 4/13/2000 |
| Complete equipment de-installation | 4/16/2000 |

## 5.9 Planning Considerations and Limitations

The overriding consideration when conducting the tests is to ensure that the test activities do not impact the normal airline/airport operations. Test personnel are to act as monitors and data collectors only, once testing has begun.

# APPENDIX A
# TEST PROCEDURES

## A.1 CHECK-IN PROCEDURE (MAA, PEN, SIN, SFO, AND YVR)

### A.1.1 Objective

The objectives of this test are:

1. To verify that RFID bag tags can be successfully and reliably encoded, printed and attached to baggage with no adverse impact to the current airline baggage check-in procedures.

2. To verify the reliable tracking of baggage from check-in through the arrival process using RFID.

### A.1.2 Check-in Site Test Procedures

1. The modified bag tag printers will have been installed at designated check-in stations at all five airports. The assigned FAA personnel or their designated agent will load each printer with RFID bag tag stock prior to the start of testing.
2. Singapore and Alaska Airlines personnel will perform normal passenger/baggage check-in procedures and print RFID bag tags using the modified bag tag printers. They will then attach the RFID bag tags to baggage as it is checked in. If RF encoding fails, a visual indication (RF VOID) will be printed on the bag tag.
3. Singapore and Alaska Airlines personnel and/or FAA or FAA support personnel will collect any failed bag tags. FAA or FAA support contractor personnel will record the following information on the back of the tag:
   - Time/Date
   - Printer Station
   - Brief description of the failure
4. Singapore and Alaska Airlines personnel and/or FAA or FAA support contractor personnel will collect any RFID bag tags that were printed but never used.
5. FAA or FAA support contractor personnel will monitor the baggage check-in process. During check-in, they will record the following data:
   - Manual count of the total number of valid RFID bag tags issued and <u>not</u> placed on delivery belt (oversize, animal cages, re-booked, etc.)
   - Any errors encountered in printing RFID bag tags
   - Any difficulties encountered with system operation
   - Any observed problems experienced by airline personnel in performing check-in procedures
   - Any observed delays in the check-in process as a result of system operation
   - Any other factors related to the use of the RFID system which affect the check-in process

## A.2 DELIVERY/SORTATION AREA PROCEDURES (SIN, SFO, AND YVR)

### A.2.1 Objective

The objectives of this test are:

1. To verify that the RFID bag tags can be read dynamically, during the baggage delivery/sortation process using Fixed RFID Readers, and that the RFID bag tags will withstand the normal rigors of baggage handling during the delivery/sortation process.
2. To verify the reliable tracking of baggage from check-in through the arrival process using RFID.

### A2.2 Delivery/Sortation Area Test Procedures

1. The Fixed RFID Readers, each with a VC, will have been installed on the delivery/sortation belts at the Singapore, San Francisco, and Vancouver airports only. All of the Fixed RFID Readers will be operational prior to the start of testing.
2. Prior to reaching the final make-up belt, the Fixed RFID Readers will automatically read each RFID bag tag, as it passes through the readers. The VCs will record the RFID bag tag data from the Fixed RFID Readers.
3. FAA or FAA support contractor personnel will monitor the automatic RFID bag tag reading process at intervals during the test flights. FAA or FAA support contractor personnel will record the following data:
   - Any difficulties encountered with system operation
   - Any impact resulting from the use of the RFID system
   - Any other factors related to the use of the RFID system which affect the baggage sortation process
4. At the end of each day, FAA test personnel will download, from their VCs, the data file of bag tags read by the Fixed RFID Readers. This will be used for later analysis of the test data.

## A.3 BAGGAGE MAKE-UP AREA PROCEDURES (PEN, MAA, SIN, SFO, AND YVR)

### A.3.1 Objective

The objectives of this test are:

1. To verify that the Handheld RFID Readers and the RFID bag tags will withstand the normal rigors of baggage handling without failure.

2. To verify that the Magellan RFID bag tags can be read dynamically, during the baggage make-up process using the Magellan Fixed Reader.

3. To verify the reliable tracking of baggage from check-in through the arrival process using RFID.

### A.3.2 Baggage Make-up Area Test Procedures

1. The Handheld RFID Readers, each with a VC, will have been installed in the designated baggage make-up areas at the Penang, Madras, Singapore, San Francisco, and Vancouver airports only. The Magellan Fixed Reader with a VC will have been installed in the designated baggage make-up area at San Francisco only. All of these readers will be operational prior to the start of testing.

2. Singapore and Alaska Airlines personnel will perform normal baggage handling procedures at their respective airports. In addition, FAA test personnel, or their designated agents, will read each RFID bag tag using a Handheld RFID Reader. When the trigger on the Handheld RFID reader is pulled and held, a red LED will light. The red LED will go off as the reader is held near the tag and a successful read has been taken. If the red LED stays on, a read failure has occurred. In that case, the trigger on the RFID Handheld reader can be released, and normal processing of the bag will continue without any further reads. The Handheld RFID Readers will be connected to VCs. The VCs will record the RFID bag tag data from the Handheld RFID Readers.

3. In the San Francisco Baggage Make-up Room only, FAA test personnel will attach Magellan RFID tags to all bags going to Vancouver. These bags will then be passed through the Magellan Fixed Reader. The Magellan Fixed reader will be connected to a VC, which will record the RFID bag tag data as it is read.

4. FAA or FAA support contractor personnel will monitor the Baggage Make-up Room process including the Handheld RFID Reader, and the Magellan Fixed Reader operation. During the Baggage Make-up processing, the following data will be recorded:

    - License Plate of any RFID bag tag that could not be read by the Handheld Reader
    - License Plate of any RFID bag tag that was not read at all by the Handheld Reader due to any alternate handling procedures for that particular bag

- Manual count of the total number of bags with test tags sent through the Magellan Fixed Reader
- Any read errors resulting from the inability of the handheld RFID reader to read the RFID bag tag
- Any read errors resulting from erroneous readings by the handheld RFID reader
- Any difficulties encountered with system operation
- Any operator impact resulting from the use of the RFID system
- Any other factors related to the use of the RFID system, which affect the baggage make-up process

5. At the end of each day, FAA test personnel will download, from their VCs, the data file of RFID bag tags read by the Handheld RFID Readers, and the Magellan Fixed Reader. This will be used for later analysis of the test data.

## A.4 BAGGAGE TRANSFER AREA PROCEDURES (SIN)

### A.4.1 Objective

The objectives of this test are:

1. To verify that the RFID bag tags can be read dynamically, during the baggage transfer process using Fixed RFID Readers, and the RFID bag tags will withstand the normal rigors of baggage handling during the transfer process.

2. To verify the reliable tracking of baggage from check-in through the arrival process using RFID.

### A.4.2 Baggage Transfer Area Test Procedures

1. The Fixed RFID Readers, with VCs, will have been installed in the baggage transfer area in Singapore, and will be operational prior to the start of testing.

2. Airline personnel will perform normal baggage handling procedures during the transfer process. The Fixed RFID Readers will automatically read each RFID bag tag, as it passes through the readers. The VCs will record the RFID bag tag data from the Fixed RFID Readers.

3. FAA or FAA support contractor personnel will monitor the automatic RFID bag tag reading process at intervals during the test flights. FAA or FAA support contractor personnel will record the following data:
   - Any difficulties encountered with system operation
   - Any impact resulting from the use of the RFID system
   - Any other factors related to the use of the RFID system which affect the baggage transfer process

4. At the end of each day, FAA test personnel will download, from the VCs, the data file of RFID bag tags read by the Fixed RFID Readers. This will be used for later analysis of the test data.

## A.5 BAGGAGE ARRIVALS AREA PROCEDURES (HKG)

### A.5.1 Objective

The objectives of this test are:

1. To verify that the Handheld RFID Readers and the RFID bag tags will withstand the normal rigors of baggage handling without failure.

2. To verify the reliable tracking of baggage from check-in through the arrival process using RFID.

### A.5.2 Baggage Arrivals Area Test Procedures

1. A Handheld RFID Reader, with a VC, will have been installed in the designated baggage arrivals area at the Hong Kong airport. The reader will be operational prior to the start of testing.

2. Singapore Airlines personnel will perform normal baggage handling procedures. In addition, FAA test personnel, or their designated agents, will read each RFID bag tag using a Handheld RFID Reader. When the trigger on the Handheld RFID reader is pulled and held, a red LED will light. The red LED will go off as the reader is held near the tag and a successful read has been taken. If the red LED stays on, a read failure has occurred. In that case, the trigger on the RFID Handheld reader can be released, and normal processing of the bag will continue without any further reads. The Handheld RFID Reader will be connected to a VC. The VC will record the RFID bag tag data from the Handheld RFID Readers.

3. FAA or FAA support contractor personnel will monitor the Baggage Arrivals Area process and will record the following data:

    - License Plate of any RFID bag tag that could not be read by the Handheld Reader
    - License Plate of any RFID bag tag that was not read at all by the Handheld Reader due to any alternate handling procedures for that particular bag
    - Any read errors resulting from the inability of the handheld RFID reader to read the RFID bag tag
    - Any read errors resulting from erroneous readings by the handheld RFID reader
    - Any difficulties encountered with system operation
    - Any operator impact resulting from the use of the RFID system
    - Any other factors related to the use of the RFID system, which affect the handling process

4. At the end of each day, FAA test personnel will download, from the VC, the data file of RFID bag tags read by the Handheld RFID Reader. This will be used for later analysis of the test data.

## A.6 DOMESTIC ARRIVALS AREA PROCEDURES (SFO)

### A.6.1 Objective

The objectives of this test are:

1. To verify that the RFID bag tags can be read dynamically, during the baggage arrival process using Fixed RFID Readers, and the RFID bag tags will withstand the normal rigors of baggage handling during the arrival process.

2. To verify the reliable tracking of baggage from check-in through the arrival process using RFID.

### A.6.2 Domestic Arrivals Test Procedures

1. The Fixed RFID Readers, with VCs, will have been installed in the domestic arrival area in San Francisco only, and will be operational prior to the start of testing.

2. Airline personnel will perform normal baggage handling procedures during the arrival process. The Fixed RFID Readers will automatically read each RFID bag tag, as it passes through the readers. The VCs will record the RFID bag tag data from the Fixed RFID Readers.

3. FAA or FAA support contractor personnel will monitor the automatic RFID bag tag reading process at intervals during the test flights. FAA or FAA support contractor personnel will record the following data:
   - Any difficulties encountered with system operation
   - Any impact resulting from the use of the RFID system
   - Any other factors related to the use of the RFID system which affect the baggage transfer process

4. At the end of each day, FAA test personnel will download, from the VCs, the data file of RFID bag tags read by the Fixed RFID Readers This will be used for later analysis of the test data.

## A.7 INTERNATIONAL ARRIVALS AREA PROCEDURES (SFO AND YVR)

### A.7.1 Objective

The objectives of this test are:

1. To verify that the RFID bag tags can be read dynamically, during the baggage arrival process using Fixed RFID Readers, and that the RFID bag tags will withstand the normal rigors of baggage handling during the arrival process.

2. To verify that the Magellan RFID bag tags can be read dynamically, during the baggage arrival process using a Magellan Fixed Reader, and that the RFID bag tags will withstand the normal rigors of baggage handling during the arrival process.

3. To verify the reliable tracking of baggage from check-in through the arrival process using RFID.

### A.7.2 International Arrivals Test Procedures

1. Fixed RFID Readers, with VCs, will have been installed at the International Arrivals Area at San Francisco and Vancouver, and will be operational prior to the start of testing.

2. In addition, the Magellan Fixed Reader, with a VC, will have been installed at the International Arrivals Area at Vancouver only, and will be operational prior to the start of testing.

3. Airline personnel will perform normal baggage handling procedures during the arrival process. The Fixed RFID Readers will automatically read each RFID bag tag, as it passes through the readers. The VCs will record the RFID bag tag data from the Fixed RFID Readers.

4. FAA or FAA support contractor personnel will monitor the automatic RFID bag tag reading process at both airports at intervals during the test flights. FAA or FAA support contractor personnel will record the following data:
   - Any difficulties encountered with system operation
   - Any impact resulting from the use of the RFID system
   - Any other factors related to the use of the RFID system which affect the baggage transfer process

5. At the end of each day, FAA test personnel will download, from their VCs, the data files of RFID bag tags read by all readers. This will be used for later analysis of the test data.

## A.8 AIRCRAFT RAMP PROCEDURES (YVR)

### A.8.1 Objective

The objectives of this test are:

1. To verify that the Magellan RFID bag tags can be read dynamically, during the baggage unloading process, using a Magellan Fixed Reader, and that the RFID bag tags will withstand the normal rigors of baggage handling during the unloading process.

2. To verify the reliable tracking of baggage from check-in through the arrival process using RFID.

### A.8.2 Aircraft Ramp Test Procedures

1. The Magellan Fixed Reader and VC will have been installed on the designated ramp loader, and will be operational prior to the start of testing.

2. Airline personnel will perform normal baggage handling procedures at the aircraft ramp. The Magellan Fixed Reader will automatically read the RFID bag tags as the bags are unloaded from the aircraft and move down the ramp. The VC will record the RFID bag tag data from the Fixed Reader.

3. FAA or FAA support contractor personnel will monitor the unloading process. During the unloading processing, the following data will be recorded:
   - Any difficulties encountered with system operation
   - Any operator impact resulting from the use of the RFID system
   - Any other factors related to the use of the RFID system, which affect the baggage handling process

4. At the end of each day, FAA test personnel will download, from the interfacing VC, the data file of Magellan RFID bag tags read at the aircraft ramp. This will be used for later analysis of the test data.

# APPENDIX B

# DATA COLLECTION FORM

**PHASE IID RFID OPERATIONAL TEST**
**SINGAPORE & ALASKA AIRLINES TRIAL**

# GENERAL DATA COLLECTION FORM

*(Record any problems, anomalies or delays)*

| | |
|---|---|
| **Incident No.**<br>**Incident Type***<br>**Date/Time** \| **Location**<br>**Flight No.**<br>**Tag No.** (if Tag incident) | **DETAILS** |
| **Incident No.**<br>**Incident Type***<br>**Date/Time** \| **Location**<br>**Flight No.**<br>**Tag No.** (if Tag incident) | **DETAILS** |
| **Incident No.**<br>**Incident Type***<br>**Date/Time** \| **Location**<br>**Flight No.**<br>**Tag No.** (if Tag incident) | **DETAILS** |

* Incident Type
B = Belt Reader (SCS)
O = Operator
T = Tag
H = Handheld Reader (SCS)
P = Printer
V = Vendor Control (VC)
M = Miscellaneous / Other
S = BRS
L = Mobile Reader (Magellan)