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Test and Evaluation of the Integrated RFID Baggage Handling System at San Francisco International Airport - Quick Look Test Report

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Final Report

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16. Abstract

A Test and Evaluation of the integrated Radio Frequency Identification (RFID) Baggage Handling Systems (BHS) was conducted at the San Francisco International Airport (SFIA) on May 1-2, 2001. The system is installed in the new International Terminal. This report is a preliminary summary of the results of this test.

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2. SYSTEM DESCRIPTION

The system configuration is shown in Figure 1. The RFID system is used to route selectee baggage to the required security equipment for inspection. The first components of the system are located at the check-in counters. The check-in counters are equipped with SCS Corporation S512 Reader/Programmers. Each check-in counter has an RFID antenna mounted underneath the counter and connected to an S512 Reader/Programmer.

The TagTrak Baggage Reconciliation System (BRS) provided by Ultra Electronics is also integrated into the system.

If the check-in system indicates that a passenger has been designated as a selectee, the following occurs:

1. The check-in agent prints the passenger's standard baggage tag.
2. The agent scans the barcode located on the baggage tag and places an RFID Security Tag in the designated antenna area at the check-in counter.
3. The RFID Security Tag is then automatically programmed with the bag's barcode number, flight number and check-in sequence number.
4. The BRS issues a "STOP" message against the bag.
5. The baggage tag and the RFID Security Tag are then affixed to the bag and the bag is placed onto the conveyor belt leading into the BHS.

Until the "STOP" message is cleared indicating that the bag has gone through the proper inspection procedures, the BRS will give an indication that the bag is not authorized to load.

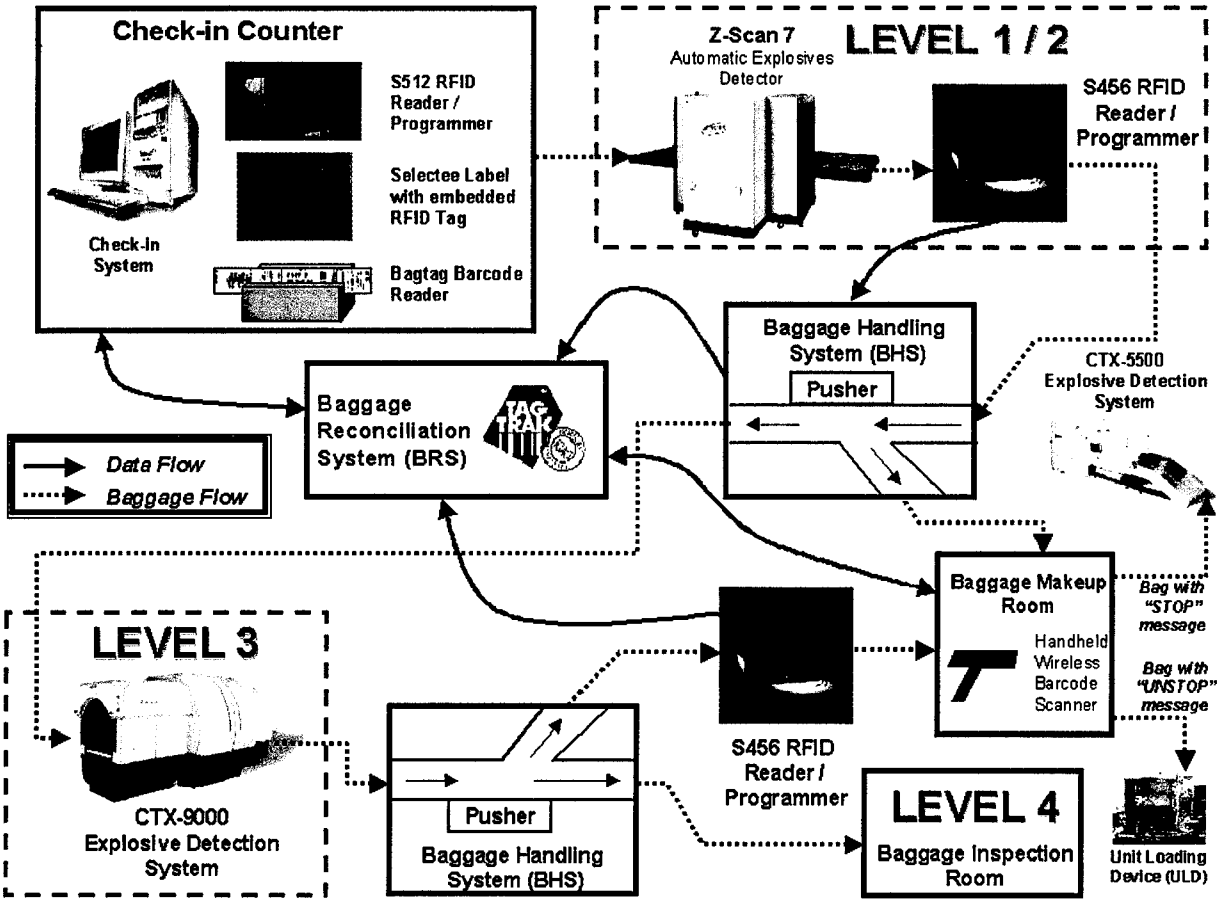

FIGURE 1. BAGGAGE HANDLING SYSTEM CONFIGURATION - SFIA (INTERNATIONAL TERMINAL

There are four security inspection levels through which a bag may pass. The first inspection area is LEVEL 1. This inspection area consists of a Z-Scan 7 Automatic Explosives Detector (x-ray device) integrated into the BHS. The Z-Scan 7 does an automatic inspection of the bag. If the automatic inspection finds something questionable and designates the bag as suspect, a LEVEL 2 inspection is done on the bag. This consists of using the Z-Scan in an interactive operator driven mode. If a bag is still considered suspect after a LEVEL 2 inspection, the bag is automatically routed to LEVEL 3. All checked baggage is routed through the LEVEL 1 inspection area (i.e. 100% of checked baggage is X-rayed). In the case of a selectee bag, after leaving the Z-Scan the bag is automatically routed to the LEVEL 3 inspection area regardless of the LEVEL 1/2 results. This automatic routing is accomplished using an SCS S456 RFID Reader/Programmer located downline from each Z-Scan. If the SCS S456 RFID Reader/Programmer reads an RFID tag it notifies the BHS to route the bag to the LEVEL 3 inspection area.

The third inspection area is LEVEL 3. This inspection area consists of a CTX-9000 Explosive Detection System (EDS), developed by InVision Technologies Incorporated, integrated into the BHS. The CTX-9000 is a revolving, multiple cross-section scanning machine similar to a medical CAT scan machine. Multiple cross-sections of the target object are scanned. A

computer assembles the resulting images to display numerous different views of the object being examined. After inspection by the CTX-9000, the bag is either cleared or remains suspect. If the bag is cleared by the CTX operator, the BHS routes/pushes the bag onto the belt leading to the Baggage Make-up Room. An SCS S456 RFID Reader/Programmer is located on the belt leading to the Baggage Make-up Room. When the RFID Reader/Programmer reads the RFID Security Tag the bag tag number is sent to the BRS and the BRS issues an "UNSTOP" message against that bag. If the bag is still considered suspect the bag is routed to the final inspection area, LEVEL 4 (Baggage Inspection Room). LEVEL 4 inspection consists of a manual bag search and a test for trace explosives. If after the LEVEL 4 inspection the bag is considered cleared, an authorized supervisor can issue an "UNSTOP" message against the bag in the BRS and the bag can then be sent to the Baggage Make-up Room.

Upon reaching the Baggage Make-up Room, each bag is scanned using a wireless handheld barcode scanner. The handheld scanner is linked to the BRS. The handheld scanner will indicate whether or not a bag is authorized to be loaded. If the bag is a selectee bag and the "UNSTOP" message has not been issued against the bag, the handheld scanner will indicate that the bag has not cleared security and must be hand carried to the CTX-5500 for inspection. The BRS provides a safety net for the system. If for some reason the RFID Reader/Programmer fails to read the RFID Security Tag on a selectee bag and/or the BHS mishandles the bag, the bag will not be routed to the proper inspection area. In this case the "UNSTOP" message will not be issued and the handheld scanner will not allow the bag to be loaded. In addition the BRS eliminates the need for manual baggage reconciliation.

The following are the companies providing the equipment and services to SFIA:

Baggage Handling Systems - BAE Automated Systems
BRS System / System Integration- Ultra Electronics
RFID Systems - SCS Corporation

3. TEST AND EVALUATION RESULTS

Table 1 provides the test and evaluation results. The test was conducted on 4 flights over a two-day period. The test used actual passenger baggage. Sixty non-selectee passenger bags were selected from each flight. The bags were treated as actual selectee bags and the procedure for selectee bags described in the Introduction and System Description was applied to each of these bags. The bags were monitored throughout the system to insure that they reached the proper inspection points. Test personnel were also stationed along the BHS to physically sight the test bags and record whether or not they reached the proper inspection area. After each test, data was downloaded from the individual RFID Reader/Programmers and the BRS.

TABLE 1. TEST AND EVALUATION RESULTS

Date	Flight	Check-In RFID Security Tags *ENCODED / SENT*	RFID Security Tags *READ / RECEIVED* LEVEL 1/2	RFID Security Tags *READ / RECEIVED* LEVEL 3	Make-up Room Load Status
05/01/2001	MX0975	60 / 60	60 / 60	58 / 58 *(Note 1)*	56 ATL * 2 NOT ATL
05/01/2001	BR0027	60 / 60	60 / 60	60 / 60	60 ATL
05/02/2001	BA0284	60 / 59 *(Note 2)*	58 / 59 *(Note 3)*	56 / 56 *(Note 4)*	56 ATL 3 NOT ATL
05/02/2001	UA0805	56 / 56	56 / 56	56 / 56	56 ATL

RFID Reader Overall Read Rate LEVEL 1/2 + LEVEL 3: (Total RFID tags read / Total read attempts)	***464 / 465 (99.8 %)***

NOTES:

1. 2 bags read correctly by LEVEL 1 RFID Reader/Programmer were mishandled by BHS ** and not sent to LEVEL 3.
2. 1 bag encoded at check-in was not sent (Passenger did not fly.).
3. 1 bag not read (missed) by LEVEL 1 RFID Reader/Programmer (not sent to LEVEL 3).
   1 bag read correctly by LEVEL 1 RFID Reader/Programmer was mishandled by BHS and not sent to LEVEL 3.
4. 1 bag sent to LEVEL 3 was physically removed prior to reaching LEVEL 3 RFID Reader/Programmer (oversize.)

** ATL = Authorized to Load ** BHS = Baggage Handling System*

The RFID portion of the BHS provided for an overall read rate of 99.8%. Only one bag out of 465 sent through an RFID Reader/Programmer was not read. Table 1 shows that three bags that were read properly at the RFID array were subsequently mishandled by the BHS. The final report will provide further analysis of the causes of these mishandled bags.

The evaluation of the system as a whole indicates that it can successfully and reliably perform the function of routing selectee baggage to the proper inspection areas. The system provides for an effective safety net (BRS), preventing bags missed by an RFID Reader/Programmer or mishandled by the BHS from being loaded onto the aircraft. The BRS also provides an effective automated process for reconciling baggage, thereby eliminating the need for manual reconciliation and the errors associated with it.

A Performance Verification Test (PVT) was conducted by SFIA in February 2001 to validate the system performance and to formally accept the system. If available, the data from the PVT will be included as a supplement in the Final Report that will follow this Quick Look Report.