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RELATIONAL DATABASE DESIGN OF A SHIPBOARD AMMUNITION INVENTORY, REQUISITIONING, AND REPORTING SYSTEM

by

David W. Clemens

June 1990

Thesis Advisor Magdi N. Kamel

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Relational Database Design of a Shipboard Ammunition
Inventory, Requisitioning, and Reporting System

by

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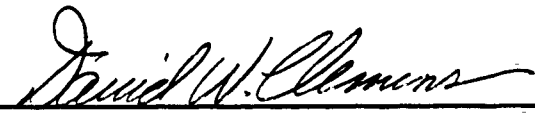
Author: 

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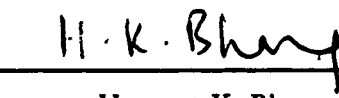

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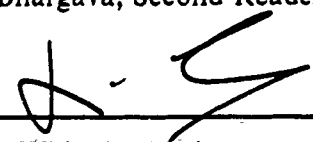

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ABSTRACT

This thesis defines the analysis and design necessary to automate the current manual procedures for the inventory, requisitioning, and reporting of shipboard ammunition. After verifying data and functional requirements of the system, this study specifies the logical database design and application design of a relational shipboard ammunition management database application. In addition, the PARADOX relational database management system software package is used to implement the relations and specify the required reports for a prototype application. The potential for integrating an expert system with this shipboard ammunition relational database is discussed and other areas for future work are suggested.

TABLE OF CONTENTS

I. INTRODUCTION 1
A. PURPOSE 1
B. SCOPE 2
1. Scope of System 2
2. Scope of Thesis 2
C. METHODOLOGY 3
D. PREVIOUS WORK 4
E. ORGANIZATION 5

II. THE SHIPBOARD AMMUNITION MANAGEMENT PROCESS 7
A. SHIPBOARD FORMS AND REPORTS 7
1. Inventory Records 7
a. Master Stock Record Card 7
b. Lot Location Card 8
c. Serial Location Card 8
2. Requisition Records 9
3. Transaction Records 10
a. Ammunition Transaction Report 10
b. Ammunition Reclassification 11
B. INTERFACE WITH EXTERNAL SYSTEMS 12
C. PROCESS SCENARIO 13
D. PROBLEM DEFINITION 14

III. REQUIREMENTS VERIFICATION 16
A. DATA REQUIREMENTS 16
1. Object Overview - Modeling the User's View 16
2. Object Descriptions 17
a. COMMAND Object 17
b. REQUISITION Object 18
c. REQN LINE ITEM Object 18
d. AMMO INVENTORY Object 19

e. LOT CONTROLLED AMMO Object 19
f. SERIAL CONTROLLED AMMO Object 19
g. SERIAL & LOT CONTROLLED AMMO Object 19
h. TRANSACTION Object 20
3. Object Specifications 20
a. Object Definitions 20
b. Domain Definitions 21
B. APPLICATION (FUNCTIONAL) REQUIREMENTS 21
1. Dataflow Diagrams 21
2. Description of Dataflow 22
3. Application Functional Components 24
a. Inventory Management 24
b. Requisition and Turn-In Generation 25
c. Generate Reports 26
4. Interapplication Requirements 26
5. Operations Requirements 27
a. System Operation 27
b. Backup and Security 27
c. Users 28
6. Administrative and Environmental Requirements 28

IV. LOGICAL AND APPLICATION DESIGN 29
A. LOGICAL DESIGN--TRANSFORMATION OF OBJECTS 29
1. COMMAND Object 29
2. REQUISITION & REQN LINE ITEM Objects 29
3. AMMO INVENTORY Object 30
4. TRANSACTION Object 31
5. SERIAL and/or LOT CONTROLLED AMMO Objects 31
B. APPLICATION DESIGN 32
1. Application Scope 32
2. Control Mechanisms 32
a. Selection of Control Method 32
b. Menu System 33
3. Logic and Design Materialization 34

V. PHYSICAL DATABASE DESIGN 36
A. DBMS OVERVIEW 36
B. CONSTRUCTING THE TABLES IN PARADOX 37
C. REPORT SPECIFICATION IN PARADOX 39

VI. SUGGESTIONS FOR FUTURE STUDY 41
A. DEVELOPMENT OF AN EXPERT DATABASE SYSTEM 41
B. OTHER SUGGESTIONS FOR FUTURE WORK 42

APPENDIX A. OBJECT DIAGRAMS 45

APPENDIX B. OBJECT SPECIFICATIONS 51
A. OBJECT DEFINITIONS 51
1. COMMAND Object 51
2. REQUISITION Object 51
3. REQN LINE ITEM Object 51
4. AMMO INVENTORY Object 52
5. LOT CONTROLLED AMMO Object 53
6. SERIAL CONTROLLED AMMO Object 53
7. SERIAL & LOT CONTROLLED AMMO Object 53
8. TRANSACTION Object 54
B. DOMAIN DEFINITIONS 55

APPENDIX C. DATAFLOW ANALYSIS 64

APPENDIX D. SAMPLE FORMS 71

APPENDIX E. FUNCTIONAL COMPONENT DESCRIPTIONS 76
A. MANAGE INVENTORY APPLICATION 76
1. Manage Inventory Update Mechanisms 76
a. Add New COMMAND Data 76
b. Edit COMMAND Data 77
c. Add a New Stock Record 77
d. Edit Descriptive Data 78
e. Add (Post) a Transaction 79

f. Edit Transaction Data 80
g. Add a New Serial/Lot Record 80
h. Edit Serial/Lot Information 81
2. Manage Inventory Display Mechanisms 81
a. COMMAND Information Display 81
b. Stock Record Display 82
c. Stock History Display 82
d. Display Lot/Serial Record 83
3. Manage Inventory Control Mechanisms 83
B. GENERATE REQUISITIONS APPLICATION 84
1. Generate Requisitions Update Mechanisms 84
a. Add a Requisition 84
b. Edit Requisition Data 84
2. Generate Requisitions Display Mechanisms 85
a. Single Requisition Display 85
b. Requisition Generation 86
c. Turn-In Document Generation 86
3. Generate Requisitions Control Mechanisms 87
C. GENERATE REPORTS APPLICATION 87
1. Generate Reports Update Mechanisms 87
2. Generate Reports Display Mechanisms 87
a. Requisition Log Report 87
b. Maintenance Due Summary Report 88
c. Ship Ammunition Listing 88
d. Allowance List Report 89
e. NAR Management Report 89
f. Allowance Tracking Report 90
g. Ammunition Transaction Report (ATR) 91
h. ATR Log Report 91
i. SORTS Message Input Report 92
j. Ship Ammunition Inventory Report (Summary) 93
k. Turn-In Log Report 93
l. Ship Ammunition Inventory Report (Detailed) 94
m. Outstanding Requisition Summary Report 94
3. Generate Reports Control Mechanisms 95

APPENDIX F. RELATIONAL SCHEMA 96

APPENDIX G. MENU HIERARCHY DIAGRAMS 98

APPENDIX H. LOGIC SPECIFICATIONS 103
A. MENU 0 (MAIN MENU) 103
B. MENU 1 (INVENTORY MENU) 103
1. Menu 1-1 (Master Stock Records) 103
a. Append Master Stock Records 104
b. Edit Master Stock Records 104
c. Query or Display Master Stock Records 105
2. Menu 1-2 (Serial-Lot Records) 105
a. Append Serial and Lot Stock Records 105
b. Edit Serial and Lot Stock Records 105
c. Query or Display Serial and Lot Stock Records 106
3. Menu 1-3 (Process Transactions) 106
a. Add Transaction 106
b. Delete Transaction 106
c. Edit Transaction 107
C. MENU 2 (REQUISITION/TURN-IN MENU) 107
1. Append Requisitions 107
2. Edit Requisitions 108
3. Query or Display Requisitions 109
4. Menu 2-4 (Generate Requisitions or Turn-Ins) 109
a. Generate DD Form 1348 Requisition 109
b. Generate DD Form 1348 Turn-In 110
c. Generate DAAS Requisition 110
d. Generate Naval Message Requisition 111
D. MENU 3 (GENERATE REPORTS MENU) 112
1. Menu 3-1 (Inventory Reports) 112
a. Inventory Summary Report 112
b. Allowance List Report 113
c. NAR Management Report 113
d. Allowance Tracking Report 113
e. SORTS Message Input Report 114

f. Ship Ammunition Inventory Report (Summary) 114
g. Ship Ammunition Inventory Report (Detailed) 115
h. Maintenance Due Summary Report 115
2. Menu 3-2 (Generate Transaction Reports) 115
a. Generate ATR 116
b. ATR Log Report 116
3. Menu 3-3 (Requisition & Turn-In Reports) 117
a. Requisition Log Report 117
b. Turn-In Log Report 117
c. Outstanding Requisition Report 118
E. MENU 4 (COMMAND INFORMATION MENU) 118
1. Edit Command Information 118
2. Display Command Information 119

APPENDIX I. PARADOX TABLES 120

APPENDIX J. PARADOX DATA VALIDITY CHECKS 143

APPENDIX K. PARADOX REPORTS 146

APPENDIX L. ATR PREPARATION RULE BASE 155
A. INPUT 155
1. From ARMIRS Database 155
2. From User Responses To Queries 155
a. Multiple Choice 155
b. Text for Addresses 155
B. OUTPUT TO DATABASE 155
C. USER DIALOG 156
1. User Menu Selections 156
2. User Text Entry 157
D. RULE BASE 157
1. ATR Message Security Classification Rules 157
2. ATR Message Addressing Rules 159

LIST OF REFERENCES 163

BIBLIOGRAPHY 165

INITIAL DISTRIBUTION LIST 167

I. INTRODUCTION

A. PURPOSE

Operational and training readiness of Navy ships depends on the efficient management of onboard supplies. Food, fuel, and ammunition inventories must be effectively monitored and controlled. Higher command authorities have recognized the critical nature of these inventories by mandating reporting procedures to ensure the proper placement of these vital supplies. Clearly, the ability of a warship to go quickly into combat is determined largely by the supplies carried in her own hull.

The vital importance of efficient shipboard inventory management is especially obvious in the area of conventional ammunition inventory, requisitioning, and reporting. Ammunition logistics determines a ship's possible endurance and available tactics. In peacetime, tracking the expenditure and replacement of shipboard ordnance is especially important because of its impact on combat systems training readiness. A ship in which operational and tactical decision makers are unaware of the quantity and type of ordnance onboard is at a clear disadvantage in peacetime and may prove to be a dangerous liability in hostile environments.

Over the past decade, audits of shipboard ammunition management procedures have focused attention on an apparent inability to maintain accurate ammunition records. For example, two General Accounting Office (GAO) investigations (GAO, 1981 and 1982) found significant discrepancies between reported quantities and assets actually onboard. The Naval Audit Service discovered a similar finding when it audited small arms and ammunition (NAS, 1981). As we face the austere defense funding levels expected for the 1990's, Navy managers must address the deficiencies inherent in the current manual system of shipboard ammunition management.

The present (entirely manual) system of shipboard ammunition management is manpower intensive, inefficient, invites errors, and provides poor information support for shipboard managers. The requisitioning, status tracking, expenditure reporting, and inventory management of ammunition inventories to comply with detailed requirements of higher authority imposes a significant administrative burden on Weapons Department personnel. An automated system would relieve part of this administrative burden, making time available for important combat systems training. In addition, an automated system would make accurate ammunition information more accessible to decision mak-

ers both on and off the ship. Unfortunately, automated tools for shipboard ammunition management do not exist, either as part of the Shipboard Non-Tactical ADP (SNAP) system installed on Navy ships or as a stand-alone microcomputer application.

The purpose of this thesis is to provide the analysis and design for a prototype relational database application intended to automate the manual system of shipboard ammunition inventory, requisitioning, and reporting.

B. SCOPE

1. Scope of System

This thesis defines the relational database design of the proposed Ammunition Requisition Management, Inventory, and Reporting System (ARMIRS), a single-user, microcomputer-based database application. The scope of ARMIRS is limited in that (1) the current system defines the principal functional requirements of the automated system, (2) the special requirements of ammunition stores ships afloat and naval magazines ashore are not addressed, and (3) only non-nuclear ordnance management is modeled.

It is not the intent of this research to specify the ideal methods for shipboard ammunition management or to suggest fundamentally different methods of ordnance inventory, requisition, or reporting. Rather, ARMIRS is an automated application of a manual system, using forms and reports familiar to users of the current system.

In addition, ARMIRS will not meet the special requirements of non-combatant ships. A single ammunition supply ship carries ammunition bound for many combatant ships and has especially complex requirements for ammunition load management.

Finally, ARMIRS is an unclassified system for unclassified ordnance. Nuclear weapons management has distinct managerial and security requirements beyond the scope of this system. Because of the comparatively small quantity of weapons involved and the demanding security requirements, inclusion of special weapons within the scope of ARMIRS is not required.

2. Scope of Thesis

This thesis will facilitate future development of a prototype ARMIRS system by defining the data and functional requirements of the system. The deliverable product from this thesis is the documentation of the analysis and design phases of systems development. A high-level conceptual data model is described. This conceptual schema is a concise description of the user's data requirements and includes detailed descriptions of the data types, relationships, and constraints. The functional requirements of a shipboard ammunition management system will also be specified. These design specifi-

cations are independent of any particular Database Management System (DBMS). The specifications from this thesis can then be implemented with a variety of DBMS application tools. Data model mapping into the data model of PARADOX,[1] a relational microcomputer DBMS product with built-in application development facilities, is used only to demonstrate the transformation of the conceptual schema from a high-level data model to an implementation data model. In addition, PARADOX is used as a graphic interface tool to specify the ARMIRS reports. However, a DBMS-specific, working prototype is beyond the scope of this thesis.

C. METHODOLOGY

This thesis generally follows the object-oriented database design steps outlined by Kroenke and Dolan (1988, pp. 87-216) and by Elmasri and Navanthe (1989, pp. 453-483). In general, these steps include:

1. Model the user's view of the data as objects.
2. Specify the application and its functional components as data flows.
3. Define the relational schema.
4. Design the control and display features of the application, including forms and reports.

According to Kroenke and Dolan (1988, pp. 96-97), there are two methods to use in identifying and describing objects: (1) examine the application outputs and work backwards to the object structure, or (2) ask the user to describe the objects and model the objects from their characteristics and the application. The first methodology is useful when an improved application for an existing system is required. By knowing the system output, it is possible to determine the input. The second method is required for new applications. Because there are no reports or views to examine, the analysts begin by asking users to describe their view of the system objects.

The former methodology is appropriate for ARMIRS. The ARMIRS requirements analysis draws from the previous requirements work by Alderman (1986) and Smith (1987) as well as the author's own shipboard ammunition management experience.[2] In addition, interviews with Gunnery Officers and Gunnery Petty Officers aboard four

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1 PARADOX is trademark of Borland International.

2 The author served as ASW Officer (13 months) and Weapons Officer (5 months) aboard a KNOX-class frigate.

combatant ships[3] were conducted during July 1989 to supplement the author's expertise and aid in modeling the user's view of the system.

This thesis incorporates the dataflow diagram methodology of Yourdon (1989) into the Kroenke and Dolan framework. The techniques developed by Hayes-Roth (1985) as applied by Kamel and Lekey (1990) are used to define a rule-based expert system that could be integrated with the ARMIRS database to assist in Ammunition Transaction Report (ATR) and requisition preparation.

The specific tools used and their relationship to the corresponding design steps are discussed in the context of thesis organization. This organization closely parallels the format used by the author in an unpublished work (Buzzard, *et. al.*, 1989) using the Kroenke and Dolan framework.

D. PREVIOUS WORK

As previously discussed, this thesis is limited to the analysis and design phase of the database application system life cycle. The problem of this phase, as stated by Elmasri and Navanthe (1989, p. 457), is to "design the logical structure of one or more databases to accomodate the information needs of the users in an organization for a defined set of applications". This thesis does not attempt to rewrite the existing requirements analysis of Alderman (1986) or the requirements analysis and partial, DBMS-specific design by Smith (1987). Instead, this thesis is a continuation of these previous efforts to automate ammunition management.

Alderman's (1986) thesis was heavily influenced by the Navy's Conventional Ammunition Integrated Management System (CAIMS) database. The data dictionary he presents for a shipboard system is copied from the COBOL description of data elements in the CAIMS system. Alderman's (1986, pp. 32-35) file-based system is also outdated because it uses separate files (and forms) for sonobouys and for explosive ordnance. Sonobouys previously had different reporting and requisitioning requirements. Use of a file-based approach created unnecessary complexity, including many condition flags. Because Alderman specified custom-made security and backup components in the system rather than simply adding commercially available software to accomplish these system management functions, additional dataflow diagrams and forms were necessary. In addition, because a query-by-forms model was not used, the review, create, and update functions were each accomplished by unique forms. Alderman (1986, p. 106-127) used

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[3] USS MCCLUSKEY (FFG-41), USS MARVIN SHIELDS (FF-1066), USS STEIN (FF-1065), and USS JOHN YOUNG (DD-973).

43 forms to define the system, many of them unnecessary for the reasons discussed above. The requirements analysis is also incomplete in that important functions are not described. For example, the internal reports generated by the system for shipboard use are not described or even listed. Alderman, a Supply Corps officer, oriented the requirements analysis toward a Navy-wide logistics view than from the shipboard user's view of the system.

Smith's (1987) thesis comes closer to defining the user's view of a shipboard ammunition management system. An analysis of the current manual system receives some examination. The major shortcoming in Smith's work is the attempt to begin the implementation (construction) phase before completing the design phase. The result is a partial, DBASE III[4]-specific implementation fragment. Smith's (1987, p. 53) chapter on "design" *begins* with a physical structure description of the DBASE III files used. As Whitten, *et. al.*, (1986, p. 158) point out, the design specifications should be fully completed before the implementation phase begins. We should avoid the temptation to prematurely program from an incomplete design or we risk numerous delays. The Smith (1987) thesis is therefore an analysis and implementation approach to the shipboard ammunition management problem. There is nothing in that thesis resembling a logic description or logic specification (pseudocode) to bridge the gap between analysis and Smith's DBASE III code. For this thesis, some reverse engineering was applied to some of Smith's (1987, pp. 137-177) DBASE code to provide another user's view. Smith (1987, p. 68) only implemented the requisition functions of a shipboard ammunition management system. Neither Alderman (1986) nor Smith (1987) used objects and their relationships to model the data.

E. ORGANIZATION

This chapter has discussed the need for automating the shipboard ammunition management process, the scope of both the proposed ARMIRS database application and the scope of this thesis, and some of the general steps and tools used to define the ARMIRS design.

The next chapter describes the current manual system for shipboard ammunition management. The manual forms and reports are discussed and the user's view of the ordnance management process is analyzed.[5] The problem statement is further defined.

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4 DBASE III is a trademark of Ashton-Tate.

5 LT Peter C. Lyle, USNR contributed useful comments on Chapter II.

Chapter III updates and modifies the previously discussed prior work on the requirements analysis through the use of objects. The objects are identified and described using object diagrams and object specifications. The functional components (update, display, and control mechanisms) of ARMIRS are defined. Dataflow diagrams are used to describe the process.

Chapter IV covers the transformation of the objects into a relational diagram. The menu-driven control mechanisms are defined with menu hierarchy diagrams. Finally, the logic specifications used to complete each menu option are listed in a Structured English format.

Chapter V describes the use of the PARADOX DBMS package to demonstrate the implementation of the relations. The required internal and external reports are also defined.

The final chapter briefly investigates a possible expert system interface and suggests other future work on automating shipboard ordnance management.

II. THE SHIPBOARD AMMUNITION MANAGEMENT PROCESS

The purpose of this chapter is to review the current manual system for managing ammunition aboard Navy ships. Before an automated system can be designed, we need to understand the functionality of the current system. It is then possible to analyze problems and define solutions. This chapter first examines the forms and reports used in ordnance management. These forms and reports form the basis for the data requirements discussed in the chapter that follows. The interface with external systems is analyzed and a typical shipboard ammunition management scenario is presented. After defining these mission requirements, the problems with the current manual system will be discussed.

A. SHIPBOARD FORMS AND REPORTS

1. Inventory Records

a. Master Stock Record Card

The heart of the shipboard ammunition inventory function is the Ammunition Master Stock Record Card (NAVSUP Form 1296). One record card is maintained for each Navy Ammunition Logistics Code (NALC) held in a ship's ammunition inventory. The NALC indicates the functional type of ammunition. Each NALC has one or more associated National Item Identification Numbers (NIIN). The NIIN further defines the specific type of ammunition. For example, one NALC identifies 12-gauge shotgun shells containing size 00 shot. Within that NALC, one particular NIIN is for shells with a paper case while another NIIN refers to shells with a plastic case (Smith, 1987, p.16).

The Master Stock Record Cards, filed by NALC and then by NIIN, contain general information on the NIIN. This information includes:

- Nomenclature (Short Title)
- Unit of Issue (Packaging)
- Shipfill or Mission Allowance
- Training Allowance
- Supply Cognizance Symbol (COG)
- Material Control Code (MCC)
- Department of Transportation Hazardous Material Code

- Net Explosive Weight (NHEEW)
- Coast Guard Hazardous Material Class
- Shipboard Stowage Location
- Remarks

In addition, the record card contains a history of transactions effecting the status or quantity of that NIIN. Information on the current inventory balance is obtained from this section of the card. The card is organized into rows for up to 16 transactions. The column headings are:

- Entry Date
- Document Number (Activity + Date + Serial Number)
- Quantity Received
- Quantity Issued
- Expenditure Type
- Expenditure Quantity
- Quantity On-Hand (Serviceable)
- Quantity On-Hand (Unservicable)
- Ammunition Transaction Report (ATR) Serial Number
- Unexpended Training Allowance
- Quantity Due In

b. Lot/Location Card

For each lot number (if any) within a NIIN, lot card(s) (NAVSUP Form 1297) are filed behind their master stock cards. Much of the information on this card is copied from the parent master card. The only additional information in the NIIN descriptive section is a place for the lot number. The transactions section of the lot card is identical in format to the corresponding section on the master card except that a column for consignee/consignor is added. The lot card is used to record transactions for a single lot. The transactions on each NIIN's lot cards is copied from the NIIN master card. There is no information on the lot cards (except for lot number, of course) that is not also contained on the master card.

c. Serial/Location Card

Some ordnance items are designated for increased tracking by assignment of unique serial numbers. For example, all missiles, all torpedoes and some mines (SPCCINST 8010.12D, 1988, p. 8-4-7) have serial numbers while gun ammunition does

not have an identifier for a single round. Items that require Serial/Lot Item Tracking (SLIT) have one or more Serial/Location Cards (NAVSUP Form 1356) filed behind the master card. SLIT controlled items may be serial number controlled (one or more serial cards for each master record card) or serial *and* lot controlled (*both* lot cards and serial cards for a single master record card).

The serial cards contain most of the generic NIIN information found on the master card (and lot cards). The transaction section has three additional columns:

- Serial Number (each card has space for 17 serialized items, one for each row)
- Maintenance Due Date
- Condition (Servicable or Unservicable)

Like the lot cards, the serial cards duplicate information found on their master cards.

2. Requisition Records

The goal of every ship is to maintain all of their ammunition allowance onboard or on order. Ships create orders for ammunition by transmitting requisitions. In general, these ammunition requisitions contain the following minimum information:

- Document Number
- Document Identifier
- Requisition Addressees
- Location for Receipt
- NALC
- NIIN
- Nomenclature (Short Title) [manual requisitions only]
- Quantity Desired
- Unit of Issue
- COG Symbol
- Project Code
- Media Status Code
- Signal Code
- Demand Code
- Advice Code
- Fund Code
- Priority Code
- Required Delivery Date

- Remarks [manual and naval message requisitions only]
- Classification

The format of the above information varies with the type of requisition used. A ship may requisition ammunition using three different requisition formats:

1. Defense Automatic Addressing System (DAAS) Message Requisition. These machine-read messages are prepared to an exact format specification (see SPCCINST 8010.12D, 1988, pp. 8-2-6 to 8-2-16). For example, these requisitions cannot contain remarks, are limited to only specified addressees, and must be unclassified.
2. Naval Message Requisition. Requisitions excluded from submission via DAAS are submitted via naval message. Requisitions that require narrative remarks or action addressees other than DAAS Dayton, Ohio are in this format. Like the DAAS requisitions, these requistions are transmitted from the ship via the Navy telecommunications system.
3. Manual Requisition. The DOD Single Line Item Manual Requisition Form (DD Form 1348) are hand-carried or mailed to a naval magazine or weapons station ashore. The requisition information is then entered into the CAIMS system from the weapons facility's ADP equipment. DD Form 1348 is also used when ships turn-in or off-load ammunition to shore activities.

In addition to a file of requisitions (often containing all three formats) and turn-in documents, the ship maintains a locally prepared Requisition Log and Turn-In Log or a combination log summarizing both requisitions and turn-ins. The requirement for and format of this record is not specified by higher authority but is recommended because it greatly aids the assignment of document numbers and tracking of outstanding requistions. This log is list of document numbers (the identifier for requisitions and turn-in document) usually with columns for NALC, quantity, short title, and requisition status remarks.

3. Transaction Records

a. Ammunition Transaction Report

Every action that results in a change to a ship's ammunition inventory (including receipt, issue, transfer, expenditure, loss, gain, or change in condition) must be reported (within 48 hours) in a prescribed report format (SPCCINST 8010.12D, 1988, p. 8-4-3). The ATR is a formatted naval message containing the following information:

- Classification
- Addressees
- Reference (last ATR or other ATR referenced to)
- Unit Identification Code (UIC) of reporting unit

- UIC of training allowance allocation command
- ATR Serial Number
- Julian Date of Transaction
- Activity Classification Code (ACC)
- NALC
- NIIN
- Condition Code
- Beginning Balance
- Serial Number (if applicable)
- Lot Number (if applicable)
- Source UIC (for receipts)
- Source Service Code (for receipts)
- Expenditure Transaction Type
- Reclassification Code
- Ending Balance
- Remarks

As with the inventory information, ATR format varies with the type of control (Material Condition Code) applicable to that type of ordnance. The individual transaction lines in an ATR contain information that varies depending on whether the item is non-SLIT, SLIT reportable by lot, SLIT reportable by serial, or SLIT reportable by serial *and* lot. Another highly variable item on an ATR is the list of action and information addressees which depends both on the location of the unit and the type of ordnance involved in the reported transaction.

Each ship maintains a locally prepared ATR Log (often in addition to an ATR file) to summarize the command's ammunition transaction history and to assist in assigning correct ATR serial numbers. As with requisitions, it is essential that ATRs are received by addressees in the correct sequence with no unassigned or duplicated serial numbers. This log commonly consists of rows for each ATR serial number with columns for message date-time group, NALC(s), type of transaction, and ending balance.

b. Ammunition Reclassification

Ammunition is reclassified when external inventory or technical managers determine that a particular item or lot should be used in a limited fashion or considered unserviceable. This reclassification can be the result of ammunition malfunction, tests,

shelf-life expiration, or quality evaluation (NAVSEAINST 8015.1A, 1988, p. XI-1). If the affected ammunition is not properly marked when reclassified, both in the magazine and on the inventory record, serious personnel injuries or weapons systems damage can result. In addition, mixing serviceable and unserviceable ammunition aboard ship presents an explosive safety hazard.

Ships periodically receive Notices of Ammunition Reclassification (NAR) messages listing ammunition with a revised condition code. These serialized messages are then checked against the ship's ordnance holdings to determine applicability. If the ship holds the referenced ammunition, the ordnance is tagged, inventory cards are updated, an ATR is transmitted to show the revised condition code, and action is taken depending on the new condition code. All NAR messages are filed until incorporated into the (approximately annual) revision to the Naval Sea Systems Command (NAVSEA) publication listing all Navy ammunition that is unserviceable, suspended, or of limited use (NAVSEA TWO24-AA-ORD10, 1989).

B. INTERFACE WITH EXTERNAL SYSTEMS

The current shipboard ammunition management system does not exist in isolation from inventory management at higher levels. The forms and reports discussed above exist not only to assist shipboard decision makers in managing ordnance inventories but serve to keep higher eschelon commanders informed of ammunition inventories for the squadron, group, and fleet. While the automation boundary of the proposed ARMIRS system stops at the brow of a single ship, it is important to recognize the place of shipboard ammunition management in the larger scheme of Navy-wide logistics.

The Navy's Conventional Ammunition Integrated Management System (CAIMS) is directed by the Navy Ship's Parts Control Center (SPCC) at Mechanicsburg, Pennsylvania. CAIMS is an integrated management information system using large scale automatic data processing equipment designed to provide daily updates of ammunition inventories to Fleet-level and Navy Department commanders (OPNAVINST 8000.13, 1971, p. 3). It is therefore the Navy's central repository of ammunition inventory information. However, CAIMS is more than just an inventory tool. It is also used for readiness assessment, operational decision making, technical evaluation, procurement planning, and budget determination (Swanson, 1977, p. 23). The ATRs submitted to SPCC form the interface between the ship and the central CAIMS database. SPCC provides information to ships in the form of quarterly reconciliation reports. These reports reflect data on selected items from the ship's inventory according to the CAIMS

database. The reconciliation report is compared to the (manual) inventory records and CAIMS is updated with an ATR from the ship. SPCC also provides feedback to ships on erroneous ATRs. For example, a ship is notified by naval message if there is a missing ATR or if an ATR serial number out of sequence.

The Naval Ordnance Management Information System (NOMIS) is installed at major ordnance facilities ashore.[6] The NOMIS stock records are the official inventory records of the weapons station. This system provides information support for the receipt, storage, segregation, issue, and movement of conventional ammunition ashore (NAVSEAINST 8015.1A, 1988, p. 2). ATRs from shore installations are transmitted to CAIMS via AUTODIN. Just as in the ship-to-CAIMS interface, accurate and timely transaction reporting is the cornerstone of CAIMS accuracy. The interface between NOMIS and the fleet is through the requisitions and turn-in documents generated onboard.

C. PROCESS SCENARIO

The following sample transaction history (adapted from SPCCINST 8010.12D, 1988, p. 12-1-B1) illustrates how the forms, reports, logs, and files discussed above are used together in a typical shipboard ammunition management situation.[7] While this scenario does not fully describe the information flow and requirements of ARMIRS, it does help illustrate characteristics of the current manual system and aids in defining the problems with the *status quo*.

1. (900210) Opened new master stock record card with quantities carried over from previous records. Posted 746 to ONHAND BALANCES (CONDITION CODE "A") and 150 to UNEXPENDED TRAINING ALLOCATION.[8] Itemize the master card quantity by lots and copy the information to the new lot cards.
2. (900312) Fired 63 rounds in a gunnery exercise. Post 63 to Transaction Type "F". Update the balance to show 683 in Condition Code "A". Reduce UNEXPENDED TRAINING ALLOCATION to 87. Use the ATR Log to locate the next ATR serial number. Post the ATR serial number to the master card. Copy information to the lot cards. Draft an ATR message and file a copy.

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6 WPNSTA Charleston, WPNSTA Concord, WPNSTA Earle, WPNSTA Seal Beach, WPNSTA Yorktown, NAVORDSTA Indian Head, and NAVUSEAWARENGSTA Keyport.

7 The scenario is for 5-inch gun projectiles aboard a destroyer.

8 Note that UNEXPENDED TRAINING ALLOWANCE is on a fiscal year basis and is reduced any time a training, test, or operations expenditure in posted. A balance cannot be carried over to a new fiscal year. The amount of the authorized Training Allowance (formally known as the Non-Combat Expenditure Allowance, or NCEA) is entered on 01 October of each year.

3. (900313) Requisition 63 rounds to replace the ammunition used in yesterday's gunnery exercise. Use the requisition log to ensure that the next requisition serial number is used. Post requisition R5406600728009 to DOCUMENT NUMBER and post 63 rounds to QUANTITY DUE IN.

4. (900325) Fired 12 rounds for test. Post 12 to Transactions, Type "G". Reduce ONHAND Condition "A" to 671 and UNEXPENDED TRAINING ALLOCATION to 75. Prepare the next ATR message and post the report serial number to the ATR block on the master card. Update the quantity on the lot card.

5. (900429) Received the 63 rounds ordered last month. Post R5406600728009 to DOCUMENT NUMBER and Transaction Type C. Increase Condition Code "A" amount to 734. Reduce QUANTITY DUE IN to 0. Update the Requisition Log. If these new rounds are from a different lot, create a new lot card and transfer the information from the master card. Prepare an ATR and update the ATR Log.

6. (900515) Receive a Notice of Ammunition Reclassification (NAR) regarding the suspension of one lot. Post quantity 21 to Transaction Type "X". Reduce Condition Code "A" to 713 and open a balance of 21 in Condition Code "J". Prepare an ATR to report the change in Condition Code.

7. (900604) Fired 32 rounds in another gunnery exercise. Posted 32 to Transaction Type "F". Reduce Condition Code "A" to 681. Reduce UNEXPENDED TRAINING ALLOWANCE TO 43. Prepare ATR message and post the report serial number to the ATR block on the master card. Update the lot card.

8. (900704) Receive a NAR regarding the lot in Condition Code "J". The lot is declared unserviceable. Post 21 rounds to Transaction Type "X" and Condition Code "H". Reduce Condition Code "J" by 21. Prepare an ATR to show the change in Condition Code.

9. (900806) Offload the 21 unserviceable rounds at Naval Magazine Lualualei, HI. Prepare a DD Form 1348 turn-in document and enter the document number on the master card and in the Turn-In Log. Adjust the quantities on the inventory card, decreasing Condition Code "H" by 21. Prepare an ATR to report the transfer.

D. PROBLEM DEFINITION

The preceding overview of the current manual system for shipboard ammunition management helps define some of the problems with the exisiting system:

- The system is inefficient because it often requires the same information to be written more than once (e.g., copy data from master cards to lot or serial cards).
- Filing of inventory cards only by NALC and NIIN limits the flexibility and value of the system. Sorting and displaying ammunition inventory information by other attributes would require annotating and refiling each card.
- Extracting information from many inventory cards, logs, files, and publications is time consuming.
- There are no reliable and easily accessed indicators of undesirable situations (e.g., expired maintenance due dates, low stock levels, or low training allowance balances).

- Working with the current system is highly repetitive and can be especially frustrating for inexperienced personnel.
- The error-prone manual ammunition management system undermines the reliability of the Navy-wide CAIMS database which depends on accurate and timely transaction reports.
- The manual preparation of complex and time-consuming forms and reports (especially ammunition transaction reports and requisitions) is an inefficient use of personnel.

This chapter has defined the data and processes involved in the current manual system of afloat ordnance management. An analysis of these forms, reports, and procedures helps define the problem domain. In the next chapter, an information model is used to describe the vocabulary and conceptualization of this problem domain.

III. REQUIREMENTS VERIFICATION

The previous chapter defined the problem domain for shipboard ammunition management. This chapter is concerned with building a model of the information in that domain. This information model identifies and abstracts what is in the problem. Similar "things" in the problem are identified and abstracted as *objects* We will see how this process of object definition helps formalize knowledge about ordnance management on U.S. Navy ships. After the objects are defined, a model of the system's data (i.e., object) flows is constructed to aid application analysis.

A. DATA REQUIREMENTS

1. Object Overview - Modeling the User's View

An object, as defined by Shlaer and Mellor (1988, p. 14), is an abstraction of a set of real-world things such that (1) all of the real-world things in the set (the instances) have the same characteristics, and (2) all instances are subject to and conform to the same rules. These two characteristics help define objects that allow simple operations on the data that are easy to understand and easy to get right.

Identifying the objects in shipboard ammunition management is straightforward. We start by asking, "What are the *things* in the ordnance inventory, requisitioning, and reporting problem?" These ammunition-related things fall into two broad categories: (1) tangible things, and (2) incidents or interactions.

Tangible things are the easiest objects to find. Given the problem discussion in the last chapter, we clearly have ammunition as a tangible object. But we have different requirements for capturing information on this ammunition. Is it ammunition we have onboard (AMMO INVENTORY object) or ammunition we want to obtain (REQUISITION and LINE ITEM objects)? It is also important how this ammunition is controlled and accounted for. Some ammunition is uniquely identified by the serial number on an individual piece of ordnance. Other rounds are identified by just a lot number. Requirements also exist to identify some ammunition by both serial and lot number. Some ammunition has neither lot numbers nor serial numbers. These different views of the problem require different objects. In addition, we need to capture information about our ship and about the ship or weapons station participating in our ammunition transactions (COMMAND object). From our knowledge of the tangible things involved in ammunition management, the following objects are easy to identify:

- COMMAND
- REQUISITION
- REQN LINE ITEM
- AMMO INVENTORY
- LOT CONTROLLED AMMO
- SERIAL CONTROLLED AMMO
- SERIAL & LOT CONTROLLED AMMO

Incident or interaction objects represent an event (something which happens at a specific time) or have a "transaction" quality (relating to two or more other objects in our model). Incidents (like expending ammunition during a gunnery exercise) or transactions (like receiving requisitioned torpedoes from the naval weapons station) result in changes to a ship's ammunition inventory. Information about these changes is captured in the TRANSACTION object.

Object diagrams, like those in Appendix A, are pictures of the user's perception of an object in the work environment. These objects diagrams help to summarize knowledge of an object and to present it visually and unabiguously. The diagrams in Appendix A follow the object diagram conventions of Kroenke and Dolan (1988, pp. 91-97). The eight objects in the ARMIRS database are represented as eight boxes. Inside each box is a list of all properties of that object. Some of the properties are written in lowercase letters, while others appear in uppercase letters and are enclosed in boxes themselves. Some of these properties have the letters MV next to them. The paragraphs that follow examine the object diagrams in Appendix A while discussing the object properties.

2. Object Descriptions

a. COMMAND Object

The COMMAND object (Figure 1) includes ten properties. Each property represents an important characteristic of the ship or shore activity involved in an ammunition transaction, such as the unit identification code (UIC), the ship or station name (Name), and descriptive information about the ammunition in the command's inventory (AMMO INVENTORY - MV). The first eight properties listed (see Appendix A) are non-object properties. The last two, which are capitalized and enclosed in boxes, are object properties. An object property is a characteristic of the entity that is actually another object (Kroenke and Dolan, 1988, p. 91). As a result, there are other object diagrams for REQUISITION and AMMO INVENTORY. The REQUISITION object

will contain properties of the ammunition requisitions sent by a ship and the AMMO INVENTORY object will contain properties of the ordnance held onboard. This is an example of one object "containing" other objects. Since a command instance is uniquely identified by a UIC, this object identifier is distinguished from the other properties by an asterisk in the object diagrams.

The COMMAND object includes properties that are allowed to have a single value while others are allowed to have multiple values. For example, a command instance is allowed to have only one value for UIC. However, AMMO INVENTORY and REQUISITION are allowed multiple values (indicated by the letters MV) because a command holds many inventory items (the instances represented by the Master Stock Record cards) and many requisitions (each instance is an entry in the command's Requisition Log or File).[9]

b. REQUISITION Object

The REQUISITON object (Figure 1) contains general information about ammunition requisitions sent from one command and filled by another. This object does not contain desired NIINs or quantities. That information is found in REQN LINE ITEM. The instance of the REQUISITION object is a single requisition header (either DAAS, naval message, or DD Form 1348) uniquely identified by a document number. A requisition contains one or more line items (described in detail in the REQN LINE ITEM object) for each type of ammunition desired. A requisition also includes a document identifier and security classification and may contain remarks (depending on the requisition format chosen). The requisition is addressed to multiple action or information addressees in accordance with fleet instructions and depending on the type of ordnance desired.

c. REQN LINE ITEM Object

The information in this object (Figure 2), found at least once in every requisition, is represented by a single line on an ammunition requisition. A separate line is used for each NIIN. For example, on a single requisition for Harpoon missiles, shotgun rounds, and signal flares, we would find three different line items. Each line item contains information on the quantity desired as well as the desired delivery date. A requisition line may have a classification different (but not higher) than the entire requisition. Since a

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9 As Kroenke and Dolan (1988, p. 94) point out, whether a property is single or multiple-valued has nothing to do with whether it is an object or non-object property. Note that the COMMAND object happens to contain single-valued, non-object properties and multi-valued, object properties only by coincidence.

line item is associated with only one requisition, the REQUISITION object is a single-value, object property of this object. (Obviously a line item does not exist alone without a requisition header.) A line item instance may be associated with one Master Stock Record Card so that many of the properties of INVENTORY (i.e., unit of issue and COG symbol) are "contained" in the REQN LINE ITEM object and found on ammunition requisitions.

d. AMMO INVENTORY Object

An instance of the AMMO INVENTORY object (Figure 3) is the descriptive header on a single Master Stock Record Card. With instances uniquely identified by NIIN, this object captures information on ammunition held by a command (i.e., allowance, shipboard location(s), and COG symbol). The history of inventory balance changes for that NIIN is captured in the TRANSACTION object discussed below. The AMMO INVENTORY object also contains the total quantity on hand as posted from ammunition transactions. Associated with an AMMO INVENTORY instance may be one or more lot controlled, serial controlled, or serial and lot controlled objects. REQN LINE ITEM is also a multi-value, object property of AMMO INVENTORY.

e. LOT CONTROLLED AMMO Object

Lot controlled ammunition (Figure 4) is uniquely identified by lot number and has one or more shipboard stowage locations. AMMO INVENTORY is a single-value, object property here because of the one-to-many relationship between the Master Stock Record Card (AMMO INVENTORY properties) and the Lot/Location Card(s) (LOT CONTROLLED AMMO properties). TRANSACTION is a multi-value object property since one ammunition lot has one or more transactions.

f. SERIAL CONTROLLED AMMO Object

The serial number is the object identifier for this object (Figure 4). The non-key attributes include maintenance due date, type of maintenance due code, and a stowage location. As with the LOT CONTROLLED AMMO object, AMMO INVENTORY is a single-value, object property here. In addition, the TRANSACTION object is a property of SERIAL CONTROLLED ammunition. One serial number has one or more associated transactions.

g. SERIAL & LOT CONTROLLED AMMO Object

This object includes all of the properties found in the previous object with the addition of the lot number.

h. TRANSACTION Object

A TRANSACTION instance is represented by one of the lines on the balance history section of a Master Stock Record Card. This object (Figure 5) therefore includes AMMO INVENTORY as a single-value, object property. Every balance change is uniquely identified by a single line on a serially numbered ATR. Every ATR has multiple addressees. Single-value, non-object properties of this object include the transaction date, the old balance, the quantity issued/received/expended, and updated condition code. Since a TRANSACTION can involve any of the three ammunition control categories discussed above (or none of them for non-SLIT transactions), a diagonal line in the corner of these object boxes indicates that only one (or none) of these object properties may apply in a TRANSACTION instance.

3. Object Specifications

Appendix B presents the complete object specifications for ARMIRS. The appendix consists of two parts: (1) object definitions, and (2) domain definitions. Object definitions, as used by Kroenke and Dolan (1988, p. 108), list all the properties of an object and indicate the domain from which values for each property can be drawn. The domain definitions specify formats, lengths, and special restrictions on the values of each domain. Note that the domain definitions are separate from the object definitions. This helps reduce duplicate domain definitions because one domain may be used for multiple properties. For example, the same domain (Navy command names) can be used for both COMMAND.Names and REQUISITION.Addressees.

The object specifications in Appendix B are detailed enough to be used for the next phase--database design.

a. Object Definitions

The object specification syntax used by Kroenke and Dolan (1988, pp. 108-110) is used is this work. The first part of Appendix B includes the object definitions. All of the properties of an object are listed. A semicolon separates the name of each property from its domain. If the domain is another object but only some of the properties are carried over to the object being defined, then the word SUBSET is used and the properties of the foreign object are enclosed in brackets. For example, COMMAND is a foreign object in AMMO INVENTORY, with only the properties UIC, Name, and Hull Number applicable to the user's view of COMMAND data in AMMO INVENTORY.

b. Domain Definitions

The second part of Appendix B contains the domain definitions which describe the set of values from which an instance of a property may be drawn. These domain definitions also follow the Kroenke and Dolan (1988, p. 110) syntax. They include both physical and semantic descriptions. The physical description may contain a mask--a restriction on the allowable values. For example, "Fund codes" is a domain whose description includes a mask specifying that the first digit must be a letter and that the last digit must be the number six. In the physical descriptions, "numeric" means the digits 0 through 9, "alphabetic" means the letters A thorough Z, and "text" includes letters, numbers, and symbols.

B. APPLICATION (FUNCTIONAL) REQUIREMENTS

1. Dataflow Diagrams

One widely used tool for studying business functions is the dataflow diagram. Dataflow diagrams (DFDs) help determine how the organization creates, edits, deletes, and displays objects. DFDs also serve as a clear and convenient communication tool for users and analysts. Even in situations where automation is not of interest, DFDs are used for problem analysis. For example, this tool has been used to document and analyze physical product flows in manufacturing firms as well as information flows in service organizations (Kuehn and Fleck, 1990, p. 10).

As Yourdon (1989, p. 140) pointed out, DFDs are particularly valuable for operational systems in which the *functions* of the system are of paramount importance and more complex than the data that the system manipulates. The DFD is just one of the modeling tools available to study the shipboard ammunition management process. It provides only one view--the functional view. The DFD is a useful tool in ARMIRS systems analysis because it aids in representing the key functions of the current manual system and helps identify the flow of data and the actions on objects.

This thesis uses the popular "Yourdon and DeMarco Methodology" for DFDs and follows the conventions used in Yourdon's (1989, pp. 139-187) classic work. The diagrams in Appendix C illustrate the use of typical Yourdon-style components in a series of leveled diagrams. These components include the process, the flow, the store, and the terminator.

The first component of the DFD is known as the process, represented graphically by a circle. The process is named with a verb-object phrase that describes what the

process does such as GENERATE REQUISITIONS, MANAGE INVENTORY, or GENERATE REPORTS.

The flow is represented graphically by an arrow in or out of the process. The flow describes the movement of data packets from one part of the system to another. As shown in the diagrams in Appendix C, the packets carried by these flows could be physical objects such as ONLOADED AMMO. Flows can be split into several more elementary data packets. For example, the dataflow ALLOWANCE in Figures 6 and 7 is split in Figure 8 into MISSION ALLOW, NCE ALLOW, and SHIPFILL ALLOW.

The store models a collection of data packets at rest. The notation for the store is two parallel lines. A store might consist of ammunition stock records in a card file or ammunition requisitions in a file folder. Figure 7 shows the five stores in the manual ammunition management system.

The context DFD (Figure 6) shows the terminators (sources and sinks) in the system; they are graphically represented by a rectangle. Terminators are the external entities with which the system communicates These entities (like "User" in Figure 6) may be internal to the organization but outside the control of the system being modeled. In the ammunition management environment, these terminators include the shipboard user, the weapons station or other ship, DAAS, SPCC, and NAVSEA.

The ARMIRS bubbles (processes) are numbered according to Yourdon's (1989, pp. 165-171) hierarchical system of leveled diagrams. Figure 6 consists of only one bubble (Process 0) representing the entire system; the dataflows show the interfaces between the shipboard ammunition management process and the external terminators. As shown by Figure 7, the DFD directly below the context diagram (called the Level 0 Diagram) represents the top-level view of the three major functions of the system, as well as the interfaces between those functions. These bubbles are numbered 1, 2, and 3. Each of these three processes is associated with a lower-level DFD (Figures 8, 9, and 10 respectively).

2. Description of Dataflow

The DFDs can be examined by tracing the flow of data in Figure 7 using the objects defined in the preceding sections. In Process 1 (Manage Inventory), the Gunnery Officer Petty Officer updates information on the ship (COMMAND object) as required and uses updated fleet instructions and references to update the ARMIRS rule base (explained in greater detail later in this thesis). The inventory cards (representing the AMMO INVENTORY, SERIAL, LOT, and SERIAL & LOT CONTROLLED AMMO objects) are updated as onloaded ammunition is received and checked. Other

inventory modifications (new instances of the TRANSACTION object) are generated when ammunition is expended. Updated allowances are also processed and Notices of Ammunition Reclassification (NARs) are compared to the AMMO INVENTORY instances to determine which NARs pertain to the command.

The process of generating requisitions (Process 2) begins with the user's decision on desired ammuntion. After reviewing the Requisition File (representing properties in the REQUISITION object) and using ship (COMMAND object) information with the system rules, a requisition header (new instance of the REQUISITION object) is created. After selecting the desired requisition format, multiple items (REQN LINE ITEM object) are added to the message header to include the desired ammunition. After the requisition is sent, requisition status messages are periodically received onboard. The information from these messages is used to update entries in the Requisition Log (updating the REQN LINE ITEM and REQN objects). A similar, but simpler, process is used to generate turn-in documents. Only one format is used for the DD Form 1348 turn-in document that accompanies offloaded ammunition.

The third major function of the shipboard ammunition management system generates internal and external reports. Internal summary reports may draw data from all the files (and from all the objects) in the system to produce a variety of reports for shipboard decision makers in response to user queries. For example, Serial/Location cards in the inventory card file (SERIAL and SERIAL & LOT CONTROLLED AMMO objects) are reviewed for a report on ordnance with soon-to-expire maintenance due dates. Allowance data from the Master Stock Record Cards (AMMO INVENTORY object) is compared with current balance (posted from TRANSACTIONS) to produce a report allowing the tracking of training allowance expenditures throughout the fiscal year. ATRs are also produced by Process 3. Every inventory transaction (corresponding to new instances of the TRANSACTION object) requires a transaction report that draws information from the inventory cards (and objects), the ship (COMMAND object) information, and the rule-based expertise (e.g., determining the ATR addressees).

The dataflow diagrams in Appendix C illustrate the three key ARMIRS functions discussed above: inventory processing, requisition management, and report generation. Obviously some of these processes seem to overlap (e.g., both Process 1 and Process 3 update instances of the TRANSACTION object). Figure H1 in Appendix C helps relate the three ammunition management functions to the eight objects defined earlier in this chapter. Rather than using several logs and files to store information, a

single database is used to store the objects. The three ARMIRS functions read and/or write object information as shown by the arrows in Figure 11. The specific functional components of these applications and objects are discussed in the following sections.

3. Application Functional Components

a. Inventory Management

The inventory management process (Process 1) reads and writes four objects as discussed below:

(1) Read and Write the COMMAND Object. As shown in the Level 0 Diagram (Figure 7), the Gunnery Officer (through Process 1) writes the COMMAND object which is later read to generate requisitions (Process 2) and reports (Process 3). Figure 12 in Appendix D shows the form used to both update and display the COMMAND object. When the ARMIRS system is first installed aboard a ship, the Database Adminstrator enters the UIC, command name, hull number, and service code. This information will not change as long as the system remains onboard and the ship remains in commission. As the ship's location and fleet commander change, this form is also used to update the database. For each requisition or transaction, information on the other command involved (either another ship or a weapons station) is entered. This form is also used to display command information even when updating is not required.

(2) Read and Write the AMMO INVENTORY Object. As shown in Figure 11, the inventory management process reads and writes ammunition inventory data. This information is entered into the database by a form similar to the one shown in Figure 13. This form captures information in the AMMO INVENTORY object and is similar to the Master Stock Record Form used in the manual system. The upper part of the form is used to record descriptive information (AMMO INVENTORY object) about a particular NIIN held in inventory. This form, like the Command Information Form discussed above, is used both to update (including creation or modification of an object instance) and display information in response to user queries. For example, if the user wished to see all of the inventory records for torpedoes, he would enter the torpedo COG of 4T in the "COG" field in Figure 13. Using the query-by-example facility, the user would then be able to page through a series of inventory screens (Figure 13) for torpedoes. As a result, the inventory form is a dual purpose form. Some of the data in the form's fields would be typed in by the user and others would be provided by the database, depending on whether append (update for a new instance), update, or display options were selected from a system menu.

The update and display mechanisms used with this object (as well as for the other objects discussed below) are fully described in Appendix E.

(3) Read and Write the TRANSACTION Object. Changes to the command's ammunition inventory are made through use of the form shown in Figure 13 and discussed above. The middle part of that form is used to update and display information on how the inventory quantity and condition have changed (TRANSACTION object). The bottom area on the Figure 13 form is used for more detailed information on the ATR generated (from the TRANSACTION object) for each transaction. For example, in an ammunition receipt transaction, the quantity, date, and document number of the DD Form 1348 accompanying the ammunition would be entered. The system would add the old balance to the quantity received to give a new balance. This quantity is then posted to the AMMO INVENTORY object and becomes the balance brought forward for the next transaction. The expert database system discussed in Chapter VI (when used) would provide the information on the "Addressees" field of Figure 13. In addition, the lower part of the Serial/Lot Information Form (Figure 14) is used to display TRANSACTION data for ammunition with serial and/or lot numbers. Appendix E describes the adding (posting), editing, and deleting of TRANSACTION instances.

(4) Read and Write LOT, SERIAL, and SERIAL & LOT AMMO Objects. The form shown in Figure 14 is also used to update and display database information on serial and lot ammunition in the inventory. The serial and/or lot number is entered on the top part of the form. The lower part of the form, drawn from the TRANSACTION object, allows update and display of inventory transactions affecting SLIT-controlled items. For example, to display information on a particular Harpoon missile, the serial number would be entered and the form (corresponding to both the Serial/Location and Lot/Location cards in the manual system) would be displayed with all applicable data fields completed. If the user did not have the serial number available but knew the NALC for Harpoon missiles, the NALC would be entered in the query-by-forms mode and the user could page through a series of screens, one screen for each Harpoon missile onboard.

b. Requisition and Turn-In Generation

The requisition and turn-in generation process uses the the forms discussed above and the Requisition Information Form (Figure 15) to:

(1) Read the COMMAND Object. The COMMAND object is used by this process to furnish data on the originating and receiving commands for ammunition requisition and turn-in documents.

(2) Read the AMMO INVENTORY Object. Turn-in documents and requisitions use descriptive ammunition information from this object.

(3) Read the TRANSACTION Object. As discussed in the detailed functional component descriptions (Appendix E), the generation of turn-in documents requires TRANSACTION information.

(4) Read SERIAL and/or LOT CONTROLLED AMMO Objects. If a turn-in item is controlled by serial number or lot number, then the applicable object must be read by this process to generate turn-in documents. Items are not requisitioned by specific serial or lot numbers.

(5) Read and Write REQUISITION and REQN LINE ITEM Objects. Ammunition requisitions are created, updated, and displayed using the form shown in Figure 15. To create a new requisition, the user would enter all the information shown on the form. REQUISITION object information is used to construct the message header. The individual REQN LINE ITEM instances are created by completing the lower half of the form. As requisition status messages on these line items are received by the ship, the "Status" field is updated. To review a requisition, the user would type in the document number in the appropriate field and the system would display that requisition.

c. Generate Reports

This process reads all eight ARMIRS objects to produce ATRs and internal reports. In addition, Process 3 writes TRANSACTION data to the database when the ATR serial number is assigned to a transaction.

4. Interapplication Requirements

Coordination of data processing and the sequential relationship between Process 1 (Manage Inventory) and the other processes (Generate Requisitions and Generate Reports) require that initial data entry about the ship and the ammunition inventory be completed before the system can be fully utilized. This initial entry is accomplished using the forms shown in Figures 13 and 14 as previously discussed. If an item is controlled by serial and/or lot number, a Master Stock Record must be created before transactions can be applied and posted. Transactions to SLIT items must be processed through the transaction section of the form in Figure 13. As in the manual system, a Serial/Lot Record cannot exist without the parent master record.

A prerequisite for full use of the requisition generation function (Process 2) requires information on the commands involved (using Figure 12) as well as user input on

the type and quantity of ammunition desired (using the form in Figure 15). The user must also select a requisition format in order to output a requisition.

In a similar way, Process 3 (Generate Reports) requires that the database already contain information on ammunition and requisitions before selected reports can be considered complete and accurate. Transaction reports can be generated only after the inventory has been updated to reflect the balance changes. In addition, operation of the ATR expert database system (or user input if the expert system is not used) must be completed before an ATR is ready for transmission.

5. Operations Requirements

a. System Operation

Because of the high frequencies and volumes required for the update and display activites shown in Appendix E, full use of ARMIRS requires a robust and dependable system. It is especially important that the system is fully operational during periods of high ammunition transaction volume. These periods include:

- Immediately prior to a deployment when major ammunition onloads are scheduled.
- Before an overhaul period when ship-wide offloads are required.
- After drydock periods when ammunition magazines must be refilled.
- During refresher training and other training periods when expenditure of ammunition is high.
- After combat operations requiring ammunition expenditure.
- Prior to repairs in or near ammunition magazines requiring a partial offload.

b. Backup and Security

Procedures for system backup and security contribute toward the overall operational readiness of ARMIRS. Backups are recommended after every three to four minor transactions or weekly (whichever comes first). More frequent backups may be required if system volumes and frequencies exceed those shown in Appendix E. In addition, a backup copy of the supporting microcomputer DBMS should be stored in a secure location. Strict enforcement of backup procedures will simplify the task of data and system recovery.

Although an essential component of a working ARMIRS system, backup procedures and logic are not specified in this thesis. A variety of generic microcomputer backup tools are commercially available. Custom design of ARMIRS-specific backup software is not necessary when compatible backup software is so common.

The security of ARMIRS data also requires attention. Some ARMIRS data (e.g., some ATRs and requisitions) and the ammunition inventory taken as a whole are classified Confidential. Password administration and control, assigned access, physical security of the microcomputer (and backup data disks), and protection against compromising electronic emissions are required. As with backup systems, software already exists to encrypt data and protect against unauthorized access. Although essential to eventual implementation, the specific security software selected does not impact database design and is beyond the scope of this thesis.

c. Users

The users of ARMIRS data include:

- Routine Users: Gunnery Officer, ASW Officer, Gunner's Mates (Gun and Missile) and Torpedomen.
- Database Adminstrator (Weapons Officer) to establish and enforce procedures for:
  - Database backup and recovery
  - Data and system security (passwords and physical security)
  - System application maintenance
  - Training of system users
- Occasional (Query Only) Users: CIC Officer, Operations Officer, Commanding Officer, and inspectors receiving ARMIRS information through reports processed by routine users as intermediaries.

6. Administrative and Environmental Requirements

As Database Administrator (DBA), the Weapons Officer will supervise operation of ARMIRS. In addition to the specific responsibilities listed above, the DBA will be responsible for initial system setup and bulk data entry. During initial conversion from the manual system, a large volume of database entries will be made as data is transferred from the stock record cards, ATR logs, and requisition files. An improved sytem for this initial bulk data entry could be implemented in a later version of ARMIRS.

The unique and demanding shipboard environment imposes additional constraints on hardware requirements. TEMPEST-approved Zenith 248 microcomputers (PC AT[10] equivalents) and printers are available on many Navy ships and could be utilized for ARMIRS use.

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10 PC and PC AT are trademarks of International Business Machines Corporation.

IV. LOGICAL AND APPLICATION DESIGN

This chapter uses the objects and relationships defined in Chapter III to develop the ARMIRS relational schema. This view of the object relationships, together with the previously discussed object/data flows, is then used to design the application menus.

A. LOGICAL DESIGN--TRANSFORMATION OF OBJECTS

The transformation of the ARMIRS objects into relations is described below for each object. The overall view (schema) of these relations is shown in Appendix F.

1. COMMAND Object

The COMMAND object consists of two multi-valued object properties (REQUISITION and AMMO INVENTORY) and eight non-object properties. An instance of COMMAND is a Navy activity identified by a Unit Identification Code (UIC). The relation shown in Appendix F shows COMMAND (with UIC as the key attribute) as the parent relation and REQUISITION (keyed on Document Number) as one child and AMMO INVENTORY (with NIIN as the key) as another.

Both relationships are described as one-to-many. This type of relationship is shown as a forked line, with the fork on the "many" side of the relationship. One command has many NIINs in its ammunition inventory and many Document Numbers in its Requisition Log. In a one-to-many relationship, the key of the parent relation (UIC) is placed as a foreign key in the child relation. Both relationships have a mandatory-to-optional constraint. Every requisition must belong to a command (actually two COMMANDS, the ARMIRS ship [S_UIC] and the other command involved in a transaction [O_UIC]). However, it is possible to have a command without a requisition. An inventory item exists somewhere; it always belongs to a command. However, a command (in the ARMIRS view) would not exist without an ammunition inventory. In the relation diagram (Figure 16), the circle shows the optional side while the bar shows the mandatory side.

2. REQUISITION & REQN LINE ITEM Objects

The REQUISITION object consists of two COMMAND object properties, one multi-value object property (REQN LINE ITEM), one multi-value non-object property (Addressees), and five single-value non-object properties. The Document Number uniquely identifies a single requisition.

REQN LINE ITEM includes several single-value non-object properties and two single-value object properties (REQUISITION and AMMO INVENTORY). An instance of this object is a line on a requisition identified by *requested* NIIN. This NIIN may or may not be a NIIN currently in INVENTORY.

The relationship between REQUISITION and REQN LINE ITEM is clearly one-to-many. A requisition has one or more ammunition items on it, but the line items belong to one requisition. A parent-child relationship exists and Document Number becomes a foreign key in REQN LINE ITEM. This is a mandatory-mandatory relationship because a requisition must have at least one line item (or the ship would not be requisitioning anything) and a line item could not exist alone without a requisition header.

Requisition Addressee is a multi-value non-object property of REQUISITION. Like all composite objects, more than one relation is required for representation. One requistion must have multiple information or action addressees. Document Number is therefore a key (and also a foreign key) in the REQ-ADDR relation.

3. AMMO INVENTORY Object

The large AMMO INVENTORY object consists of five multi-value objects, a single-value object (COMMAND), two multi-value properties (Mission Area and Stowage Location), and many properties with single values. A NIIN uniquely identifies a particular type of ammunition in inventory.

There is a one-to-many relationship between AMMO INVENTORY and both the REQN LINE ITEMS and TRANSACTION objects. As a result NIIN becomes a foreign key in the child relations. The relationship between INVENTORY and TRANSACTION is mandatory-mandatory because a NIIN instance (a Master Stock Record Card) will always have at least one transaction (even if it is only the balance change that brought it to the ship). Of course, a balance change could not exist without a parent inventory.

Two composite objects (AMMO-MISSN and NON-LOT LOC) are also represented in the relational AMMO INVENTORY schema. Operational reporting (i.e., SORTS message) requirements require shipboard personnel to assign one or more combat mission areas to a NIIN if the item supports an identifiable combat mission. A NIIN may have more than one mission area. For example, a certain type of 5-inch gun projectile could be used both in anti-surface (ASUW mission area) and naval gunfire support (AMW mission area) roles. Assignment of these SORTS report mission areas is not required for all NIINs; some inventory items (e.g., small arms ammunition and

pyrotechnics) are not assigned to mission areas. The relational diagram shows this one-to-many, mandatory-optional relationship.

The second AMMUNITION INVENTORY composite object is NON-LOT LOC. This relation expresses the assignment of multiple shipboard stowage locations to non-SLIT NIINs. (Assigning locations to the serial and/or lot items is handled in other relations.) One NIIN may be distributed to many ammunition lockers and magazines. Every NIIN onboard must have a shipboard stowage location. An empty stowage location is not of concern for ARMIRS purposes.

4. TRANSACTION Object

As discussed in the preceding section, TRANSACTION is the child relation in the one-to-many relationship between AMMO INVENTORY and TRANSACTION. As a result, TRANSACTION inherits NIIN as a foreign key.

Each transaction has multiple addressees for the ATR. A transaction cannot be considered complete without ATR addressees.[11] This composite object is also shown in the relational diagram.

The relationship between TRANSACTION and the three SLIT categories is discussed in the next section.

5. SERIAL and/or LOT CONTROLLED AMMO Objects

These three objects, like their siblings TRANSACTION and REQN LINE ITEMS, are characterized by one (AMMO INVENTORY) to many (SERIAL and/or LOT CONTROLLED AMMO) relationships. In each case, the key of the parent (NIIN) becomes a foreign key in the child relation.

All three of these relationships with AMMO INVENTORY are mandatory-optional. An inventory item may be non-SLIT (having neither serial nor lot numbers). However, the SLIT items can only exist as a part of inventory; they can have no existence alone.

Each of the SLIT objects contain TRANSACTION as a multi-value object property, shown as three one-to-many relationships in Figure 16. Lot Number and Serial Number are foreign keys in this relation. For non-SLIT items, these foreign keys would have null values. As with the AMMO INVENTORY object, the three SLIT relations must always have at least one transaction (even if it is just the receipt transaction from an initial onload). Of course, a TRANSACTION instance could apply to a non-SLIT item.

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11 The rules for determining these addressees is shown in Appendix L.

Shipboard stowage location is a composite object (LOT-LOCATION) for ammunition controlled only by lot number. A lot may be distributed among multiple ammunition lockers and magazines. A lot number in inventory must have a shipboard stowage location. Again, there is no requirement to recognize empty lockers and magazines.

Ammunition controlled by serial number has location as a single-value property because a serial number designates one ammunition round with only one location.

B. APPLICATION DESIGN

1. Application Scope

As previously discussed, application of ARMIRS falls naturally into three primary functions: inventory management, requisitioning, and report generation. Routine ARMIRS users are involved in all three processes; occasional (query-only) users include middle and upper management whose interaction with ARMIRS is only through the report generation function, often with the Gunnery Officer as intermediary. All of the ARMIRS processing responsibilities could be handled by one person, if necessary. Obviously a single-user application is appropriate. In ARMIRS, each user's view is fully inclusive. Of course, some restrictions on access are desirable to protect classified inventory data. These security mechanisms (e.g., password systems, encrypted data, etc.) will be provided by software outside ARMIRS or other (e.g., physical security) safeguards.

All three of the ARMIRS functions can be run from the same microcomputer. This microcomputer could be located in the Weapons Department office where many ships maintain their manual records. The frequencies and volumes shown in Appendix E make it clear that a single-user system is appropriate, even on larger ships. There is not even a requirement to put certain ARMIRS functions on different shipboard computers. All authorized ARMIRS users would have the same processing rights.

2. Control Mechanisms

a. Selection of Control Method

One of the most important decisions in the design of the ARMIRS user interface is the selection of the transaction control method, since it determines how and whether the shipboard user will be able to control the application. A menu-driven system would minimize cognitive demands on ARMIRS users. Users would not need to learn any special function keys or commands. Menu screens show the only options available at the time; the users do not have to recall specific system functions.

This does not mean that menus are without problems. Experienced users, while finding menus helpful at first, may find them tedious after they learn ARMIRS. Having to step through a series of menu screens can be time-consuming and frustrating for the sophisticated user. The use of function keys and commands is appropriate for a user who uses the application frequently (i.e., the Gunnery Officer in the ARMIRS case).

The best solution would be to provide ARMIRS users with *both* menus and commands to control the system. A user could then choose between the two methods. This thesis specifies the menu system for ARMIRS. Design of a command language is not required. Many microcomputer DBMSs support a query language, such as the ANSI-standard Standard Query Language (SQL). When selecting a DBMS for ARMIRS implementation, query language support should be an important consideration.

b. Menu System

The diagrams in Appendix G illustrate the multiple choice, multiple path ARMIRS menus. As shown in Figures 17 through 20, a simple tree structure allows the user to make a series of choices that take him down through lower layers of menus until reaching the desired destination. The top-level menu shown in Figure 17 is the ARMIRS main menu consisting of the basic system options. Implementation of ARMIRS should include designation of one keystroke to return to this menu from anywhere in the menu hierarchy.

ARMIRS uses the "object-action" strategy of menu design. The top menu (Menu 0) refers to three broad object categories: (1) inventory objects (AMMO INVENTORY, TRANSACTION, SERIAL and/or LOT CONTROLLED AMMO), (2) requisition objects (REQUISITION, REQN LINE ITEM), and (3) the Navy activity object (COMMAND). When the user selects one of these options, the lower menus lead him to select an action (e.g., add, edit, generate) to be performed on the objects. Kroenke and Dolan (1988, pp. 269-270) point out that this object-action design is closer to most users' perspective than the alternative action-object structure.

If a user selects one of the four sub-menus shown in Figure 17, he is presented with either a third-level menu (Figures 18, 19, and 20) or a form/report (if he has arrived at an option that does not chain to a lower menu). This menu structured is outlined in the next section.

3. Logic and Design Materialization

The top ARMIRS menu provides the initial user interface and provides five initial options:

1. Inventory Management
2. Requisition/Turn-Ins
3. Reports
4. Ship Information[12]
5. Exit to Operating System

Selection of these first four choices result in the menus outlined below:

1. Inventory Management
   a. Master Stock Records
      1) Append
      2) Edit
      3) Query/Display
   b. Serial/Lot Records
      1) Append
      2) Edit
      3) Query/Display
   c. Process Transactions
      1) Add Transaction
      2) Delete Transaction
      3) Edit Transaction
2. Requisitions/Turn-Ins
   a. Append
   b. Edit
   c. Query/Display
   d. Generate Requisition/Turn-In
      1) DD-1348 Requisition
      2) DD-1348 Turn-In
      3) DAAS Requisition

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12 Selected by the user on a separate menu but functionally part of the inventory management process.

4) Naval Message Requisition

3. Generate Reports
   a. Inventory Reports
      1) Inventory Summary Report
      2) Allowance List Report
      3) NAR Management Report
      4) Allowance Tracking Report
      5) SORTS Message Input
      6) Ship Ammunition Inventory (Summary)
      7) Ship Ammunition Inventory (Detailed)
      8) Maintenance Due Summary Report
   b. Transaction Reports
      1) ATR Generation
      2) ATR Log
   c. Requisition/Turn-In Reports
      1) Requisition Log
      2) Turn-In Log
      3) Outstanding Requisition Report
4. Ship Information
   a. Edit Ship Data
   b. Display Ship Data

The detailed logic for each of these menu options and reports is described in Appendix H. Every menu path is described in a Structured English pseudocode that defines the ARMIRS system logic. Structured English borrows logical constructs from computer programming languages. However, the use of computer jargon is avoided and the specification is easier for system designers and implementers to understand. The use of Structured English in Appendix H to define the ARMIRS menu and processing logic avoids many of the limitations and ambiguities of ordinary English but does not limit understanding only to those who know a particular computer programming language.

V. PHYSICAL DATABASE DESIGN

This chapter translates the relational schema into a series of linked tables using PARADOX. After defining these tables, the ARMIRS reports are implemented.

A. DBMS OVERVIEW

Recall that objects are not stored in a database; they represent things in the user's work environment. There is not yet a DBMS product that actually stores objects (Kroenke and Dolan, 1988, pp. 256-257). In the previous chapter, the ARMIRS objects were transformed into relations. When the user enters a query about an object, the DBMS constructs the object from data in several tables. The process of creating these tables (in the data model of a particular DBMS software package) is called materiaiizing the objects. In this chapter, the abstract ARMIRS objects and relations are implemented into a series of tables which a DBMS uses in running the application.

The first step in this materialization process is selecting a particular DBMS data model. Three microcomputer DBMS software packages were available for ARMIRS object materialization: (1) INGRES for PCs (Version 5.0),[13] (2) DBASE III, and (3) PARADOX (Version 3.0).

INGRES is strongly based in relational database theory; it has a pedigree that streches back to university research in the relational model from the early 1970s. Installed at several thousand sites worldwide, this DBMS has directly or indirectly influenced the design of several other relational systems (Date, 1987, p. iv). INGRES runs in may different environments (e.g., VMS, UNIX, VM/CMS, and MS-DOS), but is not widely used on microcomputers. The author's previous INGRES application development experience (Buzzard, *et. al.*, 1989) resulted in an appreciation of the power of INGRES but disatisfaction at the error-prone PC implementation of this mainframe-oriented DBMS. INGRES supports SQL and includes a visual forms editor allowing form definition directly on the screen. Reports are specified in lines of INGRES report specification code. INGRES implementation would support the ARMIRS application through the use of a form or example query facility (as specified in the requirements analysis).

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13 INGRES is a trademark of Relational Technology, Inc.

DBASE III was considered for ARMIRS object materialization because it has become the *de facto* microcomputer DBMS standard. (Although advertised as "relational", DBASE III and IV (along with FOXBASE and other DBASE language dialects) actually are "relational-like" file-based systems.) As Smith (1987, p. 48) points out, the widespread use of DBASE makes it a good candidate for use in eventual ARMIRS implementation. A significant disadvantage of DBASE is its relatively poor application development facility. Where INGRES uses a visual editor to design screens (forms and menus), DBASE requires programming lines of "@ x,y SAY..." commands to specify the location of all screen elements. In contrast to the fourth generation language (4GL) used in INGRES application development, DBASE uses more traditional (and more difficult) coding techniques.

PARADOX combines the full power and application development tools of INGRES with the widespead acceptance and PC robustness of DBASE III. In PARADOX, both forms and reports are specified visually, requiring no coding. A query-by-example facility is also present. PARADOX's ease of use aided object materialization for this thesis and make it a prime candidate for use in future ARMIRS application development.

B. CONSTRUCTING THE TABLES IN PARADOX

ARMIRS objects were materialized using a multitable design. Using the previously defined object definitions and domain definitions, field names were assigned and field types were specified. Figure 21 in Appendix I shows how the AMMO INVENTORY object was tranformed into a table. All of the single-value non-object attributes are listed with the key attribute (AMMO INVENTORY.NIIN) listed first and shown with an asterisk. The domain definitions were then used to enter the appropriate field type in the table definition form. The domain definitions were adjusted if required to fit the PARADOX syntax while preserving the previously defined ARMIRS physical constraints. For example, the attribute FSC consists of four numerals, which can include leading zeros (e.g., 0087) important for precisely formatted reports. If the PARADOX "number" format had been specifed in Figure 21, the FSC of 0087 would become 87 when the leading zeros were removed. FSC is therefore defined as type A (for alphanumeric) with four digits, even though non-numeral characters would never appear in an FSC. As a result, the leading zeros are preserved. This format change is not a disadvantage for FSC because computations are not performed on this attribute.

However, there are cases when we want to implement a mask as a validity check. This thesis previously defined the physical attributes of the domain definitions in Ap-

pendix B. During the implementation of ARMIRS into the PARADOX model, these constraints on valid data were also specified. In PARADOX, as in other DBMS products, we want to supplement the information in the field description so that when the user enters data, the system will automatically check not only on the field type but also on other requirements. For example, using validity checks makes it possible to specify that in the two character alphanumeric COG Symbol the first character is a number and the second character is a capital letter. PARADOX then enforces these requirements whenever values are entered or changed. In PARADOX it is possible to enter validity checks on (1) a minimum value (e.g., the minimum FAD is "1"), (2) a maximum value (e.g., the maximum value on Required Delivery Date is 366), (3) a default value (e.g., if Activity Classification Code is not entered, the default value of "A" indicating combatant ships and submarines will be used), and (4) a "picture" of the exact format. These validity checks for the ARMIRS PARADOX tables are shown in Appendix J.

After defining the data implementation from the objects and specifying the validity checks from the domain definitions, the next step is to use the relational schema to define relationships between the tables. The several one-to-many relationships are defined by how the tables are set up. For example, the AMMO INVENTORY relation is characterized by seven one-to-many relations:

1. One AMMO INVENTORY (NIIN) to many Mission Areas
2. One AMMO INVENTORY (NIIN) to many TRANSACTIONS
3. One AMMO INVENTORY (NIIN) to many Stowage Locations
4. One AMMO INVENTORY (NIIN) to many REQN LINE ITEMS
5. One AMMO INVENTORY (NIIN) to many LOT CONTROLLED AMMO
6. One AMMO INVENTORY (NIIN) to many SERIAL CONTROLLED AMMO
7. One AMMO INVENTORY (NIIN) to many SERIAL & LOT AMMO

The materializations of these one-to-many relations of AMMO INVENTORY are listed in Figure 22. Each of these detail tables is shown in Figures 23 through 29. Notice that these detail tables (for the "many" side of the relationship) reflect the multi-value object attributes in AMMO INVENTORY in addition to the multi-value non-object properties. They were created by placing NIIN, the key of AMMO INVENTORY, on the first line of the detail tables (but this time without an asterisk). The master and detail tables are then linked.

Figure 30 shows the materialization of the TRANSACTION object. Since the attribute ATR Addressees is a multivalue property of TRANSACTION, the detail table

in Figure 31 was constructed using the procedure discussed above. ATR Serial Number is listed first (again, without an asterisk) in the detail table. Figures 32 through 42 show how a similar procedure was used to define and link the remaining ARMIRS relationships.

C. REPORT SPECIFICATION IN PARADOX

After defining how one table is linked to another in the multitable ARMIRS database, reports were implemented for these multiple tables. This process involved linking one table to another and designing their shared report.

Before producing reports on this multitable database, it was necessary to decide which table would be the master table for each report. In a database like ARMIRS described by one-to-many relationships, the table on the "many" side of the relationship must be the master report table while the table on the "one" side (which had the key field designated with an asterisk) is the detail "lookup" table. When choosing which table to make the master table of these reports, the table that can be linked to the most detail tables is the best candidate. The ARMIRS reports implemented in PARADOX (and shown in the Appendix K custom report specifications) fell into three main categories: (1) single table reports, (2) multiple table (linked) reports, and (3) complex multiple table reports requiring queries.

The easiest type of report to implement (and also the rarest in ARMIRS) was the single table report. For example, the Ship Ammunition Listing Report (Figure 43 in Appendix K) and the Allowance List Report (Figure 44) both came directly from the unlinked master ammunition table (M_inv). The table was first transformed into a default tabular report format. Editing the field displays, editing the columns, and revising the headings (e.g., placing the date in the heading of each report) gave final form to the visual report specification. Grouping, which controls how the report information is sorted and divided, was then added. As shown in Figure 43, PARADOX report specifications include the group bands that enclose the report table. In the Ship Ammunition Listing, COG is the most significant grouping and defines the principal sort. It is followed by NALC, the next inner group.

The second type of report, the linked table report, was the most common. After deciding which table should be the master table, a report is designed on this table by linking the master table to the lookup table. This provides access to the fields in both tables which can be selected, edited, and placed on the report. Figure 45 is an example of this type of linked table report. The Allowance Tracking Report is creating by linking

a table (M_inv) derived from the AMMO INVENTORY object with a table (Am_bal) formed from the TRANSACTION object. Recall that the table "Am_bal" was on the "many" side of the relationship and "M_inv" was on the "one" side. The two tables are linked together with "M_inv" as the lookup table and "Am_bal" as the master table. After extensive editing, the group bands are added. Notice that the table is sorted by NALC, a field in the detail (M_inv) table. Figure 45 also illustrates use of a calculated field. The percentage of shipfill allowance onboard is calculated for this report and does not come from a table. The upper right corner of the report shows the specification for this calculated field. Figures 46 through 48 also illustrate the features of the linked table report.

The final type of report also uses linked tables but in a slightly different way. In PARADOX, it is not possible to link lookup tables to other lookup tables. In the case of several ARMIRS tables, it was therefore not possible to include these tables in a single report using the link commands. In these cases, it was necessary to compose a query that joined all the desired fields into a single "answer table". A report was then generated on that table. The reports in Figures 49 and 50 illustrate this type of report specification. For example, the SORTS Message Input Report (Figure 49) uses information on mission areas (Am_mis) and balance changes (Am_bal) with inventory information. The mission area and balance changes are both on the "many" side of the one-to-many relationship with the inventory table (keyed by NIIN). It was possible to link these tables only by querying them on the desired report fields and sending the output to a table specifically designed for this report (Sorts_rp). The report specification was then designed from this answer table. The NAR Management Report in Figure 50 is another example of this type of report. Because of the the one-to-many relationship between ammunition inventory [the one] and both balance changes (Am_bal) and lot controllled ammunition (Am-lot) [the many], the query function was used to fill a newly created table from which the report was specified.

This chapter represents the first steps in implementing the ARMIRS relational design in the data model of a specific microcomputer DBMS. Obviously, there is much work remaining before ARMIRS can be fully implemented as a functioning prototype. The final chapter of this thesis suggests some promising areas for future work.

VI. SUGGESTIONS FOR FUTURE STUDY

A. DEVELOPMENT OF AN EXPERT DATABASE SYSTEM

Shipboard ammunition management, especially the preparation of requisitions and transaction reports, is a very rule-intensive process. Expertise in ATR and ammuniton requisition drafting comes only after hours of work using many required references. Gradually, the Gunnery Officer becomes familiar with the procedures used to draft these documents. By the time the user has become familiar with the intricacies of this function, the new expert is often transferred to another division or ship. After this loss of corporate knowledge, the learning process begins again with another officer. Unless the Weapons Department is fortunate enough to have a former Gunnery/Ordnance Officer available to share his expertise, preparation of ATRs and requisitions will initially be ineffecient and subject to errors. A computer-based system combining the ARMIRS database developed in this thesis and an expert system incorporating the rules from fleet ammunition management instructions promises to be a valuable aid in ATR/requisition processing and Gunnery Officer training.

Integrating the ARMIRS database and the fleet ammunition management instructions into an expert database system is the most promising suggested area for further work. Other researchers in this field (Kamel and Lekey, 1990) have demonstrated the value and feasibility of such an approach to create a loosely coupled system in which the database's integrity is maintained while an expert system uses the data, its own rule base, and user input. The ARMIRS database could still be used as a stand-alone interactive system for ammunition management. As a component in the expert database system, it would provide data to an Ammunition Management Expert System. For example, using ARMIRS information about the ship and the ammunition involved in a transaction, the expert database system would use its rules to create the ATR header, aiding in classification and addressing decisions essential to transaction report drafting. Appendix L describes the dialogue and rule base components of just such an expert database system for creating the ATR header.

As shown in Appendix L, the system dialogue consists of a series of questions presented to the user as multiple choice menus and data entry lines. When the expert database system is selected, the user is prompted for answers to these questions. Information from the COMMAND and AMMO INVENTORY (through TRANS-

ACTION) objects is extracted from the database and applied to the addressing and classification rules. The resulting decisions are displayed to the user and passed to the TRANSACTION object in the ARMIRS database from which an ATR can be generated.

The rule base, also shown in Appendix L, is a series of 20 rules in the IF-THEN format used by Hayes-Roth (1985, pp. 930-934). This rule base performs logical decisions using input from the ARMIRS database to help make the classification and addressing decisions used in the ATR header.

Use of an expert system shell (with an expanded set of IF-THEN rules) working together with the ARMIRS database offers the promise of storing ammunition management expertise and making this rule-based knowledge available to shipboard personnel. The development of an expert database system is the most promising area for future work.

F. OTHER SUGGESTIONS FOR FUTURE WORK

This thesis represents only an initial iteration of system development for a prototype shipboard ammunition management system. In addition to work on the expert database system discussed above, the following projects are suggested:

1. Fully implement the ARMIRS design (including security and backup components not designed in this thesis) with a relational microcomputer DBMS software package.
2. Using the testing theories of software engineering, develop a test and evaluation plan to specify white- and black-box testing strategies for ARMIRS, including the development of sample data sets.
3. Using a commercially available prototype/demo software product with "screen-grabber" capability (i.e., PROTEUS, etc.), produce a "workalike prototype", product demonstration, or ARMIRS tutorial. None of these would require full DBMS implementation (item 1 above) as a prerequisite and would be an excellent vehicle for user input for the next design iteration.
4. Select an ARMIRS test ship, use a functioning prototype (from item 1 above) to run ARMIRS in parallel with the manual system, solicit feedback, and report lessons learned.
5. Write a ARMIRS user's manual that would completely guide the ammunition management (or computer) novice through system use.
6. Investigate the feasibility of incorporating ARMIRS into the Shipboard Non-Tactical ADP System (SNAP) now common on U. S. Navy ships.
7. Analyze the issues in directly connecting ships to SPCC's Navy-wide CAIMS database or the NOMIS system at weapons stations. What changes would be required of the ARMIRS design? How could ARMIRS interface with the shore establishment?

8. Develop a bar code scanning module to work with the ARMIRS database application aboard ship. The system should be compatible with the Fleet Optical Scanning Ammunition Marking System (FOSAMS) used in shore-based ammuntion management systems.
9. Enhance ARMIRS functionality by proving for efficient bulk data initial entry.
10. Use commercial form-generation software packages to reproduce DD Form 1348 and other forms in a manner consistent with ARMIRS database design but not limited to a specific DBMS implementation (i.e., DBASE, PARADOX, etc.).

APPENDIX A. OBJECT DIAGRAMS

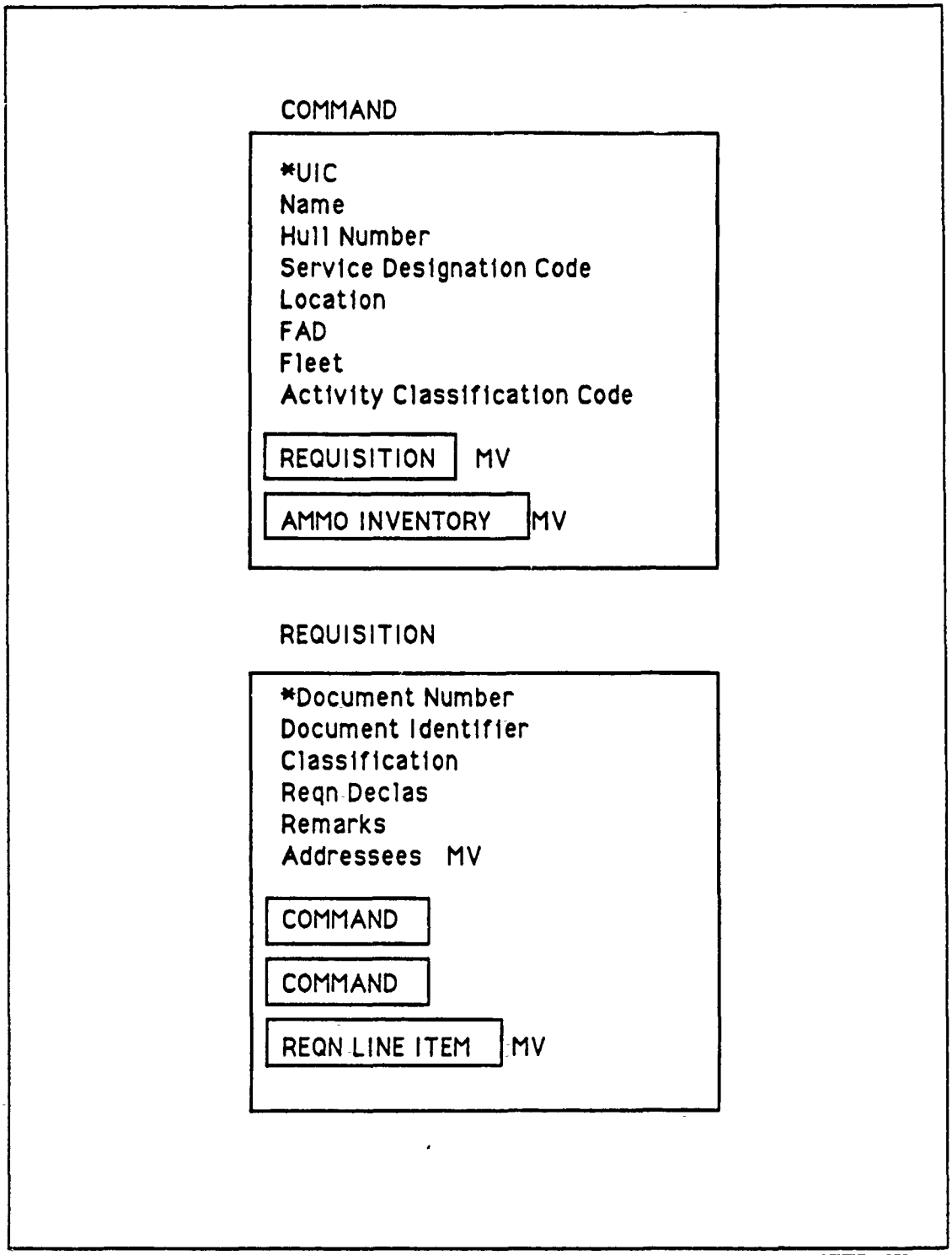

Figure 1. COMMAND and REQUISTION Objects (* = object identifier)

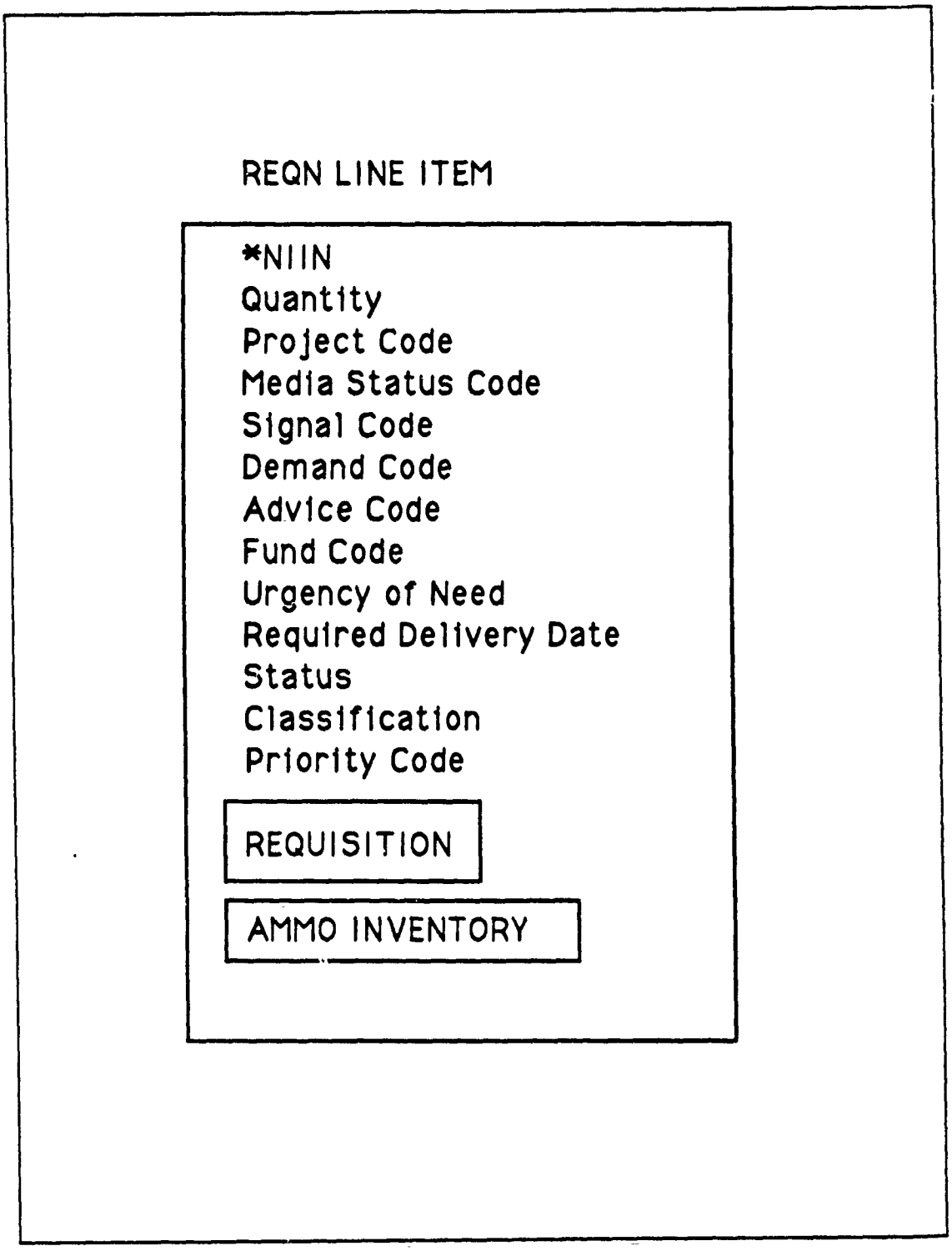

Figure 2. REQN LINE ITEM Object

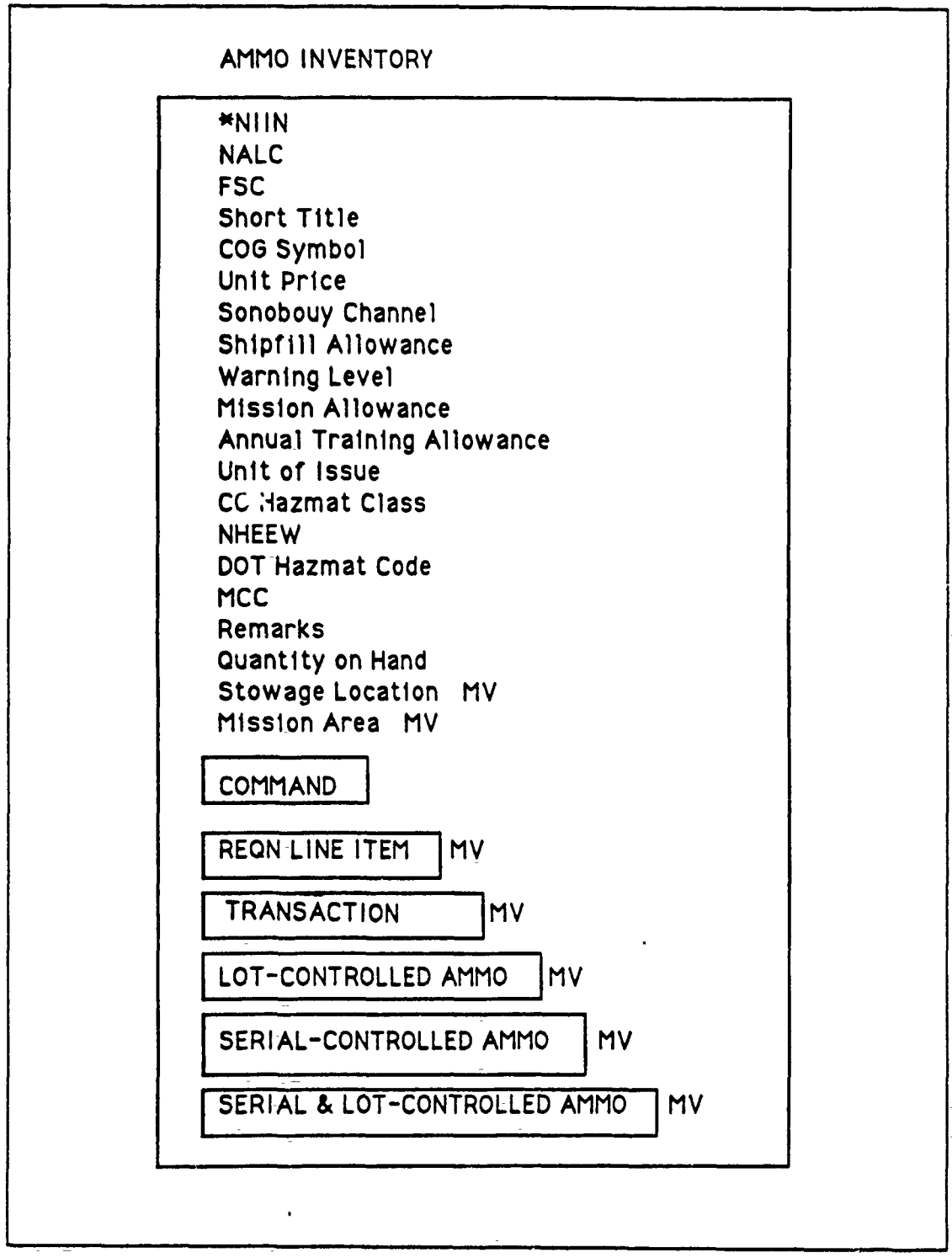

Figure 3. AMMO INVENTORY Object

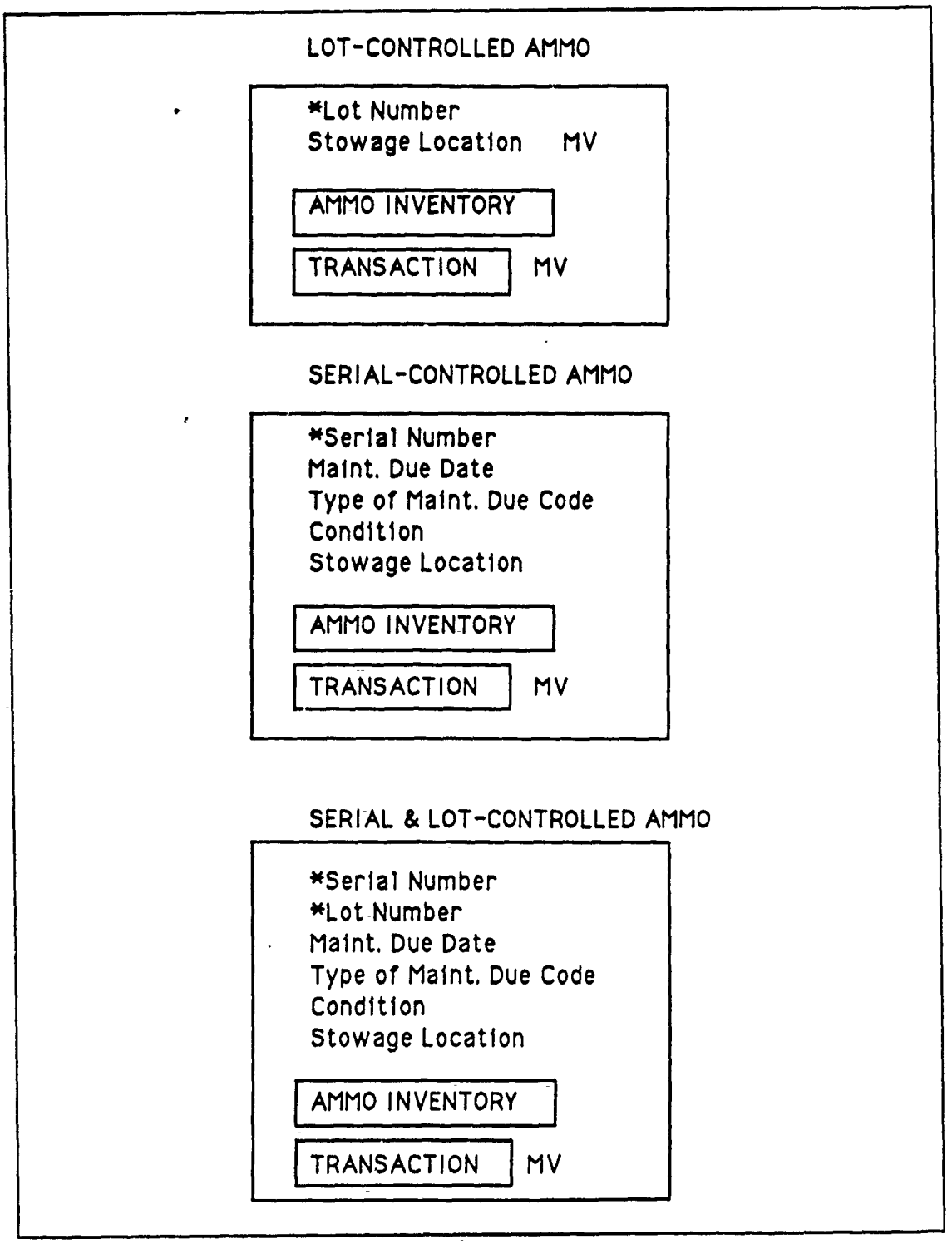

Figure 4. LOT and/or SERIAL AMMO Objects

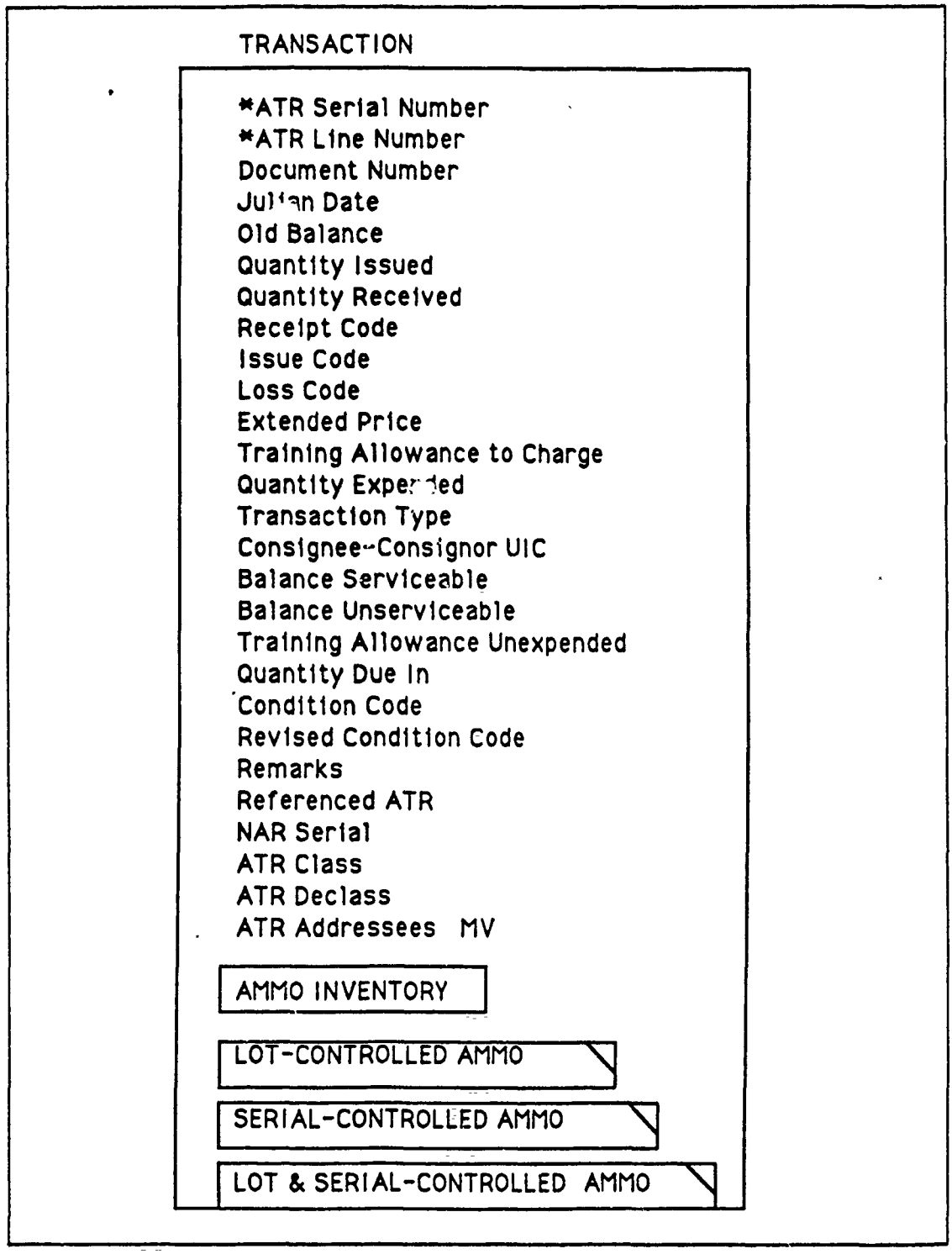

Figure 5. TRANSACTION Object

APPENDIX B. OBJECT SPECIFICATIONS

A. OBJECT DEFINITIONS

1. COMMAND Object

- *UIC; Unit-identification-codes
- Name; Navy-command-names
- Hull Number; Hull-numbers
- Service Designation Code; Service-designation-codes
- Location; Mailing-addresses
- FAD; Force-activity-designators
- Fleet; Logistics-commanders
- Activity Classification Code; Activity-classification-codes
- REQUISITION MV; REQUISITION object
- AMMO INVENTORY MV; AMMO INVENTORY object

2. REQUISITION Object

- *Document Number; Document-numbers
- Document Identifier; Document-identifiers
- Classification; Security-classifications
- Reqn Declas; Declas-dates
- Remarks; Remarks
- Addressees MV; Navy-command-names
- COMMAND; COMMAND object
- COMMAND; COMMAND object SUBSET [UIC, Name, Location] [14]
- REQN LINE ITEM MV; REQN LINE ITEM object

3. REQN LINE ITEM Object

- *NIIN; National-item-identification-numbers
- Quantity; Reqn-qty

---

14 Note that the COMMAND object occurs twice in the REQUISITION Object. The first occurence is for the ship sending the requisition (the ship of interest for ARMIRS purposes). The second occurence is for the ship or weapons station filling the requisition. In the latter case, only a subset of the COMMAND object properties is needed for the requisition.

- Project Code; Project-codes
- Media Status Code; Media-status-codes
- Signal Code; Signal-codes
- Demand Code; Demand-codes
- Advice Code; Advice-codes
- Fund Code; Fund-codes
- Urgency of Need; Need-urgencies
- Required Delivery Date; Required-delivery-dates
- Status; Reqn-status
- Classification; Security-classifications
- Priority Code; Priority-codes
- REQUISITION; REQUISITION object
- AMMO INVENTORY; AMMO INVENTORY object

4. AMMO INVENTORY Object

- *NIIN; National-item-identification-numbers
- NALC; Navy-ammunition-logistics-codes
- FSC; Federal-supply-codes
- Short Title; Nomenclature
- COG Symbol; Material-cognizance-symbols
- Unit Price; Money
- Sonobouy Channel; Sonobouy-channels
- Shipfill Allowance; Shipfill-allowances
- Mission Allowance; Mission-allowances
- Annual Training Allowance; NCEA-training-allowances
- Unit of Issue; Units-of-issue
- Stowage Location MV; Shipboard-magazines-and-lockers
- CG Hazmat. Class; USCG-hazardous-material-classifications
- Activity Classification Code; Activity-classification-codes
- NHEEW; Net-explosive-weights
- DOT Hazmat. Code; DOT-hazardous-material-classifications
- MCC; Material-control-codes
- Remarks; Remarks

- Warning Level; Low-stock-warning-levels
- Quantity on Hand; Onboard-totals
- Mission Area MV; Mission-areas
- REQN LINE ITEM MV; REQN LINE ITEM object SUBSET [NALC, NIIN, Quantity]; REQUISITION object SUBSET [Document Number]
- COMMAND; COMMAND object SUBSET [UIC, Name, Hull Number]
- TRANSACTION MV; TRANSACTION object
- LOT CONTROLLED AMMO MV; LOT CONTROLLED AMMO object
- SERIAL CONTROLLED AMMO MV; SERIAL CONTROLLED AMMO object
- SERIAL & LOT CONTROLLED AMMO MV; SERIAL & LOT CONTROLLED AMMO object

5. LOT CONTROLLED AMMO Object

- *Lot Number; Lot-numbers
- Stowage Location MV; Shipboard-magazines-and-lockers
- AMMO INVENTORY; AMMO INVENTORY object
- TRANSACTION MV; TRANSACTION object

6. SERIAL CONTROLLED AMMO Object

- *Serial Number; Serial-numbers
- Maint. Due Date; Maint-due-dates
- Type of Maint. Due Code; Maint-due-types
- Condition; Conditions
- Stowage Location; Shipboard-magazines-and-lockers
- AMMO INVENTORY; AMMO INVENTORY object
- TRANSACTION MV; TRANSACTION object

7. SERIAL & LOT CONTROLLED AMMO Object

- *Lot Number; Lot-numbers
- *Serial Number; Serial-numbers
- Maint. Due Date; Maint-due-dates
- Type of Maint. Due Code; Maint-due-types
- Condition; Conditions
- Stowage Location; Shipboard-magazines-and-lockers
- AMMO INVENTORY; AMMO INVENTORY object

- TRANSACTION MV; TRANSACTION object

8. TRANSACTION Object

- *ATR Serial Number; ATR-serial-numbers
- *ATR Line Number; ATR-line-numbers
- Document Number; Document-numbers
- Julian Date; Julian-dates
- Old Balance; Old-balances
- Quantity Issued; Issued-qty
- Quantity Received; Received-qty
- Receipt Code; Receipt-codes
- Issue Code; Issue-codes
- Loss Code; Loss-codes
- Extended Price; Money
- Training Allowance to Charge; Unit-identification-codes
- Quantity Expended; Expended-qty
- Transaction Type; Transaction-types
- Consignee or Consignor UIC; Unit-identification-codes
- Balance Serviceable; Serviceable-balances
- Balance Unserviceable; Unserviceable-balances
- Training Allowance Unexpended; NCEA-remaining
- Quantity Due In; Due-in-qty
- Condition Code; Condition-codes
- Revised Condition Code; Condition-codes
- Remarks; Remarks
- Referenced ATR; ATR-serial-numbers
- NAR serial; NAR-serial-numbers
- ATR Class; Security-classifications
- ATR Declas; Declas-dates
- ATR Addressees MV; Navy-command-names
- AMMO INVENTORY; AMMO INVENTORY object
- LOT CONTROLLED AMMO; LOT CONTROLLED AMMO object, or
- SERIAL CONTROLLED AMMO; SERIAL CONTROLLED AMMO object, or

- SERIAL & LOT CONTROLLED AMMO; SERIAL & LOT CONTROLLED AMMO object

B. DOMAIN DEFINITIONS

(1) Activity-classification-codes

- Alphabetic 1
- Code (from SPCCINST, 1988, p. 8-5-D1) indicating the intended use of ammunition stocks carried by a command.
- ARMIRS default is [A], indicating use on combatant ships and submarines.

(2) Advice-codes

- Text 2
- Code from requisition originators to initial processing points to provide coded instructions to supply sources.

(3) ATR-line-numbers

- Numeric 2
- Indicate position of a transaction line item on an Ammunition Transaction Report.

(4) ATR-serial-numbers

- Numeric 3
- Serial number locally assigned to an Ammunition Transaction Report. Restarts at 001 after reaching 999.

(5) Conditions

- Text 1
- ARMIRS code indicating ammunition condition either as serviceable [S] or unserviceable [U].

(6) Condition-codes

- Alphabetic 1
- Code (from SPCCINST 8010.12D, 1988, p. 1-2-C1) for classifying ammunition in terms of readiness for issue and use, or to identify action underway to change the status of the material.
- ARMIRS default is [A], indicating fully serviceable ammunition.

(7) Declas-dates

- Text 7, mask NNAAANN
- Where NN is numeric, AAA is alphabetic [JAN...DEC], and NN is numeric.
- The date a classified message is to be declassified (e.g., 29APR59).

(8) Demand-codes

- Text 1
- Indicates whether the demand for a requisitioned item is recurring [R] (ARMIRS default) or non-recurring [N].

(9) Document-identifiers

- Text 3
- Code (from SPCCINST 8010.12D, 1988, p. 8-2-6) to indicate the purpose of document (i.e., requisition, cancellation, follow-up, etc.)

(10) Document-numbers

- Text 14, mask TNNNNNNNNNNNNN,
- Where TNNNNN is the UIC, NNNN is the julian date, NNNN is serial number.
- Identifies a requisition or turn-in document.

(11) DOT-hazardous-material-classifications

- Text 2
- Code assigned by the Department of Transportation to indicate the type of hazard involved when shipping ammunition.

(12) Due-in-qty

- Numeric 5
- Requisitioned quantity still outstanding. Represents the unfilled balance of a requistion.

(13) Expended-qty

- Numeric 5
- Quantity of ammunition reduced from inventory by means other than transfer or condition code change.

(14) Federal-supply-codes

- Numeric 4
- Code used with NIIN or NALC for ammunition identification.

(15) Force-activity-designators

- Numeric 1
- Number [1-5] assigned to a command from NAVSUP Pub 485, sections 3045-3049 to reflect operational readiness and used (with Urgency of Need Code) to assign a requisition priority.

(16) Fund-codes

- Text 2, mask T6,
- Where T is text [either 2 or Y] and 6 is the numeral six.
- Code used to cite accounting data on requisitions.
- Fleet units use fund code Y6 (ARMIRS default) and shore units use fund code 26.

(17) Hull-numbers

- Text 8
- Hull number assigned to a commissioned naval vessel (e.g., FF1071, SSN685).

(18) Issue-codes

- Text 6
- Code (from SPCCINST 8010.12D, 1988, p. 8-5-H1) indicating how ammunition was issued from inventory to another command.

(19) Issued-qty

- Numeric 5
- Quantity transferred from a command resulting in an inventory quantity decrease.

(20) Julian-dates

- Numeric 4, mask YDDD,
- Where Y is the last digit of the year [0-9] and DDD is the number assigned to the day [001-366].
- Date of an event or document consisting of the units digit of the year and a three digit expression of the numeric equivalent of the day of the year (e.g., 9004 is 04 JAN 1989).

(21) Logistics-commanders

- Alphabetic 4
- The Fleet CINC having authority over a unit's ammunition logistics reporting.
- Commands under CINCPACFLT use [PAC] while units under CINCLANTFLT use [LANT].

(22) Loss-codes

- Alphabetic 5
- Code (from SPCCINST 8010.12D, 1988, p. 8-5-I1) indicating how ammunition was lost from inventory (i.e., through physical count, by accounting error, by theft, etc.)

(23) Lot-numbers

- Text 16
- A number assigned at the time of manufacture to a group of ammunition rounds, each component of which is produced by one manufacturer under uniform conditions and which is expected to perform in a uniform way.

(24) Low-stock-warning-levels

- Numeric 2 [.01-.99]
- Stock level (expressed as a percentage of allowance) where the user is warned of a low stock condition.

(25) Mailing-address

- Text 30
- Location of an ammuntion transaction or a requested delivery location (e.g., CONCORD CA or PEARL HARBOR HI).

(26) Maint-due-dates

- Text 3, mask MYY,
- Where M is the month [1-9,O,N,D] and YY is the last two digits of the year.
- The month and year (e.g., N90 is NOV 1990) of the next scheduled maintenance on items with serial numbers serial numbers.

(27) Maint-due-types

- Alphabetic 1
- Indicates the type of periodic maintenance required for torpedoes and air-launched missiles from SPCCINST 8010.12D (1988, p.8-5-B1).

(28) Material-cognizance-symbols

- Text 2, mask NA,
- Where N is a number and A is a letter.
- Indicates the Inventory Control Point, office, or agency which exercises supply management responsibility for an item.
- Allowed values for conventional ammunition are 0T, 2D, 2E, 2T, 4E, 4T, 6T, 8E, 8S, 8T, and 8U.

(29) Material-control-codes

- Alphabetic 1
- Code assigned by the Inventory Manager to indicate to field activities that special reporting or control requirements may be necessary. Indicates a serial/lot tracked item.

(30) Media-status-codes

- Text 1
- Code used in requisitions to indicate the type of supply status required and the method by which it is to be furnished.

(31) Mission-allowances

- Numeric 5
- The quantity of ammunition above and beyond shipfill allowance for use on a specific mission.

(32) Mission-areas[15]

- Alphabetic 4
- Combat mission area(s) associated with an ammunition type.
- Allowed values are [ASUW, ASW, AAW, AMW (for amphibious warfare), and MIW (for mine warfare)] as described in NWP-7.
- Used in SORTS readiness report input to the Operations Department.

(33) Money

- Text 13, mask NN,NNN,NNN.NN
- Where N is numeric and a leading dollar sign is not used.
- Used for prices on turn-in documents.

(34) NAR-serial-numbers

- Numeric 5, mask YYNNN,
- Where YY indicates the year and NNN indicates the serial number.
- Assigned to Notices of Ammunition Reclassification.

(35) National-item-identification-numbers

- Text 9
- A stock number assigned by the Defense Logistics Services Center to each item in the Federal Cataloging Program.

(36) Navy-ammunition-logistics-codes

- Text 4
- Code assigned to ammunition groups by SPCC.

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15 LCDR Carl A. Carpenter, USN contributed useful insights on the Operations Department view of ammunition inventory data.

(37) Navy-command-names

- Text 30
- Name of a command as listed in the Plain Language Address Directory.

(38) NCEA-remaining

- Numeric 5
- The quantity of ammunition with a training allowance available for expenditure in the current fiscal year.

(39) NCEA-training-allowances

- Numeric 5
- The quantity of a particular ammunition item authorized for expenditure in a fiscal year for training. Promulgated in the 30000 series NAVSEA Shipfill Allowance List.

(40) Need-urgencies

- Alphabetic 1
- Letter code [A, B, or C] designating the impact on mission readiness if a requisition is not received by the required delivery date. Used with Force Activity Designator to give a requisition's priority.

(41) Net-explosive-weights

- Text 10
- Total weight of explosive components of a device. Expressed in whole numbers with the units (i.e., 20 LBS, 30 KG).

(42) Nomenclature

- Text 20
- Short text description of ammunition consisting of noun name and MK/MOD from NAVSEA TW010-AA-ORD-010.

(43) Old-balances

- Numeric 5
- The inventory balance prior to a transaction or the balance brought forward to a new inventory record.

(44) Onboard-totals

- Numeric 5
- The total quantity onboard for a particular NIIN, regardless of condition.

(45) Priority-codes

- Numeric 2
- Code expressing the relationship between COMMAND.FAD and REQN LINE ITEM.Urgency of Need to represent the priority assigned to a requisition.

(46) Project-codes

- Text 3
- Code assigned to a specific project by DoD. Used on requisitions for recognition throughout the distribution system.

(47) Receipt-codes

- Text 6
- Code (from SPCCINST 8010.12D, 1988, p. 8-5-G1) indicating how the material was added to the command's inventory.

(48) Received-qty

- Numeric 5
- Quantity of ammunition received and added to the inventory.

(49) Remarks

- Text 30
- Text used for adding comments and references where desired.

(50) Reqn-qty

- Numeric 5
- Quantity of an ammunition item requisitioned.

(51) Reqn-status

- Alphabetic 1, mask [U,P,F,C]
- ARMIRS code indicating the status of a requisition line item where [U] = unfilled, [P] = partial, [F] = filled, and [C] = cancelled.

(52) Required-delivery-dates

- Text 3
- Three-digit Julian date [1-366] indicating the date required for receipt of requisitioned ammunition.

(53) Security-classifications

- Alphabetic 1

- Code indicating security classification of a requisition, transaction report, or other message (or part of any message).
- Unclassified is indicated [U] (ARMIRS default) and Confidential is indicated by [C]. Secret and Top Secret are not used for conventional ammunition messages.

(54) Serial-numbers

- Text 16
- An identification number given to an single ammunition round.

(55) Service-designation-codes

- Text 1
- Code designating a military service or part of one of the uniformed services.

(56) Serviceable-balances

- Numeric 5
- Quantity of ammunition available for use.

(57) Shipboard-magazines-and-lockers

- Text 12
- Compartment number of ammunition storage location.

(58) Shipfill-allowances

- Numeric 5
- Ammunition quantity computed for allowance requirements during provisioning.

(59) Signal-codes

- Text 1
- Code on requisition indicating consignee (ship to) and the activity to receive the bill (bill to).

(60) Sonobouy-channels

- Numeric 2
- Indicates the preset channel on certain sonobouys.

(61) Transaction-type

- Text 2
- Code (from SPCCINST 8010.12D, 1988, p. 8-5-F1) indicating the type of transaction (i.e., receipt, issue, adjustment, inventory loss, etc.).

(62) Unit-identification-codes

- Numeric 5
- Code which identifies a command.

(63) Units-of-issue

- Alphabetic 2
- Abbreviation representing a quantity and serving as a unit of measurement when issuing ammunition (e.g., BX, EA, CA).

(64) Unserviceable-balances

- Numeric 5
- Quantity of ammunition unavailable for use due to condition code.

(65) USCG-hazardous-material-classifications

- Text 4
- Classification codes of hazardous munitions as determined by the U.S. Coast Guard and found in NAVSEA OP 2165, Vol. 2. This code determines how ammunition is loaded aboard ship.

APPENDIX C. DATAFLOW ANALYSIS

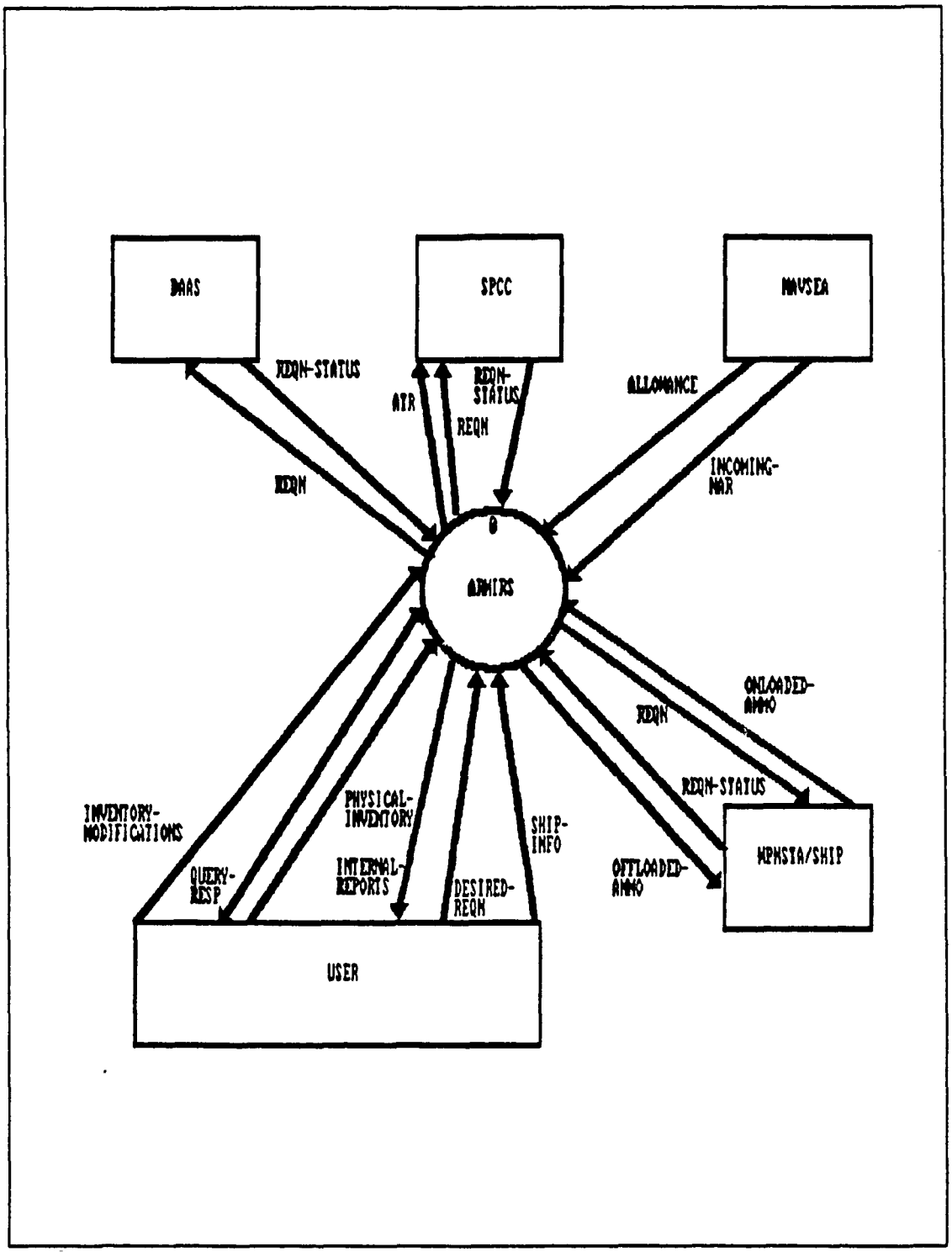


Figure 6. Context Diagram

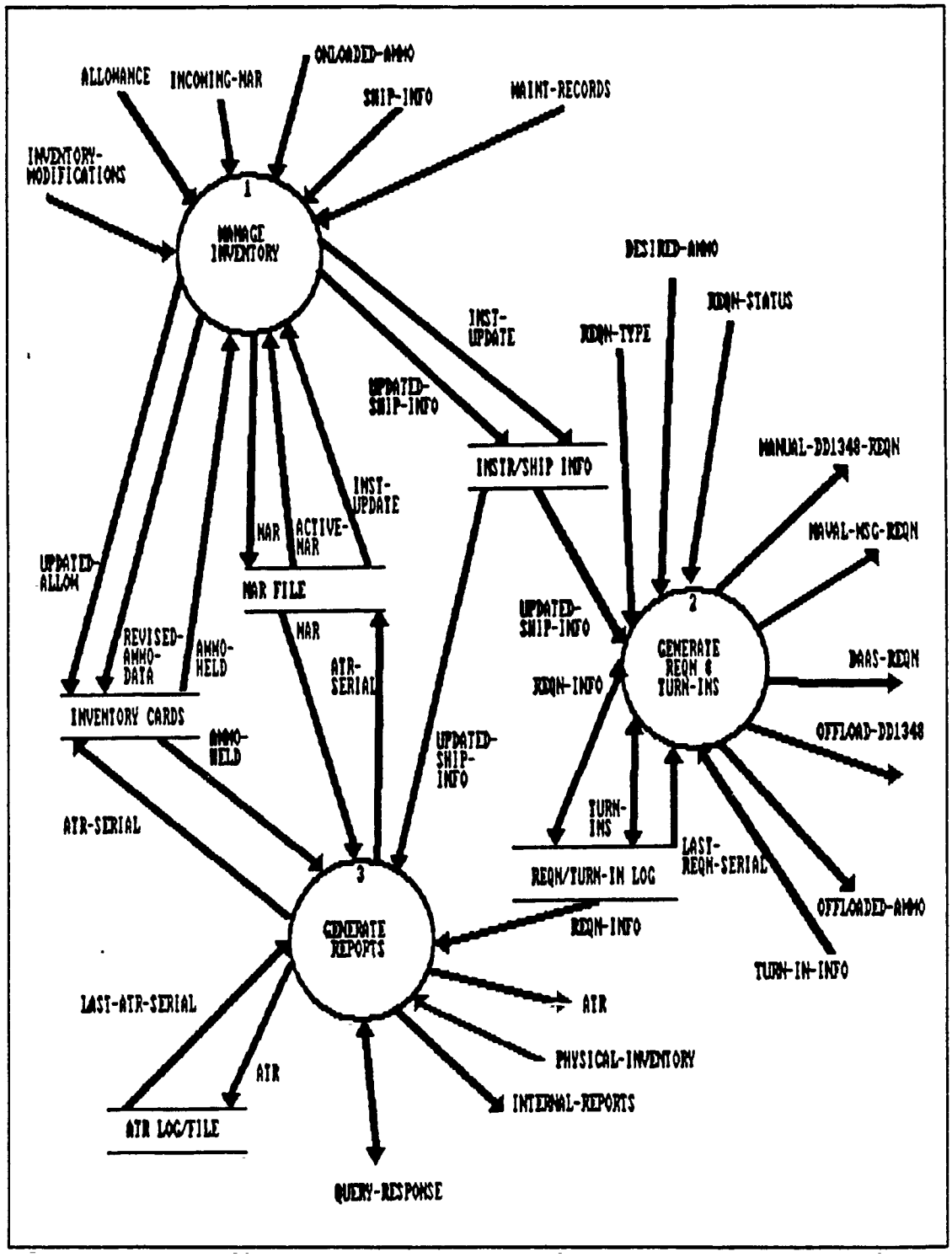


Figure 7. Level 0 Diagram

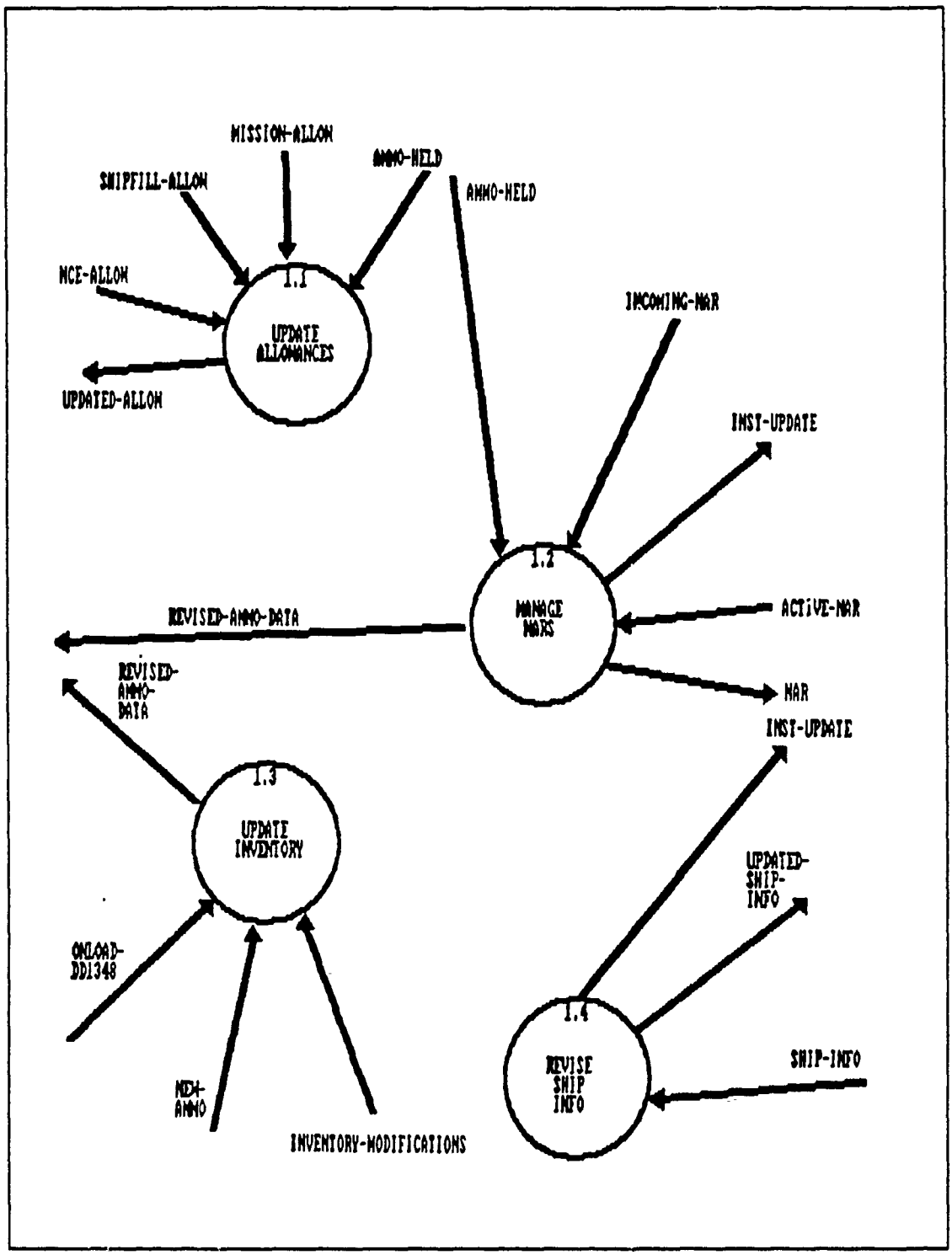


Figure 8. Process 1 (Manage Inventory) Diagram

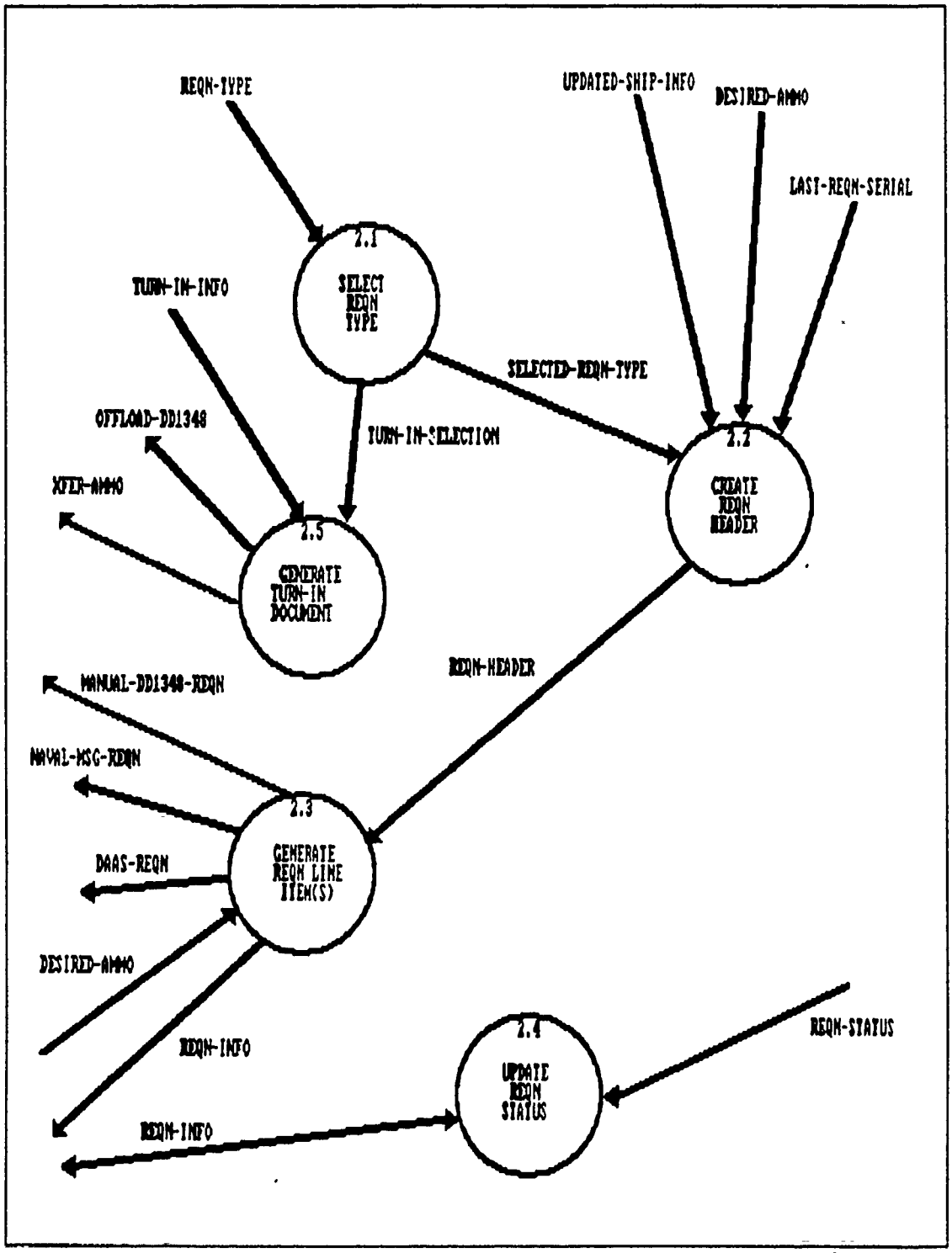


Figure 9. Process 2 (Generate Requisitions/Turn-Ins) Diagram

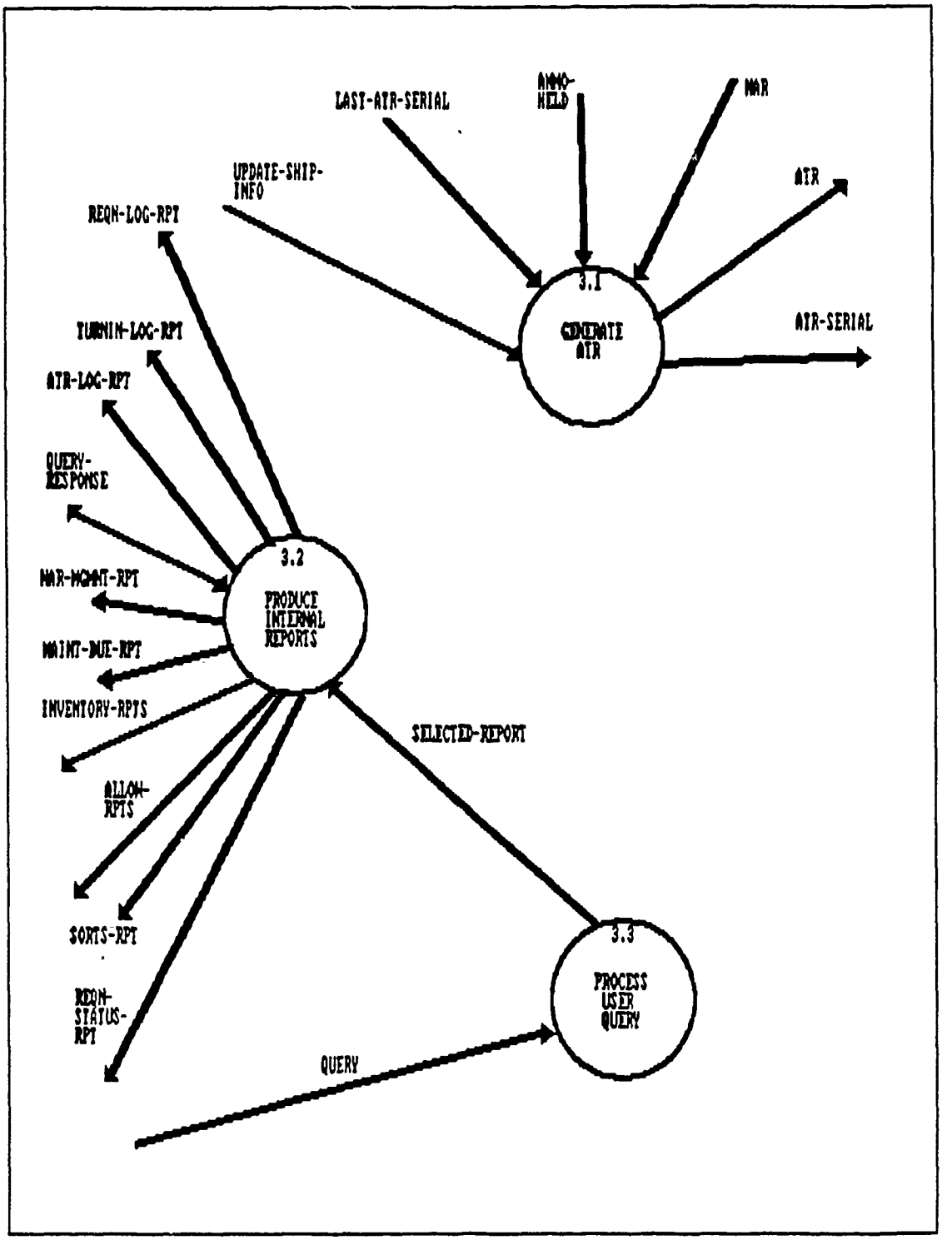


Figure 10. Process 3 (Generate Reports) Diagram

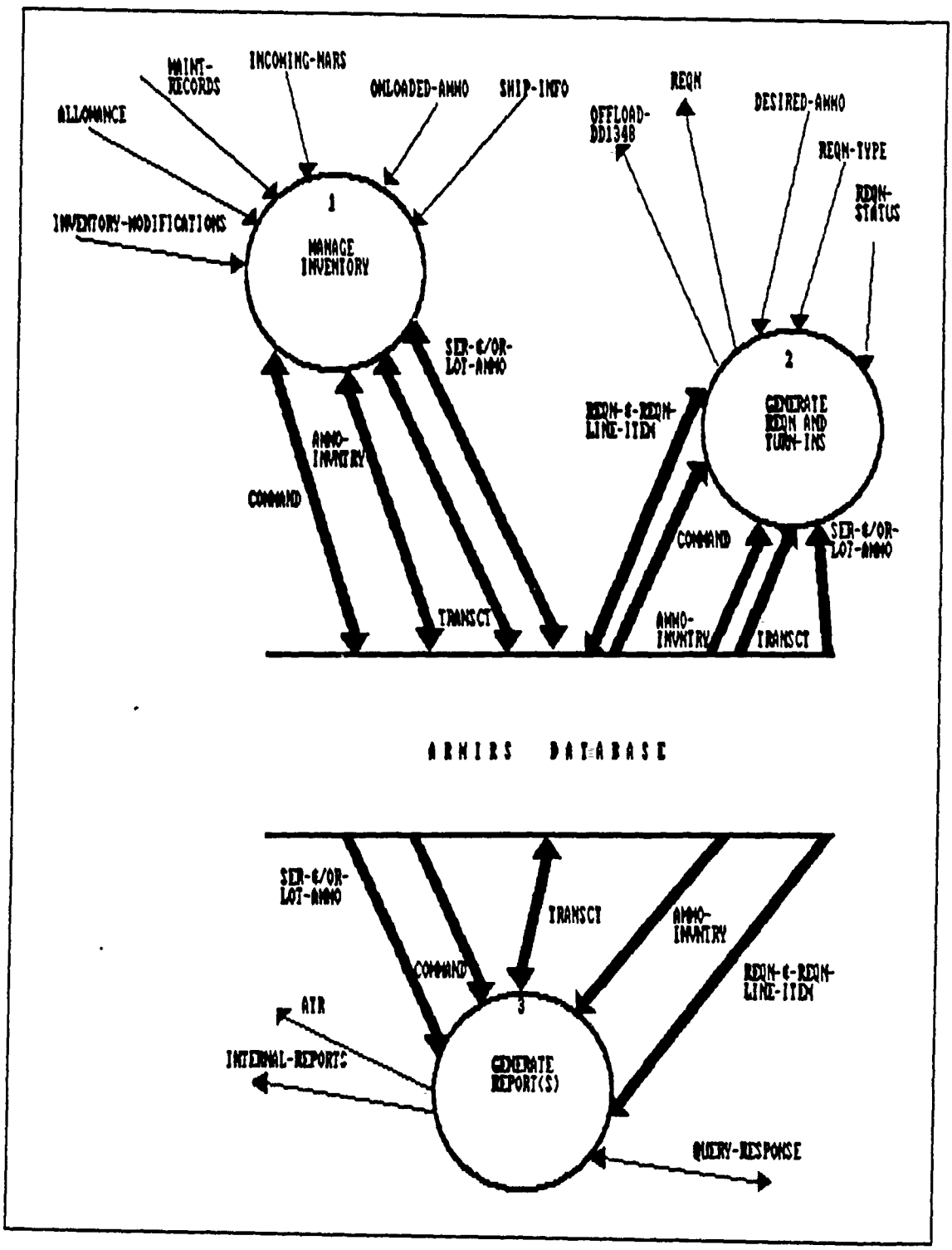


Figure 11. Data Flow as Objects in ARMIRS

APPENDIX D. SAMPLE FORMS

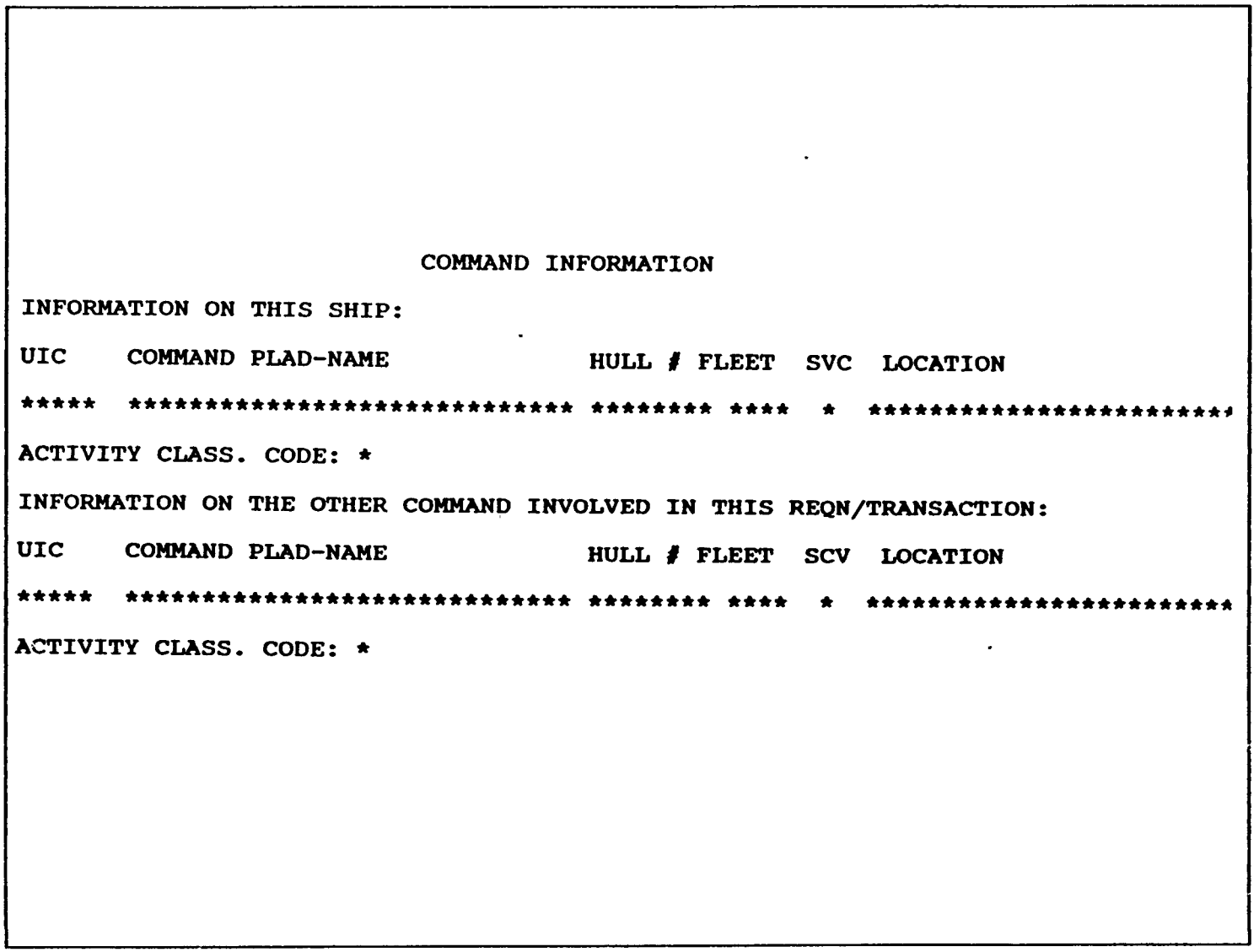
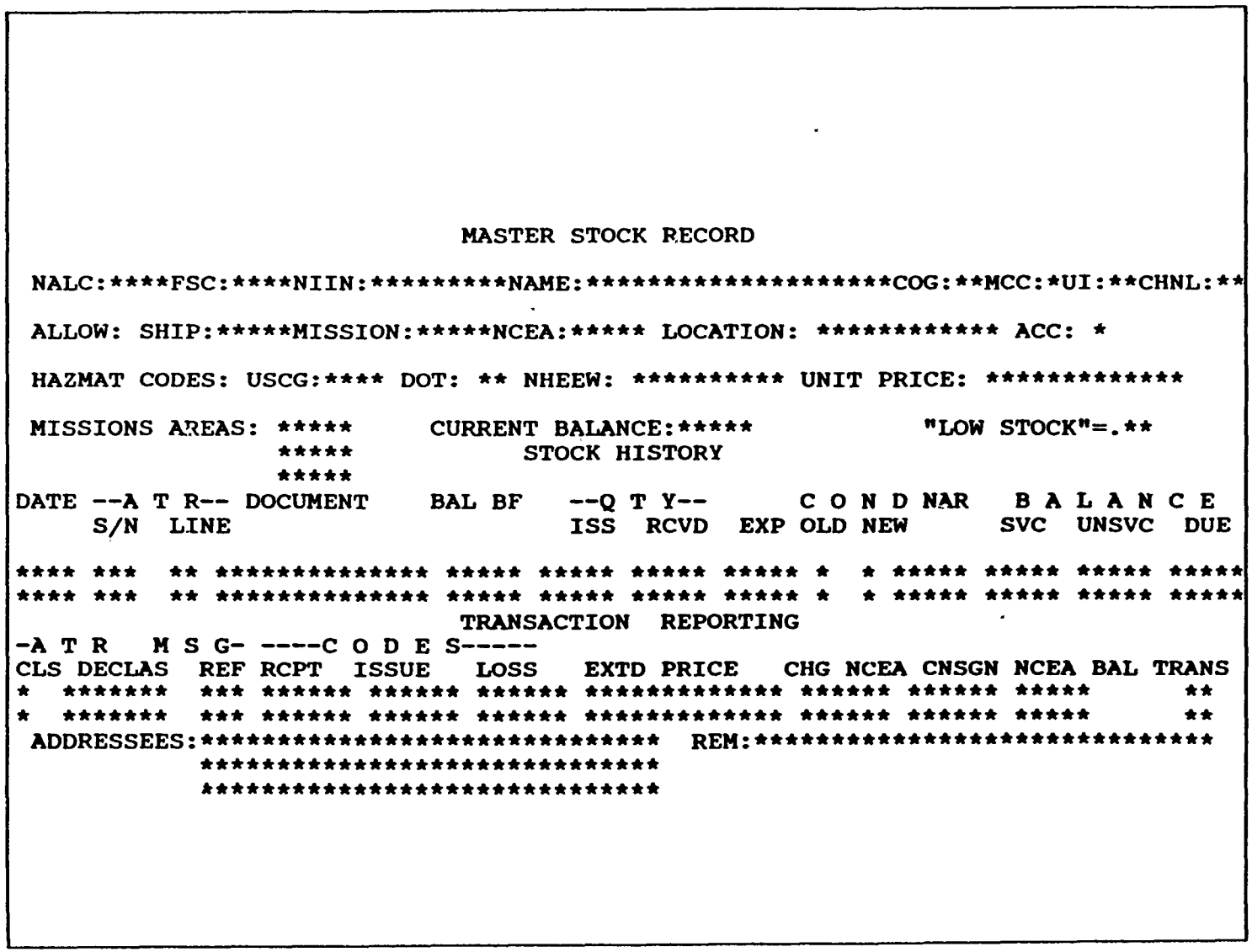


Figure 12. COMMAND Information Form



MASTER STOCK RECORD

NALC:****FSC:****NIIN:*********NAME:**********COG:**MCC:*UI:**CHNL:**

ALLOW: SHIP:*****MISSION:*****NCEA:***** LOCATION: ********** ACC: *

HAZMAT CODES: USCG:**** DOT: ** NHEEW: ********** UNIT PRICE: **********

MISSIONS AREAS: ***** CURRENT BALANCE:***** "LOW STOCK"=.**
***** STOCK HISTORY
*****

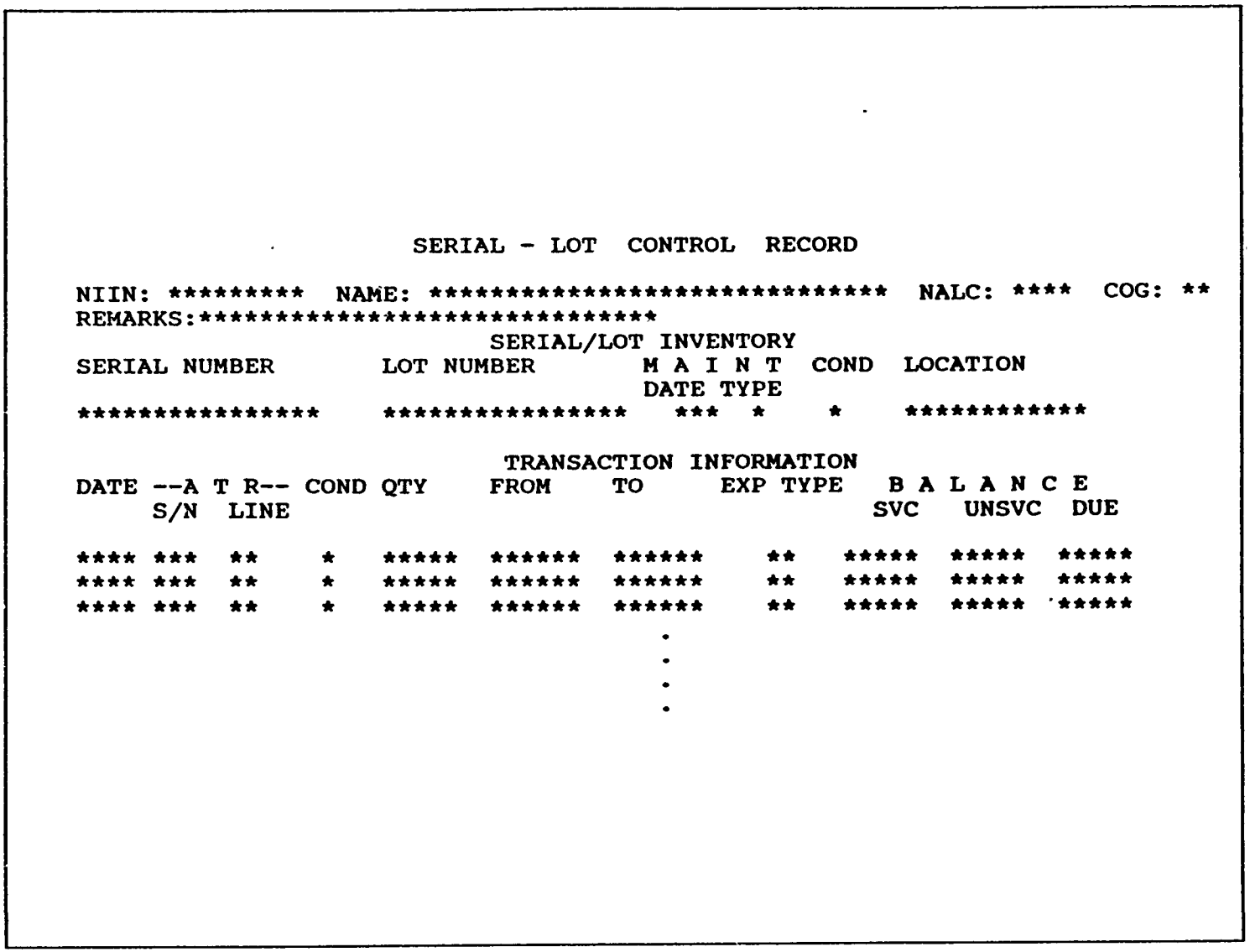
DATE	--A S/N	T LINE	R-- DOCUMENT	BAL BF	--Q ISS	T RCVD	Y-- EXP	C OLD	O NEW	N	D	NAR	B SVC	A UNSVC	L DUE	A	N	C	E
****	***	**	**********	*****	*****	*****	*****	*	*	*****	*****	*****	*****						
****	***	**	**********	*****	*****	*****	*****	*	*	*****	*****	*****	*****						

TRANSACTION REPORTING

-A CLS	T DECLAS	R	M	S	G- REF	----C O D E S----- RCPT	ISSUE	LOSS	EXTD PRICE	CHG	NCEA	CNSGN	NCEA BAL	TRANS
*	*******		***		******	******	******	**********	******	******	*****			**
*	*******		***		******	******	******	**********	******	******	*****			**

ADDRESSEES:********** REM:**********
****
****

Figure 13. INVENTORY and TRANSACTION Information Form



SERIAL - LOT CONTROL RECORD

NIIN: ********* NAME: ********** NALC: **** COG: **
REMARKS:**********

SERIAL/LOT INVENTORY

SERIAL NUMBER	LOT NUMBER	MAINT DATE	MAINT TYPE	COND	LOCATION
**********	**********	***	*	*	**********

TRANSACTION INFORMATION

DATE	--A S/N	T LINE	R--	COND	QTY	FROM	TO	EXP	TYPE	BALANCE SVC	BALANCE UNSVC	BALANCE DUE
****	***	**		*	*****	******	******		**	*****	*****	*****
****	***	**		*	*****	******	******		**	*****	*****	*****
****	***	**		*	*****	******	******		**	*****	*****	*****

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Figure 14. SERIAL/LOT Information Form

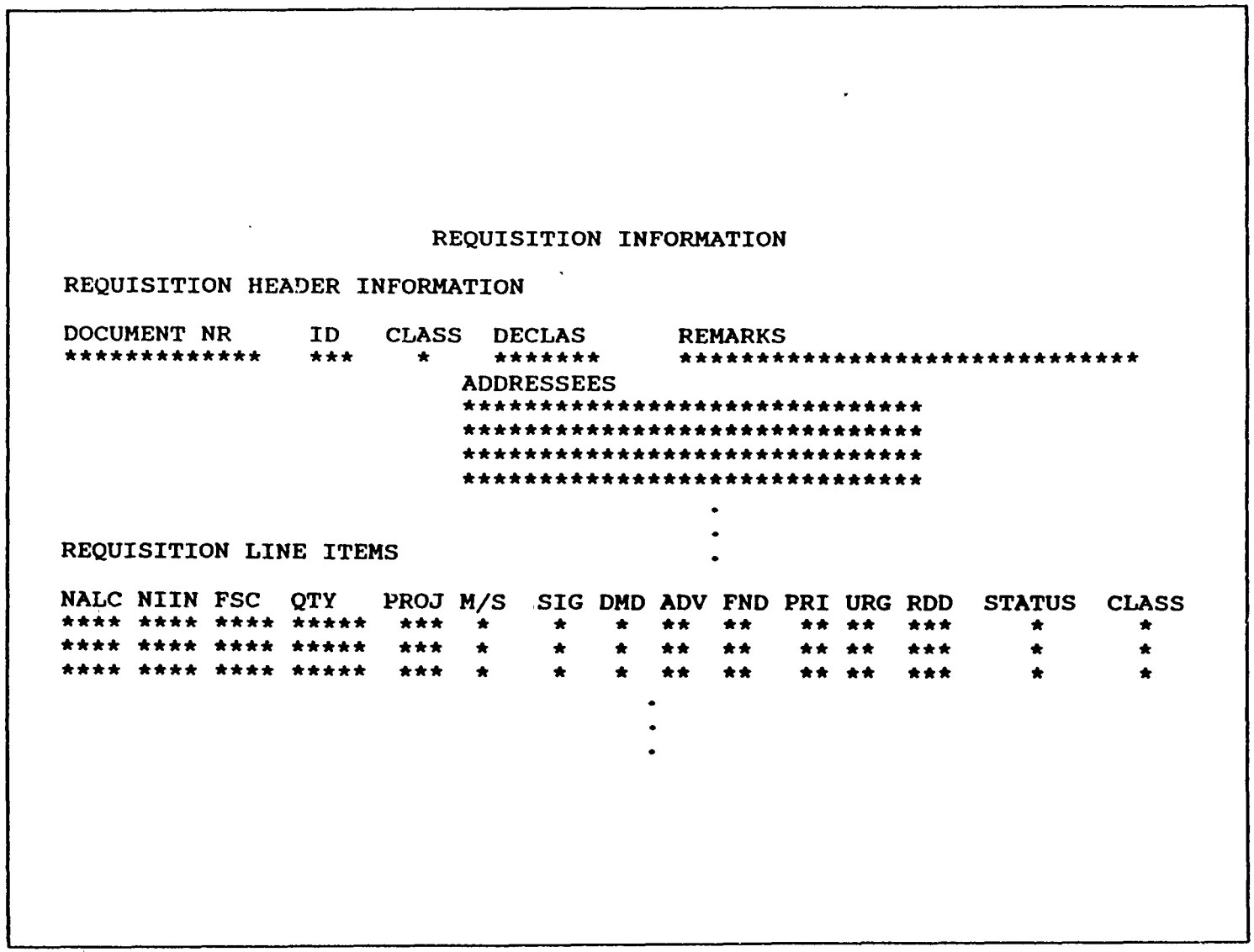

Figure 15. REQUISITION Information Form

APPENDIX E. FUNCTIONAL COMPONENT DESCRIPTIONS

A. MANAGE INVENTORY APPLICATION

1. Manage Inventory Update Mechanisms

a. Add New COMMAND Data

16

- Input
  - UIC, Name, Hull Number, Fleet, Service Code, Activity Classification Code, and Location (required only for requisitions) of the ARMIRS ship.
  - UIC, Name, Hull Number (N/A for shore commands), Service Code, Activity Classification Code, and Location (required only for requisitions or turn-ins) of the other unit, if any, involved in an inventory action.
- Output
  - New COMMAND object instance
  - Confirmation message on screen
- Processing Notes
  - There may not be information on another command to enter if the system is newly installed and has not yet been used for a transaction involving another command.
  - The location and fleet of the ARMIRS ship may change, but the other ship information is static.
  - There is not always another unit involved in a reportable action. For example, the system does not make any use of information on another command for a transaction involving an ammunition expenditure (e.g., loss, firing, etc).
- Volume[17]
  - Once for ARMIRS ship static information.
  - 14 times per year for information on the participating unit.
- Frequency
  - Monthly (as information changes)

---

16 Functionally part of the inventory management process but selected by the user from a separate menu.

17 Volumes and frequencies are (maximum) estimates for Knox class frigates, a typical smaller combatant ship. Values for other platforms may vary. Volumes and frequencies are highly dependent on a ship's operating schedule.

b. Edit COMMAND Data

- Input
  - Correction information on own ship or other unit as provided by Gunnery Officer based on information tied to major ship movements.
- Output
  - Modified COMMAND object instance(s)
  - Confirmation message on screen
- Processing Notes
  - This function changes basic command and location data to update the COMMAND object.
  - There are no multiple presentations of this screen for the user to page through. New information is simply typed over the outdated information on the form (Figure 12) and the update is processed.
  - A history of COMMAND Information Forms is not required. Only one form is required and that form is updated as changes occur.
- Volume
  - 14 times per year.
- Frequency
  - Monthly (as information changes)

c. Add a New Stock Record

- Input
  - Ammunition received onboard for which a stock record does not already exist.
  - NALC, FSC, NIIN, Name, COG, MCC, and Sonobouy Channel from the markings on the ammunition, markings on the shipping container, or from the DD Form 1348 which accompanies the onloaded ammunition.
  - Shipfill and NCEA Allowances from allowance lists held by the ship.
  - Unit Price, NHEEW, DOT and USCG Hazmat codes from NAVSEA publication TWO 10-AA-ORD-10 held onboard.
  - Shipboard location (for non-SLIT-controlled items) from the Gunnery Officer or Chief Gunner's Mate in accordance with the ship's loading plan.
  - Defined low stock level as determined by the Weapons Officer.
  - Combat mission area(s) supported by this item from the Weapons Officer (after liason with the Operations Officer).
- Output
  - New AMMO INVENTORY object instance
  - Confirmation message on screen

- Processing Notes
  - User may not have all the available information at the time of inital entry (e.g., receipt of a new NALC for which Operations and Weapons Department Heads have not defined the mission area(s) supported) and later editing may be required when all the information has been collected.
  - Equivalent action in the manual system would be to discover that a Master Stock Record Card does not exist for a newly acquired NIIN, obtain a blank card, complete the header information, and file the card.
  - This action completes the top section of the form shown in Figure 13.
- Volume
  - Six times per year
- Frequency
  - Bimonthly

d. Edit Descriptive Data

- Input
  - Correction information from revisions to: (1) allowance lists, (2) the loading plan, (3) NAVSEA Publication TWO 10-AA-ORD-010 ("The NALC/NIIN Book"), and (4) the Weapons Officer's determination as to low stock warning levels and mission area(s) supported.
  - AMMO INVENTORY object instance
- Output
  - Modified AMMO INVENTORY object instance
  - Confirmation message on screen
- Processing Notes
  - This function modifies the general, descriptive (not quantity) information on a particular NALC and NIIN.
  - Equivalent in the manual system to making corrections to the non-transaction fields on the Master Stock Record Card.
  - Retrieved from the database (most commonly by NIIN) in a query and edit mode when changes are necessary. Requires NIIN (or other property in the top section of Figure 13) for retrieval.
- Volume
  - Four times per year
- Frequency
  - Quarterly

e. Add (Post) a Transaction

- Input
  - AMMO INVENTORY object
  - Balance change information shown on the "Stock History" and "Transaction Reporting" sections of Figure 13 entered by the user.
  - ATR addressees from an expert database system (see Chapter VI) or from user input.
- Output
  - Updated AMMO INVENTORY object (new total posted)
  - New TRANSACTION object instance
  - Updated SERIAL and/or LOT CONTROLLED AMMO object instance (if applicable)
  - Confirmation message on screen
- Processing Notes
  - Each change in ammunition inventory, regardless of the reason, requires a new TRANSACTION instance.
  - Manual equivalent to this operation is to make a single line entry on the transaction history section of the Master Stock Record Card in preparation for drafting an ATR.
  - If a serial number or lot number exists for a NIIN, the Serial/Lot Record is also updated.
  - The total quantity on hand, regardless of condition, is update to the AMMO INVENTORY (NIIN) record when the transaction is posted (automatically in ARMIRS).
  - User must assign the next sequential ATR serial number (from the ATR Log) to each instance.
  - Document Number is required only for receipt and turn-in transactions. It is obtained from the DD Form 1348 accompannnying the ammunition (receipt) or assigned by the user (turn-in).
- Volume
  - 60 per year, with most of the transactions occuring in two or three major onloads offloads per year.
  - Peak activity before or after deployments and overhauls.
- Frequency
  - Weekly

f. Edit Transaction Data

- Input
  - TRANSACTION object instance
  - ATR Serial Number and Line Number from the user
  - Revised transaction data from the user
- Output
  - Modified TRANSACTION object instance
  - Updated SERIAL and/or LOT CONTROLLED AMMO object instance (if applicable)
  - Confirmation message on screen
- Processing Notes
  - Used to correct typographical errors on a TRANSACTION instance already added to the database.
  - To change the meaning of a TRANSACTION instance on a transaction for which an ATR has already been transmitted, a new instance (see preceding section) must be created and a new ATR generated.
  - Manual equivalent to this action is correction (erasure) of a field on a single line in the transaction history section of the Master Stock Record Card.
- Volume
  - 16 times per year
- Frequency
  - Monthly

g. Add a New Serial/Lot Record

- Input
  - Serial Number and/or Lot Number from markings on the ammunition, on the container, or on the DD Form 1348 accompanying the ammunition.
  - Maintenance Date, Maintenance Type, and Condition Code from the maintenance records accompanying the item.
  - Location for shipboard stowage from the Gunnery Officer or GMC in accordance with the ordnance loading plan.
- Output
  - New SERIAL/LOT CONTROLLED AMMO instance
  - Confirmation message on screen
- Processing Notes
  - Entered on the center section of the Serial/Lot Information Form (Figure 14).

- Requires a "parent" AMMO INVENTORY instance (with the NIIN of the prospective "child" lot or serial controlled item) already in the database before this process can occur.

- Volume
  - 30 times per year, usually grouped into 4 major offload or onloads
- Frequency
  - Quarterly

h. Edit Serial/Lot Information

- Input
  - Correction to descriptive information on a lot or serial ordnance item, including change to Maintenance Due Date, Maintenance Due Type, or Location.
- Output
  - Modified LOT and/or SERIAL CONTROLLED AMMO instance
- Processing Notes
  - Condition Code (and Quantity) are not revised in this process. Those actions require transaction reports and are accomplished through TRANSACTION.
  - This function accomplishes the same result for SLIT-controlled ammunition as that performed by "AMMO INVENTORY: Edit Descriptive Data" (Section A-1-d of this Appendix) for non-SLIT ammunition.
  - Equivalent action in the manual system is correcting non-transaction information on a Serial/Location Card or a Lot/Location Card.
  - Records are retrieved from the database in a query-by-forms edit mode using the Serial Number or Lot Number as the basis for retrieval.
- Volume
  - Six per year
- Frequency
  - Bimonthly

2. Manage Inventory Display Mechanisms

a. COMMAND Information Display

- Output Description
  - Form showing UIC, Hull Number (ships only), Command Name, Location, Activity Classification Code, Fleet, and Service Code for the host (ARMIRS) ship and the other command involved in a transaction or requisition (See Figure 12).
- Source Data
  - COMMAND object

- Processing Notes
  - Since there is only one form representing both current instances of the COMMAND object, displaying the form is activated by a menu selection and not a query-by-forms action (on UIC, etc.).
  - The form is displayed prior to generating a requisition or transaction when the user finds the COMMAND data outdated.
- Volume
  - 35 times per year
- Frequency
  - Biweekly

b. Stock Record Display

- Output Description
  - Form showing descriptive data on a NIIN as shown in Figure 13.
- Source Data
  - AMMO INVENTORY object
  - AMMO INVENTORY property (commonly NIIN) keyed by user and used as the basis for record retrieval.
- Processing Notes
  - If NIIN (the key attribute in AMMO INVENTORY) is used in the display query-by-forms mode, then only one screen will be available for display. If the user has only the NALC or (worse) only the COG then it will be necessary to page through a number of screens until the desired object instance is found.
  - Equivalent in the manual system to looking up a Master Stock Record Card in a set of cards filed by NALC and then by NIIN.
- Volume
  - 40 per year
- Frequency
  - Biweekly

c. Stock History Display

- Output Description
  - Form showing the stock and transaction history for a NIIN. Information on this form (Figure 13) includes Balance, Condition Codes, Quantity, New Balance and other information shown on the ATR(s) for this NIIN.
- Source Data
  - TRANSACTION object
  - AMMO INVENTORY object

- NIIN (or other property to use in retrieval) from user

- Processing Notes
  - See Stock Record Display
- Volume
  - 60 per year
- Frequency
  - Weekly

d. Display Lot/Serial Record

- Output Description
  - Form showing descriptive data on a serial or lot controlled item as shown in Figure 14.
- Input
  - SERIAL CONTROLLED AMMO object, or
  - LOT CONTROLLED AMMO object, or
  - SERIAL & LOT CONTROLLED AMMO object
  - Serial Number or Lot Number entered by the user and used as the basis for record retrieval.
- Processing Notes
  - Equivalent in the manual system to looking up a Serial/Location Record Card or a Lot/Location Record Card.
  - If Serial Number or Lot Number (the key attributes in their respective objects) are used in the display query-by-forms mode, then only one screen will be retrieved. However, if the user knows only a non-key attribute (e.g., NALC, COG, Location) then it will be necessary to page through a number of screens until the desired instance is found.
- Volume
  - 50 per year
- Frequency
  - Weekly

3. Manage Inventory Control Mechanisms

- Define procedures for the Gunnery or Weapons Officer to make periodic spot checks on the accuracy of command, inventory, transaction, and serial/lot number data. An enhancement to the system could involve system checking of data entries (i.e., checking to ensure that UIC and Command Name match each other from a list of Navy commands).

- System enhancement could include storage of NAVSEA Publication 10-TWO-AA-010, a large reference describing all the available NIINs in the stock system. ARMIRS could then check the existence of information entered on the Master Stock Record (e.g., checking validity of a NALC).

B. GENERATE REQUISITIONS APPLICATION

1. Generate Requisitions Update Mechanisms

a. Add a Requisition

- Input
  - COMMAND object
  - Document Number, Document Identifier, Requisition De/Classification, Addressees, and Remarks from user
  - Line item data including NALC, NIIN, FSC, Project Code, Media/Status Code, Signal Code, Demand Code, Advice Code, Fund Code, Priority, Urgency of Need, Required Delivery Date, Status, and Line Classification from the user and reference publications.
- Output
  - REQUISITION object instance
  - REQN LINE ITEM object instance(s)
  - Confirmation message on screen
- Processing Notes
  - All of the information on the Requisition Form (Figure 15) must be completed before a requisition can be generated.
  - An item need not be held in inventory to be requisitioned.
  - Initial (default) value for Requisition Status is [U] indicating unfilled.
- Volume
  - Eight per year (rare while deployed), usually with the majority of line items on two large requisitions
- Frequency
  - Quarterly

b. Edit Requisition Data

- Input
  - Update information on a requisition as provided by message or other official communication. Requisition Status is almost always the only requisition value to change between the time of transmission and material receipt.
- Output
  - Modified REQN LINE ITEM object instance

- Confirmation message on screen

- Processing Notes
  - The form shown in Figure 15 is retrieved (by Document Number) in a query-by-forms edit mode. The corrections are then entered by the user.
  - Changing the requisition attributes (except for Requisition Status which does not appear on the transmitted requisition) does not change the transmitted requistion. It is necessary to modify or cancel a transmitted requisition with a message.
  - The purpose of this update option is to allow requisition status changes to be made as status messages are received.
  - The manual system equivalent to this process is to write in a new "Status" entry in the Requisition Log on receipt of a requisition status message.
  - Different line items on the same requisition could each have a different status. Status is given for one line item.
- Volume
  - 15 per year
- Frequency
  - Monthly

2. Generate Requisitions Display Mechanisms

a. Single Requisition Display

- Output Description
  - Form displaying information on a requisition (one Document Number) and all of its line items (Figure 15).
- Source data
  - REQUISITION object
  - REQN LINE ITEM object
  - Document Number entered by user
- Processing Notes
  - Manual system equivalent is to look up a requisition in the Requisition File.
  - Retrieval by NALC or NIIN (non-key attributes here) is also possible but may be more time consuming because of multiple instances.
- Volume
  - 11 times per year
- Frequency
  - Monthly

b. Requisition Generation

- Output Description
  - Report containing all information required of a requisition and its line items as shown in Figure 15.
  - Format for output determined by user selection of a desired format.
- Source Data
  - COMMAND object
  - REQUISITION object
  - REQN LINE ITEM instance(s)
  - User selection of format desired (DD Form 1348, DAAS, or Naval Message).
- Processing Notes
  - User selects a menu option for the desired format.
  - All information on Figure 15 (except Status, which is for internal use) must be completed before a requisition can be generated.
  - Information on the ARMIRS ship and the requisitioned activity (COMMAND object) must be updated prior to generation of an accurate requisition.
- Volume
  - 11 per year
- Frequency
  - Monthly

c. Turn-In Document Generation

- Output Description
  - Output in DD Form 1348 format consisting of NIIN, Unit Of Issue, Quantity, Document Number, COG, Project Code, Unit Price, Service Code, UIC, Name, Hull Number, Extended Price, MCC, DOT and USCG Hazmat Codes, Lot or Serial Number (if applicable), Short Title, NAR Serial Number (if applicable)
- Source Data
  - TRANSACTION object
  - COMMAND object
  - AMMO INVENTORY object
  - SERIAL and/or LOT CONTROLLED AMMO object (if applicable)
- Processing Notes
  - Document Number is locally assigned and must be sequentially issued.

- Future enhancement to the system would print the boxes and columns of the DD Form 1348 rather than only providing formatted output that must be transferred to a DD Form 1348.
- Because this function uses all ARMIRS objects (except for REQN & LINE ITEM), all forms (except requisitions) must be updated prior to turn-in document generation.

- Volume
  - Four per year
- Frequency
  - Semiannually

3. Generate Requisitions Control Mechanisms

- The system should not allow assignment of duplicate documents numbers or document numbers (for the ARMIRS ship) that are out of sequence.
- Define procedures to allow the Weapons Officer or Gunnery Officer to spot check the accuracy of ARMIRS requisition data by comparing generated requisitions to SPCCINST 8010.12D and other instructions.

C. GENERATE REPORTS APPLICATION

1. Generate Reports Update Mechanisms

None. Except for a one field update to TRANSACTION, this is an output-only function.

2. Generate Reports Display Mechanisms

a. Requisition Log Report

- Output Description
  - Report displaying the requisitions issued by a command with data in columns for Document Number, NALC, Short Title, Quantity Requisitioned, Required Delivery Date, Requisition Status, and Priority.
- Source Data
  - REQUISITION object
  - REQN LINE ITEM object
  - AMMO INVENTORY object
- Processing Notes
  - Rows consist of all Document Numbers where Required Delivery Date exists (since turn-in documents [issue transactions] also are identified by document numbers but never have an RDD).
  - Rows are sorted by Document Number and then by NIIN.
  - Displays summary and status information on all requisitions, regardless of status.

- Volume
  - 18 times per year
- Frequency
  - Monthly

b. Maintenance Due Summary Report

- Output Description
  - Report summarizing maintenance due information on serially controlled items and containing columns for NALC, Short Title, Serial Number, Maintenance Due Date, and Maintenance Type.
- Source Data
  - SERIAL CONTROLLED AMMO object, or
  - SERIAL & LOT CONTROLLED AMMO object
  - AMMO INVENTORY object
- Processing Notes
  - All ammunition items with serial numbers are displayed on this report.
  - The rows on the report are sorted by NALC and then by Serial Number.
  - Maintenance Due Type may be blank for some rows. Only torpedoes and air-launched missiles have a value assigned.
- Volume
  - Four per year
- Frequency
  - Quarterly

c. Ship Ammunition Listing

- Output Description
  - A report of ammunition held (without quantities) containing columns for COG, NALC, and Short Title.
- Source Data
  - AMMO INVENTORY object
- Processing Notes
  - This report is a list of ammunition types held onboard. It does not include the quantities found on inventory reports (See TRANSACTION object).
  - Equivalent report from the manual system is processed by sorting through the Master Stock Record Cards (in NALC groups) and copying the COG, NALC, and Short Title from the card header information.

- Report rows are sorted by COG and then by NALC.

- Volume
  - 16 per year
- Frequency
  - Monthly

d. Allowance List Report

- Output Description
  - Columns for COG, NALC, Short Title, Shipfill Allowance, and Training Allowance (NCEA).
- Source Data
  - AMMO INVENTORY object
- Processing Notes
  - This report summarizes the NAVSEA (shipfill) and NCEA (training) allowances held by the ship.
  - Some NALC/NIIN items held onboard do not have shipfill or training allowances. As a result, some rows will have a zero under the Shipfill Allowance and or Training Allowance columns.
  - The manual equivalent to this report would be to create a list of NIINs and then use the two allowance lists to add allowance data for each NIIN.
  - Rows sorted by COG, NALC, and then NIIN.
- Volume
  - Four per year
- Frequency
  - Quarterly

e. NAR Management Report

- Output Description
  - Report containing columns for NAR Serial Number, NALC, Short Title, Lot Number (if applicable), and Condition Code.
- Source Data
  - AMMO INVENTORY object
  - TRANSACTION object
  - LOT and/or SERIAL CONTROLLED AMMO objects (if applicable)
- Processing Notes

- This report is used by the Gunnery Officer to cross reference Notices of Ammunition Reclassification with the onboard ammunition inventory. It is also used to prevent missing NARs.
- The only NIINs of interest here are the ones corresponding to NARS. This report selects all NIINS where a NAR Serial Number exists.
- The instances on this report are sorted by NAR Serial Number, and are therefore in chronological order.
- Equivalent in the manual system to going through the NAR File and checking against the Master Stock Record Cards to extract "active" NARs refering to ammunition held by the command.

- Volume
  - 16 times per year
- Frequency
  - Monthly

f. Allowance Tracking Report

- Output Description
  - Report containing columns for NALC, Short Title, Quantity, Shipfill Allowance, NCEA Balance (quantity unexpended for the current fiscal year's traininng allowance), and Percent of Shipfill Allowance onboard.
- Source Data
  - AMMO INVENTORY object
  - TRANSACTION object
- Processing Notes
  - NCEA Balance is calculated by adding all balance changes for the fiscal year where there is a Quantity Expended reported. This total is then subtracted from the Training Allowance for that ammunition type.
  - On 01 October of each year, the NCEA Balance is set equal to the ship's Training Allowance.
  - Percentage of Shipfill Allowance is a calculated value not stored in the database. It is used on summary reports only.
  - Equivalent processing in the manual system would require checking the transactions (since 01 October of the current fiscal year for NCEA) on the stock cards and comparing these sums against the NAVSEA Ship Allowance and the NCEA Training Allowance for each applicable NALC.
  - Unlike the Allowance List Report which only includes the allowances and not the inventory quantities, this report assists the Gunnery Officer in planning the requisitioning and expenditure of ammunition to remain close to 100 percent of Shipfill Allowance while ensuring that ammunition expenditures do not exceed the fiscal year training allowance.

- Volume
  - 15 per year
- Frequency
  - Monthly

g. Ammunition Transaction Report (ATR)

- Output Description
  - A formatted message containing all of the properties shown on the "Stock History" and "Transaction Reporting" sections of Figure 13 (except for Price which is only used for turn-in documents).
- Source Data
  - COMMAND object (UIC, Name, Service Code)
  - AMMO INVENTORY object (NALC, FSC, NIIN, COG, MCC, ACC, and Sonobuoy Channel [if applicable])
  - TRANSACTION object (except for Price)
  - SERIAL and/or LOT CONTROLLED AMMO objects (if applicable)
  - ATR Addressees and ATR Classification from the expert database module (if used) or from user input.
- Processing Notes
  - The generated ATR should be ready to transmit through Naval telecommunications channels.
  - The ATR may vary in length from one transaction (about 3 or 4 lines on the finished report) to up to six pages of transactions.
- Volume
  - 60 per year, within 48 hours of every transaction
- Frequency
  - Weekly, highly variable

h. ATR Log Report

- Output Description
  - Report showing the ATRs sent by the ship and containing columns for ATR Serial Number, ATR Line Number, Short Title, Quantity Expended / Issued / Received, Condition Code, and Quantity.
- Source Data
  - TRANSACTION object (all instances)
- Processing Notes

- Each line on this report represents an instance of the TRANSACTION object (since each transaction must have an ATR serial and line number).
- Sorting of data rows is by ATR Serial Number and then by ATR Line Number.
- ATR Serial Numbers must be sequentially assigned with no gaps in the sequence.
- In the manual system, the ATR Log performs the function of this report, allowing a quick reference to key information on transaction reports and serving as the source of ATR Serial Numbers.

- Volume
  - 30 times per year
- Frequency
  - Biweekly

i. SORTS Message Input Report

- Output Description[18]
  - Report sent as a memo from the Weapons Officer to the Operations Officer providing input for a message on combat readiness impact of ammunition stock levels (among other readiness factors).
  - Columns for Mission Area (i.e., ASW, AAW, etc.), NALC, Short Title, Quantity, Shipfill Allowance, and Percent of Allowance Onboard.
- Source Data
  - AMMO INVENTORY object (Mission, NALC, Short Title, Shipfill Allowance,Quantity)
- Processing Notes
  - Percentage of Allowance Onboard is not a database property but is a calculated value used for reports.
  - Data rows are sorted first by Mission Area and then by NALC.
  - Only NALCs with Mission Areas assigned are shown on this report. (For example, small arms ammunition and pyrotechnics do not have assigned combat mission areas and would not appear.)
  - Some of the rows on this report could be duplicated, since it is recognized that one NALC may have more than one mission area (e.g., a 5-inch gun projectile used for both ASUW and AMW).
- Volume
  - 50 per year
- Frequency

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18 LT Thomas P. Fortin, USN provided valuable input on the readiness reporting requirements of ammunition inventory information.

- Weekly

j. Ship Ammunition Inventory Report (Summary)

- Output Description
  - Inventory report including columns for COG, NALC, NIIN, Short Title, and Quantity.
- Source Data
  - AMMO INVENTORY object
  - TRANSACTION object
- Processing Notes
  - This report presents summary inventory information and does not subivide NALC and NIIN into lots or serially numbered rounds.
  - The quantities of all NIINs onboard are represented on this report.
  - Rows are sorted by COG, by NALC, and then by NIIN.
- Volume
  - 50 per year
- Frequency
  - Weekly

k. Turn-In Log Report

- Output Description
  - Report containing columns for Document Number, Date, Consignee, Short Title, and Quantity Issued.
- Source Data
  - TRANSACTION object
  - AMMO INVENTORY object
- Processing Notes
  - This report summarizes the command's history of turn-in (ammunition offload) documents.
  - Each Document Number where an Issue Code exists is represented by a row on this report.
  - Data rows are sorted by Date and then by Document Number.
- Volume
  - Four times per year
- Frequency
  - Quarterly

l. Ship Ammunition Inventory Report (Detailed)

- Output Description
  - Inventory report featuring columns for NALC, NIIN, Short Title, Lot Number, Serial Number, and Quantity.
- Source Data
  - SERIAL and/or LOT CONTROLLED AMMO object(s)
  - AMMO INVENTORY object
- Processing Notes
  - This reports subdivides NIINs by serial and lot number. It is more detailed than the "Ship Ammunition Inventory Report (Summary)" and is required less frequently.
  - Data for the Lot Number and Serial Number columns will be absent for non-SLIT items.
  - The rows will be sorted by NALC and then by NIIN.
- Volume
  - 12 per year
- Frequency
  - Monthly

m. Outstanding Requisition Summary Report

- Output Description
  - Report on unfilled requisitions consisting of columns for Document Number, NIIN, NALC, Short Title, RDD, Priority, and Quantity Requisitioned.
- Source Data
  - REQUISITION object
  - REQN LINE ITEM object
- Processing Notes
  - All Document Numbers where Requisition Status is [U]nfilled are sorted first by Document Number and then by NIIN.
  - Equivalent action in the manual system is to page through the Requisition Log and find all entries where the Requisition Status shows that the requisition is outstanding.
- Volume
  - 12 per year
- Frequency
  - Monthly

3. Generate Reports Control Mechanisms

- Send output to screen or printer at user option.
- Provide setup routines where a printer can be designated.

APPENDIX F. RELATIONAL SCHEMA

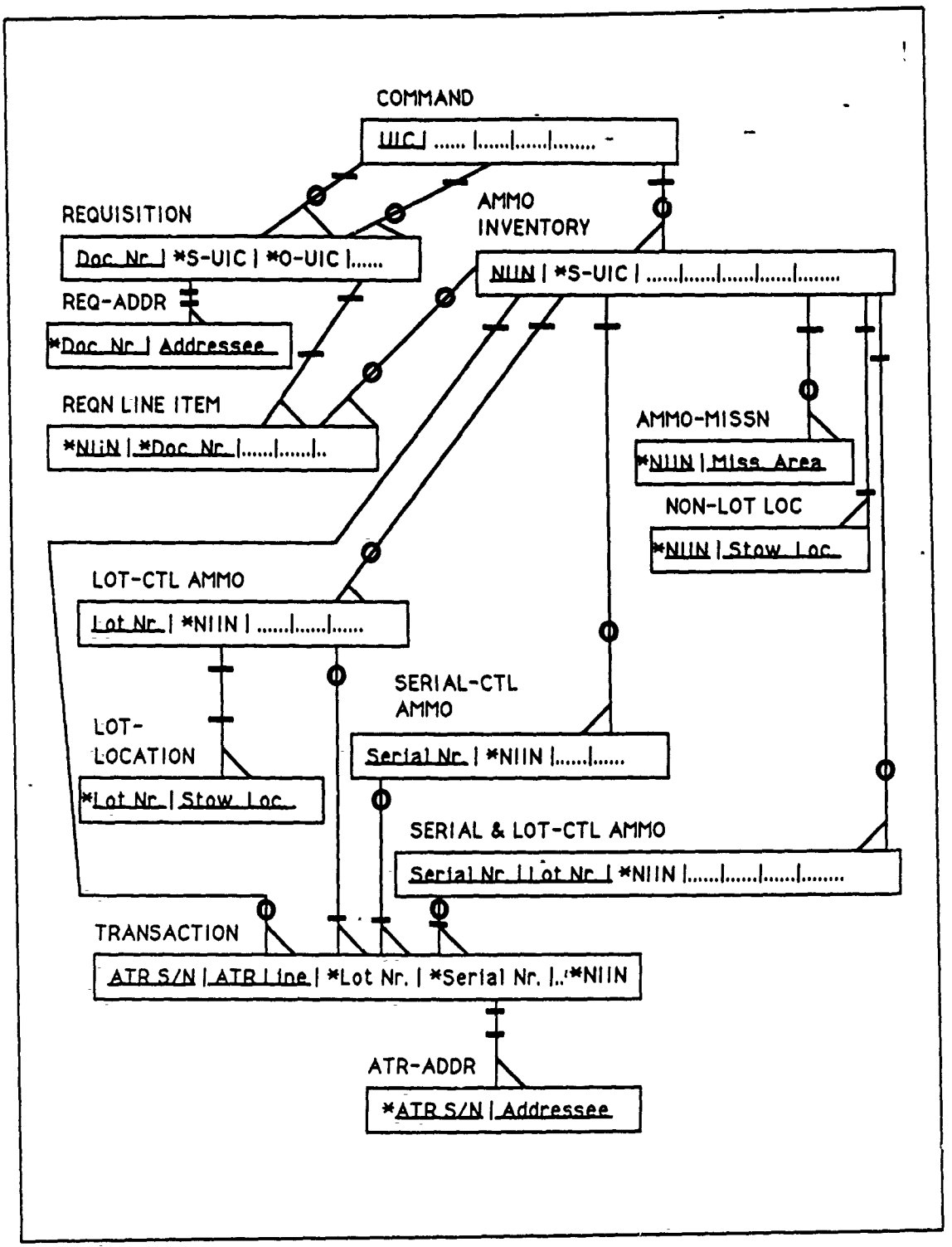


Figure 16. ARMIRS Relation Diagram (__ = key, * = foreign key)

APPENDIX G. MENU HIERARCHY DIAGRAMS

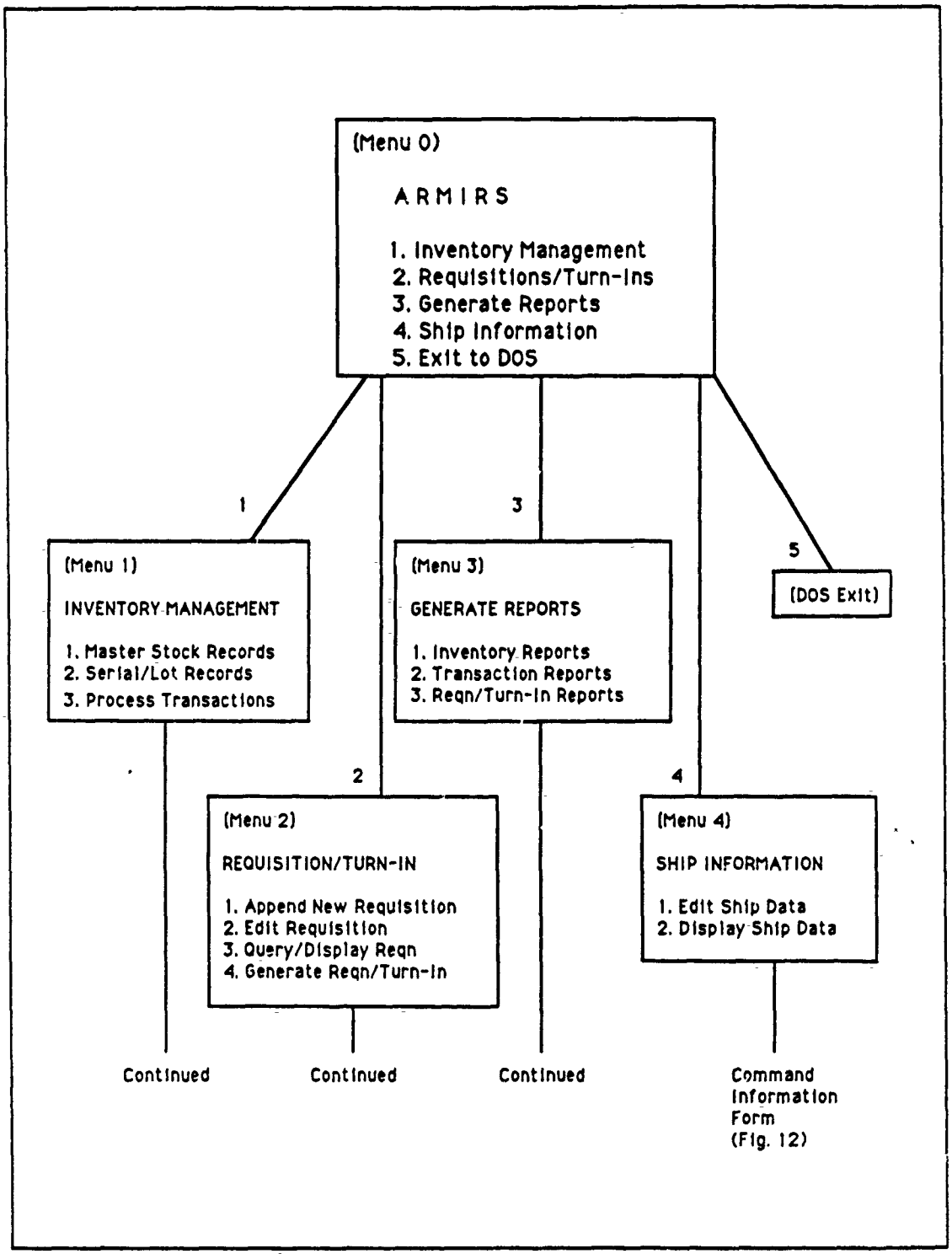


Figure 17. Hierarchy for Main and Secondary Menus

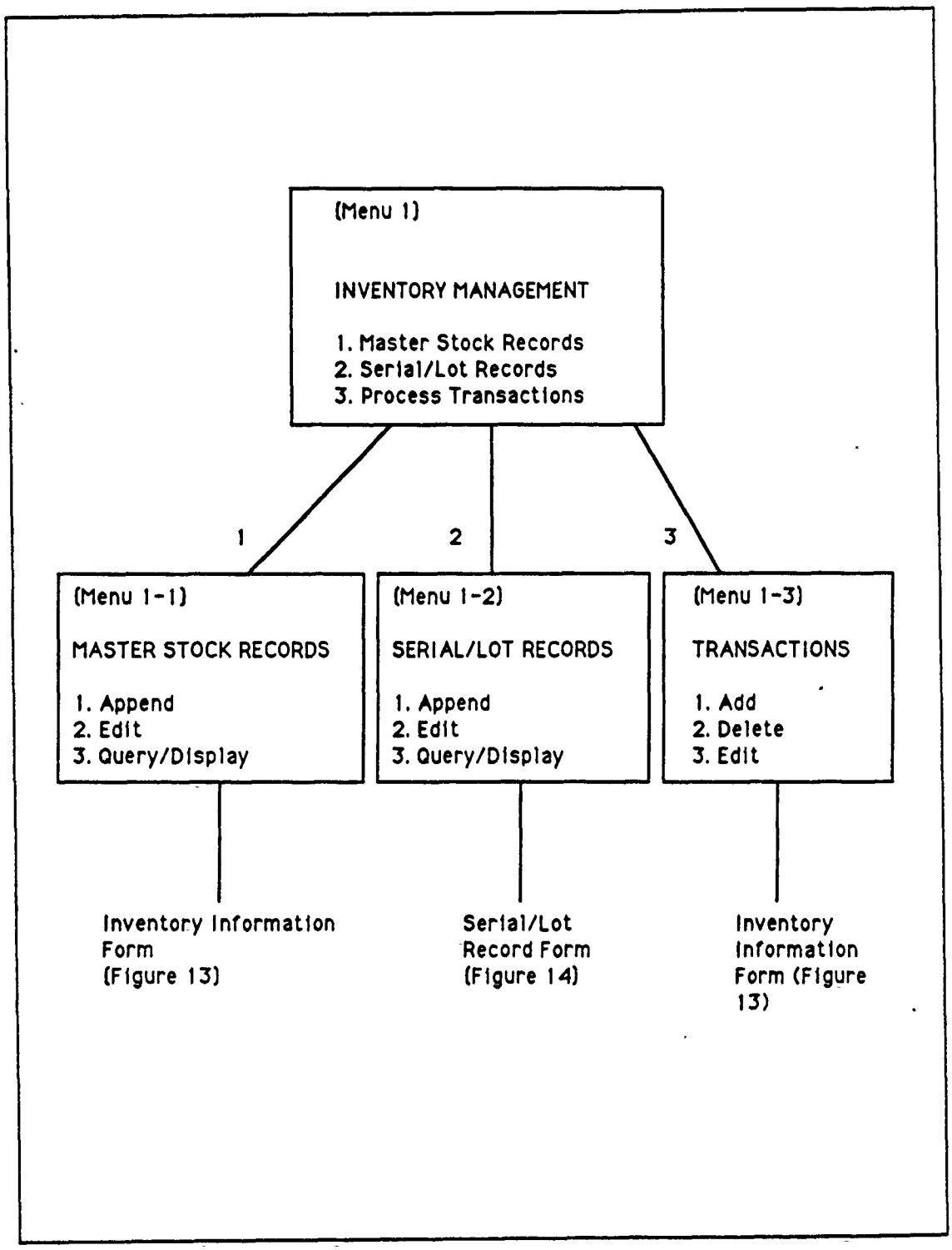


Figure 18. Hierarchy for Menu 1 (Inventory)

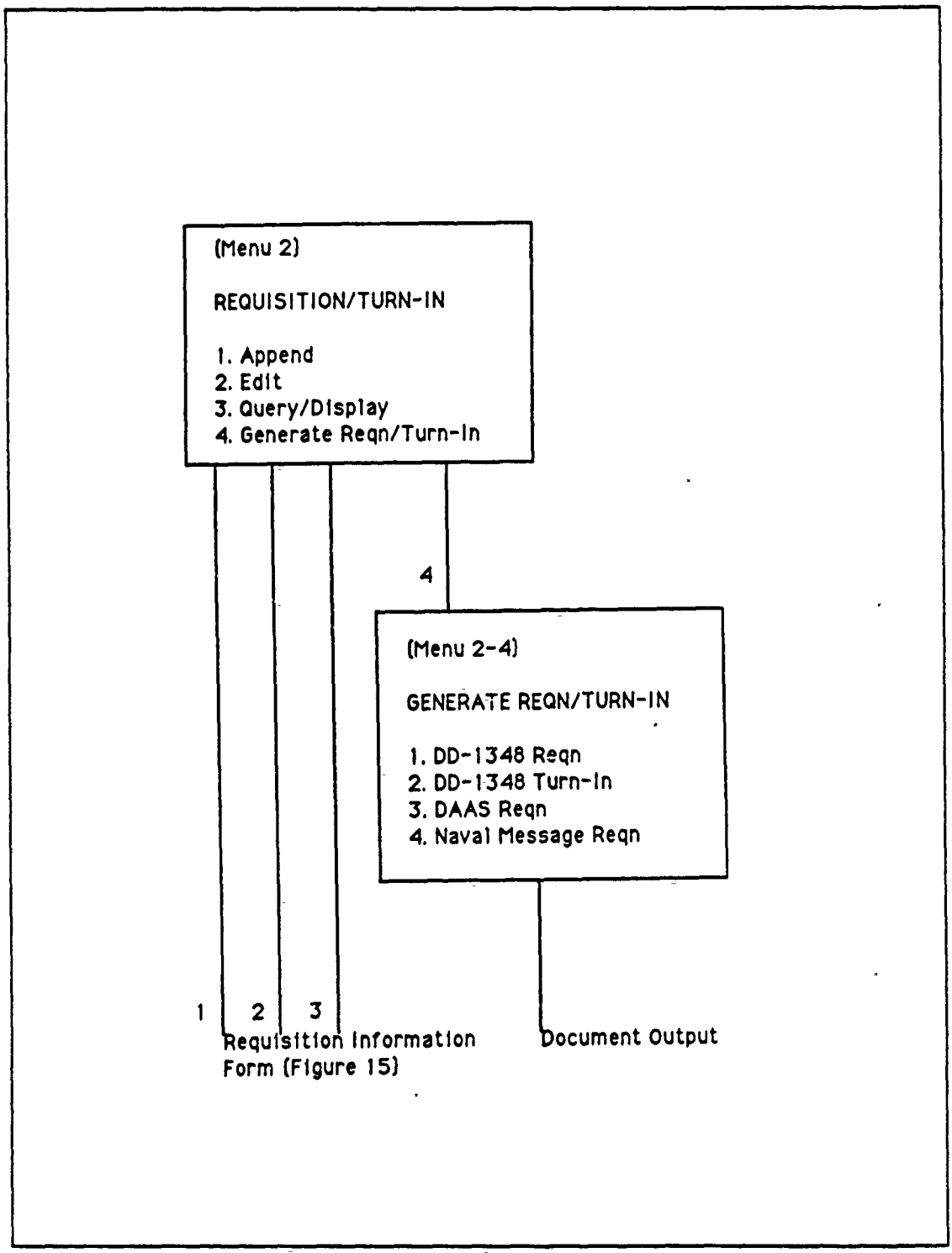


Figure 19. Hierarchy for Menu 2 (Requisition/Turn-In)

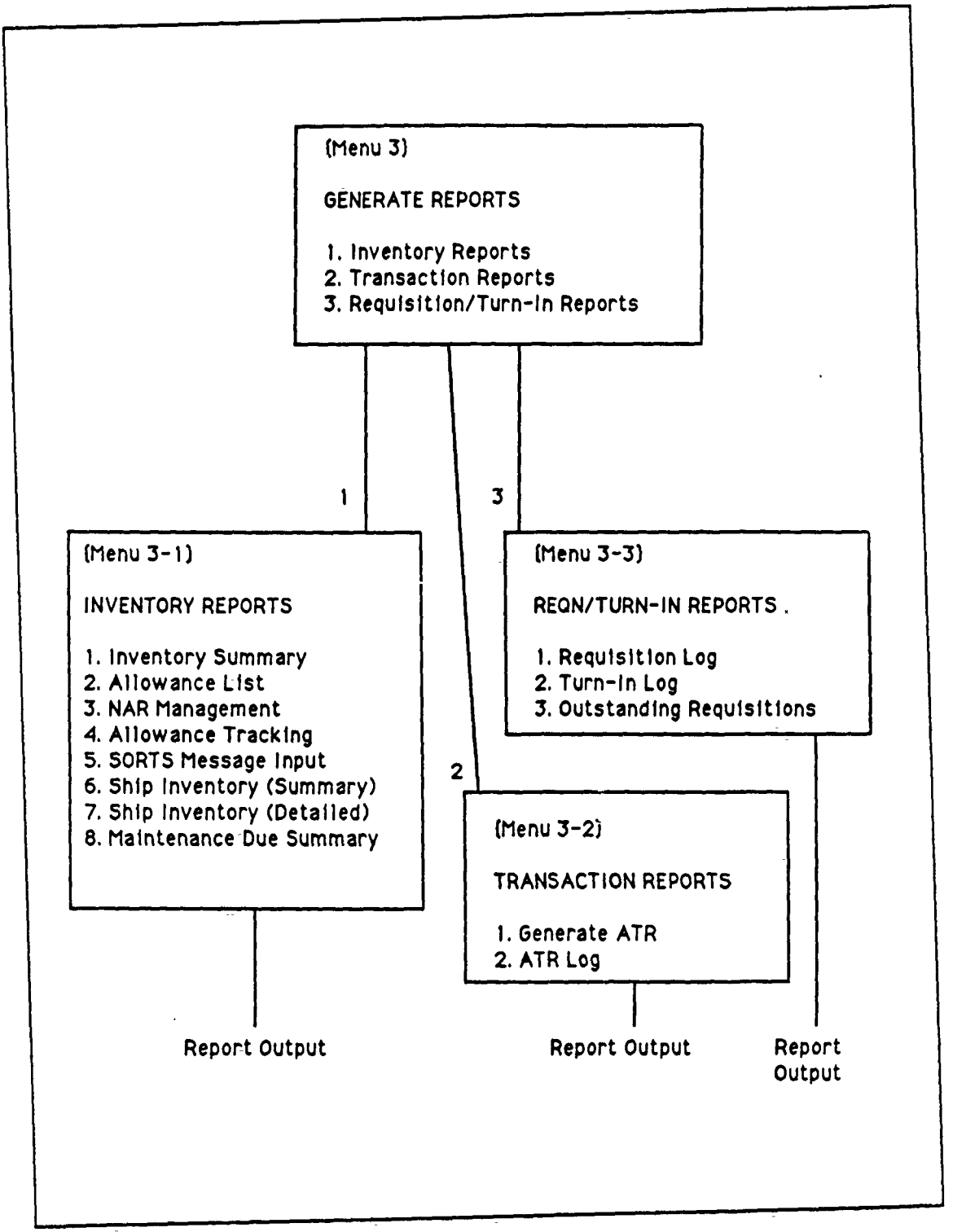


Figure 20. Hierarchy for Menu 3 (Generate Reports)

APPENDIX H. LOGIC SPECIFICATIONS

A. MENU 0 (MAIN MENU)

Until ESC entered:

- Display ARMIRS Main Menu (Figure 17)
  1. Inventory Management
  2. Requisition/Turn-In
  3. Reports
  4. Ship Information
  5. Exit to Operating System
- Get menu choice from user
- Confirm menu choice
- Case menu choice
  1. Go to Menu 1 (Inventory Management, Figure 18)
  2. Go to Menu 2 (Requisition/Turn-In, Figure 19)
  3. Go to Menu 3 (Report Generation, Figure 20)
  4. Go to Menu 4 (Ship Information, Figure 17)
  5. Exit to operating system prompt
- Else ESC

B. MENU 1 (INVENTORY MENU)

Until ESC entered:

- Display Menu 1
- Get menu choice from user [1,2,3]
- Confirm menu choice
- Go to selected menu choice

1. **Menu 1-1 (Master Stock Records)**

   Until ESC entered:

- Display Menu 1-1
- Get menu choice from user [1,2,3]
- Confirm menu choice
- Go to selected menu choice

a. Append Master Stock Records

- Display Inventory Information Form (Figure 13)
- Get NALC from user
- Get FSC from user
- Get NIIN from user
- Get Short Title from user
- Get COG from user
- Get MCC from user
- Get Unit of Issue from user
- Get Sonobouy Channel (optional) from user
- Get Shipfill Allowance from user
- Get Mission Allowance from user
- Get NCEA from user
- Get Location(s) (optional) from user
- Get USCG Hazmat Code from user
- Get DOT Hazmat Code from user
- Get NHEEW from user
- Get Unit Price from user
- Get Missions Area(s) (optional) from user
- Get Low Stock Level (default = 50%) from user
- Display confirmation message
- Store inventory data

b. Edit Master Stock Records

Until ESC entered:

- Get NIIN (or other inventory property) from user
- Display top part of Inventory Information Form (Figure 13) for desired stock record
- Get any (optional) revisions from user
- Display confirmation message
- Store revised inventory data

c. Query or Display Master Stock Records

Repeat until ESC entered:

- Get NIIN (or other inventory property) from user
- Display top part of Inventory Information Form (Figure 13) for desired stock record

2. Menu 1-2 (Serial-Lot Records)

Until ESC entered:

- Display Menu 1-2
- Get menu choice from user [1,2,3]
- Confirm menu choice
- Go to selected menu choice

a. Append Serial and Lot Stock Records

- Display Serial/Lot Record Form (Figure 14)
- Get NIIN from user
- If NIIN does not exist then:
  - Display:"YOU MUST FIRST CREATE A MASTER STOCK RECORD FOR THIS ITEM BEFORE CREATING SERIAL OR LOT RECORDS"
- Display Short Title from database
- Display NALC from database
- Display COG from database
- Display Remarks from database
- Get Serial Number (optional) from user
- Get Lot Number (optional) from user
- If Serial Number exists then:
  - Get Maintenance Due Date from user
  - Get Maintenance Due Type from user
- Get Location from user
- Display confirmation message
- Store serial and lot data

b. Edit Serial and Lot Stock Records

Repeat until ESC entered:

- Get Serial Number or Lot Number (or other property) from user

- Display Serial/Lot Record Form (Figure 14) for desired record
- Get any (optional) revisions from user
- Store revised serial and lot data

c. Query or Display Serial and Lot Stock Records

Until ESC entered:

- Get Serial Number or Lot Number (or other property) from user
- Display Serial/Lot Record Form (Figure 14) for desired record

3. Menu 1-3 (Process Transactions)

Unil ESC entered:

- Display Menu 1-3
- Get menu choice from user [1,2,3]
- Confirm menu choice
- Go to selected menu choice

a. Add Transaction

Until ESC entered:

- Get NIIN (or other inventory property) from user
- If NIIN does not exist then:
  - Display: "YOU MUST FIRST CREATE A MASTER STOCK RECORD BEFORE PROCESSING TRANSACTIONS ON THIS NIIN."
- Display selected Inventory Information Form (Figure 13)
- Get new transaction data from user
- If transactions changes quantity on hand then:
  - Update AMMO INVENTORY.Quantity on Hand (post transaction to Master Stock Record)
  - If Serial Number or Lot Number exists then:
    - Update quantity in SERIAL and/or LOT CONTROLLED AMMO
- If Serial Number or Lot Number exists then:
  - Update all (user-entered) values to SERIAL and/or LOT CONTROLLED AMMO

b. Delete Transaction

Until ESC entered:

- Get NIIN (or other inventory property) from user

- If NIIN does not exist then:
  - Display: "NIIN REQUESTED FOR TRANSACTION DELETION DOES NOT EXIST IN INVENTORY. PLEASE TRY AGAIN."
- Display selected Inventory Information Form (Figure 13)
- Get transaction line to delete from user
- Update AMMO INVENTORY.Quantity on Hand
- Delete (user-selected) line for ATR Serial Number and ATR Line Number.
- If Serial Number or Lot Number exists then:
  - Delete selected transaction from SERIAL and/or LOT CONTROLLED AMMO
- Display deletion confirmation message

c. Edit Transaction

Until ESC entered:

- Get NIIN (or other inventory property) from user
- Display selected Inventory Information Form (Figure 13)
- Get any (optional) revisions to TRANSACTION from user[19]
- Display confirmation message
- Store revised transaction data

C. MENU 2 (REQUISIT)N/TURN-IN MENU)

Until ESC entered:

- Display Menu 2
- Get menu choice from user [1,2,3,4]
- Confirm menu choice
- Go to selected menu choice

1. Append Requisitions

- Display Requisition Information Form (Figure 15)
- Get Document Number from user
- If Document Number exists then:
  - Display: "THIS DOCUMENT NUMBER HAS ALREADY BEEN ASSIGNED. SEE THE REQISITION OR TURN IN-LOG FOR MORE INFORMATION."

---

19 Used to modify an unposted transaction only.

- Get Document ID from user
- Get Classification from user
- If Classification = [C] then:
  - Get Declass Date from user
- Get Remarks from user
- Get Addressees from user
- For each requisitioned item:
  - Get NALC from user
  - Get NIIN from user
  - Display FSC from database
  - Get Quantity from user
  - Get Project Code from user
  - Get Media and Status Code from user
  - Get Signal Code from user
  - Get Demand code from user
  - Get Advise Code from user
  - Get Fund Code from user
  - Get Priority from user
  - Get Urgency of Need from user
  - Get Required Delivery Date from user
  - Get Status (optional, default = [U]nfilled) from user
  - Get Line Classification (default = [U]nclassified) from user
- Display confirmation message
- Store requisition data

2. Edit Requisitions

Until ESC entered:

- Get Document Number (or other requisition property) from user
- Display Requisition Information Form (Figure 15)
- Get any (optional) revisions from user
- Display confirmation message
- Store revised requisition data

3. **Query or Display Requisitions**

Repeat until ESC entered:

- Get Document Number (or other requisition property) from user
- Display Requisition Information Form (Figure 15) for desired requisition record

4. **Menu 2-4 (Generate Requisitions or Turn-Ins)**

Until ESC entered:

- Display Menu 2-4
- Get menu choice from user [1,2,3,4]
- Confirm menu choice
- Go to selected menu choice

a. Generate DD Form 1348 Requisition

Until ESC entered:

- For selected Document Number
  - Display "DD FORM 1348 REQISITION INPUT"
  - Generate Header Line:
    - ▲ Display Document Identifier
    - ▲ Display Media and Status Code
    - ▲ Display FSC
    - ▲ Display NIIN
    - ▲ Display Unit Of Issue
    - ▲ Display Requisition Quantity
    - ▲ Display Service Code
    - ▲ Display Document Number
    - ▲ Display Fund Code
    - ▲ Display COG
    - ▲ Display Project Code
    - ▲ Display Priority
    - ▲ Display Required Delivery Date
    - ▲ Display Advice Code
  - Display "A." [UIC, Name, Hull Number, Location for own ship]
  - Display "B." [UIC, Name, Hull Number, Location for other command]

- Display "T. DOT CLASS" [DOT Hazmat Code] "CG CLASS" [USCG Hazmat Code]
- Display "W." [NALC]
- Display "X." [Short Title]
- Display "BB. LIVE AMMO"

b. Generate DD Form 1348 Turn-In

Until ESC entered:

- For selected Document Number where Issue Code exists:
  - Display "DD FORM 1348 TURN-IN INPUT"
  - Display "HEADER LINE:"
    - ▲ Display FSC
    - ▲ Display NIIN
    - ▲ Display Unit of Issue
    - ▲ Display Service Code
    - ▲ Display Document Number
    - ▲ Display COG
    - ▲ Display Project Code
    - ▲ Display Unit Price
  - Display "A." [UIC, Name, Hull Number, Location for own ship]
  - Display "B." [UIC, Name, Hull Number, Location for other command]
  - Display "E." [Extended Price]
  - Display "P." [Material Condition Code]
  - Display "T. DOT CLASS" [DOT Hazmat Code] "CG CLASS" [USCH Hazmat Code]
  - Display "V." [Lot Number]
  - Display "V." [Serial Number]
  - Display "W." [NALC]
  - Display "AA." [NAR Serial Number]
  - Display "BB. LIVE AMMO"

c. Generate DAAS Requisition

Until ESC entered:

- For selected Document Number
  - Display "UNCLASSIFIED"

- Display "LMF = TT CIC=ZYUW"
- Display "FROM:" [Command Name]
- Display "TO: DAAS DAYTON OH"
- Display "INFO:" [Addressees]
- Display "SUBJ: AMMO MILSTRIP REQN"
- For each NIIN [requisition line]:
  - ▲ Display Document Identifier
  - ▲ Display Media and Status Code
  - ▲ Display NIIN
  - ▲ Display Quantity
  - ▲ Display Document Number
  - ▲ Display Demand Code
  - ▲ Display Signal Code
  - ▲ Display Project Code
  - ▲ Display Priority
  - ▲ Display Required Delivery Date
  - ▲ Display Advice Code

d. Generate Naval Message Requisition

Until ESC is entered:

- For a selected Document Number:
  - Display "CLASSIFICATION:" [Classification]
  - If Classification = C then:
    - ▲ Display "DECLAS:" [Declas Date]
  - Display "FROM: "[Command Name]
  - Display "TO: SPCC MECHANICSBURG PA"
  - Display "INFO:" [Addressees]
  - Display [Classification]"//NO8010//"
  - Display "AMMO MILSTRIP REQUISITION"
  - Display "1. ("[Classification]")"
  - For each NIIN (requisition line):
    - ▲ Display [Document Identifier]"/"
    - ▲ Display "NCB/"

- ▲ Display [Media and Status Code]";"
- ▲ Display [FSC][NIIN]"/"
- ▲ Display [Quantity of Issue]"/"
- ▲ Display [Quantity]"/"
- ▲ Display [Document Number]"/"
- ▲ Display [UIC]"/"
- ▲ Display [Signal Code]"/"
- ▲ Display [Fund Code]"/"
- ▲ Display [Project Code]"/"
- ▲ Display [Priority]";"
- ▲ Display [Required Delivery Date]"/"
- ▲ Display Advice Code

- Display "2. ([Line Classification]")" [Remarks]
- Display "DECLAS:"[Declas Date]

D. MENU 3 (GENERATE REPORTS MENU)

Unil ESC entered:

- Display Menu 3
- Get menu choice from user [1,2,3]
- Confirm menu choice
- Go to selected menu choice

1. Menu 3-1 (Inventory Reports)

Until ESC entered:

- Display Menu 3-1
- Get menu choice from user [1,2,3,4,5,6,7,8]
- Confirm menu choice
- Go to selected menu choice.

a. Inventory Summary Report

Until ESC entered:

- Display "AMMUNITION LISTING"
- Display [today's date]
- Display "COG...NALC...NAME"
- For all NIIN in database sort by COG then NIIN:

- Display COG
- Display NALC
- Display Short Title

b. Allowance List Report

Until ESC entered:

- Display "ALLOWANCE LIST REPORT"
- Display [today's date]
- Display "NALC...NIIN...NAME...SHIPFILL ALLOW...TRAINING ALLOW."
- For all NIIN in database where Shipfill Allowance exists OR where Training Allowance exists, sort by COG then NALC then NIIN:
  - Display NALC
  - Display NIIN
  - Display Short Title
  - Display Shipfill Allowance
  - Display Training Allowance

c. NAR Management Report

Until ESC entered:

- Display "NAR MANAGEMENT REPORT"
- Display [today's date]
- Display "NAR #...NALC...NAME...LOT #.. COND. CODE"
- Select all from database where NAR Serial Number exists, sort by NAR Serial Number:
  - Display NAR Serial
  - Display NALC
  - Display Short Title
  - Display Lot Number
  - Display Condition Code

d. Allowance Tracking Report

Until ESC entered:

- Display "ALLOWANCE TRACKING REPORT"
- Display [today's date]
- Display "NALC...NAME...QTY...ALLOW...NCEA..NCEA BAL..PCT ALLOW"

- Select all from database where Training Allowance exists OR Shipfill Allowance exists, sort by NALC then by Short Title:
  - Display NALC
  - Display Short Title
  - Display Quantity
  - Display Shipfill Allowance
  - Display NCEA Balance
  - Display (Quantity/Shipfill Allowance)*100

e. SORTS Message Input Report

Until ESC entered:

- Display [today's date]
- Display "FROM: WEAPONS OFFICER"
- Display "TO: OPERATIONS OFFICER"
- Display "SUBJ: INPUT FOR SORTS MESSAGE"
- Display "MISSION...NALC...ITEM...QTY...ALLOW...PCT OF ALLOW"
- Select all where Mission Area exists, sort by Mission Area then by NALC:
  - Display Mission Area
  - Display NALC
  - Display Short Title
  - Display Quantity
  - Display Shipfill Allowance
  - Display (Quantity/Shipfill Allowance)*100

f. Ship Ammunition Inventory Report (Summary)

Until ESC entered:

- Display "SHIP AMMUNITION INVENTORY REPORT (SUMMARY)"
- Display "(MASTER STOCK RECORDS ONLY)"
- Display [today's date]
- Display "COG...NALC...NIIN...ITEM...QTY"
- Select all, sort by COG then NALC then NIIN:
  - Display COG
  - Display NALC
  - Display NIIN

- Display Short Title
- Display Quantity

g. Ship Ammunition Inventory Report (Detailed)

Until ESC entered:

- Display "SHIP AMMUNITION INVENTORY REPORT (DETAILED)"
- Display "(INCLUDING LOT AND SERIAL ITEMS)"
- Display [today's date]
- Display "NALC...NIIN...ITEM...LOT NR...SERIAL NR...QTY"
- Select all, sort by NALC then by NIIN:
  - Display NALC
  - Display NIIN
  - Display Short Title
  - Display Lot Number
  - Display Serial Number
  - Display Quantity

h. Maintenance Due Summary Report

Until ESC entered:

- Display "MAINTENANCE DUE SUMMARY REPORT"
- Display [today's date]
- Display "NALC...ITEM...SERIAL NR...MAINT DUE...MAINT TYPE"
- Select all where Serial Number exists, sort by NALC then by Serial Number:
  - Display NALC
  - Display Short Title
  - Display Serial Number
  - Display Maint Due Date
  - Display Maint Due Type

2. Menu 3-2 (Generate Transaction Reports)

Until ESC entered:

- Display Menu 3-2
- Get menu choice from user [1,2]
- Confirm menu choice
- Go to selected menu choice

a. Generate ATR

Until ESC entered:

- Display: "CLASSIFICATION:" [ATR Class]
- If ATR Class = C then:
  - Display "DECLAS:"[ATR Declas Date]
- Display "FM:"[Command Name]
- Display "TO: SPCC MECHANICSBURG PA"
- Display "INFO:"[ATR Adressees]
- If ATR Class = C then:
  - Display "C O N F I D E N T I A L//NO8015//"
- Else
  - Display "UNCLAS//NO8015//"
- Display "SUBJ: AMMO TRANS RPT RCS SPCC 8010-12"
- Display Header Line:
  - Display "////[UIC]/[ATR Serial]/[ACC]/[Julian Date]///"
- For each transaction:
  - If Non-SLIT (MCC < > C) item:
    - Display "///[NALC][NIIN]/[Condition Code]//B[Old Balance]//[Transaction Code][Quantity]/[Consignee]/[Document Number]//[New Balance]///"
  - Else (MCC = C):
    - Display"///[NALC][NIIN]/[Condition Code]//B[Old Balance]//[Transaction Code]/ [Serial Number] ([Maint Due Date] [Maint Due Type])/ [Consignee] /[Document Number]/ [New Balance]///"
- Display "////"

b. ATR Log Report

Until ESC entered:

- Display "AMMUNITION TRANSACTION LOG"
- Display [today's date]
- Display "ATR # ... ATR LINE ... ITEM ... QTY EXPEND ... QTY ISS ... QTY RCVD ... COND CODE ... BALANCE"
- Select all where ATR Serial Number exists, sort by ATR Serial Number and then by ATR Line Number:
  - Display ATR Serial Number
  - Display ATR Line Number

- Display Short Title
- Display Quantity Expended (if any)
- Display Quantity Issued (if any)
- Display Quantity Received (if any)
- Display Condition Code
- Display Balance

3. Menu 3-3 (Requisition & Turn-In Reports)

Until ESC entered:

- Display Menu 3-3
- Get menu choice from user [1,2,3]
- Confirm menu choice
- Go to selected menu choice

a. Requisition Log Report

Until ESC entered:

- Display "REQUISITION LOG REPORT"
- Display [today's date]
- Display "DOCUMENT #...NALC...ITEM...QTY...RDD...STATUS...PRI"
- Select all Document Numbers where Required Delivery Date exists, sort by Document Number and then by NIIN:
  - Display Document Number
  - Display NALC
  - Display Short Title
  - Display Quantity
  - Display Required Delivery Date
  - Display Status
  - Display Priority

b. Turn-In Log Report

Until ESC entered:

- Display "TURN-IN LOG REPORT"
- Display [today's date]
- Display "DOCUMENT NR..DATE...TO...ITEM...QTY"

- Select all Document Numbers where Issue Code exists, sort by Date and then Document Number:
  - Display Document Number
  - Display Date
  - Display Consignee
  - Display Short Title
  - Display Quantity

c. Outstanding Requisition Report

Until ESC entered:

- Display "OUTSTANDING REQUISITION SUMMARY REPORT"
- Display [today's date]
- Display "DOCUMENT NR ... NALC ... NIIN ... ITEM ... REQD DEL DATE ... PRI ... QTY"
- Select all Document Numbers where Requisition Status = U, sort by Document Number then NIIN:
  - Display Document Number
  - Display NALC
  - Display NIIN
  - Display Short Title
  - Display RDD
  - Display Priority
  - Display Requisition Quantity

E. MENU 4 (COMMAND INFORMATION MENU)

Until ESC entered:

- Display Menu 4
- Get menu choice from user [1,2]
- Confirm menu choice
- Go to selected menu choice

1. Edit Command Information

Until ESC entered:

- Display Command Information Form (Figure 12)
- Get UIC
- Get Command Name

- Get Hull Number
- Get Fleet
- Get Service Code
- Get Location
- Get Activity Classification Code
- Get any (optional) revisions from user
- Display confirmation message
- Store revised command data

2. Display Command Information

Until ESC entered:

- Display the Command Information Form (Figure 12)

APPENDIX I. PARADOX TABLES

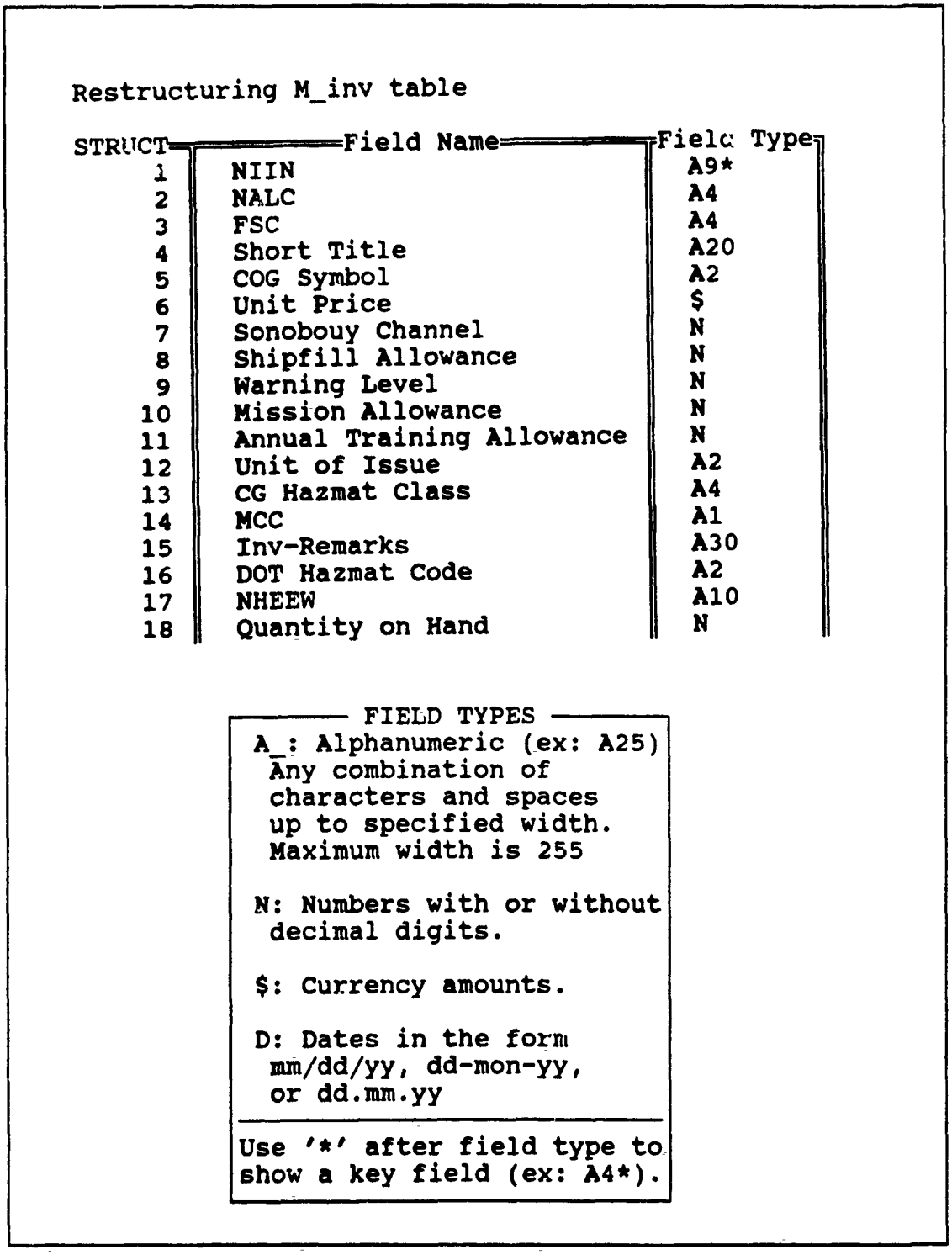


Figure 21. AMMO INVENTORY Object Materialization

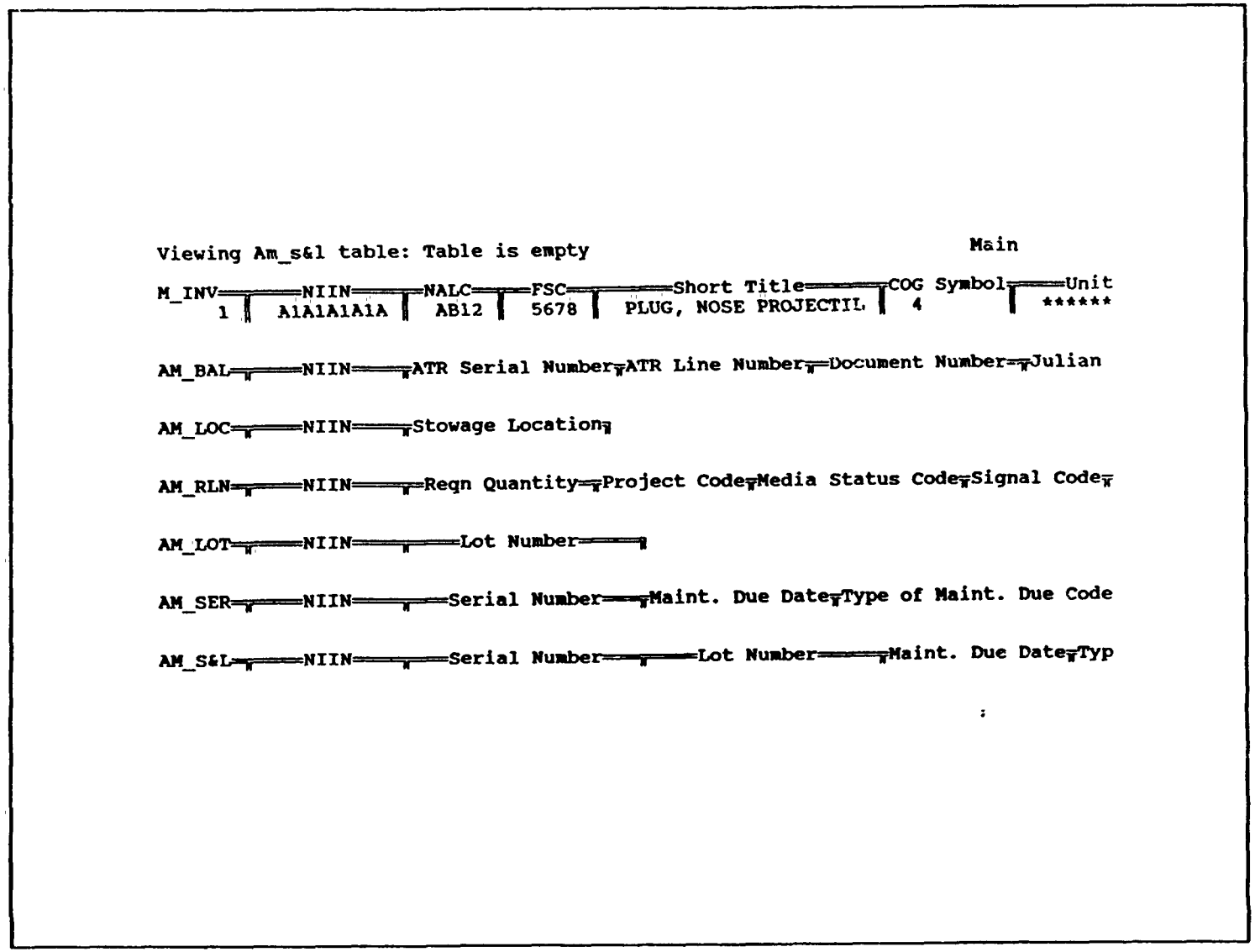


Figure 22. Detail Tables for INVENTORY Master Table

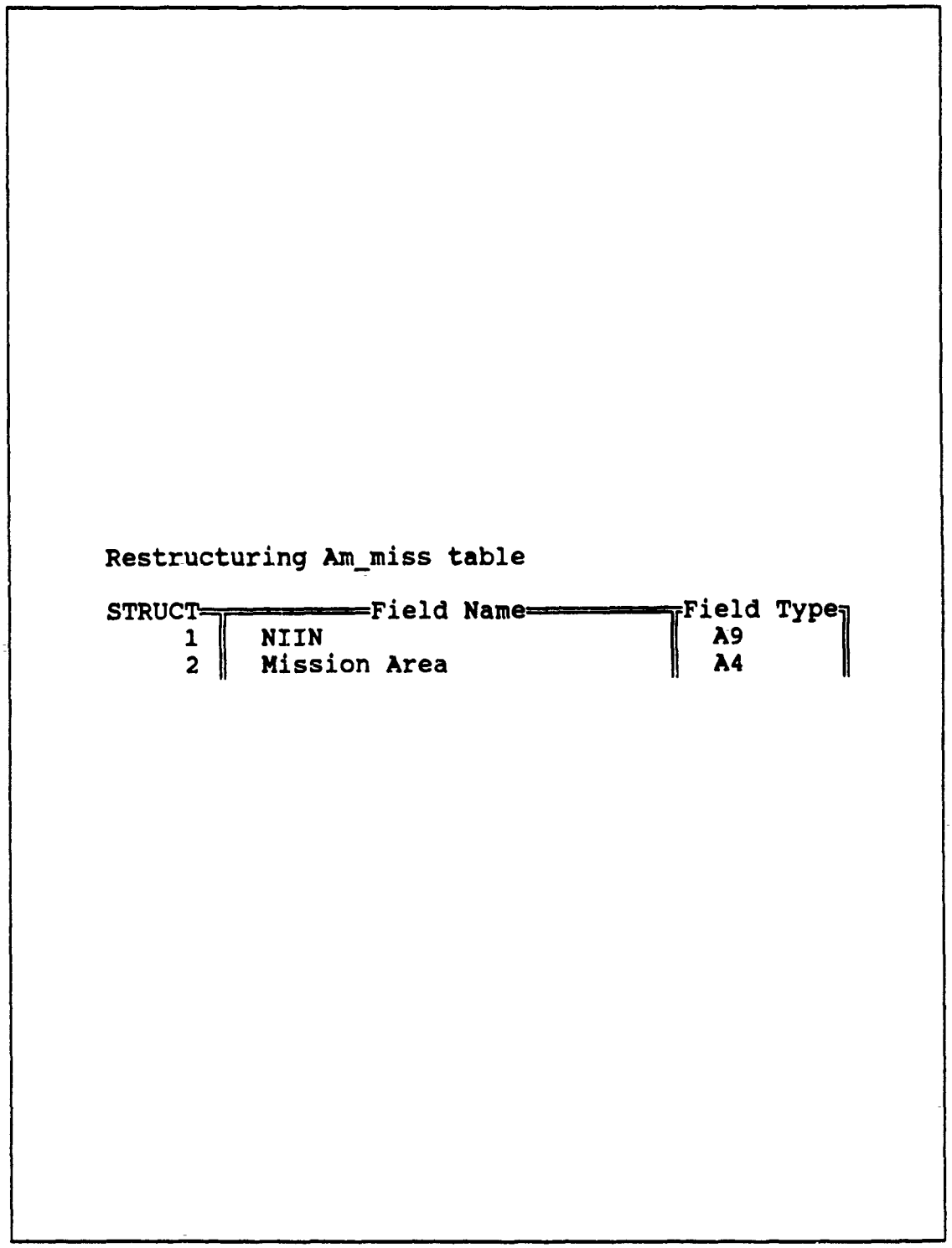


Figure 23. Mission Area Detail Table for INVENTORY

Restructuring Am_bal table

STRUCT	Field Name	Field Type
1	NIIN	A9
2	ATR Serial Number	A3
3	ATR Line Number	N
4	Document Number	A14
5	Julian Date	A4
6	Old Balance	N
7	Quantity Issued	N
8	Quantity Received	N
9	Receipt Code	A6
10	Issue Code	A6
11	Loss Code	A5
12	Extended Price	$
13	Trng Allow. to Charge	A5
14	Quantity Expended	N
15	Transaction Type	A2
16	Consignee/Consignor	A5
17	Balance Serviceable	N
18	Balance Unserviceable	N
19	Training Allowance Unexp.	N
20	Quantity Due In	N
21	Condition Code	A1
22	Revised Condition Code	A1

Restructuring Am_bal table

STRUCT	Field Name	Field Type
23	Remarks-Balchg	A30
24	Referenced ATR	A3
25	NAR Serial	N
26	ATR Class	A1
27	ATR Declas	D
28	Lot Number	A16
29	Serial Number	A16

Figure 24. TRANSACTION Detail Table for INVENTORY

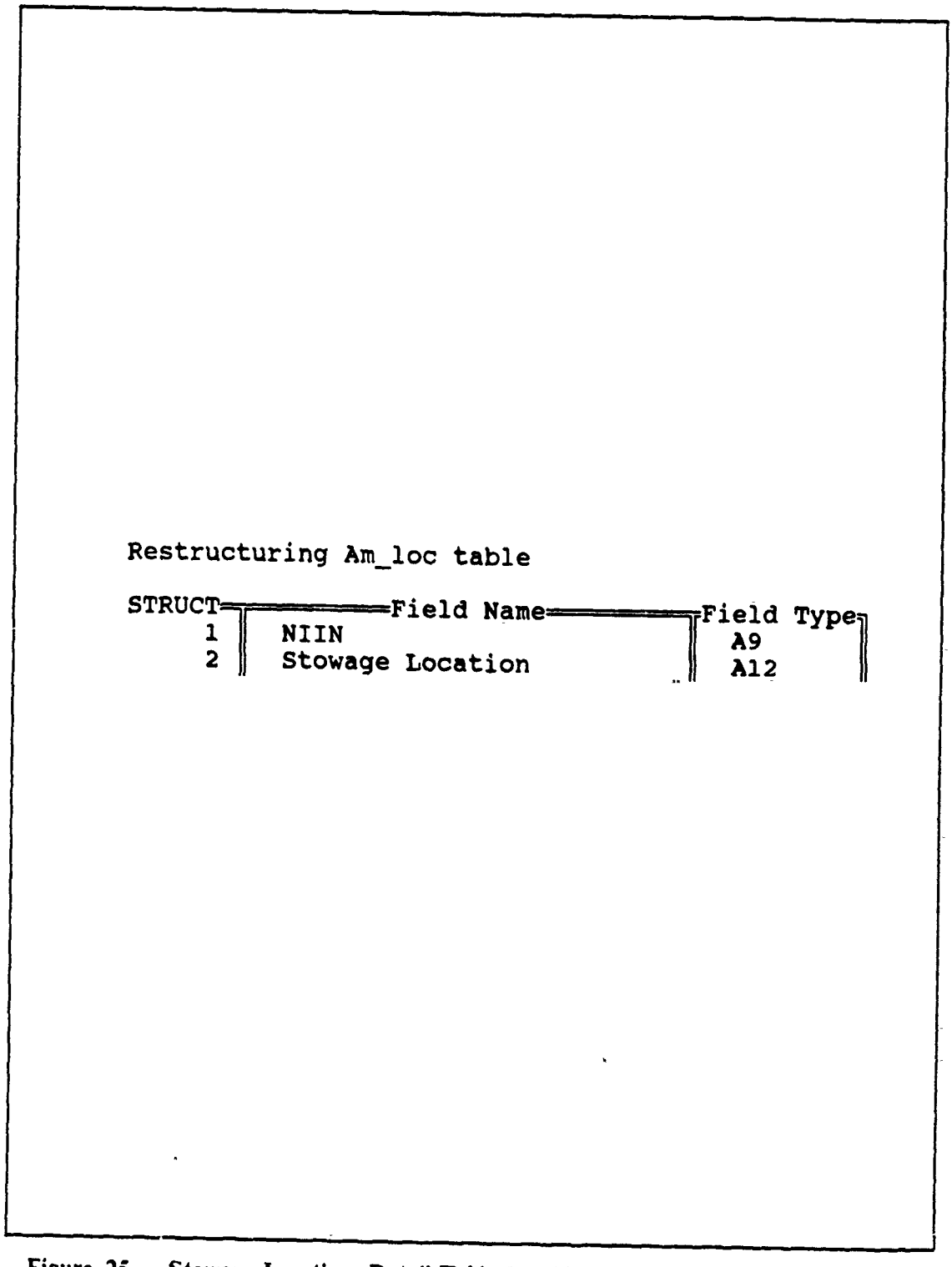


Figure 25. Stowage Locations Detail Table for INVENTORY

Restructuring Am_rln table

STRUCT	Field Name	Field Type
1	NIIN	A9
2	Reqn Quantity	N
3	Project Code	A3
4	Media Status Code	A1
5	Signal Code	A1
6	Demand Code	A1
7	Advice Code	A2
8	Fund Code	A2
9	Urgency of Need	A1
10	Required Delivery Date	A3
11	Status	A1
12	Line Class	A1
13	Priority	A2
14	Document Number	A14

Figure 26. REQN LINE Detail Table for INVENTORY

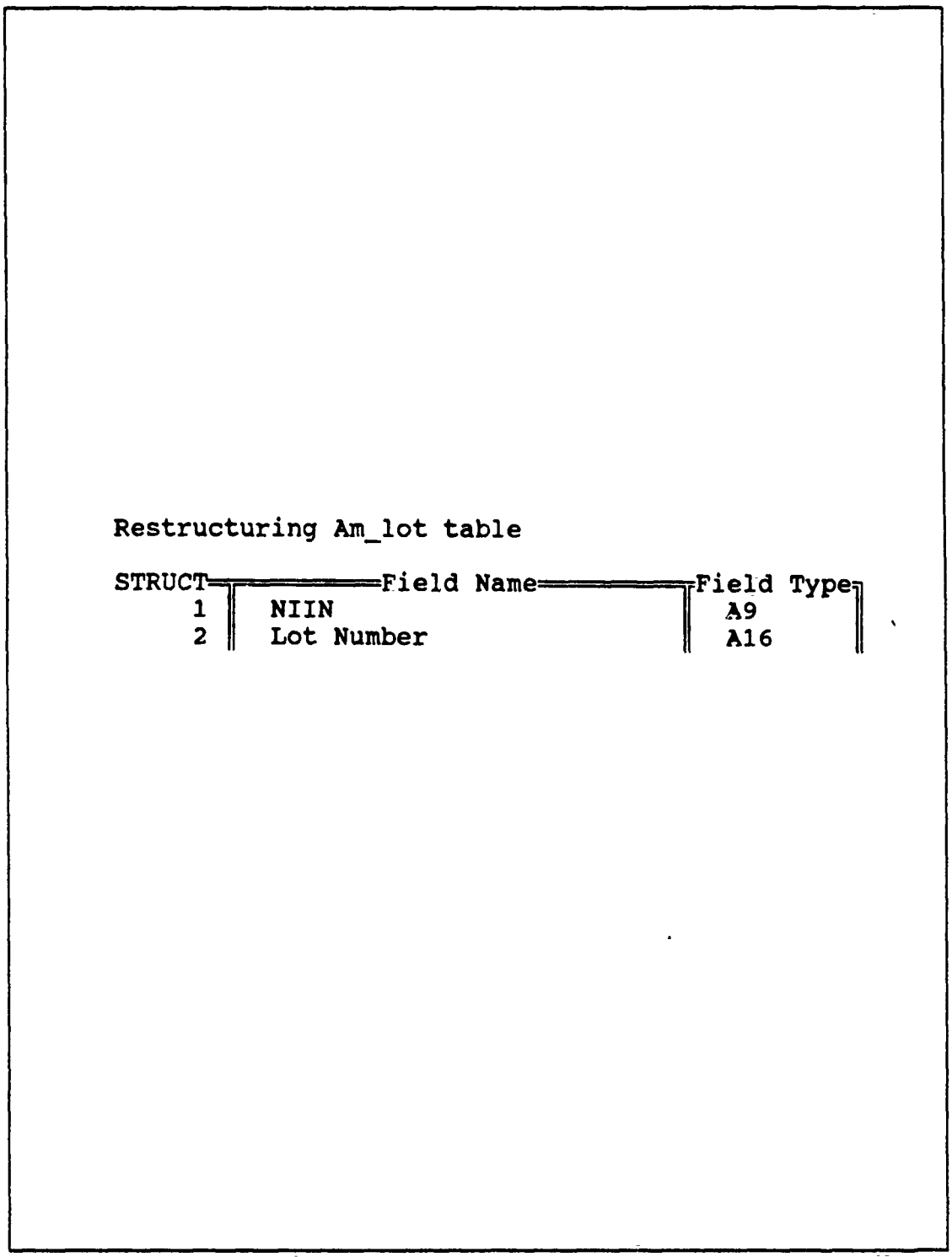


Figure 27. LOT AMMO Detail Table for INVENTORY

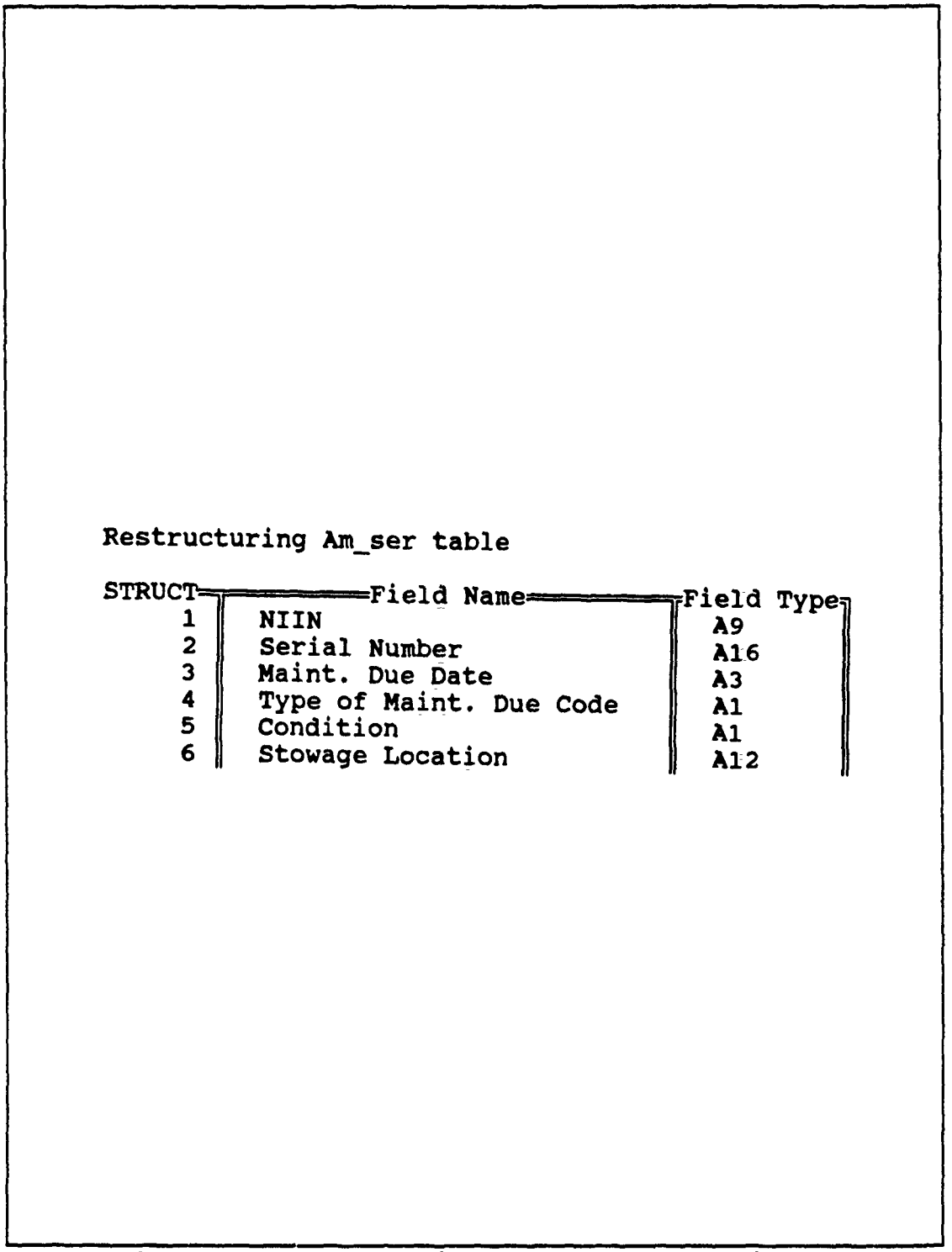
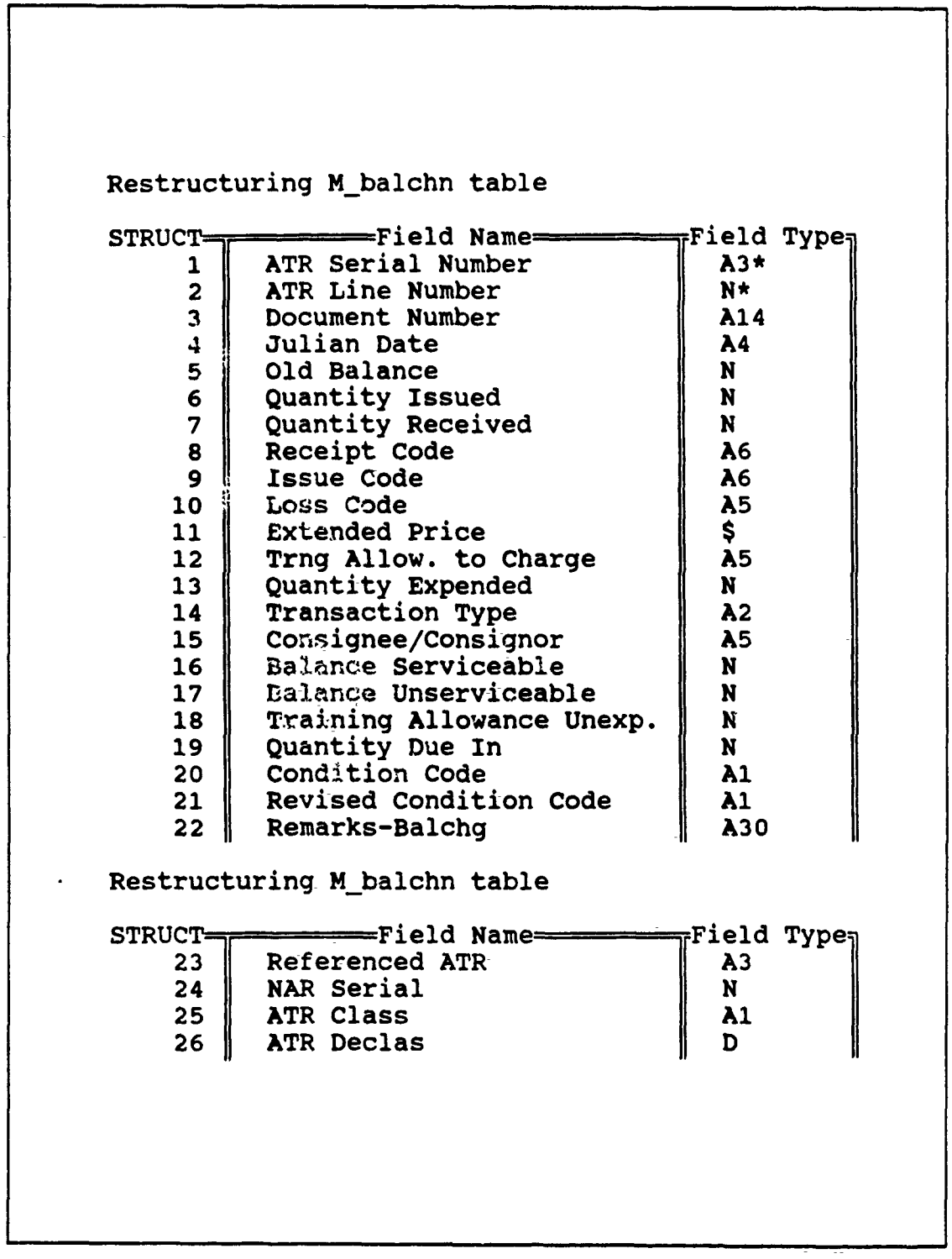


Figure 28. SERIAL AMMO Detail Table for INVENTORY

Restructuring Am_s&l table

STRUCT	Field Name	Field Type
1	NIIN	A9
2	Serial Number	A16
3	Lot Number	A16
4	Maint. Due Date	A3
5	Type of Maint. Due Code	A1
6	Condition	A1
7	Stowage Location	A12

Figure 29. SERIAL & LOT AMMO Detail Table for INVENTORY



Restructuring M_balchn table

STRUCT	Field Name	Field Type
1	ATR Serial Number	A3*
2	ATR Line Number	N*
3	Document Number	A14
4	Julian Date	A4
5	Old Balance	N
6	Quantity Issued	N
7	Quantity Received	N
8	Receipt Code	A6
9	Issue Code	A6
10	Loss Code	A5
11	Extended Price	$
12	Trng Allow. to Charge	A5
13	Quantity Expended	N
14	Transaction Type	A2
15	Consignee/Consignor	A5
16	Balance Serviceable	N
17	Balance Unserviceable	N
18	Training Allowance Unexp.	N
19	Quantity Due In	N
20	Condition Code	A1
21	Revised Condition Code	A1
22	Remarks-Balchg	A30

Restructuring M_balchn table

STRUCT	Field Name	Field Type
23	Referenced ATR	A3
24	NAR Serial	N
25	ATR Class	A1
26	ATR Declas	D

Figure 30. TRANSACTION Object Materialization

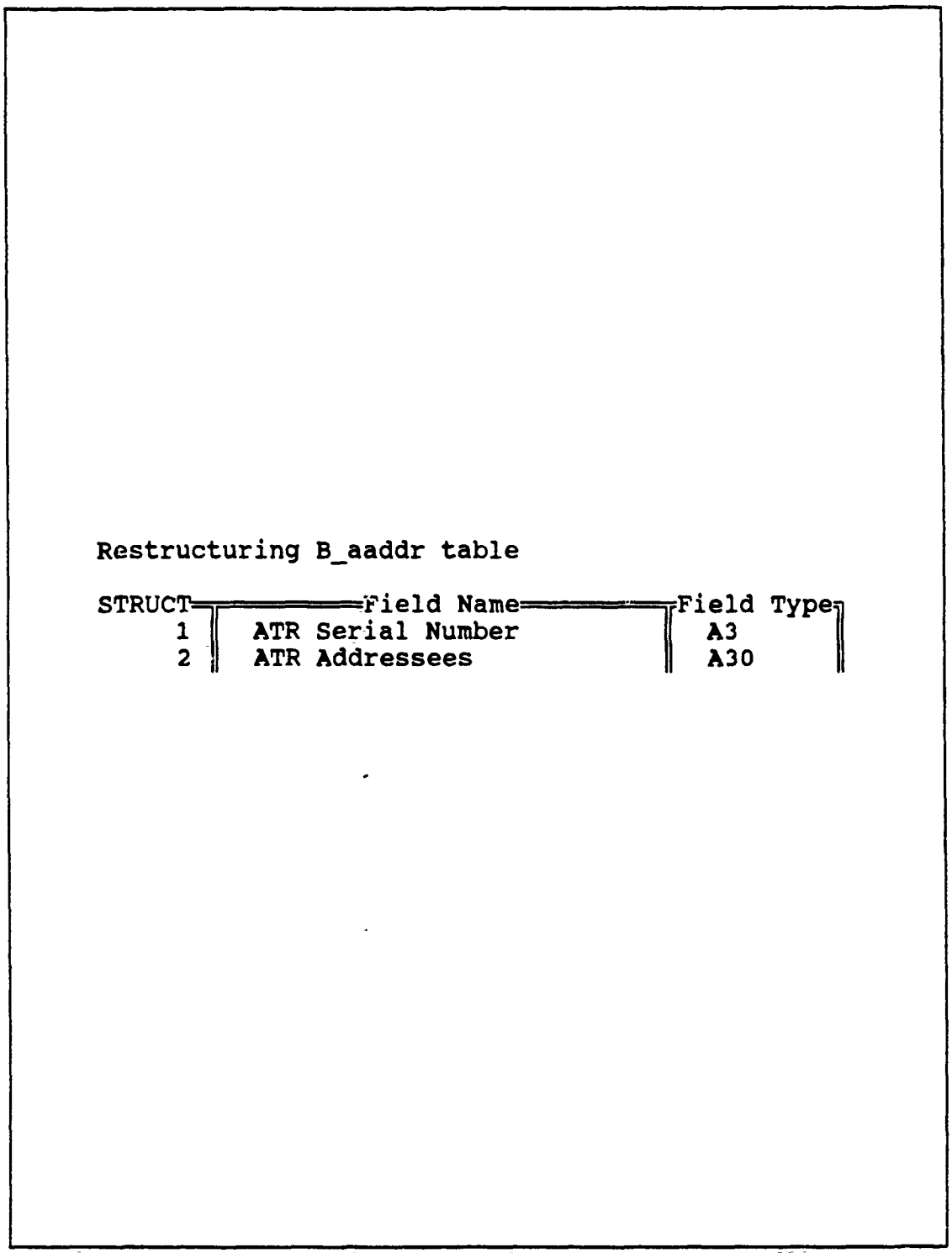


Figure 31. ATR Addressees Detail Table for TRANSACTION

Restructuring Lot_loc table

STRUCT	Field Name	Field Type
1	Lot Number	A16
2	Stowage Location	A12

Figure 32. Stowage Locations Table

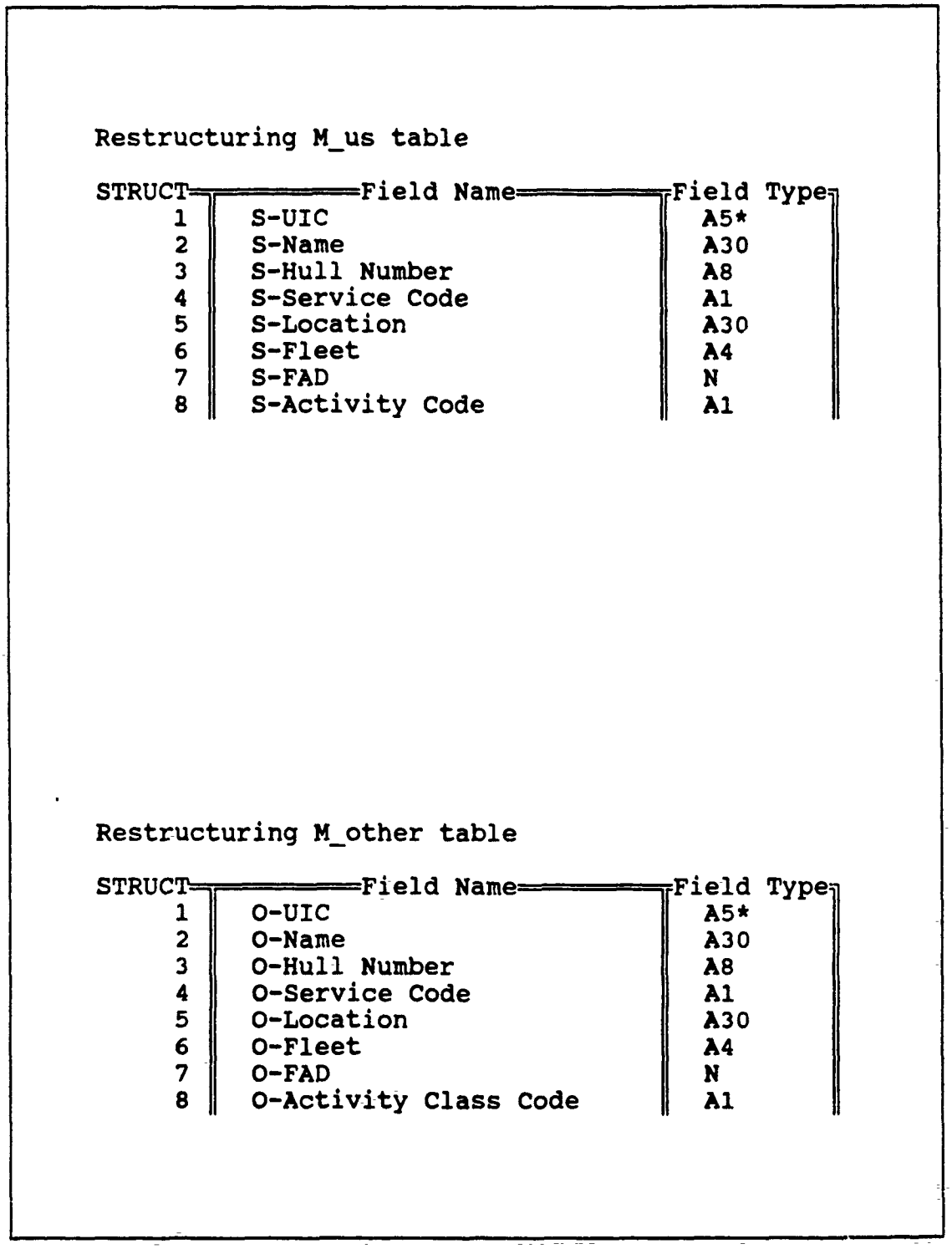


Figure 33. COMMAND Object Materialization

Figure 34. Detail Tables for COMMAND Master Table

Restructuring Us_inv table

STRUCT	Field Name	Field Type
1	S-UIC	A5
2	NIIN	A9
3	NALC	A4
4	FSC	A4
5	Short Title	A20
6	COG Symbol	A2
7	Unit Price	$
8	Sonobouy Channel	N
9	Shipfill Allowance	N
10	Warning Level	N
11	Mission Allowance	N
12	Annual Training Allowance	N
13	Unit of Issue	A2
14	CG Hazmat Class	A4
15	MCC	A1
16	Remarks-Inv	A30
17	DOT Hazmat Code	A2
18	NHEEW	N
19	Quantity on Hand	N

Figure 35. INVENTORY Detail Table for COMMAND

Restructuring Us_req table

STRUCT	Field Name	Field Type
1	S-UIC	A5
2	Document Number	A14
3	Document Identifier	A3
4	Reqn Class	A1
5	Reqn Declas	D
6	Remarks-Reqn	A30
7	O-UIC	A5

Figure 36. REQUISITION Detail Table for COMMAND

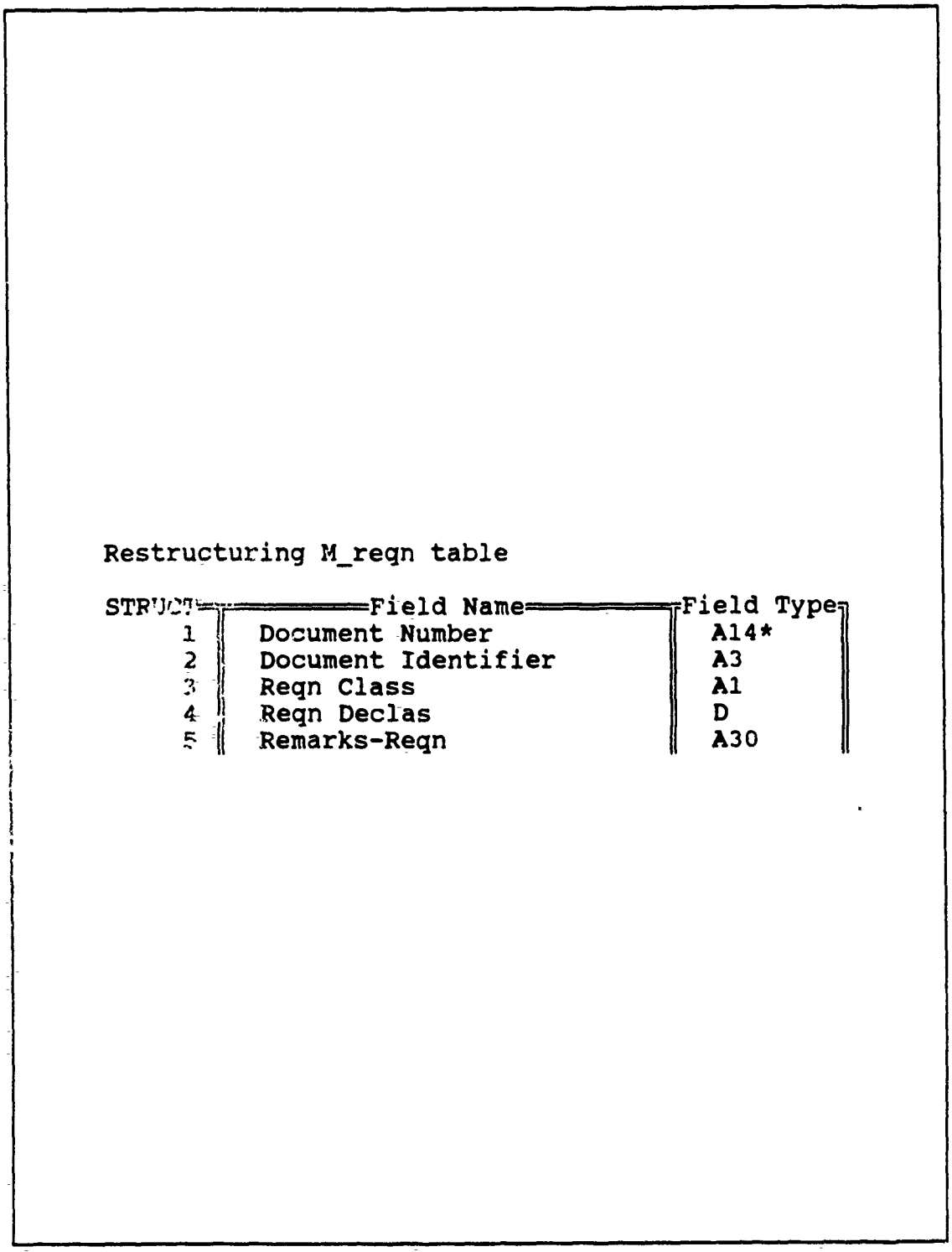


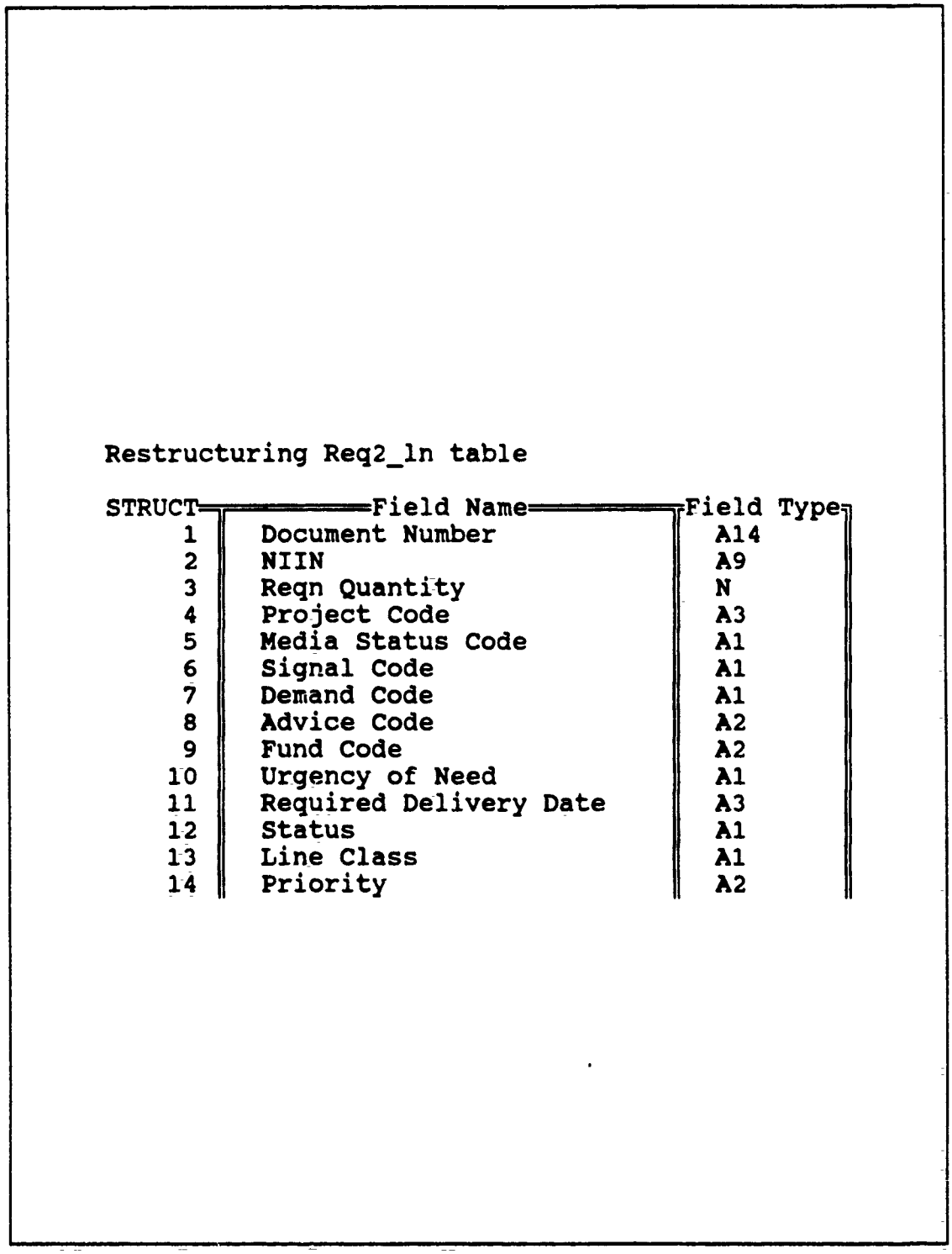
Figure 37. REQUISITION Object Materialization

Figure 38. Detail Tables for REQUISITION Master Table

Restructuring Req_adr table

STRUCT	Field Name	Field Type
1	Document Number	A14
2	Requisition Addressees	A30

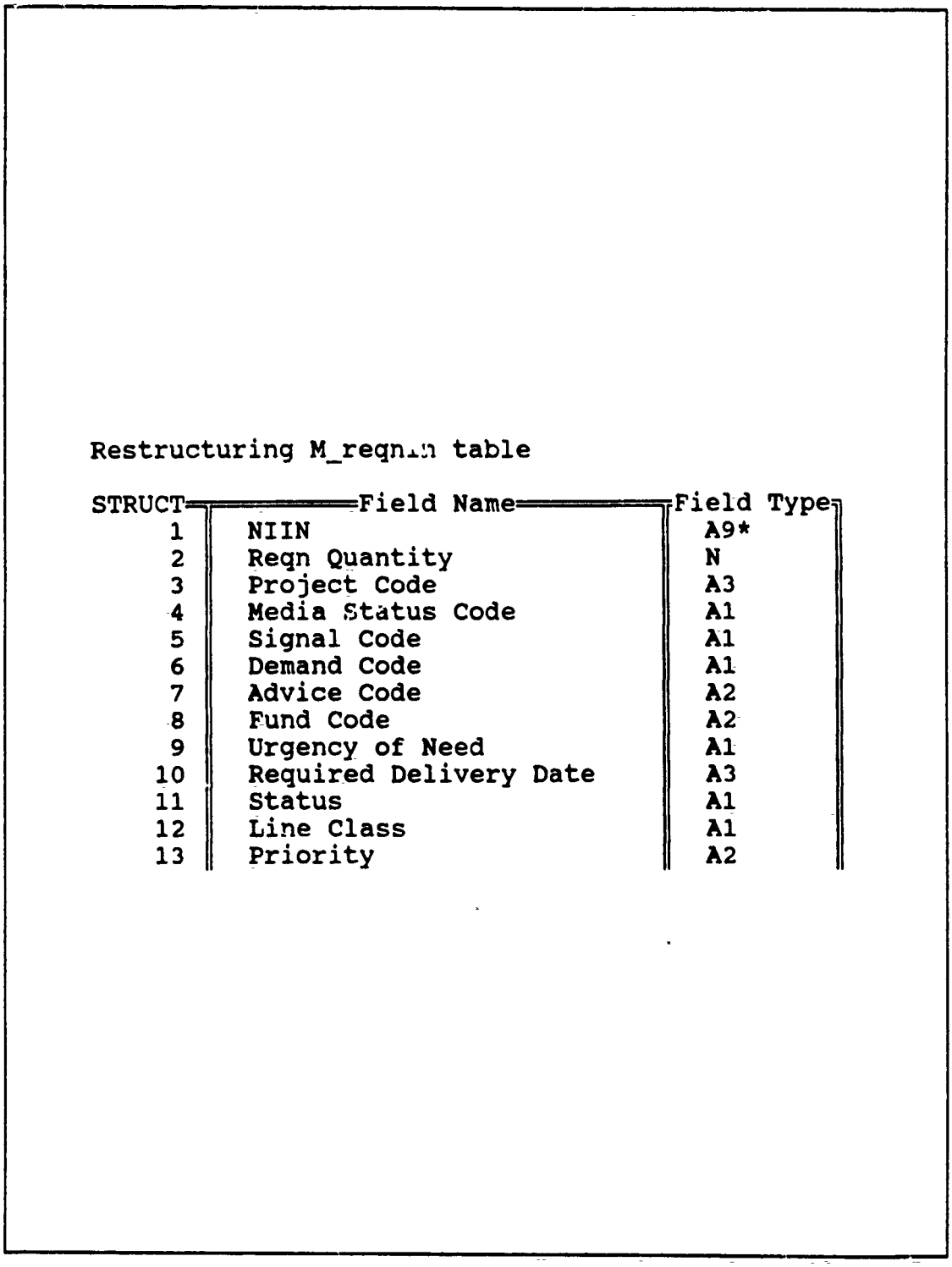
Figure 39. Addressees Detail Table for REQUISITION



Restructuring Req2_ln table

STRUCT	Field Name	Field Type
1	Document Number	A14
2	NIIN	A9
3	Reqn Quantity	N
4	Project Code	A3
5	Media Status Code	A1
6	Signal Code	A1
7	Demand Code	A1
8	Advice Code	A2
9	Fund Code	A2
10	Urgency of Need	A1
11	Required Delivery Date	A3
12	Status	A1
13	Line Class	A1
14	Priority	A2

Figure 40. LINE ITEM Detail Table for REQUISITION



Restructuring M_reqn.n table

STRUCT	Field Name	Field Type
1	NIIN	A9*
2	Reqn Quantity	N
3	Project Code	A3
4	Media Status Code	A1
5	Signal Code	A1
6	Demand Code	A1
7	Advice Code	A2
8	Fund Code	A2
9	Urgency of Need	A1
10	Required Delivery Date	A3
11	Status	A1
12	Line Class	A1
13	Priority	A2

Figure 41. LINE ITEM Tables

Restructuring M_s&lam table

STRUCT	Field Name	Field Type
1	Serial Number	A16*
2	Lot Number	A16*
3	Maint. Due Date	A3
4	Type of Maint. Due Code	A1
5	Condition	A1
6	Stowage Location	A12

Restructuring M_seram table

STRUCT	Field Name	Field Type
1	Serial Number	A16*
2	Maint. Due Date	A3
3	Type of Maint. Due Code	A1
4	Condition	A1
5	Stowage Location	A12

Figure 42. SERIAL & LOT and SERIAL AMMO Tables

APPENDIX J. PARADOX DATA VALIDITY CHECKS

The following symbols are used in used in the PARADOX "Picture" data masks below:

- # = Numeric digit
- ? = Letter (A-Z or a-z)
- & = Letter (convert to uppercase)
- @ = Any character
- ! = Any character (convert to uppercase)
- ; = Take literally
- * = Repetition counts (any length allowed by field type)
- , = Alternative values

As discussed in Chapter V, these data masks were adapted from the ARMIRS domain definitions and use the symbols shown above:

- Activity Classification Code: Default = A, Picture = A,B,D
- Advice Code: Picture = #&
- Annual Training Allowance: Picture = #####
- ATR Class: Default = U, Picture = U,S
- ATR Line Number: Picture = ##
- ATR Serial Number: Picture = ###
- Balance Serviceable: Picture = #####
- Balance Unserviceable: Picture = #####
- CG Hazmat Class: Picture = !!!!
- COG Symbol: Picture = #&
- Condition: Default = S, Picture = S,U
- Condition Code: Default = A, Picture = A
- Consignee/Consignor: Picture = #####
- Demand Code: Default = R, Picture = N,R
- Document Number: Picture = &##########
- Document Identifier: Picture = A01,A04,A0A,A0D
- FAD: Min = 1, Max = 5, Picture = #

- Fleet: Picture = PAC, LANT
- FSC: Picture = ####
- Fund Code: Default = Y6, Picture = Y6, 26
- Hull Number: &*!
- Issue Code: Picture = !!!!!!
- Julian Date: Max = 9366, Picture = ###
- Line Class: Default = U, Picture = C,U
- Location: Picture = &*?
- Loss Code: Picture = LOSPI,LOSCE,LOSDE,LOSMD,LOSOT
- Maint. Due Date: Picture = [#,&],##
- MCC: Picture = &
- Media Status Code: Picture = !
- Mission Allowance: Picture = #####
- Mission Area: Picture = ASW,ASUW,AAW,AMW,MIW
- NALC: Picture = !!!!
- Name: Picture = .*!
- NAR Serial: Picture = #####
- NHEEW: *!
- NIIN: Picture = *!
- Old Balance: Picture = #####
- Priority: Min = 1, Max = 15, Picture = ##
- Project Code: Picture = ###
- Quantity Due In: Picture = #####
- Quantity Expended: Picture = #####
- Quantity Issued: Picture = #####
- Quantity on Hand: Picture = #####
- Quantity Received: Picture = #####
- Receipt Code: Picture = *!
- Referenced ATR: Picture = ###
- Reqn Class: Default = U, Picture = C,U
- Reqn Quantity: Picture = #####
- Required Delivery Date: Min = 001, Max = 366, Picture = ###

- Requisition Addressees: Picture = *!
- Revised Condition Code: Picture = &
- Serial Number: Picture = *!
- Service Code: Picture = !
- Shipfill Allowance: Picture = #####
- Short Title: Picture = *!
- Signal Code: Picture = &
- Sonobuoy Channel: Picture = ##
- Status: Default = U, Picture = U,C,P,F
- Training Allowance Unexp.: Picture = #####
- Training Allow. to Charge: Picture = #####
- Transaction Type: Picture = &
- Type of Maint. Due Code: Picture = &
- UIC: Picture = #####
- Unit of Issue: Picture = &&
- Urgency of Need: Picture = A,B,C
- Warning Level: Picture = .##

APPENDIX K. PARADOX REPORTS

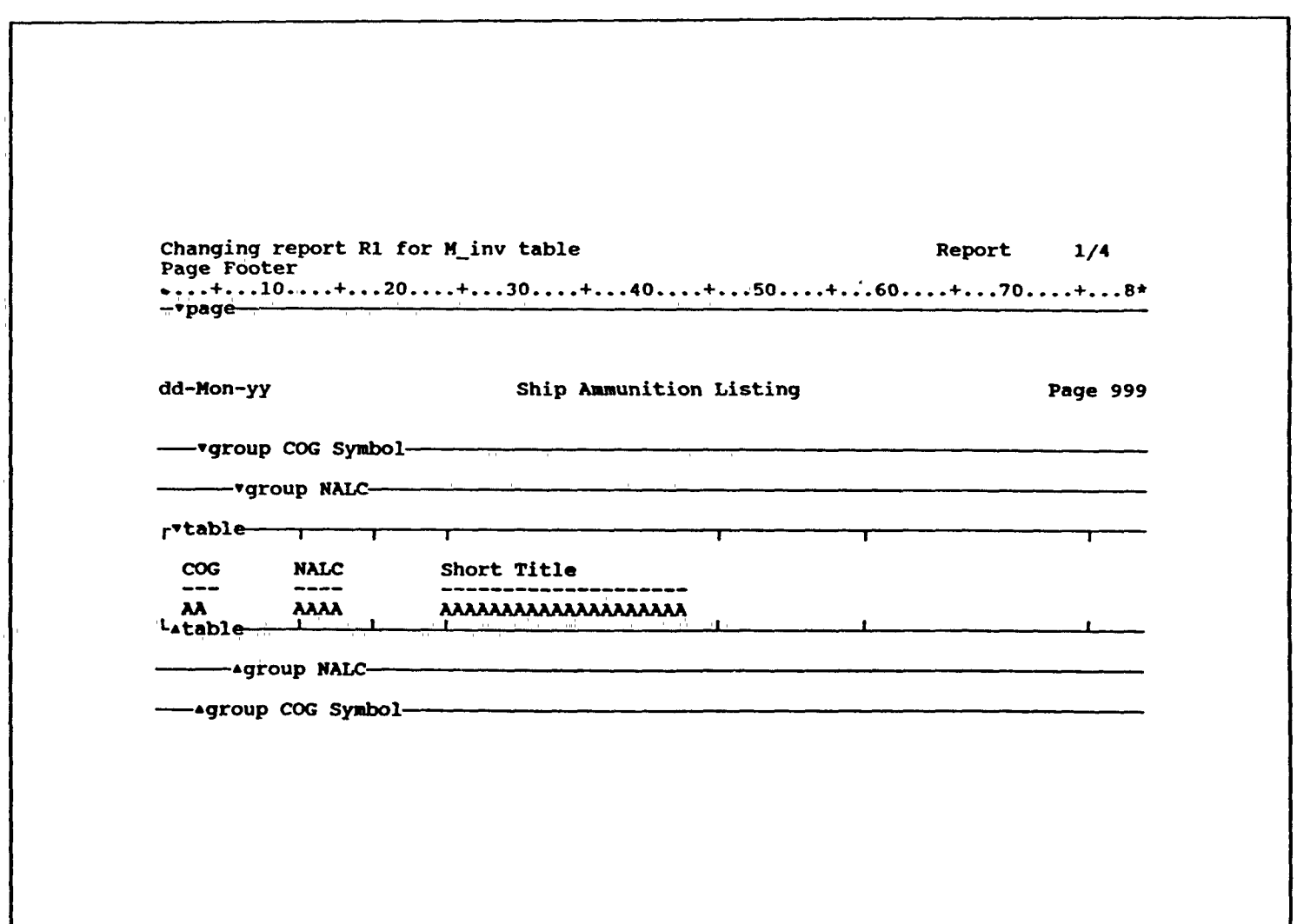


Figure 43. Ship Ammunition Listing

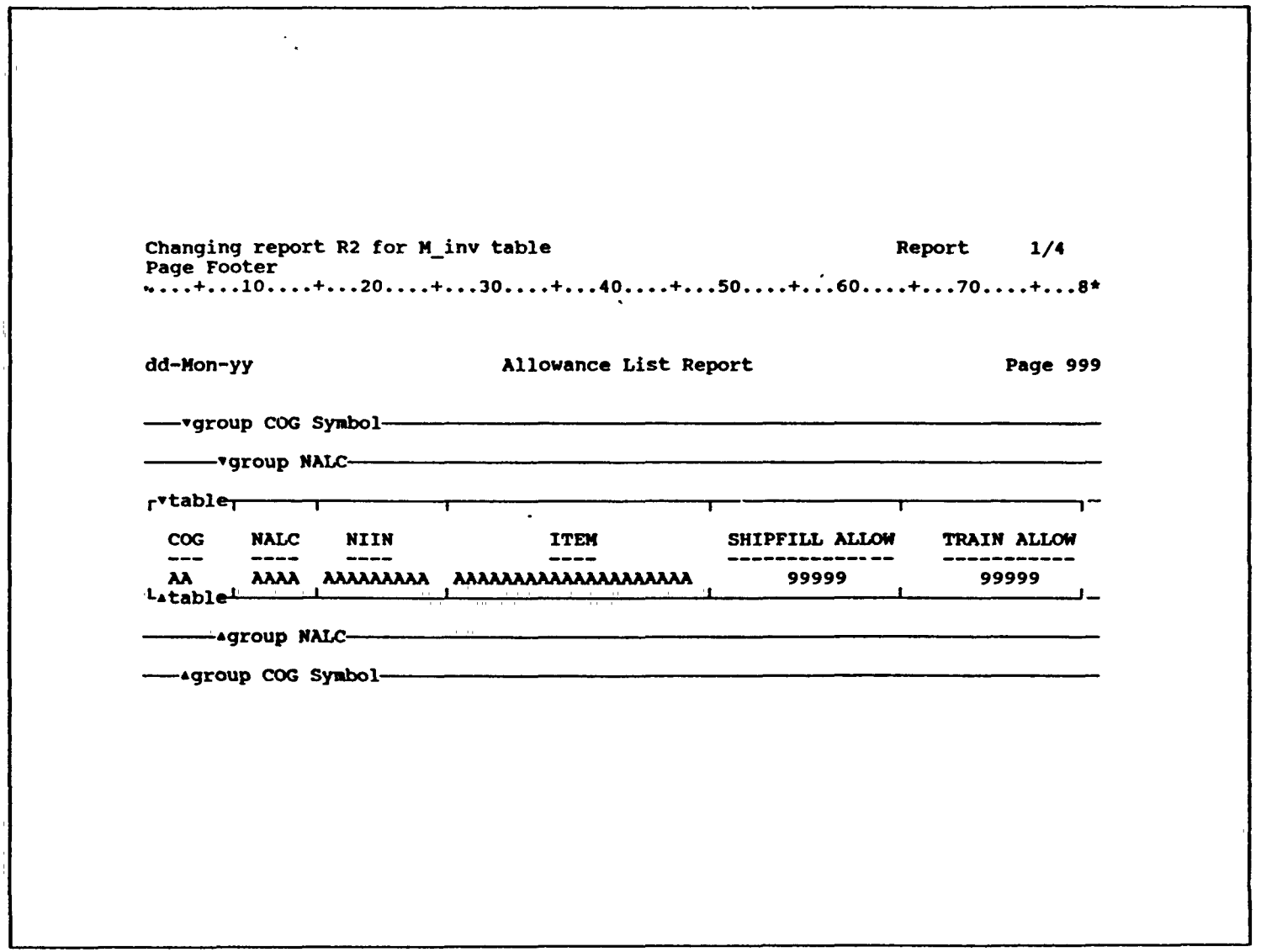


Figure 44. Allowance List Report

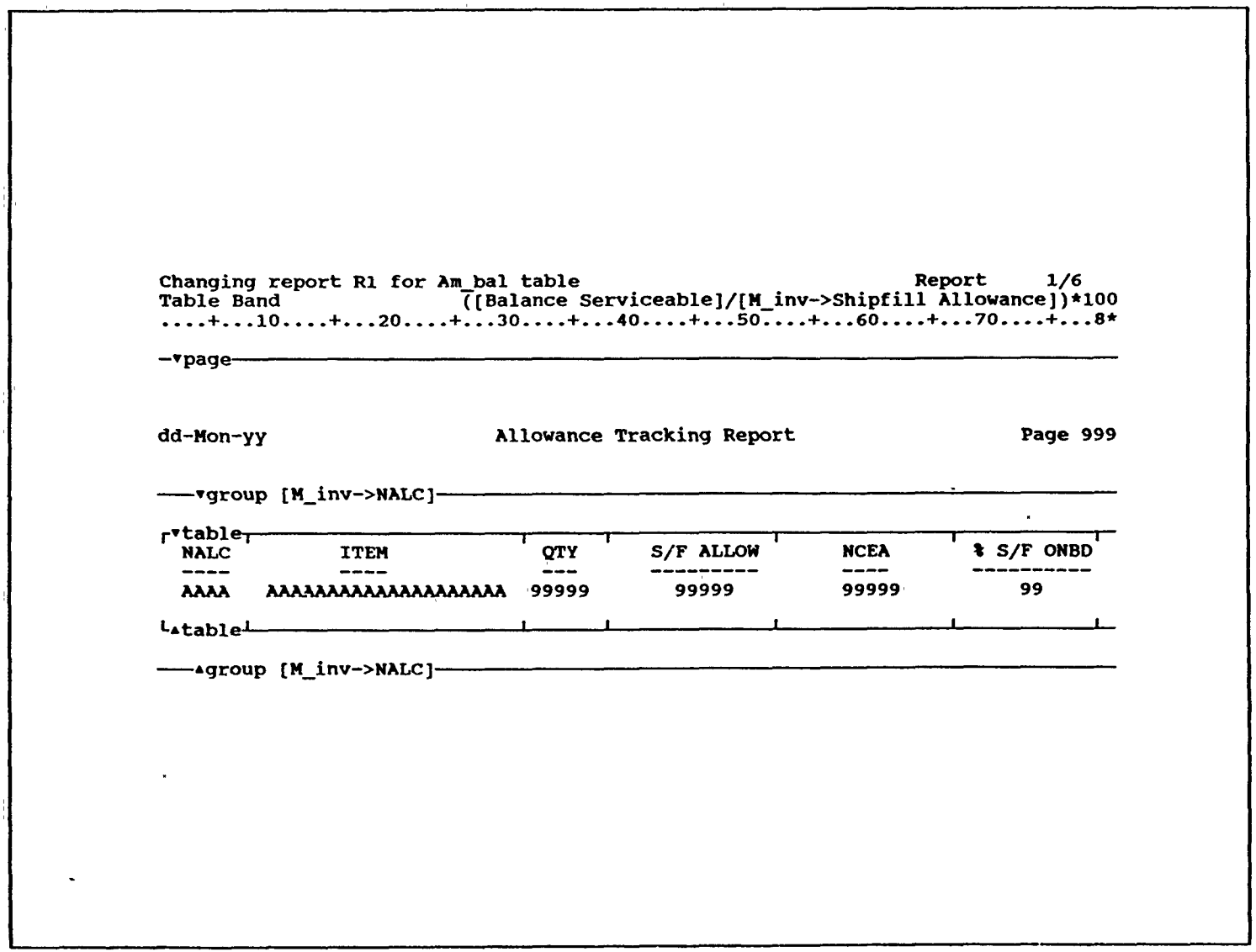


Figure 45. Allowance Tracking Report

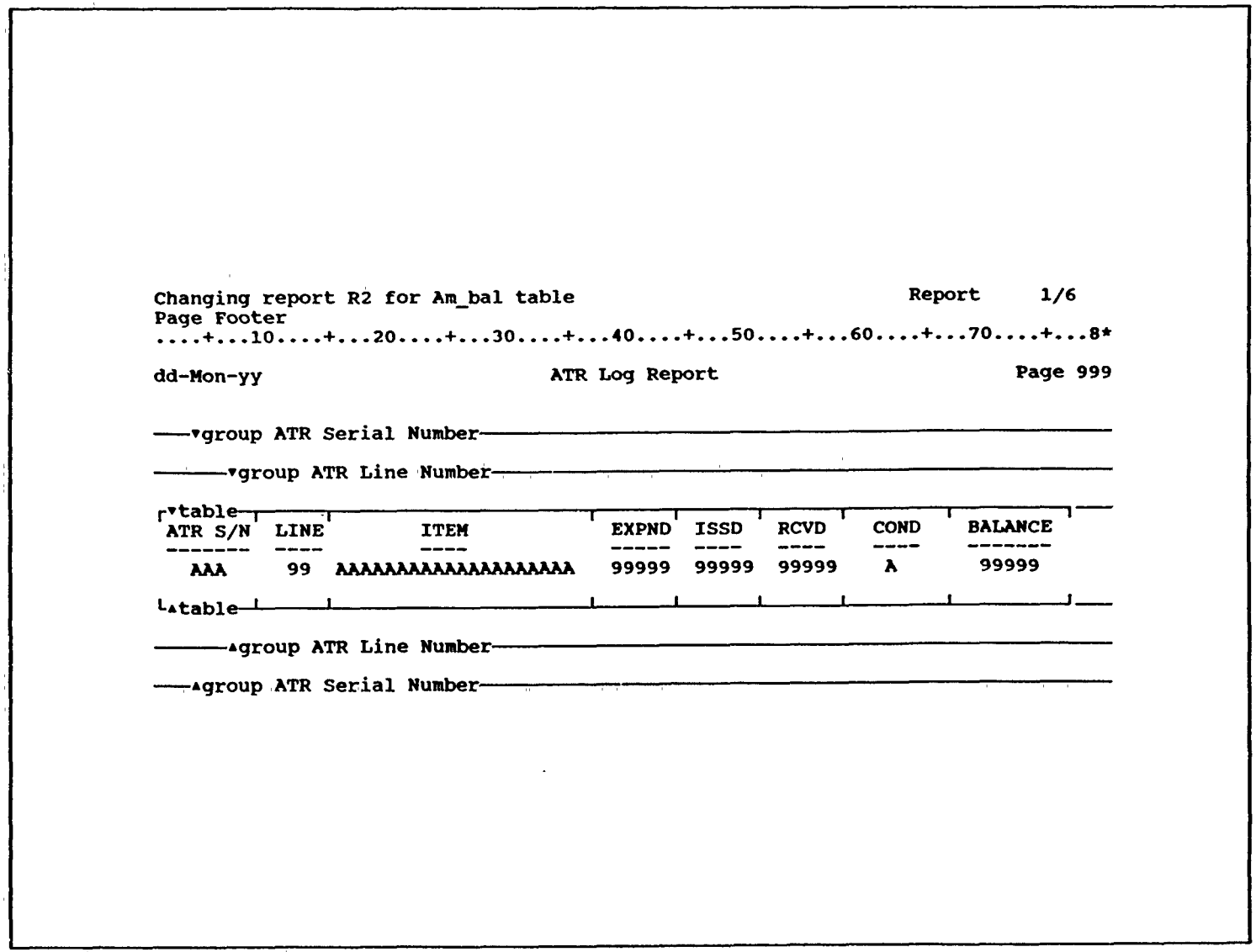


Figure 46. ATR Log Report

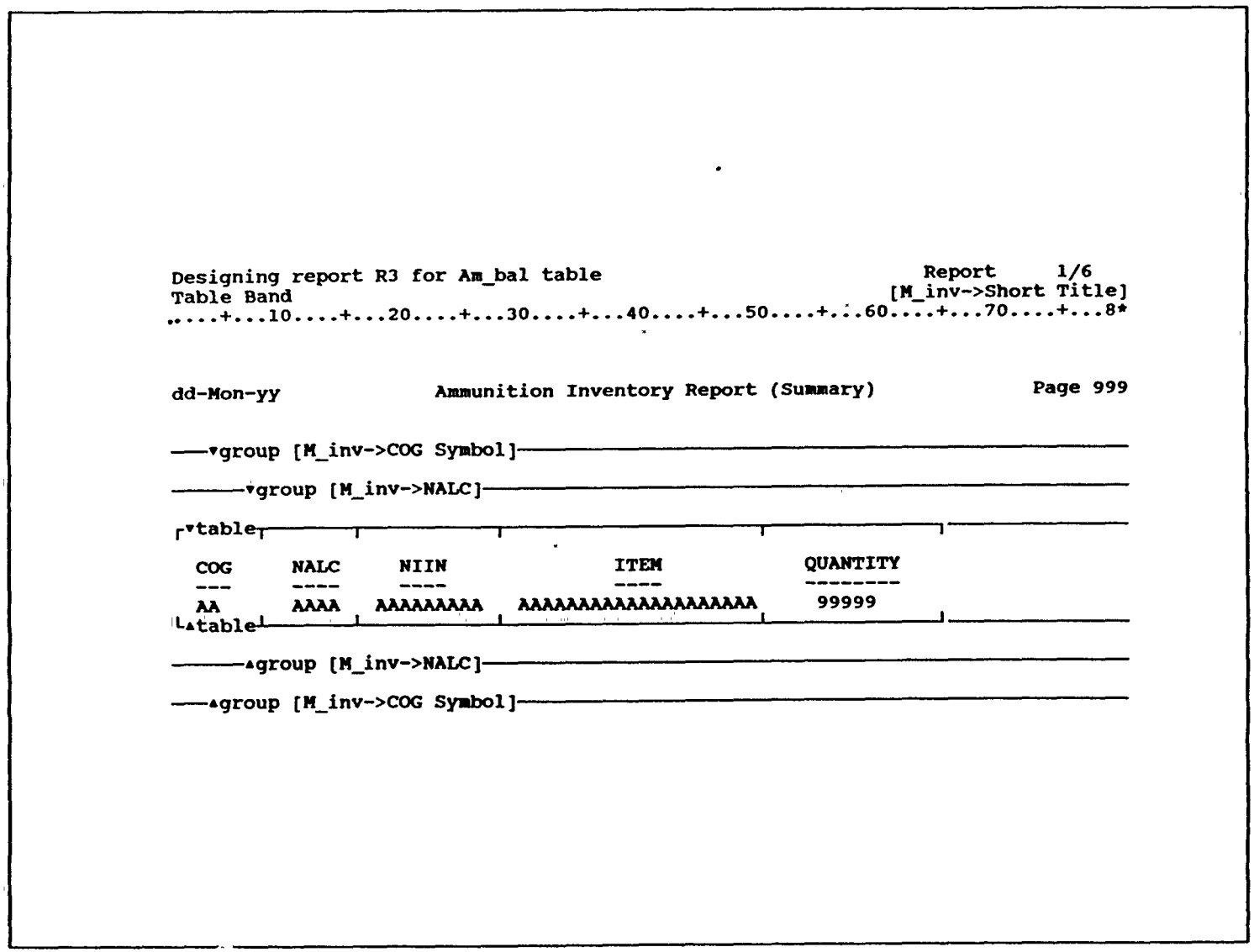


Figure 47. Ammunition Inventory Report (Summary)

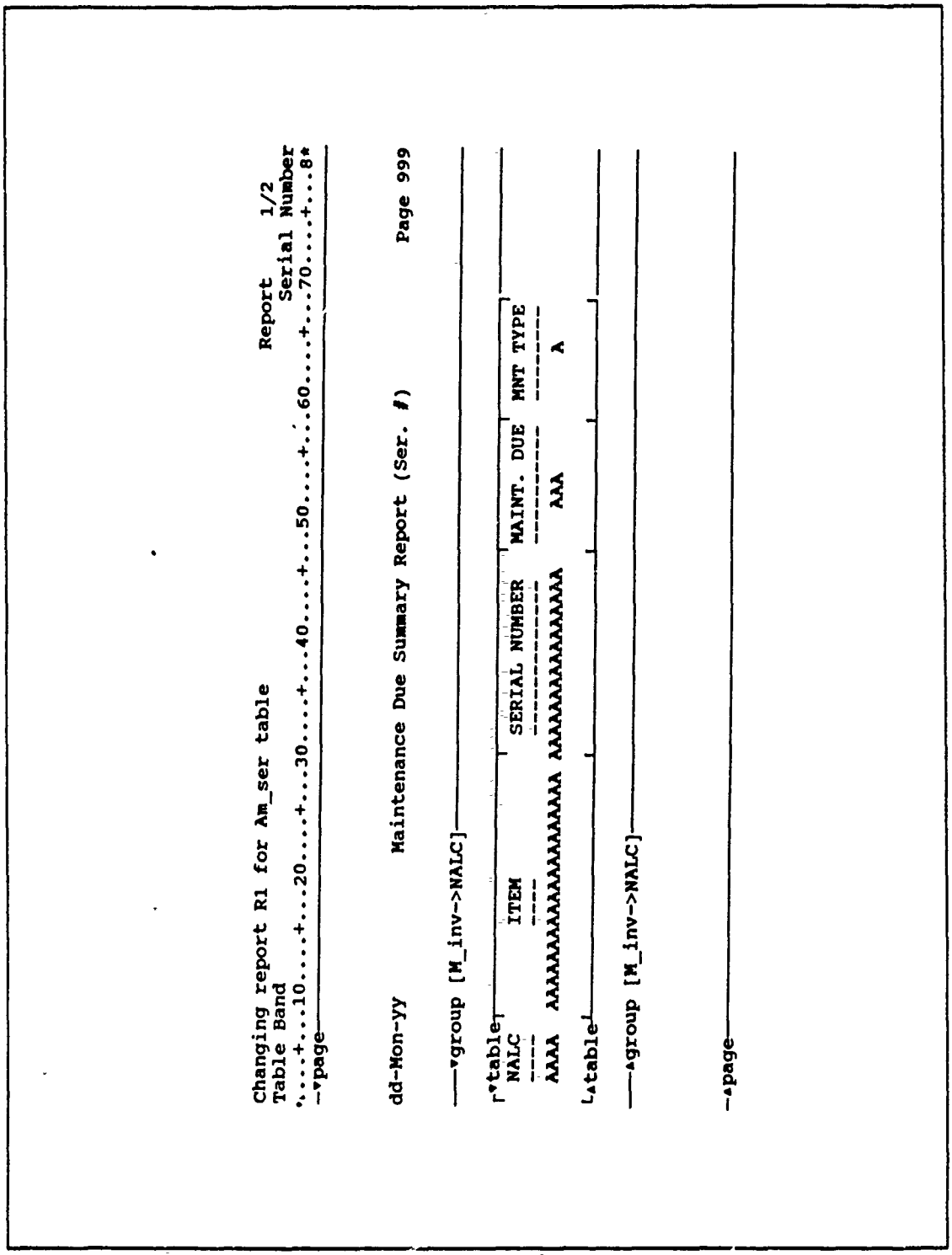
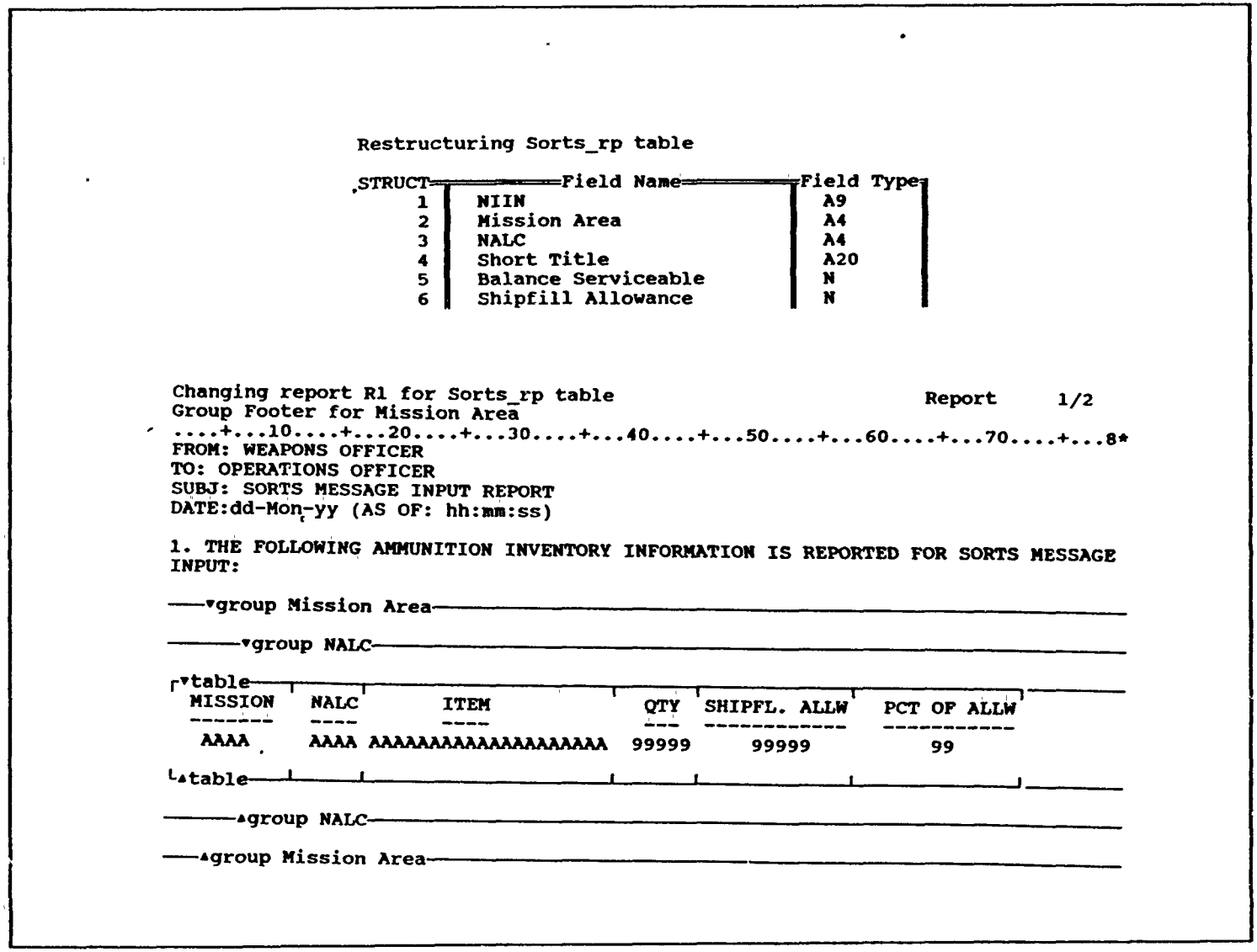


Figure 48. Maintenance Due Summary Report

Figure 49. SORTS Message Input Report



Restructuring Sorts_rp table

STRUCT	Field Name	Field Type
1	NIIN	A9
2	Mission Area	A4
3	NALC	A4
4	Short Title	A20
5	Balance Serviceable	N
6	Shipfill Allowance	N

Changing report R1 for Sorts_rp table Report 1/2
Group Footer for Mission Area
....+...10....+...20....+...30....+...40....+...50....+...60....+...70....+...8*
FROM: WEAPONS OFFICER
TO: OPERATIONS OFFICER
SUBJ: SORTS MESSAGE INPUT REPORT
DATE:dd-Mon-yy (AS OF: hh:mm:ss)

1. THE FOLLOWING AMMUNITION INVENTORY INFORMATION IS REPORTED FOR SORTS MESSAGE INPUT:

▾group Mission Area

▾group NALC

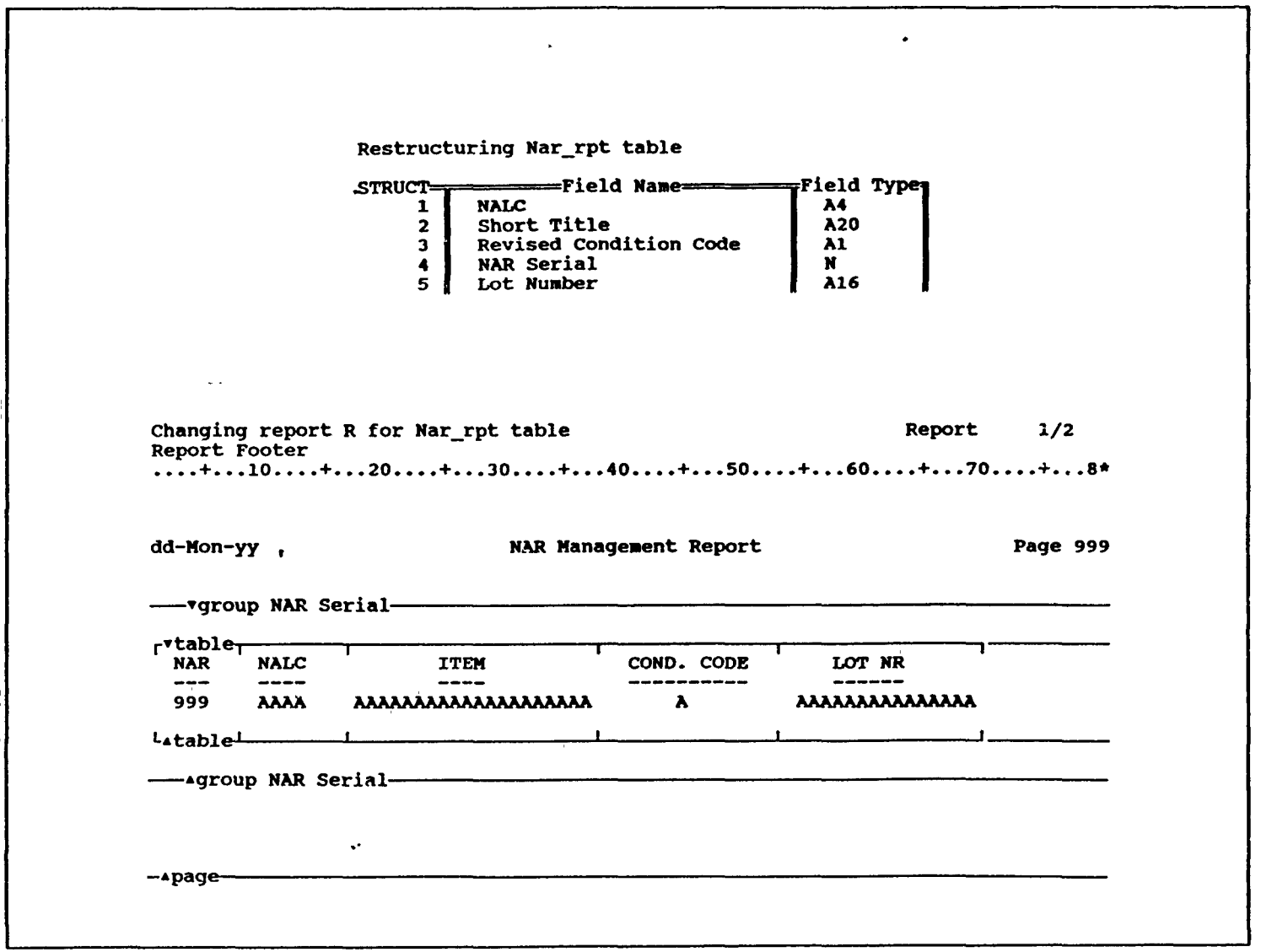
▾table

MISSION	NALC	ITEM	QTY	SHIPFL. ALLW	PCT OF ALLW
AAAA	AAAA	AAAAAAAAAAAAAAAAAAAA	99999	99999	99

▴table

▴group NALC

▴group Mission Area



Restructuring Nar_rpt table

STRUCT	Field Name	Field Type
1	NALC	A4
2	Short Title	A20
3	Revised Condition Code	A1
4	NAR Serial	N
5	Lot Number	A16

Changing report R for Nar_rpt table Report 1/2
Report Footer
....+...10....+...20....+...30....+...40....+...50....+...60....+...70....+...8*

dd-Mon-yy , NAR Management Report Page 999

▼group NAR Serial

▼table

NAR	NALC	ITEM	COND. CODE	LOT NR
---	----	----	----------	------
999	AAAA	AAAAAAAAAAAAAAAAAAAA	A	AAAAAAAAAAAAAAA

▲table

▲group NAR Serial

▲page

Figure 50. NAR Management Report

APPENDIX L. ATR PREPARATION RULE BASE

A. INPUT

1. From ARMIRS Database

- AMMO INVENTORY.NALC
- COMMAND.Fleet
- COMMAND.Hull Number
- AMMUNITION.COG

2. From User Responses To Queries

a. Multiple Choice

- CHOP
- CHOP_From
- CHOP_To
- Deployed_To
- Loadout
- Pre_Load
- 60_Days_Before
- Will_Deploy

b. Text for Addresses

- Ex_Wep_Prep
- In_Transaction
- Squadron
- Tender

B. OUTPUT TO DATABASE

- TRANSACTION.ATR Class
- TRANSACTION.ATR Declas
- TRANSACTION.Addressee (multi-valued)

C. USER DIALOG

1. User Menu Selections

1. MLSF Ships
   - IF COMMAND.Hull Number = A[*]
   - THEN
   - ASK MLSF: "Is this a Mobile Logistics Fleet ship?"
   - CHOICES MLSF: Yes, No
2. Complete Onload/Offload
   - ASK Loadout: "Was this transaction a complete ship onload or offload?"
   - CHOICES Loadout: Yes, No
3. Current Deployment
   - ASK Deployed_To: "Where are you currently deployed?"
   - CHOICES Deployed_To: MED, WESTPAC, 6FLT, None of these, Not Deployed Now
4. Pre-Deployment Period
   - IF Deployed_To = Not Deployed Now
   - THEN
   - ASK 60_Days_Before: "Will your ship deploy within 60 days?"
   - CHOICES 60_Days_Before: Yes, No
5. Pre-Deployement Loadout
   - IF 60_Days_Before = Yes
   - THEN
   - ASK Pre_Load: "Was this transaction a pre-deployment loadout?"
   - CHOICES Pre_Load: Yes, No
6. Deployment Destination
   - IF 60_Days_Before = Yes
   - THEN
   - ASK Will_Deploy: "Where will you deploy ?"
   - CHOICES Will_Deploy: MED, WESTPAC, 6FLT, None of these
7. Changing Operational Commanders (CHOP)
   - ASK CHOP: "Is this ATR a CHOP report?"
   - CHOICES CHOP: Yes, No
8. CHOP Destination and Source

- IF CHOP = Yes
- THEN
- ASK CHOP_To: "What is your CHOP destination?"
- CHOICES CHOP_To: LANT, PAC, EUR, Other
- AND
- ASK CHOP_From: "What is your CHOP source?"
- CHOICES CHOP_From: LANT, PAC, EUR, Other

2. User Text Entry

1. Submarines
   - IF COMMAND.Hull Number = SSN[*] OR SSBN[*]
   - THEN
   - ASK Tender: "Type in the message address of your parent or operational submarine tender:"
   - CHOICES Tender: (user-entered text)
2. Exercise Weapons
   - ASK Ex_Wep: "Does this transaction involve exercise weapons?"
   - CHOICES Ex_Wep: Yes, No
   - IF Ex_Wep = Yes
   - THEN
   - ASK Ex_Wep_Prep:"Type in the message address of the activity preparing the exercise weapon:"
   - CHOICES Ex_Wep_Prep: (user entered text)
3. Additional Standard ATR Addressees
   - ASK Squadron: "Type in the message address(es) of your parent/operational squadron commander:"
   - ASK In_Transaction: "Type in the the message address(es) of all other activities involved in this transaction:"
   - CHOICES Squadron: (user entered text)
   - CHOICES In_Transaction: (user entered text)

D. RULE BASE

1. ATR Message Security Classification Rules

(1) Submarines

- IF COMMAND.Hull Number = SSN[*] OR SSBN[*]

- THEN
- TRANSACTION.ATR Class = C AND TRANSACTION.ATR Declas= today + 6 years
- [THEN GOTO Addressing Rules]
- BECAUSE: ATRs submitted by submarines (regardless of material reported) are classified Confidential and are declassified after six years.

(2) Missiles, Rockets, and Torpedoes

- IF AMMUNITION.COG = 8E OR 4E OR 4T OR 8T
- THEN
- TRANSACTION.ATR Class = C AND TRANSACTION.ATR Declas = today + 6 years
- BECAUSE: ATRs pertaining to missiles or torpedoes are classified Confidential and are declassified after six years.

(3) Sonobouys

- IF AMMUNITION.COG = 8U
- THEN
- TRANSACTION.ATR Class = C AND TRANSACTION.ATR Declas = today + 6 years
- BECAUSE: ATRs pertaining to sonobuoys are classified Confidential and are declassified after six years.

(4) Complete Offloads and Onloads

- IF Loadout = Yes
- THEN
- TRANSACTION.ATR Class = C AND TRANSACTION.ATR Declas = today + 6 years
- BECAUSE: ATRs pertaining to complete onloads/offloads may contain information revealing onboard capabilities of major weapons systems. They are classified Confidential and declassified after six years.

(5) Mines

- IF AMMUNITION.COG = 6T
- THEN
- TRANSACTION.ATR Class = C AND TRANSACTION.ATR Declas = today + 30 years
- BECAUSE: ATRs pertaining to mines, destructors, or mine components are classified Confidential and are declassified after 30 years.

2. ATR Message Addressing Rules

(1) COMINEWARCOM/COMOMAG

- IF AMMUNITION.COG = 6T
- THEN
- [additional] TRANSACTION.Addressee = COMINEWARCOM CHARLESTON SC and COMOMAG CHARLESTON SC
- BECAUSE: All units reporting mines, destructors, or mine components must info COMINEWARCOM and COMOMAG.

(2) CINCLANTFLT

- IF (CHOP_To = LANT) OR (CHOP_From = LANT)
- THEN
- [additional] TRANSACTION.Addressee = CINCLANTFLT NORFOLK VA
- BECAUSE: All units reporting CHOP to or from the Atlantic Fleet must info CINCLANTFLT.

(3) CINCPACFLT/COMNAVLOGPAC

- IF (COMMAND.Fleet = PAC) OR (CHOP_To = PAC OR CHOP_From = PAC)
- THEN
- [additional] TRANSACTION.Addressee = CINCPACFLT PEARL HARBOR HI and COMNAVLOGPAC PEARL HARBOR HI
- BECAUSE: All Pacific Fleet units and other units upon CHOP to or from the Pacific Fleet must info CINCPACFLT/COMNAVLOGPAC.

(4) CINCUSNAVEUR

- IF (COMMAND.Fleet = LANT AND Deployed_To = 6FLT)
- OR (COMMAND.Fleet = LANT AND MLSF = Yes AND 60_Days_Before = Yes AND Will_Deploy = 6FLT)
- OR (CHOP_To = EUR OR CHOP_From = EUR)
- THEN
- [additional] TRANSACTION.Addressee = CINCUSNAVEUR LONDON UK
- BECAUSE: Atlantic Fleet units deployed to the Sixth Fleet, Atlantic Fleet MLSF ships within 60 days prior to such deployment, and all units reporting CHOP to or from the European area must info CINCUSNAVEUR.

(5) COMNAVAIRLANT

- IF (COMMAND.Fleet = LANT) AND (AMMUNITION.COG = 8U)
- THEN

- [additional] TRANSACTION.Addressee = COMNAVAIRLANT NORFOLK VA
- BECAUSE: Atlantic Fleet units reporting sonobouys must info COMNAVAIRLANT.

(6) COMNAVAIRPAC

- IF (COMMAND.Fleet = PAC) AND (AMMUNITION.COG = 8U)
- THEN
- [additional] TRANSACTION.Addressee = COMNAVAIRPAC SAN DIEGO CA
- BECAUSE: Pacific Fleet units reporting sonobouys must info COMNAVAIRPAC.

(7) Commander, Task Force 73

- IF (COMMAND.Fleet = PAC) AND (Deployed_To = MED OR Deployed_To = WESTPAC
- OR (COMMAND.Fleet = PAC) AND ((MLSF = Yes) OR (COMMAND.Hull Number = CV[*] OR CVN[*]) AND (60_Days_Before = Yes))
- OR (COMMAND.Fleet = PAC) AND (Pre_Load = Yes) AND (AMMUNITION.COG = 8E OR 4E OR 8T OR 4T OR 6T OR 8U)
- THEN
- [additional] TRANSACTION.Addressee = CTF SEVEN THREE
- BECAUSE: Pacific Fleet units deployed to MED/WESTPAC and Pacific Fleet MLSF and aircraft carriers within 60 days prior to deployment in addition to Pacific Fleet units reporting predeployment loadouts involving air launched missiles, surface launched missiles, torpedoes, mines, and sonobuoys must info CTF 73.

(8) Commander, Task Force 63

- IF (COMMAND.Fleet = LANT) AND (Deployed_To = MED)
- OR (COMMAND.Fleet = LANT) AND ((MLSF = Yes) OR (COMMAND.Hull Number = CV[*] OR CVN[*]) AND (60_Days_Before = Yes))
- OR (COMMAND.Fleet = LANT) AND (Pre_Load = Yes) AND (AMMUNITION.COG = 8E OR 4E OR 8T OR 4T OR 6T OR 8U)
- THEN
- [additional] TRANSACTION.Addressee = CTF SIX THREE
- BECAUSE: Atlantic Fleet units deployed to the MED and Atlantic Fleet MLSF and aircraft carriers within 60 days prior to deployment in addition to Atlantic Fleet units reporting predeployment loadouts involving air launched missiles, surface launched missiles, torpedoes, mines, and sonobuoys must info CTF 63.

(9) COMFAIRWESTPAC

- IF (COMMAND.Fleet = PAC) AND (AMMUNITION.COG = 4E OR 8E)
- THEN
- [additional] TRANSACTION.Addressee = COMFAIRWESTPAC ATSUGI JA and COMFAIRWESTPAC DET CUBI PT RP
- BECAUSE: Pacific Fleet units reporting air launched missiles must info COMFAIRWESTPAC.

(10) COMPACMISTESTCEN

- IF (AMMUNITION.COG = 4E OR 8E) OR (AMMO INVENTORY.NALC = <Sea Sparrow> OR <Harpoon>)
- THEN
- [additional] TRANSACTION.Addressee = COMPACMISTESTCEN POINT MUGU CA
- BECAUSE: All units reporting air launched missiles, Sea Sparrow, or Harpoon will info COMPACMISTENTCEN.

(11) COMTHIRDFLT/COMNAVSURGRU MIDPAC

- IF (COMMAND.Fleet = PAC) AND (In_Transaction = NAVMAG LUALUALEI HI) AND (AMMO INVENTORY.NALC = <5"/54 Puff> OR <5"/38 Puff>)
- THEN
- [additional] TRANSACTION.Addressee = COMTHIRDFLT AND COMNAVSURFGRU MIDPAC
- BECAUSE: Pacific Fleet units onloading or offloading 5"/54 or 5"/38 Puff rounds from/to Naval Magazine Lualualei, HI will info COMTHIRDFLT and COMNAVSURFGRU MIDPAC.

(12) JCMPO

- IF AMMO INVENTORY.NALC = <Tomahawk>
- THEN
- [additonal] TRANSACTION.Addressees = JCMPO WASHINGTON DC
- BECAUSE: All units reporting Tomahawk missile transactions will info JCMPO.

(13) CMC WASHINGTON DC

- IF AMMUNITION.COG = 0T
- THEN
- [additional] TRANSACTION.Addressee = CMC WASHINGTON DC

- BECAUSE: All units reporting Marine Corps-controlled ammunition will info CMC.

(14) NAVSHIPWPNSYSENGSTA

- IF AMMUNITION.COG = 8E OR 8T
- THEN
- [additional] TRANSACTION.Addressee = NAVSHIWPNSYSENGSTA PORT HUENEME CA
- BECAUSE: All units reporting surface launched missiles and certain air launched missiles will info NAVSHIPWPNSYSENGSTA.

(15) PACMISTESTCEN DELANT

- IF (COMMAND.Fleet = LANT) AND (AMMUNITION.COG = 8E)
- THEN
- [additional] TRANSACTION.Addressee = PACMISTESTCENT DELANT YORKTOWN VA
- BECAUSE: Atlantic Fleet Units reporting certain air launched missiles will info PACMISTESTCEN DELANT.

(16) Standard Information Addressees

- [additional] TRANSACTION.Addressees = Tender AND Squadron AND In_Transaction AND Ex_Wep_Prep AND FLTAC CORONA CA
- BECAUSE: All units always info parent submarine tenders, squadron commanders, commands involved in the transaction, exercise weapon preparation activity, and FLTAC Corona, CA.

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