Final Report

Smart Storeroom Phase II

RFID and RFDC Demonstration
Aboard
USS NORMANDY (CG-60)

22 March 2002

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ACRONYMS

ADMIN	Administration
AE	Apportioned Effort
AIS	Automated Information System
AIT	Automatic Identification Technology
ASDOF	Afloat Supply Department of the Future
ATAC	Advanced Traceability and Control Program
BCA	Business Case Analysis
BPA	Business Processing Analysis
CD	Compact Disk
CINCLANTFLT	Commander-in-Chief, U.S Atlantic Fleet
CNO	Chief of Naval Operations
CO	Contracting Officer
COG	Cognizance
COMNAVSUPSYSCOM	Commander, Naval Supply Command
COMNAVSURFLANT	Commander, Naval Surface Force, Atlantic
CONREP	Connected Replenishment
COSAL	Consolidated Ship's Allowance List
COTS	Commercial-Off-The-Shelf
DLR	Depot Level Repairables
DoD	Department of Defense
DRID	Defense Reform Initiative Directive
DTO	Direct Turnover
EDVR	Enlisted Data Verification Report
EIRP	Effective Isotropic Radiated Power
EMC	Electromagnetic Compatibility
ERP	Effective Radiated Power
ERP	Enterprise Resource Planning
FACTS	Fleet Automated Control Tracking System
FISC	Fleet Industrial Supply Center
FOSSAC	Fitting Out & Supply Support Assistance Center
FSA	Fleet Support Activity
FTE	Full-time Equivalent
FY	Fiscal Year
GAO	General Accounting Office
HAZMIN	Hazardous Waste Minimization Program
HERO	Hazards of Electromagnetic Radiation to Ordnance
HICS	Hazardous Item Control System
HNA	Host Nation Approval
IBS	Integrated Barcode System
ID	Identification
IDTC	Inter-Deployment Training Cycle
IHD	Indian Head Division
IRRD	Issue, Release, Receipt, Documents
JFMO	Joint Frequency Management Office

JMFOLANT	Joint Frequency Management Office, Atlantic
LAMPS	Light Airborne Multipurpose System
LAN	Local Area Network
LCAV	Logistics Customer Asset Visibility
LCPO	Leading Chief Petty Officer
MAF	Maintenance Action Form
MHE	Material Handling Equipment
MILHDBK	Military Handbook
MILSTD	Military Standard
MILSTRIP	Military Standard Requisition and Issue Procedures
NAVICP	Naval Inventory Control Point
NAVSEA	Naval Sea Systems Command
NAVSUP	Naval Supply Systems Command
NAWCAD	Naval Air Warfare Center Aircraft Division
NEC	Naval Enlisted Classification Code
NMCI	Navy Marine Corp Intranet
NSN	National Stock Number
NWCF	Navy Working Capital Fund
OMMS	Organizational Maintenance Management System
OSHA	Occupational Safety and Health Administration
PC	Personal Computer
POM	Program Objective Memorandum
RF	Radio Frequency
RFDC	Radio Frequency Data Collection
RFI	Ready for Issue
RFID	Radio Frequency Identification
ROI	Return on Investment
ROLMS	Retail Ordnance Logistics Management System
ROM	Retail Operations Management
RPPO	Repair Parts Petty Officer
RSUPPLY	Relational Supply
SAC	Special Accounting Class
SALTS	Standard Automated Logistics Tool Set
SFM	Supply Financial Management
SK	Store Keeper
SNAP	Standard Non-Tactical Automated Data Processing
SOW	Statement of Work
SPAWARSYSCEN	Space and Naval Warfare Systems Center, Chesapeake
SUADPS	Shipboard Uniform Automated Data Processing System
SUPADD	Supplementary Address
SUPPO	Supply Officer
TAC	Tactical Advanced Computer
TAV	Total Asset Visibility
UIC	Unit Identification Code
UPC	Universal Product Code
VERTREP	Vertical Replenishment

PREFACE

This work was supported by the Naval Supply Systems Command (NAVSUP), Mechanicsburg, PA, as part of the Afloat Supply Department of the Future (ASDOF) initiative.

Acknowledgements

The following people were involved in the preparation, conduct and analysis of this demonstration.

The ship test team consisted of Mr. John Hopkins, Naval Air Warfare Center Aircraft Division (NAWCAD) St. Inigoes/BAE Systems Inc., Mr. Jay Cerow, NAVSEA Indian Head/Logmation, Mr. Anthony Mansfield and Mr. Rob Dryer, NAVSEA Indian Head.

Ms. Sandy Butler, Ms. Deanna Hall and Mr. Larry Nosek, all of NAWCAD St. Inigoes/BAE Systems Inc. performed environmental and electromagnetic compatibility (EMC) tests.

Unsparing support was provided aboard ship by LCDR Scott Gehring, USN, SUPPO; SKCS Gary Duncan, USN, LCPO; and all ship's crew with whom our test team came in contact.

Mr. Rich Sheaffer, NAVSUP ASDOF Program Manager, provided valuable assistance during both phases of this concept exploration. CAPT Steve Romano and Ms. Lillian Greico provided the leadership necessary during the development and progress of this project.

Finally, thanks to RDML William Maguire for his early guidance and direction and emphasizing NAVSUP's commitment to exploring new technologies to improve Naval supply processes.

EXECUTIVE SUMMARY

The SMART Storeroom project began in response to the CNO directive to NAVSUP to pursue incorporation of RF technologies as a long-term afloat inventory management solution. Successful results of this project will provide crucial information for ascertaining the merits of using Radio Frequency (RF) devices as part of the Afloat Supply Department of the Future (ASDOF) program's objectives.

Radio-frequency identification (RFID) systems and radio-frequency data collection systems (RFDC) technologies are experiencing rapid growth in private industry as a result of improvements in performance, reductions in cost, and increasing industry appreciation of the benefits of Automatic Identification Technology (AIT) in providing Total Asset Visibility (TAV). The use of RFID and RFDC systems provide near-real-time inventory system updates while significantly reducing the possibilities for human errors by nearly eliminating the requirement for manual data entry of inventory information into the computer databases during receipt, stow, issue, and inventory processing.

In addition to the technology demonstration, a business process analysis was conducted and additional process enhancement recommendations are provided. As demonstrated during this phase, each RF hardware system functions well within the shipboard environment. This demonstration adopted the philosophy of taking advantage of existing AIT-AIS interfaces wherever possible.

The RF emitter system enhances tracking high-dollar, high-visibility assets. Its primary benefit is providing a hands-free total asset visibility solution for designated material. The RFDC system enhances management of stock and direct turnover material using existing and future barcode technology. RFDC systems can be used in either an RF or non-RF mode. The RF systems are extremely effective and efficient. Their insertion will significantly enhance inventory accuracy while facilitating improved manpower allocation.

1.0 INTRODUCTION

Smart Storeroom is an initiative of the Afloat Supply Department of the Future (ASDOF) and is in response to the Chief of Naval Operation's (CNO) Inter-Deployment Training Cycle (IDTC) workload reductions and Defense Reform Initiative Directive (DRID) #54 strategic objectives. In NAVOP 8/99, 182252Z Oct 99, IDTC Workload Reduction Year End Status Report, NAVSUP was directed to "pursue incorporation of RF technology as a long term afloat inventory management solution," because "this technology has the potential to dramatically reduce, if not eliminate, the need for physical inventories."

The plan for Smart Storeroom is to attach radio frequency identification (RFID) tags on Depot Level Repairable (DLR) and high dollar consumable spare parts. These new tags, used in conjunction with Radio Frequency Data Collection (RFDC), bar codes, and other Automatic Identification Technology (AIT), will significantly reduce the workload involved in the storeroom functions of receipt, issue, stowage, location audit, and physical inventory, while increasing inventory accuracy. This reduced workload will return valuable discretionary time to the commanding officers. As the manning levels onboard ships continue to decrease and new "smart ships" are being designed for minimum sized crews, it is essential for the warfighter that initiatives, like Smart Storeroom, are successfully deployed.

Radio-frequency identification (RFID) systems – non-contact, non-optical identification systems using small radio frequency "tags" and readers – and radio-frequency data capture (RFDC) systems – barcode scanners with RF links to computers – offer the potential for improved accuracy in inventory control compared with traditional manual methods. Both of these technologies are experiencing very rapid growth in private industry as a result of improvements in performance, reductions in cost, and increasing industry appreciation of the benefits of the benefits of automated inventory technology (AIT). RFID offers the possibility of totally automatic inventory control – real-time knowledge of what is in a storeroom, what has been issued, and what has been received. RFDC, while requiring manual operation of the scanner, offers the possibility of error-free entry of inventory information into computer databases without a wire connection.

An Environmental Proof of Concept (Phase I) was conducted in Fall of 2000. Two demonstrations took place on ex-USS America and USS Harry S Truman to prove whether RFID and RFDC systems would perform effectively in an afloat marine environment. There were two major concerns that were addressed. First was the reflective nature of ship structures that result in multipath propagation and signal nulls. Second was interference with and from shipboard electronics systems. These demonstrations clearly proved the feasibility of using RF technology in a shipboard environment. Results of this demonstration are available from the Smart Storeroom project manager.

With Phase I showing that RF technology would be viable in the afloat environment, the Operational Proof of Concept was launched as Phase II. This demonstration is to assess the ability to integrate RFID and RFDC technologies into shipboard supply processes. This report documents the findings of this demonstration and recommends what a Smart Storeroom is.

2.0 BUSINESS PROCESS ANALYSIS

2.1 Background

In performing research for the Naval Supply Systems Command (NAVSUP) Afloat Supply Department of the Future (ASDOF) Smart Storeroom initiative, it is necessary to observe the current processes, functions and manning of afloat supply departments stock control (S-1) divisions. The size of a Stock Control Division varies by the size and mission of the ship embarked on. The Stock Control Division onboard a fast attack submarine may consist of only two personnel, while stock control functions onboard a nuclear powered aircraft carrier may be performed by over 100 personnel in three separate divisions.

The Ticonderoga-class of Guided Missile Cruiser is considered a representative platform, with many similarities to other platforms, (i.e. Destroyers, Frigates, and Amphibious Landing Ships) especially when considering weapons systems supported, manning, and use of Automated Information Systems.

The USS Normandy (CG 60), a Ticonderoga-class Guided Missile Cruiser based at Naval Station Norfolk Virginia was selected as a platform for observation and testing. Representatives from the Naval Air Warfare Center Aircraft Division, St. Inigoes, and Naval Surface Warfare Center, Indian Head observed processes and interviewed personnel onboard USS Normandy from 29 October through 2 November 2001.

2.2 Manpower

2.2.1 Eleven Storekeepers assigned to perform issue and receipt of materials, accounting, report generation, and other tasks needed for functioning of division.

- E-8/SKCS 1 (Duncan) *
- E-6/SK1 1 (Baxter) *
- E-5/SK2 4 (Black, Broyles, Aguirre, Surratt) **
- E-4/SK3 3 (Turner, Denton, Kimmey)
- E-3/SKSN 2 (DeLeon, Ross)

* One of these personnel is required to have the 2820 SNAP II/III SFM Supervisor Naval Enlisted Classification Code (NEC).

** Two of these personnel are required to have the 2813 SNAP II/III SFM Journeyman User Naval Enlisted Classification Code (NEC).

2.2.2 No non-designated personnel, one person (SK3 Kimmey) is presently assigned to FSA duties. One person (SK2 Aguirre) is permanently assigned to the LAMPS det when embarked. It is noted that according to the Enlisted Data Verification Report (EDVR), the Stock Control Division is manned at 100 percent of billets authorized. It is a common occurrence for ships of this type to be manned at less than 100 percent of billets authorized. There are documented instances where a Ticonderoga-class stock control division has operated with as few as eight Storekeepers onboard.

- E-5/IT2 1 Snap Administrator (Patterson)

2.2.3 IT2 Patterson was the only person assigned to operate the SNAP system onboard USS Normandy. One other person is cross-trained to operate the system in the event that IT2 Patterson is absent from the ship. This could be an issue should an unprogrammed loss take place.

2.2.4 S-1 Stock Control Division is responsible for material support of the ship, including stocking of materials, purchase and procurement of items for stock and direct turnover, issue of materials to customers, and financial reporting to internal work centers and external activities.

2.2.5 S-5 HAZMIN is responsible for maintaining inventory, issuing, reclamation and disposal of materials designated as "hazardous." It is manned with non-supply personnel. The division maintains and operates the Hazardous Item Control System (HICS) used for management of hazardous materials. The HICS software is based on a stand alone PC and does not interface with SNAP.

2.3 Current use of Automated Information Systems

USS Normandy currently uses the Standard Non-Tactical Automated Data Processing (SNAP) II System to record personnel; manpower, material, and financial transactions related to the ships operations. SNAP is divided into modules that manage different types of information. SNAP ADMIN manages Human Resource information, SNAP MAINTENANCE tracks and accounts for work performed to ship systems, and allows technicians to identify failed material and initiate requisitions for material. SNAP Supply Financial Management (SFM) performs inventory and financial management of the items found in the ship's Consolidated Ship's Allowance List (COSAL) which are authorized spare parts stored to repair or replace weapons systems onboard the ship. Supply personnel use SFM to process requisitions initiated within the SNAP Maintenance module.

2.4 Current use of Automatic Information Technology (AIT)

2.4.1 The Stock Control (S-1) division currently uses no form of AIT in day-to-day operations. However, it is noted that most stowage locations are identified with linear bar codes for each separate location. This suggests that some form of AIT has been attempted onboard USS Normandy. Interviews with crewmembers indicate that USS Normandy at one time did possess bar code scanners. However, due to problems in use, lack of training, and reliability of these scanners, their use was discontinued. There are currently no scanners onboard.

2.4.2 The Sales (S-3) division that manages the ships store for retail sales uses the Retail Operations Management (ROM II) System to record transactions in the Ships retail stores and vending machines related to sales, inventory and re-order of commodities stored and sold for individual use. Symbol 5500 scanners are used to read Universal Product Code (UPC) bar codes.

2.4.3 The Hazardous Material (S-5) division operates the Hazardous Inventory Control System (HICS) that identifies materials by linear bar code labels on container packaging. Information stored in this system relates to proper use, disposal, and safety information for commodities carried onboard USS Normandy identified as hazardous materials.

2.5 As-Is Processes

2.5.1 Receipts

1. Pallets delivered to pier via mechanized material handling equipment (MHE).
2. Breakdown of pallets by Storekeepers (SK's).
3. SK's sort into Direct Turnover (DTO) and Stock categories:
    - Validate by screening Supplementary Address and Project/Priority Code.
    - If customer information is not visible via SuppAdd or Project/Priority, then requisition number must be validated against requisition record in SNAP.
    - Depot Level Repairable DTO materials were not turned over on the pier due to the need to verify retrograde turn in with the appropriate division/work center repair parts petty officer.
    - Some items are differentiated by document series; (i.e. the 7000 series of document serial numbers was used strictly for consumable items supporting the LAMPS helicopter detachment.
4. Load smaller material into mailbags.
5. Bring material onboard ship (no material handling equipment observed in use).
6. Unload mail sacks in Main Issue storeroom.
7. Segregate materials by stock or DTO.
8. Segregate stock materials by storeroom.
9. Process for stowage in location (stock) or place in customer bins (DTO) after verification of DD1348 and SNAP (if DD1348-1A documentation is insufficient to identify whether the material is stock or DTO.)
10. Validate material with requisition (look for visible damage, a Ready for Issue (RFI) Tag for Depot Level Repairables (DLR), NSN of material matches NSN information on documentation, quantity matches DD1348 quantity. Any discrepancies between material and DD1348 documentation should be noted on DD1348 at this time.); circle quantity, note location, date and sign.

11. Post receipt/stowage/DTO info into SNAP.

2.5.2 Inventory

1. Request a Storeroom Inventory Listing in SNAP specifying range of locations to be counted, sorted by Location sequence.
2. Assign personnel to count materials in range of locations.
3. Count material in location, specifying NSN and quantity found in that location, transcribing items and quantities counted to inventory listing. NSN's found in locations specified, but not appearing on the Inventory Listing will have NSN and quantity hand noted on the listing.
4. Validate inventory-listing quantity counted to quantity reflected on SNAP database. This is done by entering the count information for each NSN into SNAP. Upon completion of count, enter a list of any discrepancies produced by SNAP.
5. Perform causative research on discrepancies.
6. Reconcile differences.
7. Perform cleanup of data (i.e. survey's, process non-completed transactions) from data obtained from causative research.
8. Post final counts.
9. Complete inventory.

2.5.3 Material Issue

1. Technician identifies failed material.
2. Technician initiates material request in SNAP.
3. Requisition prints on mechanized DD 1250 in Supply S-1 Stock Control.
4. Supply performs technical edit and verification of DD1250 information.
5. Check for material availability in SNAP.
6. If material is carried onboard, location is determined and material is broken out for issue to customer.
7. Customer is notified of material availability.
8. Customer signs for receipt of material.
9. Issue of material is posted in SNAP.
10. (Optional) Re-Order of Stock if funds are available.

2.5.4 Direct Turnover (DTO)

1. Technician identifies failed material.
2. Technician initiates material request in SNAP.
3. Requisition prints on mechanized DD 1250 in Supply S-1 Stock Control.
4. Supply performs technical edit and verification of DD1250 information.
5. Check for material availability in SNAP.
6. Supply assigns a Requisition Number.
7. Requisition is passed off ship to Point of Embarkation.

2.6 Findings

There are several areas noted where the use of Automatic Data Collection can be employed to reduce manpower, most notably within the receiving, DTO, Stowage, and Inventory processes.

2.6.1 Receiving, DTO and Storage:

2.6.1.1 Currently, material is divided on the pier or in the hangar bay (underway) into categories of DTO and Stock. Supply personnel differentiate this by visually screening the Supplementary Address and project code of the DD1348. However, this does not prove to be a reliable indicator of whether the material is in stock or DTO. Several samples revealed documents with missing information or Unit Identification Codes (UIC) from supplying units. Also, the project codes used for stock material (EE0) are visually similar to the project code used for most DTO materials (EK5). Fourteen of 75 documents processed on 30 October were observed to fall into this category, which caused supply technicians to research these requisitions in SNAP SFM to verify whether these items were DTO or stock. Larger afloat units that utilize the SNAP I systems (Relational Supply – FORCE or Shipboard Uniform Automated Data Processing System SUADPS) use separate documents for stock and DTO material. Specific document series are assigned to each supported division. Following this practice would lessen the need to resort to query of the AIS system to determine disposition of newly received material, and speed processing of the receiving processes.

2.6.1.2 Supply personnel attempt to deliver all DTO items on the pier, but a number of items are brought into the main issue storeroom for either further screening or to be placed in bins awaiting customers to pick up the material. It is noted that all 7 Cog Depot Level Repairables for DTO were brought into supply department spaces before turnover. This was so supply personnel could ensure that customers comply with the one for one retrograde turn-in policy. Once supply personnel verified receipt of the retrograde, the DTO was turned over to the customer. However, no processing of the receipt documentation was processed until after the customer signed for delivery of the item. Several DTO items, both DLR's and consumable repair parts, were observed to sit in customer delivery bins for several days awaiting pickup by the designated customers. Since nothing had been processed within the AIS, there was no visibility within SNAP or a report of items on board, to notify the customers of material availability.

2.6.1.3 Over 95% of storeroom locations are identified with bar codes and 71 of 75 items received on 30 October were accompanied by bar coded DD1348-1A documentation. Using AIT to record turnover and storage of items for further transfer to the AIT would have saved the manpower of two individuals that key punched each receipt into SNAP over a period of two hours.

2.6.1.4 **Conclusion:** A significant amount of time is utilized in determining the disposition of received materials, moving it to processing area's, stowing material, and turning it over to customers. Materials can actually be onboard for hours or even days with virtually zero visibility. Insertion of an automatic data collection capability whether by RFID, RFDC, or compact disk (CD) into the initial receipt process would significantly enhance material visibility and receipt processing timeframes.

2.6.2 Issue:

2.6.2.1 Materials issued from stocks onboard the ship are issued using an automated DD1250 produced on a dot-matrix printer on the SNAP system. The DD1250 is not currently configured to take advantage of bar code technology.

2.6.2.2 When a requisition is created, the head of family NSN is assigned to the stock number blocks. This is known as the Prime NSN. Almost all Prime NSN's have several substitute NSN's that can be issued in lieu of the prime. However, when issuing a substitute NSN, that number must be manually inserted in place of the prime to properly document the transaction. Use of AIT to enhance this documentation would make issue of material much more efficient.

2.6.2.3 Also the requisition number assigned by SNAP for internal issues differs from the requisition number assigned if the requisition is passed off ship. A request for material originated by a ship customer would include the divisional ID number, four digit Julian date, and a three digit serial number. It appears like this: 0E021300-001. If the requirement is passed off ship, it might appear like this: V21449-1300-A001. Use of two different requisition numbers at times confuses the customers tracking their requirements, especially those unsure of whether their requirement was passed off ship or not.

2.6.2.4 **Conclusion:** It is recommended that either the DD-1250 be modified to accommodate bar code information, or the use of bar code DD1348-1A for issue of materials be inserted. The AIS would need modification to permit the printing of substitute NSN's and their locations to speed processing of material issues.

2.6.3 Inventory:

2.6.3.1 Currently supply personnel count material in location using listing provided by SNAP. This is provided in location sequence. Supply personnel count each item in location and record the NSN and quantity by hand for each item found in the range of locations. Once finished with the listing, each item is recorded by hand in SNAP. SNAP then produces a discrepancy listing of items that do not match inventory quantity or location records. Supply personnel use this listing to conduct recounts in these locations, and as an aid for causative research in reconciling discrepancies. AIT would be a great aid to the inventory process by scanning the bar codes on the material in the locations and the bar codes of the locations themselves. The information collected by the scanners could be quickly loaded to SNAP via a software interface to post counts and identify discrepancies, instead of key punching each record by hand into the SNAP AIS.

2.6.3.2 **Conclusion:** Use of an AIT enhanced Inventory process where supply personnel could scan materials in locations would greatly reduce data collection times, while improving data accuracy. Use of AIT could include ability to create a discrepancy list, post second count information, and be used to post inventory adjustment information (gains or losses) with accompanying survey information (below NAVSUP thresholds of $100 dollars).

2.7 Summary

2.7.1 Insertion of an AIT solution can be quickly and economically provided to enhance the receiving and stowing process. Over 95 percent of items being received are accompanied by DD1348-1A documentation with bar codes, and virtually all stowage locations are identified by linear bar code. Only minor modification of the existing AIS would be required.

2.7.2 An Inventory function exists to a limited degree with the SFM AIS, but the current process doubles the workload required for performing inventories and requires multiple inputs of data. It is recommended that the AIS be modified to accept the full functionality of inventory functions from an AIT application; count comparisons, inventory adjustments, location additions, and surveys, that the AIS allows.

2.7.3 To insert AIT functionality into the issue process would require major modifications to the AIS and current business process. It requires changes to the current document numbering system and forms utilized to accomplish this. At this time, it is not feasible to insert AIT into the issue process.

3.0 SUITABILITY AND ENVIRONMENTAL ANALYSIS

At present, there have been few formal studies or evaluations to determine if RFID/RFDC systems could be exploited in a shipboard environment. The purpose of the suitability and environmental assessments is to build on the Phase I demonstrations to further refine RF technology's fitness onboard U.S. Naval ships.

The suitability tests include mutual interference assessment, propagation tests in VIDMAR cabinets, ship interference assessment, ship layout and RFID placement determination, and environmental tests.

The Navy AIT Lab at the Naval Air Warfare Center Aircraft Division, St. Inigoes, Maryland, conducted these tests. The test results are located in Appendix D.

4.0 BUSINESS PROCESS DEMONSTRATION

A business process demonstration was held in order to prove the concept of a Smart Storeroom. In this demonstration, three prototype systems were taken onboard a cruiser for a two-week study of their effectiveness. The ship's supply operations of receipt, stow, issue, and inventory were mirrored by the demonstration team using the three prototype systems. This demonstration took place in Norfolk onboard USS Normandy CG 60 during from 29 October through 9 November 2001. The results of this demonstration are in the section 5.0, Demonstration Results.

5.0 DEMONSTRATION RESULTS

5.1. RFID Shipboard Test Results

5.1.1 Introduction

Tests were conducted onboard *USS Normandy* (CG 60) to show the operation of an active Radio Frequency Identification (RFID) system (global and portal capability) and an inductive RFID system (portal only). The tests were conducted over a four-day period during which ship stores moved throughout the ship. Two storerooms were used during the tests, Depot Level Repair (DLR) Storeroom and the Main Issue Storeroom. The active system was used in both storerooms while the inductive system was used only in the Main Issue. A "master" database was used to combine the information from both systems to provide a location history for the item or tell if the item was in the storeroom.

5.1.2 DLR Storeroom

The DLR storeroom has 242 items in its inventory. Only larger DLR items are stored in the DLR Storeroom. Initially, 102 of 242 total items were tagged and placed in various locations inside and outside of the packages. One reader was placed inside the storeroom and one reader was placed in the passageway outside the storeroom. Two portals were setup outside the storeroom to detect tagged items moving into and out of the storeroom. On 5 NOV 01, a tagged receipt was moved into the storeroom bringing the total tags to 103. The tag was activated by the portals and picked up by the readers. All 103 tags were detected every day during the demonstration using the test configuration of only one reader in the storeroom. On 8 NOV 01, one tagged DLR and 4 additional tags were brought into the storeroom for demonstration purposes. The check-in portal captured all signals and the beacons were also captured by the system (108 total). The results of the test proved 100% visibility of the items assigned tags in the DLR storeroom.

During receipt processing on the pier on 5 NOV 01, all receipted items were assigned inductive tags (67 total). In addition, four DLR's (included in the 67 total) were assigned emitter tags. The receiving process required all received items to be staged in the Main Storeroom for further distribution. Three of the four emitter tag signals were captured at the "check-in" portal in the Main Storeroom and 66 of the 67 inductive tag signals were captured by the handheld reader. The missing item was a large DLR one of the SK's took directly to the DLR Storeroom. The emitter tag assigned to that DLR was captured by the check-in portal outside the DLR Storeroom entrance and logged in the emitter system database inside the DLR Storeroom. Had the system portal been connected to the emitter system in the Main Storeroom, the capture of the missing DLR tag's signal would have been logged on that system.

5.1.3 Main Issue Storeroom

The Main Issue storeroom is split into two sides, an A-side and B-side. VIDMAR cabinets line the walls with smaller bulk items stored on shelves above the cabinets. Forty-nine tags were randomly assigned to items placed in the VIDMAR drawers and shelves. Two readers were placed in the corners of the B-side of the storeroom. With the two readers in the corners 37 tags were detected with 76 percent visibility. Twelve tags in the middle of the B-side were not detected and it was determined that the readers placement at the corners were unable to detect the tags in the middle of the test area. A third reader (separate from the main system) was placed between the 2 readers. The third reader detected an additional 10 tags. Forty-seven of forty-nine tags were detected with three readers used; resulting in 96 percent visibility in the main issue storeroom.
The tag signals of the three DLR's received on 6 NOV 02 were also captured in the emitter system database; first by the portal and then the periodic beacons. One DLR was issued that evening, so the tag was removed. One DLR was stowed in the VIDMAR cabinets and the third was moved to the DLR Storeroom on 8 NOV 01. The check-out portal captured the tag departure from the Main Storeroom and was captured by the check-in portal at the DLR Storeroom.

The check-in activator was placed next to the entrance and the checkout activator was placed above the exit. All items that passed by the check-in and check-out activators were detected.

Thirty-eight passive tags were assigned to items in divisional Repair Parts Petty Officer (RPPO) boxes. The handheld RFID reader detected all 38 tags when the supply department issued the items to the divisional RPPO's. One hundred percent visibility was attained using the handheld RFID reader.

5.1.4 Database

The database was created with Microsoft Access. The information from the active and passive systems was stored in various formats and a master database was needed to combine the information. The database provided a location history of any tagged item.

5.1.5 Conclusion

The tests during the demonstration showed that both active and inductive/passive RFID systems are capable of providing a reliable inventory of items in a shipboard storeroom. VIDMAR cabinets provide the most problems with the active tags due to possible shielding inside the metal drawers and requiring a complicated site survey to determine the coverage areas in the storeroom. Since the read/write capability was not used in the application of the inductive system, it is considered more cost-effective to utilize the RFDC system rather than the RFID inductive system. More research is required to determine the most effective use of the inductive/passive tags.

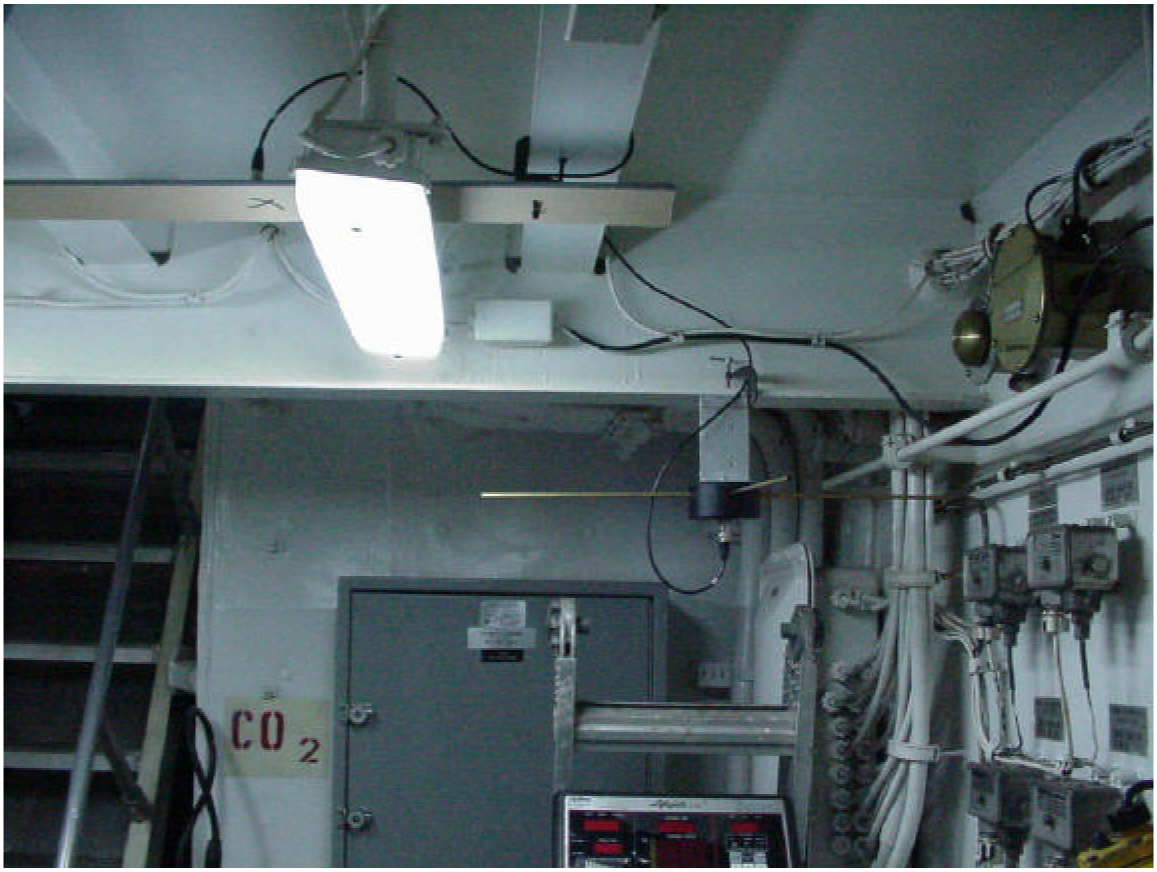

Figure 5.1 DLR Storeroom Reader

Figure 5.2 DLR Storeroom Check-out Activator

Figure 5.3 DLR Storeroom Check-in Activator

Figure 5.4 Main Issue Check-in Activator


Figure 5.5 Main Issue Check-out Activator

Figure 5.6 Main Issue Reader

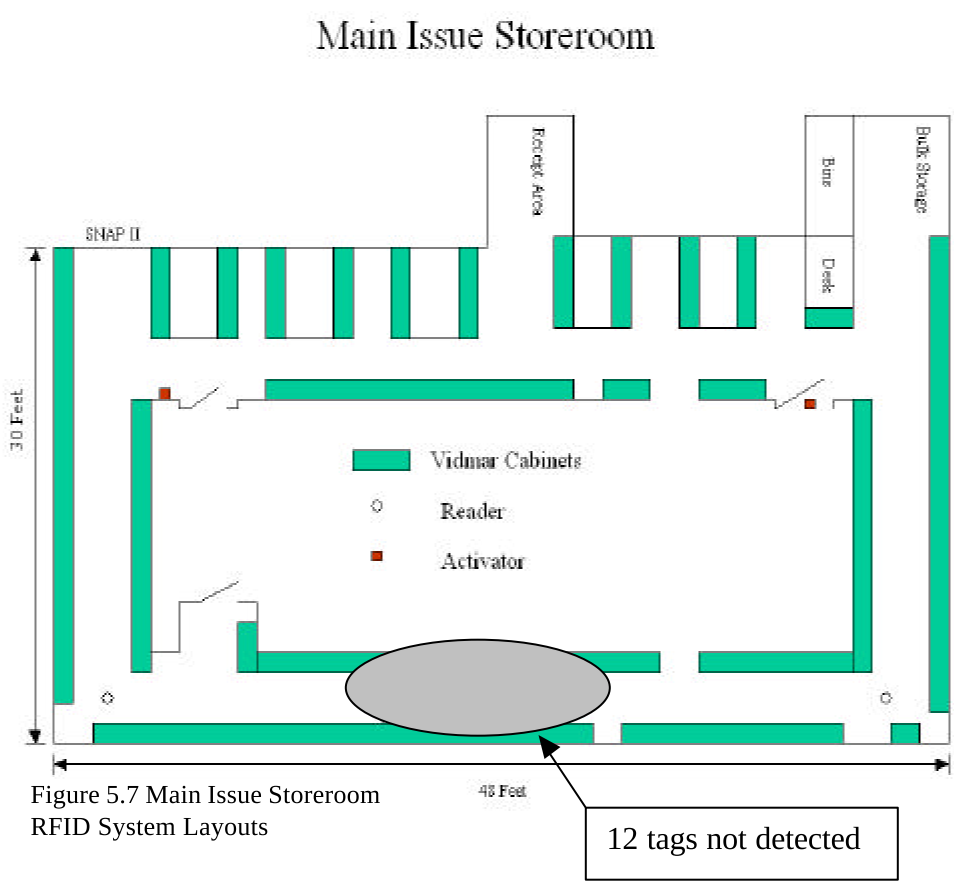

Figure 5.7 Main Issue Storeroom
RFID System Layouts

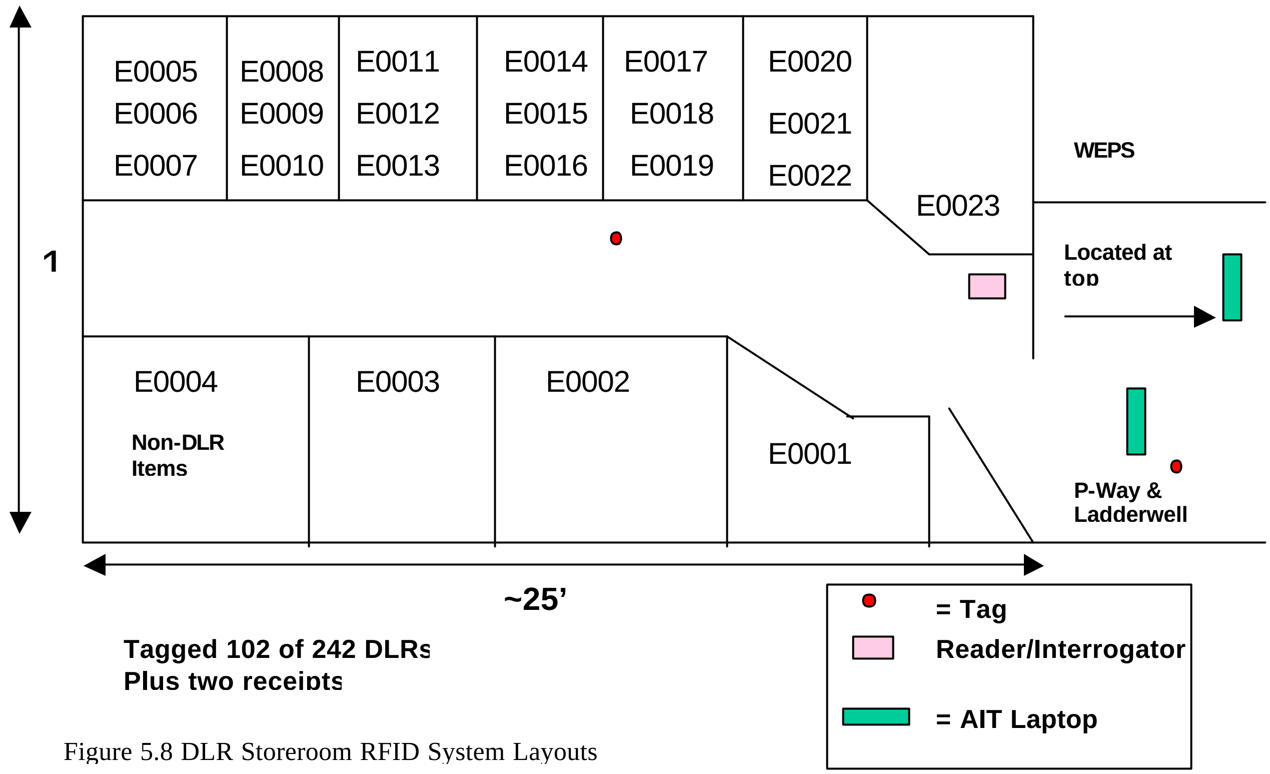

Figure 5.8 DLR Storeroom RFID System Layouts

5.2 RFDC Shipboard Test Results

5.2.1 Background

Radio-frequency identification (RFID) systems and radio-frequency data collection systems (RFDC) offer the potential for improved accuracy in inventory control compared with traditional manual methods. Both of these technologies are experiencing rapid growth in private industry as a result of improvements in performance, reductions in cost, and increasing industry appreciation of the benefits of Automatic Identification Technology (AIT) in providing Total Asset Visibility (TAV).

RFDC offers the possibility of error free entry of inventory information into computer databases without a wire connection. Despite the potential of AIT, the application of these systems in the fleet has not always been successful. This is due to difficulty in use, lack of training, or lack of understanding of the technical issues on the part of end users.

It is the intention of this demonstration to assess the performance of RFDC technology to operate in the demanding environment of a United States Navy warship. It is not our intention to select a product or system for immediate introduction to the Fleet, but to assess the performance of RFDC technology onboard a warship for potential future shipboard use.

This demonstration of RFDC technology was conducted onboard USS Normandy from 5 through 9 November 2001, while berthed at Naval Station Norfolk, Virginia. This demonstration concentrated upon showing the potential for use of RFDC in conducting receiving, Direct Turnover (DTO), and storage processes within the Supply Department.

5.2.2 Findings from the Business Process Analysis (BPA)

In order to determine where AIT may be inserted, it was necessary to perform a Business Process Analysis (BPA) of the "As-Is" processes. The USS Normandy Supply Department and Stock Control (S-1) Division were selected as atypical for purposes of this study. The BPA took place on board USS Normandy from 29 October through 2 November 2001.

The USS Normandy uses the Standard Non-Tactical Automated Data Processing (SNAP) III Automated Information System for processing three major applications, Supply Financial Management (SFM), Organizational Maintenance Management System (OMMS), and Personnel Administration (ADMIN). The SNAP III System utilizes hardware known as the Tactical Advanced Computer (TAC) system. The TAC systems use a UNIX-based operating system that allows legacy COBOL applications to be run or ported, on TAC hardware. The Storekeepers who work in the Stock Control Division onboard USS Normandy primarily use the SFM application in order to manage inventory, perform issue and receipt of stocked allowance materials, track requisitions for replenishment of stock and Direct Turnover (DTO) to customers, and perform financial reporting.

While the AIS systems are used constantly, there is currently no use of Automatic Information Technology (AIT) to feed the SNAP SFM AIS application onboard USS Normandy. Most transactions are performed through manual input of data directly into the AIS. However, there are some functions that are automated. Requisition status update processing is performed by import of a text file into the SFM application database. Also, information used to add, delete, or update Consolidated Shipboard Allowance List (COSAL) materials are performed by the import of text files. The ship's stock control personnel routinely perform batch status import processing. Other database loads and updates are performed with instruction and oftentimes on-site assistance and supervision from Type Commander or SPAWARSYSCEN representatives, due to their size and complexity.

However, the USS Normandy Stock Control Division is positioned to take advantage of AIT technology should a system be identified for installation. USS Normandy currently has the capability and equipment on-hand to print linear barcode labels. They have used this capability to affix linear barcode labels identifying over 95 percent of stock locations. The non-bar-coded stock locations could be identified and marked with linear barcode labels in less than one day's time. Given that the majority of materials received aboard are accompanied by DD1348-1A documentation with linear barcodes and most locations already marked, USS Normandy could incorporate an AIT enhanced receipt, turnover, and stowage system similar to SPAWARSYSCEN's Integrated Bar Code System (IBS) with only minor modifications to current business processes.

Currently the USS Normandy has extremely limited visibility of receipted materials onboard ship that is undergoing processing. This visibility is limited to visual indications such as materials in designated receipt processing areas or in customer bins awaiting turnover. Current practice is to not post receipt records into the AIS until the material is stowed in location or signed for by the DTO customer. DTO materials were observed to wait for several days for customer pickup, while other stock control personnel were working to expedite delivery of these "outstanding" requirements whose receipt onboard had not been updated in the AIS system. Use of an AIT system, with or without radio frequency capabilities, would enhance the visibility of materials within the receipt process.

5.2.3 Areas of AIT Insertion

The Navy AIT Lab developed a handheld application that captures information from bar-coded DD1348-1A Issue, Release, Receipt Documents (IRRD). The information captured is coded in linear barcode format and contains the Requisition Number, National Stock Number, Routing Identifier, Unit of Issue, Quantity, Cognizance Code, Condition Code, and Unit Price. For Direct Turnover (DTO) requisitions, customer identification information needs to be collected, while stowage location information is needed for stock replenishment documents. Customer ID information could be obtained from bar code information on the back of military identification cards, while stowage location can be obtained from linear barcode labels affixed to each storage location. By scanning each receipt on the pier or other receiving area, USS Normandy could obtain critical logistical information that could be used to direct work efforts or more efficiently plan job tasking and assignments.

5.2.4 Hardware/Software

The equipment used for the demonstration consisted of one Symbol PDT 7240 hand held Radio Frequency scanner, Symbol CRD 7200 Cradle, Symbol AP 3021 Access Point Antenna, and a Sony VAIO laptop computer. The PDT 7240 scanner was programmed to scan linear barcode information found on DD1348-1A Issue, Release/Receipt Documents. The scanner transfers the information collected via radio frequency to the Access Point antenna, which is connected to the VAIO laptop. The information was transferred from the hand held scanners to the laptop PC via MCL Link. The information was then collected by a Microsoft Access application developed to collect data from the DD1348-1A documents and show visibility of materials received from off the ship that are awaiting either stowage into a storeroom location or turnover to shipboard customers.

5.2.5 AIT-enhanced Business Process Demonstration

On 5 November, 115 items were received from the Fleet Industrial Supply Center and delivered to Pier 24 at Naval Station Norfolk Virginia, where the USS Normandy was berthed. The laptop computer and access point antenna were located at the quarterdeck within the skin of the ship, but with the watertight hatch dogged in an open position. Using the PDT 7240 Scanner on the pier, information from all scanned DD1348-1A receipt documents was transferred via Radio Frequency to the Access Point antenna.

Of the items received, the Symbol PDT 7240 scanner collected 90 requisitions and the data was transferred to the laptop computer. Of the receipts not collected by the handheld nine were due to only having DD1387 Military Shipping Labels (MSL) on the packaging. The DD1387 only identifies the Transportation Control Number vice the Requisition Number. Military Shipping Labels do not contain data concerning the National Stock Number (NSN), price, quantity, activity providing the material or other data required by the AIS for receipt processing. Ten other receipts on DD1348-1A's could not be completely scanned due to being printed on Heat Thermal Imaging paper. On these particular documents the bar code information on line three tended to bleed together, rendering the bar-coded information unreadable. These particular items originated from the Defense Logistics Depot New Cumberland Susquehanna PA. Two other items originated from Raytheon that had facsimile DD1348-1A documentation. These two items had Requisition Number and National Stock Number information bar coded, but the data required for identifying Routing Identifier, Cognizance Code, Unit of Issue, Condition Code and Quantity was not. The PDT7240 handheld device was programmed to capture receipt information via hand input touching the screen. However, hand input of receipts took an average of 50 seconds per receipt compared to 8 seconds per receipt scanning.

For storeroom DTO and stowage, the hardware was relocated into the Main Issue Storeroom. This storeroom surrounded enclosed office space and ladder vestibules that allowed access into the space. The PDT 7240 was able to transfer data to the access point antenna from all points within the main issue storeroom. To take advantage of this system's Radio Frequency capabilities, access point antennas would need to be installed in each supply storeroom and connected to the ship's LAN to facilitate transfer of data to a desktop application or SNAP. During the storage process for stock items, 55 receipts were stowed into locations within Supply Department storerooms. The receipts were posted by scanning bar code information from the actual DD1348-1A receipts and the bar code labels affixed to each location. Locations could be scanned on the first attempt, for all 55 items stowed into locations on 5 November.

The 55 stock requisitions with bar-coded DD1348-1A documents were stowed and the storage information was ready for transfer to the Supply SNAP AIS in less than 90 minutes after the material arrived in the main issue storeroom. This time includes processing and actual physical stowage. This was over two hours before the actual receipts had been manually posted into SNAP by duty section storekeepers. Each receipt took an average of five minutes each to process. This was accomplished by accessing the record in the SNAP AIS, validating the information on the DD1348 and the Basic Requisition File record, and key punching in the information from the DD1348 into the

SNAP AIS. The validation of information on the DD1348-1A with the actual material received had been performed twice, at the receiving area on the pier and when the material was turned over or stowed. If the AIT system could flag error conditions (i.e. incorrect quantity of material, incompatible substitute received) prior to turnover or stowage, this could allow management personnel to initiate Supply Discrepancy Report procedures and take corrective action much sooner, and prevent the inadvertent stowage and/or issue of this material.

During the DTO process, 44 separate DTO transactions were captured by scanning the bar-coded information on the DD1348-1A and simulated Identification cards to identify whose material was delivered. These were used in lieu of capturing actual Social Security Number information stored on the back of Military Identification Cards, due to Privacy Act concerns. Thirty-eight of the transactions captured were from items received on 5 November, six other turn over receipts were captured that had received prior to 5 November and had not yet been turned over to Repair Parts Petty Officers. Earlier identification of these items could have resulted in more expedient delivery to customers, who then could have completed work actions that were pending receipt of these materials. It is unknown how long each item had been onboard prior to the BPA.

NAWCAD personnel validated information on the Access database, obtainedfrom the 90 DD1348-1A's processed on 5 November, with the actual DD1348 receipts on 6 and 7 November. No discrepancies were noted between the information collected via the handheld scanner, and the information printed upon the documents.

The RFDC enhanced demonstration of receipt, turn over, and stowage was performed for several individuals representing interested commands. These persons were CAPT Toledo and CWO4 Collins, FISC Norfolk Customer Operations; CAPT (select) Romano, Mr. Daniel Olson, and Mr. John Titzel, COMNAVSUPSYSCOM; Mac McKracherne, CINCLANTFLT AIT; LCDR Dowell, SKCS Williams, SKC Raggiani, and SKC Fultz, COMNAVSURFLANT N412; and LCDR Gehring, SKCS Duncan, SK1 Baker and other Stock Control personnel, USS NORMANDY. USS Normandy Stock Control personnel commented positively about the RFDC demonstration, stating that such a device or devices would increase productivity by increased accuracy of data, and reducing man-hours required to process receipt and stow documents. Fleet representatives gave the RFID emitter system the thumbs-up and both the Commanding Officer and Supply Officer requested the emitter system be left onboard to support their imminent Supply Management Inspection. All recognized tailored suites of RF and barcode technology are needed to meet the varying requirements of each ship type. All also agreed use of barcode scanners will enhance current Supply business processes today and the RFID systems should be fielded as soon as it is available.

5.2.6 Recommendations

After demonstration of the RFDC system to shipboard personnel and other interested representatives, the following observations are offered:

- Implementation of AIT would provide quicker input of information into the AIS.
- Implementation of AIT would provide supply management personnel more timely identification of items or situations requiring management attention.
- Data was able to be accurately collected and transferred via Radio Frequency without loss.
- While AIT products are currently available, they are not compatible for use with Inventory AIS used by the majority of U.S. Navy ships.
- The current SNAP SFM AIS application used by USS Normandy is being phased out. It is recommended that ships using this AIS be implemented with Relational Supply (FORCE) to take advantage of that AIS systems AIT-friendly capabilities.

The current Automated Information System used for management of logistics processes onboard USS Normandy is the Standard Non-Tactical Automated Data Processing System III (SNAP III or Ported SNAP). This is a legacy system whose life-cycle support is provided by the Navy Space and Warfare Command Systems Center, Chesapeake Virginia (SPAWARSYSCEN). Several years ago, SPAWAR began the practice of "porting" legacy COBOL-based applications on Hewlett-Packard TAC systems using the UNIX language. TAC hardware is used for all SNAP applications. SNAP systems contain several applications, or modules for processing information. The two primary modules in SNAP II/III are Organizational Maintenance Management System (OMMS), used to document and manage work on ships weapon systems, and Supply Financial Management (SFM) used to manage stock inventories, procurement requirements, and provide financial reporting for items supporting a units mission and weapons systems.

While Automatic Information Technology (AIT) devices are not currently utilized to transfer data into SNAP SFM, it is possible to transfer text files into SFM for processing. Currently requisition status updates are processed by receiving text files through the Standard Automated Logistics Tool Set (SALTS). SALTS is a system whereby logistical information is sent and received in compressed form. Stock Control personnel perform a daily exchange of information with SALTS, which includes downloading of updated requisition status. This status, formatted as a text file in 80-position MILSTRIP is saved on a diskette, uncompressed, and transferred to the SFM application. Once loaded to the SFM application, the information updates specified requisition records. However, this process only performs updates for information with external Document Identifiers (i.e. AE1 or AS1). Internal Document Identifiers (i.e. X71 for receipt processing) can be imported, but that function is normally reserved for representatives from the Type Commander or SPAWARSYSCEN, usually as part of a re-allowancing process. But the SNAP SFM AIS application is capable of receiving imported receipt and stowage files, if engineered to do so.

SPAWARSYSCEN has currently "browned out" efforts to upgrade or add capability for legacy SNAP II/III applications. They are currently concentrating efforts on merging the Integrated Bar Code (IBS) application into the Relational Supply (FORCE) AIS. IBS is a front end AIT system consisting of hand held scanners that collect and transfer information to a desktop PC via a cradle connection. The PC then feeds its information to the AIS in a batch mode, via a port into either of the SNAP I applications Shipboard Uniform Automated Data Processing System (SUADPS) or Relational Supply (FORCE). Drawbacks of the IBS application are that the current application is only designed for SNAP I platforms, and all handheld scanners transfer data via a batch download. The vast majority of U. S. Navy warships use the SNAP II/III AIS applications, so activities using IBS are the exception rather than the norm. Also, IBS handheld devices transfer their data by batch download to a PC. Because of this, these handhelds' are limited to the number of records they can process due to memory and storage space limitations. A handheld transferring its information via radio frequency would not be as affected by record storage concerns as a handheld that transfers its information by batch transfer, because it would empty itself every time it was in range of its antenna.

It is recommended that an RFDC system be incorporated to save further time and manpower, as well as provide more timely information and asset visibility. The R-Supply FORCE application is currently only used on large afloat units such as Aircraft Carriers, Multi-Purpose Amphibious Assault Ships, Naval Air Stations, and Marine Aviation Logistics Squadrons. These units using SNAP I applications (Relational Supply FORCE) make up the Special Accounting Class (SAC) 207 of units whose inventories are owned by the Navy Working Capital Fund (NWCF). SNAP II/III units make up the Special Accounting Class (SAC) 224, and their inventories are End-Use funded.

By the estimation of SPAWAR, fleet implementation of an AIT-enhanced AIS system for SAC-224 units using Relational Supply (UNIT), will occur in three to five years. If it is not feasible to convert the SAC-224 activities to a SAC-207 AIS, then it is recommended that the legacy SNAP II/III SFM application be enabled to receive batch text files compiled from an Access or other database program be developed.

Radio Frequency has proven itself to be a useful tool in the speedy collection and transfer of data while onboard USS Normandy. Since the USS Normandy had no AIT system to compare data collection times, it’s recommended that a comparison be performed between IBS and the RFDC system, onboard a Aircraft Carrier (CV/CVN) or other large ship that uses IBS, to measure each systems speed and data collection capabilities. This would go a long way in determining Radio Frequencies potential for afloat units.

6.0 RECOMMENDED SMART STOREROOM

The Phase II (Business Process Demonstration) of Smart Storeroom has proven that Radio Frequency technology can be successfully integrated in the operation of an afloat storeroom. The recommended architecture for Smart Storeroom will consist of the introduction of both Radio Frequency Data Collection (RFDC) based bar code scanners and Radio Frequency Identification (RFID) in the afloat storeroom and its business practices. The complementary use of RFDC and RFID will improve inventory accuracy by providing near real time data entry with a reduction in errors caused by manual data entry. Smart Storeroom will allow the ship to fully leverage the benefits of existing and future bar codes by using RFDC, while positioning the Navy on the cutting edge of inventory tracking with RFID.

6.1 Proposed RF Hardware Configuration

6.1.1RFDC

The RFDC system will consist of the Symbol PDT 7242 Handheld Radio Frequency Scanner, the Symbol CRD 7200 Cradle, and the Symbol AP 3021 Access Point Antenna. Bar codes will be scanned using the handheld scanner. The data collected will be transmitted via radio frequency transmission to a wireless access point on the ship's local area network (LAN). From there, the data will be sent directly to the ship's supply automated information system (AIS). One access point antenna will be positioned inside the helo hangar to capture receipt processing during VERTREPS or anytime material is brought aboard the ship via the flight deck. The remainder of the antennas will be positioned inside the various storerooms to capture data transmissions from the scanners as material is processed into the storerooms, as appropriate. The antennas will be portable vice permanently hardwired to allow relocation or replacement of the antennas, as necessary. Less frequently used storerooms do not need a permanent antenna.

Figure 6.1 Symbol PDT 7200 series Scanners & AP 3021 Access Point Antenna

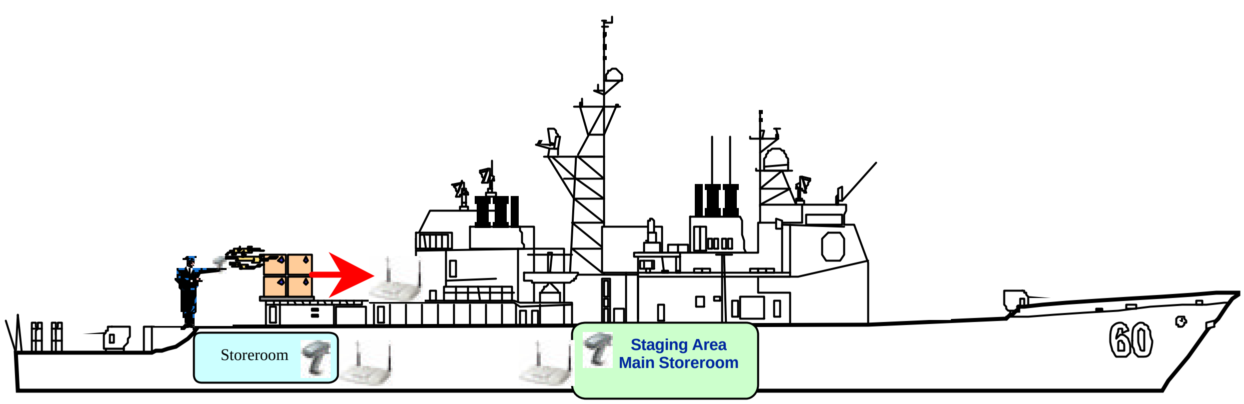

Figure 6.2 Smart Storeroom RFDC Layout

This hardware is obtainable under the AIT II contract. For a Cruiser, the recommended hardware quantities are: 6 scanners ($7668), 6 cradles ($1182), and 5 Access Point antennas ($4925) which would cost a total of $13,775. For comparison purposes, a Nimitz-class carrier has approximately 48 storerooms. The recommended quantities are 60 scanners and docking stations and 55 antennas. The total cost is $142,675. An estimate to outfit all Navy ships is presented in Appendix I, ASDOF Phase II RFDC Hardware Cost Estimate.

6.1.2 RFID

The second radio frequency technology to be inserted in Smart Storeroom is RFID. RFID has its own advantages and restrictions. An RFID emitter system will be used for both global (emitter) and portal (backscatter) applications. The emitter tags are read only. The tag identification (license plate) number is "burned" in when the tag is manufactured. The emitter tag has a battery and a wakeup frequency allows for hands-free check-in and check-out of tagged material via the portals. The tag also beacons autonomously at a set periodicity (i.e. 8-12 hours), which provides continuous global inventory of stored material. The beacon transmits at an approved frequency (i.e. 433MHz). In general, using a lower frequency requires far less power (1mW) and transmits a greater distance. This is a critical requirement for HERO certification. In addition, selecting a frequency will require coordination with the Joint Frequency Management Office (JFMO) and Host Nation Approval (HNA) for worldwide use.

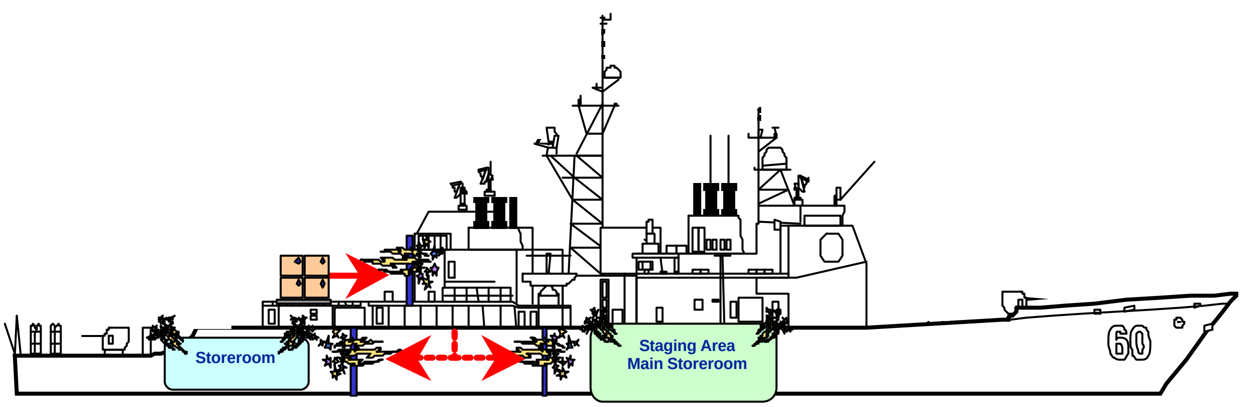

Figure 6.3 Smart Storeroom RFID Layout

Hardware components of the RFID emitter system will include bar antennas as portals, asset tags, and antennas (or reader). For the global application, a dipole (omni directional) antenna mounted on a vertical plane within the designated compartment will capture the tag's beacon (pictured below). Although a read-range in excess of thirty feet is advertised, the range will vary depending on the particular shipboard space and RF propagation. Six readers are recommended for the Main Storeroom. A thorough calibration of each space will determine the specific requirement for each space. The readers will be connected to the ship's LAN that feeds the ship-specific AIS (RSUPPLY Force, RSUPPLY Unit, SUADPS, SNAP, FACTS); SNAP II in the CG.

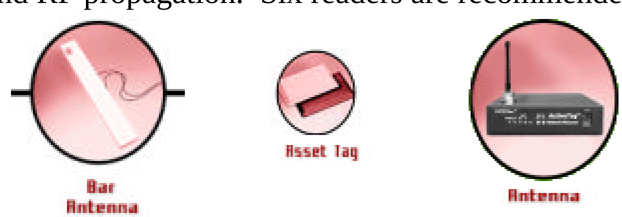

Figure 6.4 Smart Storeroom RFID Hardware

Figure 6.5 Smart Storeroom RFID Dipole Antenna

The portals and appropriate readers will be mounted at designated choke points (i.e. helo hangar, CONREP stations/Quarterdeck, various storerooms) to monitor the tagged material flow. “Check-In” and “Check-Out” portals can be designated to determine the direction the material will be moving. For portal operation, the tag has a “wakeup” receiver that is activated by a short-range 132 KHz magnetic field from a coil antenna placed at the portal. When activated by the magnetic field, the tag transmits a signal at the designated frequency to the reader. Each portal and each reader has its own identification, which will be written into the database when the signal is captured.

Figure 6.6 Smart Storeroom RFID Portal Bar Antennas

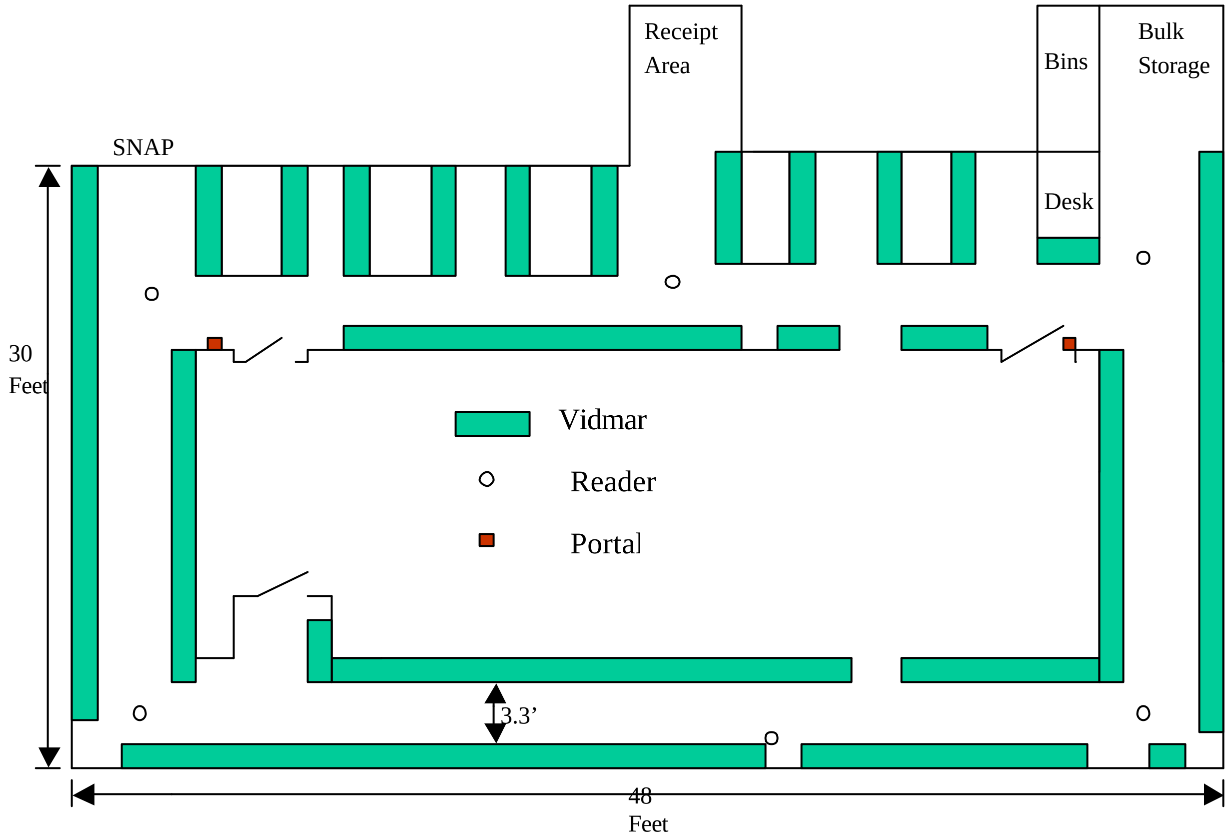

Figure 6.7 Main Storeroom Layout

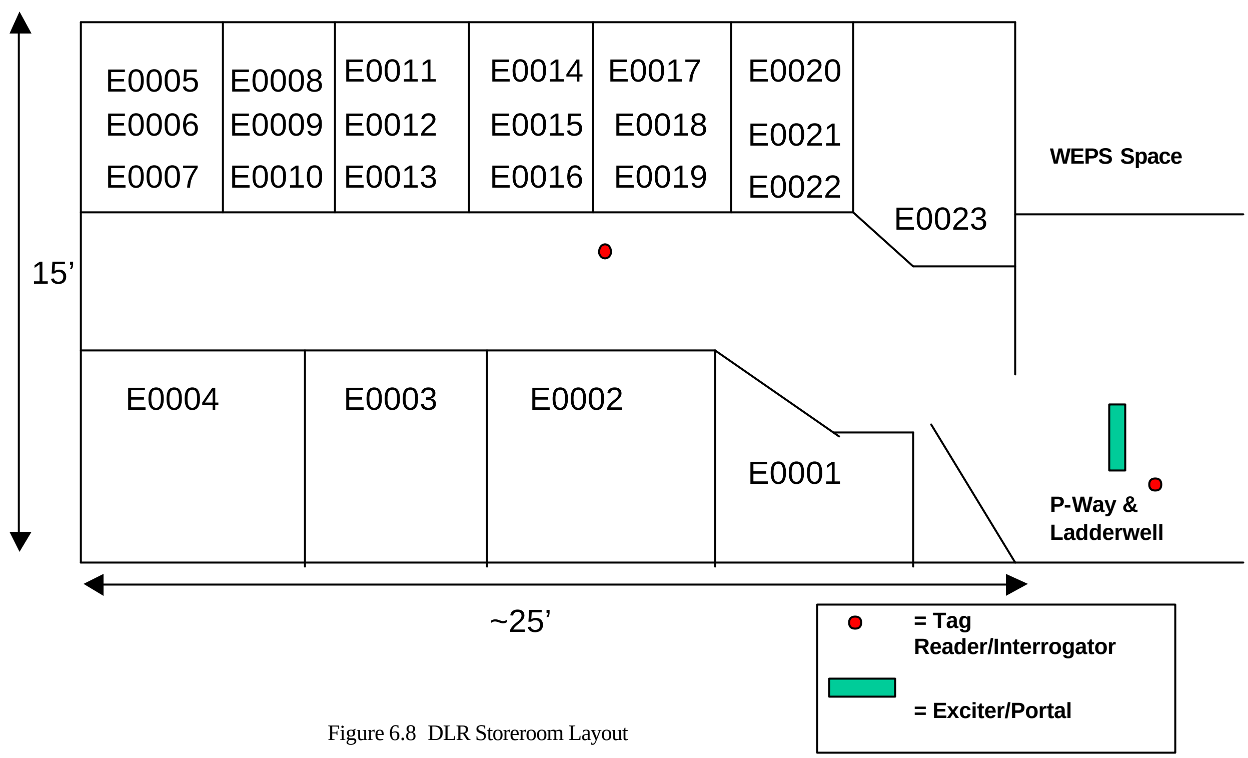

Figure 6.8 DLR Storeroom Layout

6.2 Proposed Business Practices

6.2.1 Receipts

- Pallets will be delivered to the pier from the local distribution point (pierside, VERTREP, CONREP). A "Dues" file will be provided by the distribution point; either on a diskette or via a web site. This file will be imported or downloaded into the shipboard AIS and the actual receipts will be bounced against this file as they are processed into the AIS.
- SKs will breakdown the pallets into stock replenishment and DTO. The document number series will designate which work center submitted the requisition for the DTO material. The wireless interface will allow the SK to query AIS to conduct on-site material validation.

- Stock Replenishment DLRs: Until the manufacturer, suppliers, or repair sites begin applying emitter tags to Ready-For-Issue (RFI) DLRs prior to shipping them to the end-users (Ships in this case), Supply Support personnel will have to apply the tags during the receipt process. This process will also become necessary when tags require replacing throughout the time period material is aboard the ship. Each emitter tag will have a unique barcode attached containing the tag identification number. The tag ID will also be printed on the tag in human-readable text. Until other methods of attaching the tag to the material determined, a plastic document bag with adhesive backing (sometimes called a :MAF" bag) will be used.

- The SK will use a barcode scanner (RFDC) to scan the tag barcode, item barcode, and barcoded receipt document. This barcoded information will marry the emitter tag to the material in the AIS. If the barcoded information cannot be read for some reason (damaged label, bright sun, improper printing), the appropriate information will be manually keyed into the scanner.

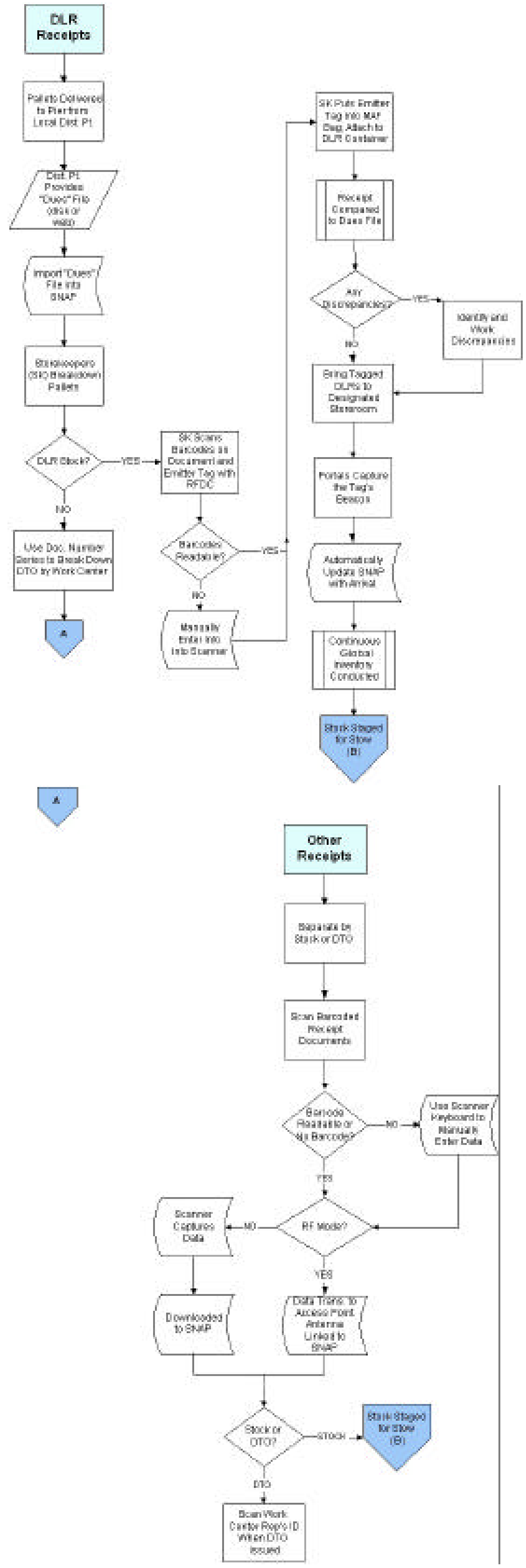

Figure 6.9 Smart Storeroom Receipt Processes

- The SK will put the emitter tag into the MAF bag and attach it to the DLR container.

- The receipt will be automatically compared to the Dues file received from the distribution point. Discrepancies will be identified and worked, as appropriate.

- The tagged DLRs will be brought aboard to the designated storeroom. The portals will excite the "wakeup" transmitter in the tag and the reader will capture the arrival of the material in the storeroom. The portal and reader will be mounted in the overhead in the passageway just outside the DLR Storeroom in such a way that all material must pass directly beneath the portal when entering or leaving the DLR Storeroom.

Figure 6.10 RFID Tag in MAF Bag on Package

- Nearly all material coming aboard ship today contains a barcode. Nearly all locations aboard Navy ships are barcoded. The majority of receipt documents are barcoded, as well. Use of any current barcode scanner technology will significantly enhance shipboard Supply Support business processes; even without RFDC capability. Use of RFDC allows for near real-time transmission of data captured by the RFDC scanner.

- Received material other than DLRs will be segregated into stock and DTO. The barcoded receipt documents will be scanned to capture the barcoded data. If the scanner is used in the RF mode, the data will be transmitted to a topside access point antenna, which is linked to the AIS. If using the Non-RF mode, the receipt data will be captured by the scanner and batch downloaded to the AIS when appropriate. Non-RF scanners will hold a limited amount of receipt information (approximately 500), which must then be downloaded to the AIS. This requires a cradle for docking the scanner and the data transfer takes approximately one half-hour. For those documents with either unreadable barcodes or without barcodes altogether, the document information can be entered using the scanner keyboard and the appropriate business process scanner function. As with the RFID emitter system, the RFDC system allows near real-time AIS updates with minimal manual data entries. The identity of the individual receiving the DTO material can be captured using the RFDC scanner upon turnover whether topside or in Supply Support.

6.2.2 Stow

- Stock DLRs

- The SK will scan the tag barcode and the location barcode to marry the DLR to the storeroom location. No further scanning is required.

- The global transmitter will beacon at a predesignated periodicity (approximately every 8 – 12 hours). The storeroom-mounted reader will capture the beacon signal the AIS will be updated automatically.

- Other Stock Material:

- The SK will scan the barcode on the material and the barcode on the location. The stow function in the scanner will update the stow in the AIS. If a non-RF scanner is used, the system will be updated when the scanner is downloaded.

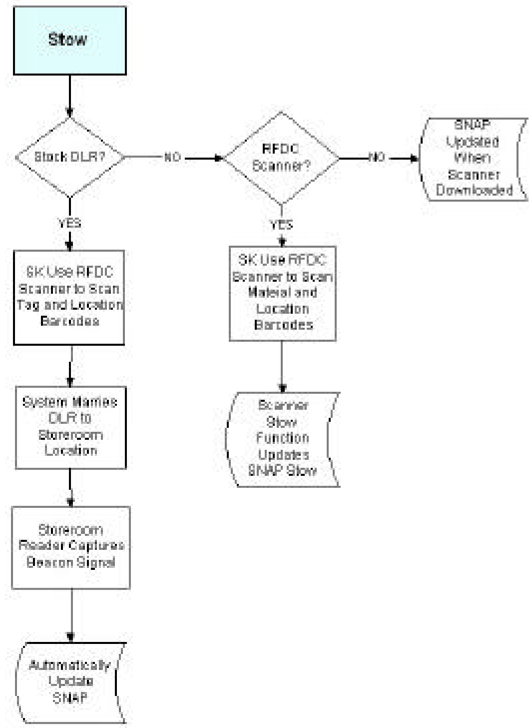

Figure 6.11 Smart Storeroom Stow Processes

Figure 6.12 Location Barcodes

6.2.3 Inventory

- Stock DLRs:

- As long as the material remains in the designated storeroom, the associated reader will capture the beacon signal to provide a global inventory of DLRs.

- Minimal manual intervention will be required. The VIDMAR cabinets are a challenge to RF transmissions. They are not currently RF capable. Each of the spaces will be calibrated prior to system installation to provide complete storeroom coverage by installed readers. However, there may still be a small number of tags that are not picked up by the readers. During the shipboard demonstration, 4% of the tags were not read in the Main Storeroom. For those few tags which are not read automatically, the SK will verify the DLRs presence in their designated locations and manually update the AIS. Or, the SK can use the RFDC scanner to scan the barcodes, which will automatically update the AIS.

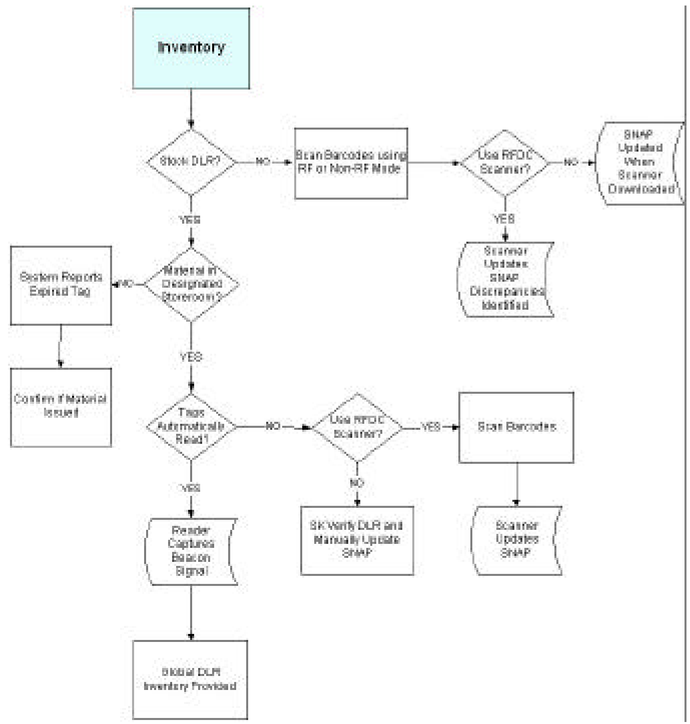

Figure 6.13 Smart Storeroom Inventory Processes

- Other Stock:

- The SK will scan the location barcode and the barcode on each item in that location. If using the RFDC scanner, data will be sent in near real-time to the AIS and discrepancies will be identified immediately, which will allow quick resolution. If using the batch function (Non-RF), the AIS will be updated as quickly as the scanner is downloaded and discrepancies will be identified once the download is complete.

6.2.4 Issue

- Stock DLRs:

- The DLR will pass through the portal. The reader will capture the wakeup signal showing the DLR departing the storeroom.

- The SK will get either an electronic or hardcopy signature of the individual receiving the material and remove the emitter tag. Once the tag is removed, it will either be assigned to a tag holding file created for unassigned tags, a retrograde DLR for turn-in to ATAC, or disposed of at which time the tag will be disabled. Once the system fails to detect the global signal for a specified number of cycles, it will indicate the tag's absence in the AIS.

- Other Stock:

- Utilizing the issue function on the scanner, the SK will scan the location barcode and the item barcode of each item issued. If the RFDC scanner is used, the on-hand quantity will be immediately updated. The quantities will be decremented from the on-hand balance in the AIS and the system will automatically generate a replenishment requisition, if an automatic reorder function exists. If using the batch mode, the AIS will be updated upon scanner download. Again, the identification of the individual receiving the material can be scanned when the item is turned over.

- The following layouts depict the locations of the readers and portals. Actual locations will be determined by calibration of the designated storerooms prior to RFID hardware installation.

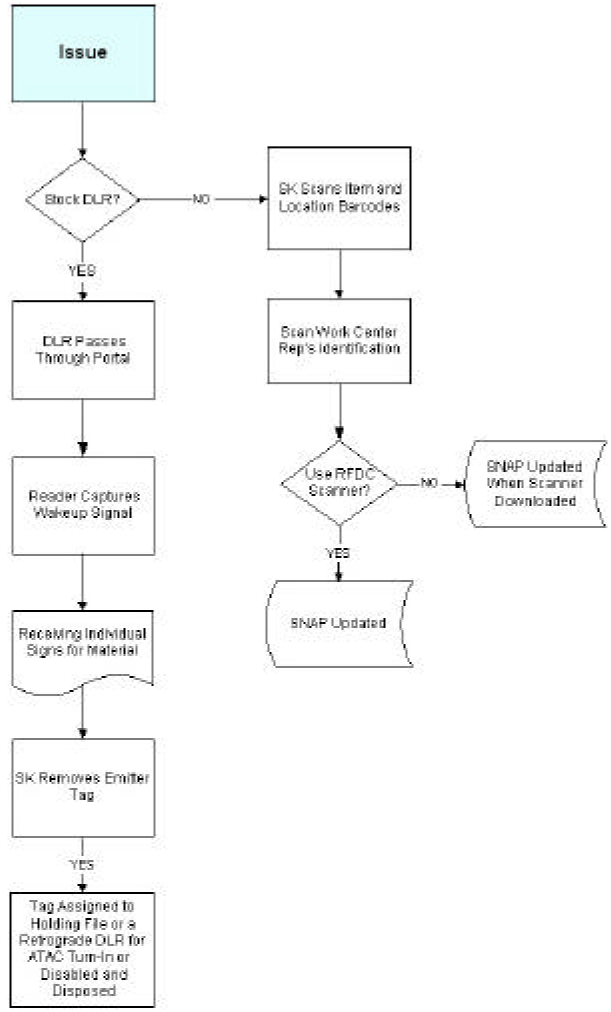

Figure 6.14 Smart Store Room Issue Processes

7.0 ISSUES TO BE ADDRESSED BEFORE DEPLOYMENT

Several issues still need to be addressed prior to deployment of Smart Storeroom. Foremost among these is developing a connection to existing and future shipboard AIS's. While NAVSEA has POM'd for Smart Storeroom in FY 04, at this time no funding has been identified to address these issues before deployment.

7.1 AIS Issues

While the intent of this second phase of demonstrations is to recommend the best architecture for an afloat Smart Storeroom, these recommendations can be used regardless of which AIS is to be interfaced to AIT hardware. Since AIT by itself is useless until it sends appropriate data to a host system, it is necessary to address the issues relating to AIS and associated interfacing requirements. Prior to full deployment, it will be obviously necessary to identify the AIS that will receive the information that the AIT will send (regardless of whether the AIT hosts data or simply carries license plate data). Once the hosting AIS is identified (RSupply Unit/Force, SNAP II, SAP, etc.), it will be necessary to create an interface linking the AIT with the AIS. Several options can be explored to accomplish this, including the following:

1. Modify existing interfaces into legacy applications to accommodate Smart Storeroom AIT
    a. Integrated Barcoding System (IBS)
    b. Logistics Customer Asset Visibility (LCAV)
2. Create a new, unique interface to transmit data between Smart Storeroom AIT and AIS.
3. Select a commercial package allowing Smart Storeroom AIT to interface with either legacy AIS or SAP.

A preliminary market survey by the Smart Storeroom Team has uncovered several commercial products that have the capability to interface RFID systems with both legacy and ERP systems. Even with a commercial interfacing solution, SPAWAR-Chesapeake would play a central role in testing and approving any shipboard AIS configuration

7.2 Militarization of Systems

Final hardware selection must account for the rugged requirements of shipboard use. It will be necessary to evaluate commercial products' abilities to withstand shipboard use, and recommend (if appropriate) a modification to systems in order to adequately improve hardware durability.

7.3 Supply Chain

It will be necessary to evaluate the need for this afloat solution to be just one part of a larger deployment, such as Navy supply chain, DoD Supply Chain, etc. At present, several efforts are potentially representative of a larger deployment than this Smart Storeroom recommendation. This recommendation can offer any larger deployment strategy an accurate account of the requirements for afloat supply departments.

7.4 Ship Alterations

Many ship alterations will be needed for a full-scale deployment. Each reader needs a LAN connection to communicate with the tracking software. Each reader and exciter will need a power supply. Welding and mounting will be for equipment installation throughout the ship.

Each of the requirements will result in changes to the ship drawings. Even during the early stages of the Smart Storeroom proof of concept, necessary organizations such as FOSSAC, NAVSEA HQ, and NAVSEA-Philadelphia have been engaged with our planning process. Similarly, it will be necessary to communicate with Ship Platform Program Offices to offer Smart Storeroom specifications to be used as requirements statements for new construction.

7.5 Deployment Considerations

As with any deployment, a deployment strategy including plans for a deployment team and schedule, as well as training and user manuals will be necessary.

7.6 Packaging

All packaging used in the Navy should be tested to determine compatibility with RFID technology. The success of a Smart Storeroom will be contingent on the ability of the AIT to be easily and securely attached to packaging. Also, it may be ultimately necessary to modify packaging requirements in the contracts for new spares. The NAVICP Packaging division in Philadelphia has been engaged in this planning process to give early guidance.

7.7 Fully Operating Smart Storeroom Prototype

As with most new system deployments, it will be necessary to deploy in waves. Even though the purpose of this phase II study was to account for shipboard consideration in the design of Smart Storeroom, deploying a first wave to two ships would allow the Smart Storeroom Team to make final evaluations before continuing full deployment.

7.8 Technical certification after hardware selection

After Smart Storeroom has down-selected to a specific manufacturer, it will be necessary to conduct a HERO certification, as well as determining the systems operating frequencies to pursue needed Host Nation Approvals. These requirements are explored further in this recommendation.

7.9 RFID/RFDC System Training:

Fleet-wide phased training must be developed and completed prior to fielding these systems. Lesson plans will require updating at Naval Supply Corps School and SK 'A' School. Regular waterfront follow-on training is also a necessity. For example, the Naval ordnance community has Retail Ordnance Logistics Management System (ROLMS) training representatives at key naval bases worldwide. Their training is augmented with training CDs, which have been provided to every ship and shore station. This training is focused on both the system itself and the AIT required to capture the ordnance inventory management data.

7.10 Top Side Emissions

The RFID emitter tags are low frequency and low power with a beacon that lasts approximately one nano-second. The beacon will be set to once every eight, twelve, or even twenty-four hours. Despite this top side emissions are an issue because there is currently no effective way to turn the beacons off during EMCON conditions. The primary location for these tags is on material stowed in Supply Department storerooms onboard Navy ships. However, experience shows there will be times when tagged material or some of the actual tags will remain topside. The range to depth test will determine the need for further emitter tag refinement.