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United States Air Force Computer-aided Acquisition and Logistics Support (CALS)

Product Definition Data (PDD) Current Environment Report

FINAL REPORT

May 1989

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The report prepared by, the U.S. Department of Transportation/Transportation Systems Center (US DOT/TSC), Cambridge, MA, documents the analysis of the current Product Definition Data (PDD) environment. This report was undertaken as part of the U.S. Air Force (USAF) Computer-aided Acquisition and Logistics Support (CALS) Program and was coordinated by the Air Force CALS Management Integration Office (MIO) at HQ Air Force Systems Command (AFSC), Andrews AFB, DC. The scope of PDD includes; engineering drawings, associated lists, specifications, analysis models, design data, manufacturing data,process data, test data, etc.
The PDD Current Environment Report describes the Air Force organizations and functions employed in the acquisition, use, and management of PDD. The flow of PDD among the Air Force and defense contractors during the design/engineering, manufacturing, and post-production phases is depicted in process flow and IDEF$_0$ diagrams. In addition, the report describes the major concerns, issues, and findings identified during the current environment analysis.

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United States Air Force
Computer-aided Acquisition and Logistics Support (CALS)

Product Definition Data (PDD)

Current Environment Report – Final Report

April 1989

DoD-VA956-89-1

PREFACE

This report prepared by the Transportation Systems Center (TSC) concludes the analysis of the current Product Definition Data (PDD) environment which was undertaken as part of the US Air Force Computer-aided Acquisition and Logistics Support (CALS) Program. This investigation was coordinated by the Air Force CALS Management Integration Office (MIO) at HQ AFSC.

The report describes the Air Force organization and functions employed in the acquisition, use, and management of engineering drawings and associated data. The flow of data among the Air Force and contractors during the design/engineering, manufacturing, and post-production phases has been defined. In addition, the report describes the major problems, issues, and findings idenufied during the current environment analysis.

The work was performed under the direction of Dr. Robert Smith of the Information Integration Division at the Transportation Systems Center (TSC) of the Department of Transportation. TSC has drawn upon the knowledge and experience of a number o consultants, and would like particularly to recognize the efforts of staff members from the following organizations: DYNATREND Inc., RJO Enterprises, and UNISYS, Inc. In addition, TSC would like to extend thanks and gratitude to the members of the Air Force and defense contractors who contributed to the development of this report.

The PDD Current Environment Report identifies a baseline for the development of an automation plan (7–10 years) to receive, store, use, and disseminate to digital PDD. Any comments or inputs are encouraged so that this report will be current and integral to the success of this program.

EXECUTIVE SUMMARY

BACKGROUND

The objective of the Air Force Computer–aided Acquisition and Logistics Support (CALS) Program is to improve weapon system reliability, supportability and maintainability, and to reduce the cost of weapon system acquisition and logistics support. As part of the Air Force CALS Program, automation plans (7–10 years) are being developed that define the infrastructure, functional requirements, technologies, and implementation strategy to receive, use, and disseminate digital technical data. The Air Force CALS Program employs a phased Modular Planning Process (MPP) which: 1) examines the current environment, 2) studies the opportunities and 3) plans the future direction. The areas of technical data currently being addressed are: Technical Orders (TOs), Product Definition Data (PDD), and Logistics Support Analysis (LSA).

The CALS *PDD Current Environment Report* documents the current functions, organizations, data, and applications for the acquisition, use, and management of PDD to support weapon systems. This report is the culmination of Phase 1 of the PDD module and provides a baseline for the development of a PDD Automation Plan.

METHODOLOGY

In order to establish a clear understanding of the PDD environment, interviews and site visits were conducted in conjunction with a review of relevant documentation. The information collected forms the basis of this report. To perform the actual examination of the current environment, three structured analysis methodologies/techniques were employed: Organization Assessment, Integrated Computer–Aided Manufacturing (ICAM) Definition ($IDEF_0$) models, and Data Flow Diagrams (DFDs).

The following is a summary of the major sections of the report:

- **Organizational Assessment** – Describes the Air Force organizations' primary functions and data usage requirements.

- **$IDEF_0$ Diagrams** – Depicts a functional description of how the Air Force acquires, uses and manages PDD. The diagrams also depict the input, controls, output, and mechanisms (ICOMs) and the interrelationship among the business functions.

- **Data Flow Diagrams (DFDs)** – Provides a clear understanding of the processes involved in the formulation of PDD by identifying the data requirements, data flows, and organizations that develop PDD during the acquisition phase, and the subsequent use of PDD by the Air Force during post-production support.

- **PDD Dimensions** – Defines the current level and volume of PDD through the identification of the number of drawings, storage requirements, and number of manual repositories.

- **Concerns, Issues, and Findings** – Identifies the concerns, issues and findings of the current PDD environment that were collected and documented during the development of the report.

CURRENT ENVIRONMENT SUMMARY

The examination of the current PDD environment, as described in the $IDEF_0$ and DFD diagrams, revealed the following three major activities:

- **Acquisition** – The major planning activities in acquiring engineering data include the formulation of the Engineering Data Management Plan (EDMP) by the Air Force Systems Command (AFSC) System Program Office (SPO) and the definition of the engineering data requirements by the ALCs during the Data Call process. The development of PDD by Contractors is divided into two major functional areas – Engineering/Design Data and Manufacturing Data. The review of PDD is accomplished through technical reviews/audits (e.g., Preliminary Design Review, Critical Design Review, Functional Configuration Audit, and Physical Configuration Audit) and In-Process Reviews (IPRs) which review the engineering drawing formats.

- **Use** – The development and use of PDD is required to support the post-production applications: Spares Reprocurement, Local Manufacturing, Repairs, and Modifications. Revisions to PDD are issued based on configuration changes as defined in Engineering Change Proposals (ECPs) and Engineering Change Orders (ECOs).

- **Management** – Engineering data is maintained and controlled in manual repositories, Engineering Data Support Centers (EDSCs), and distributed to the ALCs and Using Commands in the form of engineering drawings and aperture cards.

MAJOR CONCLUSIONS

Several key conclusions have been drawn from analyzing the PDD current environment:

- **Contractor/Air Force Data Usage Differences** – Based on an examination of the current environment, it was found that the source of information (Contractor creation of PDD) and the destination of data (Air Force use of engineering data) have major differences in scope and breadth:

  - *Contractor* – Creates a "broad" spectrum of data, namely PDD, which includes analysis models, design data, geometry, test data, processes, etc., to perform design, manufacturing, and testing of weapon systems.

- *Air Force* – Receives and uses a "limited" set of data, namely engineering data, which includes engineering drawings, associated lists, specifications, and other related information in support of post-production support activities.

- **Major Organizations** – The organizational assessment identified that the ALC Materiel Management (MM), Maintenance (MA), and Competition Advocacy (CR) Directorates are the predominant users of PDD to support spares reprocurement and sustaining engineering activities. The AFSC Product Divisions/SPO is responsible for PDD acquisition and reviews. The Using Commands require engineering drawings to support base-level repair and local manufacturing.

- **Major Applications** – Uses of PDD support four post-production support applications:

  - *Spares Reprocurement* – This process entails the assembly by the ALCs of engineering drawings, specifications, and lists for the formulation of bid sets for reprocurement.

  - *Local Manufacturing* – The ALCs and Using Commands perform local manufacture of parts when it is either more economical or timely than reprocuring spare parts. The use of 2D and 3D drawings, process specifications, and material specifications are required for local manufacturing.

  - *Repair* – Weapon system repair is performed by the ALCs and Using Commands in support of depot and base level maintenance. Engineering drawings, parts lists, specifications, and analysis data are used to support the repair process.

  - *Modifications* – This activity requires the development of modification kits based on new operational capabilities, reported deficiencies, or new mission threats. Weapon system modifications require the use of analysis models, product specifications, and engineering data. The ALCs typically are responsible for program management of modifications after Program Responsibility Management Transfer (PMRT). In addition, the ALCs and Test Wings perform some modifications organically.

- **Data Requirements** – The information required to support post-production applications are broken into the following major data classes:

  - *Analysis/Design Data* – models, loads, stress, properties, allowables.

  - *Engineering Data* – engineering drawings, parts lists, shape/size data.

  - *Specifications* – system, development, product, material and process specifications.

- *Process/Manufacturing Data* – tooling, fabrication, assembly data, numerical control data.

- *Test Data* – test plans, specifications, test requirements, flight test data.

In general, engineering and manufacturing data is required for spares reprocurement and local manufacturing while design and engineering data are required for repairs and modifications.

- **Data Formats** – Using the information from DFDs, a series of matrices were developed which provided several important observations regarding the format of PDD. It was found that the primary data formats developed by the contractors during the design, engineering, and manufacturing phases are: 2D and 3D vector images and raster images. Conversely, ALCs generally accept aperture cards/drawings in hard copy format and re-enter data into local CAD/CAM systems to support post-production applications. The primary physical storage type is magnetic media (i.e., magnetic tape or disk).

- **PDD Dimensions** – At present, the ALCs and Base-level Maintenance maintain a combined total of over 44 million aperture cards. It has been projected that there will be 80 million aperture cards at the ALCs requiring approximately 1200 gigabytes over a 5–10 year time frame.

- **Major Concerns/Opportunities** – Several concerns were identified as a result of the examination of the current environment. These concerns present potential opportunities for automation to be addressed in the PDD Automation Plan.

  - *Engineering Data Acquisition Methods* – The initial engineering data acquisition is critical to successful logistics and engineering support. Currently, concerns are attributed to three major factors: 1) inconsistent data formats, 2) IPRs focus on drawings format, not the technical accuracy and completeness, and 3) the current DRED (Deferred Requisition of Engineering Data) acquisition method causes data availability problems.

  - *Configuration Management Practices* – The major source of this concern is the incomplete engineering data packages that are accepted by the Air Force at PMRT. In addition, the current configuration of the weapon system is not consistent with the engineering data due to: 1) lost and missing data, 2) uncontrolled local drawing files, and 3) lack of controlled update procedures on ECPs/OCPs between the Air Force and contractors.

  - *Manual Access/Distribution Procedures* – The labor intensive process of managing and maintaining the aperture cards causes delays in responding to user requests for drawings at the ALCs and also causes backlogs of updates/new engineering data distributed by the ALC to MAJCOM bases.

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LIST OF ACRONYMS

AAC	Alaskan Air Command
AD	Armament Division
ADP	Automated Data Processing
AECO	Advance Engineering Change Orders
AFALC	Air Force Acquisition Logistics Center
AFTAC	Air Force Technical Applications Center
AFB	Air Force Base
AFCC	Air Force Communications Command
AFFTC	Air Force Flight Test Center
AFLC	Air Force Logistics Command
AFLCP	Air Force Logistics Command Pamphlet
AFLCR	Air Force Logistics Command Regulation
AFOTEC	Air Force Operational Test and Evaluation Center
AFPRO	Air Force Plant Representative Office
AFR	Air Force Regulation
AFRES	Air Force Reserve Forces
AFSC	Air Force Systems Command
AFSCP	Air Force Systems Command Pamphlet
AFSCR	Air Force Systems Command Regulation
AFTOMS	Air Force Technical Order Management System
AGMC	Aerospace Guidance and Metrology Center
ALC	Air Logistics Center
AMARC	Aerospace Maintenance and Regeneration Center
ANG	Air National Guard
ASD	Aeronautical Systems Division
ATC	Air Training Command
ATF	Advanced Tactical Fighter
ATI	Automated Technical Information
ATOS	Automated Technical Order System
AWACS	Airborne Warning and Control System
BCL	Binary Cutter Location
BMO	Ballistic Missile Office
BMW	Bomb Wing
BOM	Bill of Material
BW	Bomb Wing
C-E	Communications-Electronic
CAD	Computer Aided Design
CAE	Computer Aided Engineering

CALS	Computer-aided Acquisition and Logistics Support
CAM	Computer Aided Manufacturing
CAMS	Core Automated Maintenance System
CAO	Contract Administration Officer
CASC	Cataloging and Standardization Center
CCB	Configuration Control Board
C3I	Command, Control, Communication and Intelligence
CDA	Contractor Designed Activity
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CEM	Communication-Electromagnetic-Meteorological equipment
CI	Configuration Item
CIM	Computer-Integrated Manufacturing
CM	Configuration Management
CMP	Configuration Management Plan
CMO	Configuration Management Officer
CNC	Computer Numerical Control
CORE	Contracted-Out Reverse Engineering
CR	Directorate of Competition Advocacy
CRE	Engineering Data Management Division
CRED	Contract Requirements for Engineering Data
CSA	Configuration Status Accounting
CSTC	Consolidated Space Test Center
DCAS	Defense Contract Administrative Service
DCASMA	Defense Contract Administrative Service Management Area
DFD	Data Flow Diagrams
DID	Data Item Description
DLA	Defense Logistics Agency
DMMIS	Depot Maintenance Management Information System
DMO	Data Management Officer
DNC	Distributed Numerical Control
DoD	Department of Defense
DPML	Deputy Program Manager for Logistics
DOED	Deferred Ordering of Engineering Data
DOT	Department of Transportation
DPML	Deputy Program Manager of Logistics
DRED	Deferred Requisitioning of Engineering Data
DRRB	Data Requirements Review Board
DS	Directorate of Distribution
DSD	Data System Designator
DSRD	Depot Support Requirements Document

DTA	Damage Tolerance Assessment
DT&E	Developmental Test & Evaluation
ECO	Engineering Change Order
ECP	Engineering Change Proposal
EDARF	Engineering Data Activity Record File
EDCARS	Engineering Data Computer-Assisted Retrieval System
EDMO	Engineering Data Management Officer
EDMP	Engineering Data Management Plan
EDRD	Engineering Data Requirements Document
EDSC	Engineering Data Service or Support Center
EOQ	Economic Order Quantity
ERRC	Expendibility, Repairability, Recoverability & Cost
ES	Equipment Specialist
ESC	Electronic Security Command
ESD	Electronic Systems Division
ESMC	Eastern Space and Missile Center
FAR	Federal Acquisition Regulation
FCA	Functional Configuration Audit
FEM	Finite Element Model
FMS	Foreign Military Sales
FMS	Field Maintenance Squadron
FQR	Formal Qualification Review
FSD	Full Scale Development
GDA	Government Designed Activity
ICAM	Integrated Computer Aided Manufacturing
ICOMs	Inputs Controls Outputs Mechanisms
IDEF	ICAM Definition
IFB	Invitation For Bid
IGES	Initial Graphics Exchange Standard
ILS	Integrated Logistics Support
ILSP	Integrated Logistics Support Plan
IM	Item Manager
IPB	Illustrated Part Breakdown
IPR	In-Process Review
IV&V	Independent Verification & Validation
Joint STARS	Joint Surveillance Target Attack Radar Systems
JTIDS	Joint Tactical Information Distribution System
LRIP	Low Rate Initial Production
LRU	Line Replaceable Unit
LSA	Logistics Support Analysis
LSAR	Logistics Support Analysis Record

MA	Directorate of Maintenance
MAC	Military Airlift Command
MAJCOM	Major Command
MANTECH	Manufacturing Technology Program
MCCR	Mission Critical Computer Resources
MDR	Maintenance Deficiency Report
MICAP	Mission Capability
MIO	Management Integration Office
MISTR	Management of Items Subject To Repair
MM	Directorate of Materiel Management
MPP	Modular Planning Process
NC	Numerical Control
NCIPE	Numerical Control Industrial Plant Equipment
NMC	Non-mission Capable
NOR	Notice of Revision
NSN	National Stock Number
NSP	Not Separately Priced
OC-ALC	Oklahoma City Air Logistics Center
OCP	Organic Change Proposal
OO-ALC	Ogden Air Logistics Center
OT&E	Operational Test & Evaluation
PACAF	Pacific Air Forces
PCA	Physical Configuration Audit
PCO	Procurement Contracting Officer
PDD	Product Definition Data
PDES	Product Data Exchange Standard
PDMP	Programmed Depot Maintenance Program
PDR	Preliminary Design Review
PEP	Producibility and Engineering Plan
PM	Directorate of Contracting and Manufacturing
PMC	Partially Mission Capable
PMD	Program Management Directive
PMP	Program Management Plan
PMRT	Program Management Responsibility Transfer
POM	Program Objective Memorandum
PPL	Provisioning Parts List
PR	Procurement Request
PRR	Production Readiness Review
QA	Quality Assurance
QC	Quality Control
QDR	Quality Deficiency Report

RADC	Rome Air Development Center
RCC	Resource Control Center
R&D	Research and Development
REPTECH	Repair Technology Program
RFP	Request For Proposal
RFQ	Request For Quotes
R&M	Reliability and Maintainability
SA-ALC	San Antonio Air Logistic Center
SAC	Strategic Air Command
SADT	Structured Analysis Design Technique
SAMTO	Space and Missile Test Organization
SCP	System Concept Paper
SD	Space Division
SDI	Strategic Defense Initiative
SDR	System Design Review
SEMP	Systems Engineering Management Plan
SERD	Support Equipment Recommendation Data System
SM-ALC	Sacramento Air Logistics Center
SMR	Source, Maintenance and Recoverability Code
SOC	System Operational Concept
SON	Statement of Operational Need
SORD	System Operational Requirements Document
SOW	Statement Of Work
SPACECOM	Space Command
SPM	System Program Manager
SPO	System Program Office
SRR	System Requirements Review
SRU	Shop Replacement Unit
ST/STE	Special Tooling and Special Test Equipment
TAC	Tactical Air Command
TCTO	Time Compliance Technical Order
TD/CMS	Technical Data/Configuration Management System
TDP	Technical Data Package
TDR	Tear Down Deficiency Report
TEMP	Test and Evaluation Master Plan
TRC	Technology Repair Center
TO	Technical Order
TSC	Transportation Systems Center
USAF	United States Air Force
VHDL	VHSICS High Level Description Language
VHSICS	Very High Speed Integrated Circuits

WR-ALC	Warner Robins Air Logistic Center
WRDC	Wright Research and Development Center
WRDC/ML	Wright Research and Development Center, Material Laboratory
WSMC	Western Space and Missile Center

CHAPTERS 1–6

INTRODUCTION

ORGANIZATIONAL ASSESSMENT

$IDEF_0$ DIAGRAMS

DATA FLOW DIAGRAMS (DFDs)

PDD DIMENSIONS

CONCERNS, ISSUES, AND FINDINGS

SECTION 1: INTRODUCTION

1.1 BACKGROUND

In conjunction with the Department of Defense-wide Computer-aided Acquisition and Logistics Support (CALS) program, the Air Force CALS program was established to improve weapon system reliability and maintainability and to reduce the cost of acquisition and support. A major objective of CALS is to improve the flow of technical information by introducing automated techniques to improve the delivery and handling of large quantities of digitized technical data. The areas of technical data currently being addressed by this effort are: Technical Orders (TOs), Product Definition Data (PDD), and Logistics Support Analysis (LSA). Upon achieving automation, CALS will significantly reduce the amount of paper and labor necessary to receive, store, use, and disseminate these technical data.

In October 1985, an Air Force Program Management Directive (PMD) created a CALS Management Integration Office (MIO) at HQ Air Force Systems Command (AFSC) to coordinate the CALS program. The Air Force CALS MIO is responsible for planning, developing, and implementing the CALS initiatives. The U.S. Department of Transportation Transportation Systems Center (DOT/TSC) is providing systems engineering and strategic planning support. To undertake the strategic planning associated with the CALS initiatives, TSC has developed and implemented the Modular Planning Process (MPP), which is an information engineering systems approach designed to:

- Focus on technical plans that will not be outdated before implementation.
- Incorporate existing/on-going Air Force systems.
- Meet the information distribution requirements of the Air Force user community.
- Interface with a variety of organizations responsible for weapon systems acquisition and logistic support.

The MPP is divided into three phases: 1) an examination of the existing environment, 2) a study of opportunities, and 3) a plan of future direction (See FIGURE 1-1). Using this framework, *The Air Force Tech Order Management System (AFTOMS) Automation Plan* was developed and a concept has been approved for Technical Orders. Additionally, an analysis of Logistics Support Analysis (LSA) is now being conducted.

This report is the result of an examination of the existing engineering data environment, undertaken as the first phase in the MPP, and as an initial step in developing a Product Definition Data (PDD) Automation Plan. It will assist the CALS effort to plan for the

PHASE 1
EXAMINE THE ENVIRONMENT

Initiate the Process

Perform Initial Assessment
- Create Preliminary Description of Environment
- Identify Organizational Expectations
- Establish Priorities

Develop Specific Procedures
- Establish Management Plan
- Identify Advisory Group
- Prepare Project Plans

Conduct Structured Analysis

Describe Current Environment
- Create Functional Model
- Identify Major Data Elements
- Describe the Organizational Infrastructure
- Identify Major Information Flow Parameters

Assess Transitional Projects
- Identify Objectives
- Describe Functions and Data
- Identify Technologies
- Identify Infrastructure Affected

PHASE 2
STUDY THE OPPORTUNITIES

Assess Technology

Identify Existing Technologies
- Review Current Environment
- Review Ongoing Projects
- Identify Existing Technologies

Research Future Technology Opportunities
- Select Technology Areas
- Consult with Technology Experts
- Examine Similar Applications
- Review Development Trends

Establish Technology Alternatives
- Quantify Directions
- Specification of Implementation Issues
- Examine Benefits and Costs

Project Future Requirements

Forecast Requirements
- Review Applicable Scenarios
- Conduct Discussions with MAJCOMs
- Forecast Process Changes
- Assess Infrastructure Constraints

Examine Feasible Alternatives
- Determine Feasibility Issues
- Review Industry Trends

Define Future State

Describe Future Environment
- Define the Impact of Technology on Current State
- Define Projected Organizational Responsibilities
- Define Relevant Interface Requirements

Create Functional Model
- Develop a Description of Future State
- Identify Projected Major Information Flow Parameters

PHASE 3
PLAN THE DIRECTION

Formulate Alternatives

Assess Critical Issues
- Examine Objectives
- Identify Technologies
- Review Organizational Issues

Propose Initial Alternatives
- Select Future Requirements
- Identify Technologies
- Structure Proposals

Review and Modify Alternatives
- Review Criteria
- Identify Relationships with Transitional Projects
- Define Policies and Organizations Involved

Develop Consensus

Review Progress with Advisory Group
- Identify Discussion Topics and Priorities
- Evaluate Current Environment
- Establish Objectives
- Provide Access to Information

Develop Common Understanding
- Review Future Requirements
- Evaluate Recommended Solutions
- Examine Feasibility Issues

Expand Advocacy Network
- Identify Implementation Agencies
- Select Appropriate Forums
- Communicate the Plans

Prepare Implementation Plan

Define Activity Descriptions
- Establish Implementation Guidelines
- Establish Evaluation Criteria
- Develop Implementation Procedures

Develop Organization Plan
- Confirm Major Milestones
- Establish Transition Plan
- Identify Organizational Responsibilities

Establish Constituency
- Gain Management Acceptance of Plan
- Obtain a Commitment for Execution

Create Documentation
- Establish Goals
- Define Resource Requirements
- Recommend Technologies
- Define Organizational Impact
- Establish Financial Parameters

FIGURE 1-1. MODULAR PLANNING PROCESS OVERVIEW automation of PDD over the next ten years by accommodating all of the present Air Force acquisition and logistics requirements, meeting future Air Force requirements, and being flexible enough to take advantage of future advances in technology.

1.2 SCOPE

The scope of technical information for the PDD module in the current Air Force organizational and functional environment falls into two general areas, engineering data and PDD.

- **Engineering Data** – Engineering data is the primary set of information that the Air Force currently receives, such as engineering drawings, associated lists, specifications, and other related documentation to support the weapon system.
- **PDD** – PDD is the information that the contractor creates during the acquisition life cycle. It includes the various models, analysis data, design data, material characteristics, geometry, manufacturing data, test data, processes, etc., to perform design, manufacturing, and test of weapon systems development.

1.3 OBJECTIVES

The analysis of the current environment focuses on identifying the issues relating to engineering data and PDD content, automation, acquisition, use, support, and organization. Specifically, the objectives of this examination are as follows:

- Identify voids and redundancies in the acquisition, management, transfer, and use of PDD.
- Articulate responsibilities of various Air Force organizations in the planning, acquisition, management, and use of PDD.
- Increase the understanding of the creation, acquisition, use, and management of PDD by depicting that process using structured analysis methods.
- Clarify some of the differences between the formal Air Force PDD processes as defined in the Military Standards (MIL STDs) and Air Force regulations in comparison to current environment operations.
- Identify PDD user requirements that need to be addressed in the automation plan.
- Establish a baseline to study the opportunities and plan the direction of the PDD automation effort.
- Provide a benchmark for the identification of constituencies which could use PDD in the future environment.

By fulfilling these objectives the report will provide the background information necessary for subsequent analytic efforts and recommendations in the development of the PDD Automation Plan.

1.4 METHODOLOGY

Documents, site visits, and interviews were used to collect the data necessary for the study. The documentation analysis consisted of a review of all relevant Air Force acquisition regulations, mission and organization regulations, and other documents pertaining to PDD. Site visits and interviews were conducted at Air Force organizations involved in acquisition and logistics.

The following modeling tools were used to investigate the current PDD environment:

- Organizational assessment.
- Integrated Computer Aided Manufacturing (ICAM) Definition ($IDEF_0$) Model.
- Data Flow Diagrams (DFDs).

Two of these techniques ($IDEF_0$ and Data Flow Diagrams) are activity models, which document the Product Definition Data (PDD) functions by describing the operations, processes, data flows, and interrelationships among activities. The use of these techniques has enabled the scope of the current environment to be definitized.

1.4.1 Organizational Assessment

The roles of the various Air Force organizations involved in PDD acquisition, use, and management are defined by Air Force regulation and current practice. However, an articulation of the roles of these organizations is critical to developing and implementing the PDD Automation Plan. An organizational assessment was conducted, resulting in a description of the Air Force's organization, roles, and responsibilities, which is accompanied by summary matrices mapping the PDD applications and data requirements to the Air Force organizations. This assessment defines how PDD is currently used, identifies the impact of PDD on the various Air Force organizational entities, and articulates the context of PDD use in the current environment.

1.4.2 Integrated Computer Aided Manufacturing (ICAM) Definition ($IDEF_0$) Diagrams

An $IDEF_0$ model was used to provide a graphic representation of weapon system acquisition, post-production use, and management of engineering data. Each diagram is accompanied by text which describes and explains the processes. Taken as a whole, the $IDEF_0$ model provides a functional description of the engineering data process. It identifies and depicts the input data required to perform an activity, the output products resulting from that activity, the mechanisms which perform the tasks, and the controls which govern the functions. Collectively, these four constructs allow analysis of the relationships among engineering data activities and the decomposition of each activity into additional components.

1.4.3 Data Flow Diagrams (DFDs)

The DFDs are graphic representations of the flow of data between contractor and Air Force functions and organizations. This approach complements and extends the scope of the IDEF$_0$ model in the areas of weapon system design/engineering, manufacturing, and post-production support DFDs show the sources and destinations of information and thereby allow the reader to follow the flow of data from the Contractor to Air Force organizations or between activities. Additionally, DFDs are accompanied by a glossary, which includes functional descriptions and definitions of the diagram constructs.

1.5 REPORT ORGANIZATION

The report is organized to present an overview of the organizational environment, structured analysis models, PDD statistics, and a conclusion detailing concerns, issues, and major findings The Appendices provide additional detail to the major sections

- **Section 2** – Summarizes the current Air Force organizational environment and describes how PDD is used
- **Section 3** – Presents a brief discussion of IDEF$_0$ model analysis It provides a graphic representation of weapon system acquisition, post-production use, and management of engineering data
- **Section 4** – Presents the Data Flow Diagrams (DFDs) of weapon system design/engineering, manufacturing, and post-production support
- **Section 5** – Provides a quantitative view of current engineering data as well as a projection of future data volumes
- **Section 6** – Documents the concerns, issues, and findings identified during development of the organizational assessment, IDEF$_0$ diagrams, and DFDs It also incorporates information obtained from meetings with Air Force industry personnel
- **Appendices**
    - Appendix A provides a detailed description of the Air Force organizational environment
    - Appendix B presents the detailed Integrated Computer Aided Manufacturing (ICAM) Definition (IDEF$_0$) Diagrams Each diagram is accompanied by text which describes and explains the processes.
    - Appendix C shows, through DFDs, the sources and destinations of information from the Contractor to Air Force organizations or between activities It also contains a comprehensive data dictionary

- Appendix D is a list of references
- Appendix E presents a chart that summarizes the points of contact.

SECTION 2: ORGANIZATIONAL ASSESSMENT

2.1 INTRODUCTION

This section describes the roles and responsibilities of the major Air Force organizations involved in the acquisition, use, and management of PDD. This assessment focuses primarily on describing the Air Logistic Centers' (ALCs) use and application of PDD within the Air Force environment. Secondarily, the roles and responsibilities of the Product Divisions, MAJCOMs, Test Centers, and Laboratory users are described.

This assessment is based on a review of current regulations, policies, and procedures and from interviews conducted with the Air Force staff. Section 2.2 describes key staff and resource functions within the Air Force environment. Section 2.3 describes the organizational roles/responsibilities, and Section 2.4 presents the conclusions. See Appendix A for a detailed description of the roles and responsibilities of the major Air Force organizations.

2.2 STAFF/RESOURCE FUNCTIONS

The functional descriptions of the key staff and resource(s) that acquire, use, and manage PDD are based on a review of the organizational support functions.

Staff

The following staff are key in supporting PDD requirements definition, engineering support, logistics functions, and operational support of the weapon system. (See Table 2-1 for an identification of the ALC staff and the respective organizations.)

- **Engineering Data Management Officer (EDMO)** – Plans, coordinates, and manages engineering data acquisition. Assures the completion of an engineering data package necessary to support competition on subsequent buys throughout the weapon system life cycle.

- **System Program Manager (SPM)** – Manages the engineering data acquisition. Coordinates the procurement, production, materiel distribution, and logistics support functions necessary to provide effective system management of the prime weapon system at an ALC depot.

- **Equipment Specialist (ES)** – Coordinates and plans the ALC maintenance concepts and repair techniques throughout the life cycle of the weapon system. Selects the spares, parts, and kits required for repair and modification program.

- **Item Manager (IM)** – Acquires and maintains materiel, controls inventory, and provides materiel management support for the Air Force mission worldwide.

TABLE 2-1. ALC STAFF/ORGANIZATION MATRIX

	MM						MA		CR
STAFF / ORGANIZATIONS	MMS	MMA	MME	MMI	MM_R	MM_D	MA_E	MA_P	CRE
Engineering Data Management Officer									✓
System Program Manager	✓	✓							
Item Manager		✓		✓		✓			
Equipment Specialist	✓	✓		✓	✓				
Engineering Maintenance/ Planner	✓	✓					✓		
Drafting Designer			✓						
Engineer	✓	✓	✓	✓	✓			✓	✓

- **Engineering/Maintenance Planner** – Defines the technical requirements, determines the engineering drawing/process requirements, and identifies the labor and materiel requirements to meet local manufacturing and repair needs.

- **Drafting/Designer** – Provides support to the Directorates of Materiel Management (MM) and Maintenance (MA) in the production of engineering drawings/revisions, Engineering Change Orders (ECOs), and prototype drawings using conventional drafting procedures and/or CAD equipment.

- **Engineers** – Performs a variety of engineering functions such as engineering analysis, deficiency analysis, ECO development, design review support, numerical control (N/C) part programming, and testing in support of modifications, repair, and local manufacturing.

Resources

- **Engineering Data Service Center (EDSC)** – Serves as manual repositories for storage and maintenance of engineering drawings and related documentation in the form of aperture cards and hard copy drawings for Air Force weapon systems. EDSCs are located at the five ALCs, sixty-eight base level MAJCOM installations, and several other organizations.

2.3 ORGANIZATIONAL ROLES AND RESPONSIBILITIES

This section describes the major roles and responsibilities of the Air Force organizations, as well as their use, application, and requirements for PDD.

2.3.1 Headquarters Air Force Logistics Command (HQ AFLC)

HQ AFLC establishes distribution and control policies for engineering data and defines the engineering data acquisition requirements in the PMD. It also provides policy and management direction to the five ALCs and other Direct Reporting Units (Aerospace Guidance and Metrology Center [AGMC], Aerospace Maintenance and Regeneration Center [AMARC], Air Force Acquisition Logistics Center [AFALC], Cataloging and Standardization Center [CASC], and 2750th Air Base Wing) for performing all major maintenance, repair, modifications, local manufacturing, and reprocurement on Air Force weapon systems.

2.3.2 Air Logistic Centers (ALCs)

This section is a functional description of the major directorates, divisions, and branches within an ALC. These organizations represent the primary ALC users of PDD within an ALC. (Note that the organization symbols, e.g., MM_R, MA_P, are standard across the ALCs, and the "_" is substituted by the prime weapon system or commodity being managed by the respective ALC/MM or MA directorate). This section also describes the ALC roles, responsibilities, and uses of PDD.

2.3.2.1 Directorate of Materiel Management (MM)

MM is responsible for engineering management, development, and control of the design, performance, and reliability of assigned systems and equipment. MM determines the requirements for all parts of ALC systems and commodities.

Divisions

- **System Program Management Division (MMS)** - Provides the SPM functions in support of the system acquisition program. During post-Program Management Responsibility Transfer (PMRT), MMS provides engineering management for the design and configuration of assigned systems and manages the sustaining engineering support. Other divisions such as MMK, MMB, MMG, etc. also support SPM functions.

- **Acquisition Division (MMA)** - Performs engineering management of the design and configuration of assigned systems, and ensures surveillance over all aspects of the sustaining engineering support (pre-PMRT).

- **Engineering Division (MME)** - Provides centralized engineering drafting/design services for engineering requirements. Manages the distribution and control of engineering data in the ALC EDSCs. Performs engineering analysis for modifications/repairs, and provides flight testing support.

- **Item Management Division (MMI)** – Ensures that the desired performance is maintained on assigned items and serves as the AFLC logistics support item management specialist for specific items and subsystems (e.g., electrical accessories, generators).

Branches

- **Engineering and Reliability Branch (MM_R)** – Determines requirements for the acquisition of engineering data. Participates in design reviews (e.g., Preliminary Design Review [PDR], Critical Design Review [CDR]). Performs engineering analysis for modifications. Approves/disapproves ECPs. Performs analyses, and defines requirements for structural damage repairs.

- **Requirements and Distribution Branch (MM_D)** – Initiates the Procurement Request (PR) and ensures inclusion of approved engineering data. Provides item management support by acquiring and maintaining materiel inventory in support of spares reprocurement and modifications.

- **Product Management Branch (MM_P)** – Manages the Class IV and V modification programs upon receipt of a complete and procurable modification data package from MM_R.

2.3.2.2 Directorate of Maintenance (MA)

MA is responsible for managing the organic depot-level maintenance production facilities in the modification, local manufacturing, and repair of Air Force equipment. Across the five ALCs and AGMC there exist twenty Technology Repair Centers (TRCs) which provide support for depot maintenance of a particular commodity (e.g., landing gear, avionics) across a variety of weapon systems. ALC and AGMC MA directorates are organized into product divisions which are further broken down into branches, sections, and Resource Control Center (RCC) units identifying the function and the relative costs in utilizing that particular unit (e.g., plating, welding, sheetmetal).

Divisions

- **Resources Management Division (MAW)** – Serves as the directorate representative on depot maintenance in developing equipment and skill workloads in support of repairs and local manufacturing.

- **Quality Assurance Division (MAQ)** – Participates in preproduction/operational planning, recommends improved quality methods for application to maintenance workloads, and reviews engineering drawings/specifications to establish dimensional and process requirements for critical parts.

- **Aircraft Division (MAB)** – Provides engineering and management depot maintenance support to the prime weapon system for modifications and repairs.

- **Product Division (MA_)** - Provides depot maintenance repair and local manufacturing support for assigned end item commodities and industrial products, (e.g., landing gear, engines, avionics).

Branches

- **Engineering/Planning Branch (MA_E)** - Estimates the labor, cost, raw materials, and requirements to perform local manufacturing, and performs cost comparisons of the various manufacturing alternatives.

- **Production Branch (MA_P)** - Operates the local manufacturing (i.e., N/C machine shops) and repair facilities, and ensures the application of supporting procedures pertaining to the directorate of maintenance operations.

2.3.2.3 Directorate of Competition Advocacy (CR)

The primary mission of the CR organization is to acquire Level 3 engineering data packages for the competitive reprocurement of weapon systems, spare parts, and modification programs CR also supports the SPM and Item Manager (IM) organizations during the initial acquisition and modification/repair program planning to ensure proper consideration is given to competition

Division

- **Engineering Data Management Division (CRE)** - Ensures the acquisition of engineering data, tailors the DIDs, validates the data, assembles engineering data packages; and manages the reverse engineering program.

2.3.2.4 AFLC Summary

The assessment of the AFLC organizations found that the ALCs are major users of PDD. The centers require PDD during the post-production phase of weapon system support when the information is subject to heavy usage (e.g , updates, redesign, configuration changes) in support of a wide variety of post-production support applications. The support areas include modifications, spares reprocurement, repairs, local manufacturing, and numerous other depot activities (e.g , inspection, engineering analysis, reverse engineering, failure analysis, parts substitution, troubleshooting) The ALCs require design/analysis data, engineering drawings, parts lists, specifications, test data, process data, and manufacturing data (e g , tooling, fabrication, assembly) to sustain the post-production support applications. The ALCs also provide support to the Air Force Systems Command (AFSC) SPO/Product Divisions for In-Process Reviews (IPRs) and design reviews.

Two matrices summarize the ALC organizations' use of data and PDD requirements The first matrix defines the ALC staff and the respective organizations in which they are located (See Table 2-1) The second matrix maps the ALC organizations to PDD usage levels (high, medium, and low) and the data classes that are *Created* (C), *Modified* (M), and *Used* (U) during the post-production support phase (See Table 2-2). (See Section 4 for definitions of *Create, Modify, Use*, and PDD Data Classes) This matrix shows that the primary ALC users of PDD are MME and MM_R.

2.3.3 Headquarters Air Force Systems Command (HQ AFSC)

HQ AFSC is responsible for the design, development, acquisition, and delivery of Air Force weapon systems. AFSC supports the MAJCOMs' needs by the application of advanced technology in the development and enhancement of weapon systems. It supports the research, development, testing, and implementation of weapon systems throughout their life cycle Additionally, AFSC provides guidance and direction to the product divisions, laboratories, and development and test centers.

This section describes the major responsibilities of the Product Divisions and System Program Offices (SPOs) within AFSC The AFSC Product Divisions include: Aeronautical Systems Division (ASD), Electronic Systems Division (ESD), Space Division (SD), Ballistic Missile Office (BMO), and Armament Division (AD).

2.3.3.1 Product Divisions

The Product Divisions are responsible for program management and system engineering support for weapon system acquisitions Those divisions responsible for managing and acquiring large volumes of PDD are Aeronautical Systems Division, Electronic Systems Division, and Space Division ASD acquires PDD to support the development of major weapon system programs (e g , C-17, B1-B, ATF, B-2) ESD is responsible for the acquisition of PDD for major electronic/avionics programs (e.g., Joint-STARS, AWACS). SD is responsible for the acquisition of Space and Space Defense Initiative (SDI) systems

2.3.3.2 System Program Office (SPO)

During the acquisition phase, the SPOs, which reside within the AFSC Product Divisions, are responsible for defining the requirements and levels of PDD for major weapon system programs/equipment During the post-production phase, PDD is used by the ALCs and MAJCOMs to support the weapon system

The SPO receives its primary support from the AFSC Product Division engineering organization in which the EDMOs reside Within the SPO, engineering data management support is received directly from the Manufacturing/Quality Assurance (QA) Manager, the Configuration Management group, and the Deputy Program Manager for Logistics (DPML) Engineering data support is also provided by other organizations outside the SPO such as Aeronautical Systems Division Directorate of Engineering (ASD/EN), which provides flight systems, avionics, and systems engineering support

The SPOs also have a major responsibility during the design reviews/audits (e g , System Design Review [SDR] Preliminary Design Review [PDR], Critical Design Review [CDR],

TABLE 2-2. ALC USERS/PDD DATA USAGE AND DATA REQUIREMENTS

APPLICATIONS/ DATA CLASSES / ALC USERS	POST-PRODUCTION APPLICATIONS					PDD DATA CLASSES				
	Modifications	Spares Reprocurement	Repairs	Local Mfg.	Support Activities**	Analysis/ Design Data	Engineering Data	Specifications	Process/ Mfg Data	Test Data
MMS	◐	○	○	○			U	U		
MMA	◐		○	○			U	U		
MME	◐	●	◐	○	◐	C/M/U	C/M/U	C/M/U		C/U
MMI	◐	●	○	○			U	U		
MM_R	●	◐	●		◐	C/M/U	C/M/U	C/M/U	U	U
MM_D		◐					U	U		
MM_P	●		○				U	U	U	U
MAW			●	○			U			
MAQ			●	●			U	U	U	
MAB	○		○			U	U	U		C/U
MA_E	○		○	◐		U	M/U	U	C/M	
MA_P	○		○	●			U	U	U	U
CRE	●	●	◐	○		C/U	C/U	C/U	U	

LEGEND	
Data Usage	Data Requirements
● High	C - Create
◐ Medium	M - Modify
○ Low	U - Use
▢ Primary users	

** Inspection, Reverse Eng., Failure Analysis, Parts Substitution, and Troubleshooting

Physical Configuration Audit [PCA]) to review and validate PDD for technical adequacy, accuracy, and completeness. During design reviews/audits, the SPOs review the following types of PDD, usually in the form of technical reports and specifications: design data, engineering analysis data, specifications, test data, process data, and manufacturing data. Also, the SPO EDMOs are responsible for reviewing the engineering drawings and associated lists at the IPRs.

2.3.4 MAJCOMs

During the post-production phase, the MAJCOMs require PDD in the form of engineering drawings, part lists, and specifications to support base level repairs and local manufacturing. The Using Commands (Military Airlift Command [MAC], Strategic Air Command [SAC], and Tactical Air Command [TAC]) are the major MAJCOM users of engineering drawings in support of base maintenance. Other MAJCOMs which require engineering drawings to support their missions are:

- Pacific Air Forces (PACAF)
- Alaskan Air Command (AAC)
- Electronic Security Command (ESC)
- Air Force Communications Command (AFCC)
- Air Training Command (ATC)
- Space Command (SPACECOM)

2.3.5 Test and Laboratory Organizations

2.3.5.1 Test Centers

During the acquisition and post-production support phases, the test organizations/laboratories are responsible for performing operational flight testing, design/manufacturing, and installation in support of new weapon systems and modification programs. The test organizations (e.g., Air Force Operational Test and Evaluation Center [AFOTEC], Air Force Flight Test Center [AFFTC]) require PDD in the form of engineering drawings/lists, specifications, and test data (specifications and operational) to support operation flight testing and evaluations. The Test Wings require analysis/design data, drawings/lists, specifications, manufacturing data, and test data to support the design, manufacture, and test of Class II (temporary) modifications.

2.3.5.2 Laboratories

Wright Research and Development Center (WRDC) is the primary laboratory that supports the research, development, and testing of propulsion, avionics, and flight dynamics technologies for weapon system programs. WRDC/Material Laboratory (ML) also provides testing and development of state-of-the-art material applications, and performs Research and Development (R&D) of advanced PDD technologies with the AFSC Manufacturing Technology (MANTECH) and AFLC Repair Technology (REPTECH) Programs

2.4 SUMMARY MATRICES

Tables 2-3 through 2-6 are a series of matrices identifying the organizations with primary functional responsibilities, organizations supporting the major PDD data types, and the major interfaces between organizations. Conclusions of this organizational assessment follow the matrices.

- **Organization/Functions** - Table 2-3 presents a summary matrix that maps the major Air Force organizations using PDD against the functions identified in the IDEF$_0$ diagrams (Section 3 and Appendix B). The shaded areas identify ALC/MMS, ALC/MME, and ASD/EN as the primary organizations that acquire, use (i.e , post-production support), and manage PDD.
- **Organizations/Data Types** - Table 2-4 summarizes the organizations that use PDD for selected commodities (i.e., PDD data types) and differentiates organizations with major responsibility from those with support responsibility. Table 2-4 also shows that the structures (mechanical) and avionics commodities are supported by most organizational entities, and illustrates the locations that acquire, store, and disseminate the various types of PDD
- **Organizational Interfaces** - The acquisition, distribution, and dissemination of PDD is accomplished through a network of organizations within each of the Air Force Commands. The organizational interfaces to support the weapon system development are depicted in Table 2-5. The ALC/MM directorate interfaces with several organizations (e g., analyzing Maintenance Deficiency Reports [MDRs] developed by the Using Commands, initiating requests to MA for local manufacturing and to CR for spares reprocurement) The Product Divisions interact with the ALCs, AFALC, MAJCOMs, and Test organizations on a regular basis in the acquisition of PDD

  The interrelations between organizations and the physical transfer of PDD among organizations is shown in Figure 2-1. The Product Divisions are responsible for the acquisition of the weapon system and the associated engineering data. The PMRT and engineering data management and control is transferred from the Product Division SPO to the ALC SPMs Also, the transfer of data (i.e , aperture cards) from the ALCs and Using Commands are depicted in the chart.

2.5 CONCLUSIONS

A summary of the organizations and the use of/requirements for PDD over the weapon system life cycle, as well as the different classes of PDD *Created*, *Used*, and *Modified* in

TABLE 2-3. PDD ORGANIZATIONS/FUNCTIONS MATRIX

MAJCOM	ORGANIZATIONS	IDEF FUNCTIONS	ACQUIRE ENG DATA			PROVIDE POST-PROD SUPPORT					MANAGE ENG. DATA		
						USE							
			PLAN	DEVEL.	REVIEW	Mods	Spares Repro-curement	Local Mfg	Repairs	REVISE	CONTROL	DISTRIB.	RETIRE
AFLC	ALC/MMS	System Program Mgt (SPM) Division	●		●	●	○	○	○	○	○		
	ALC/MME	Engineering Division	○	○	●	○	●	○	○	●	●	●	
	ALC/MAN	Industrial Products Division						●	○				
	ALC/CRE	Engineering Data Management Div	●	○	●	○	●	○		○			
	AMARC	Aerospace Maint & Regen Center				○			○				●
* MAJOR USING CMDS	MA	Directorate Of Maintenance	○					○	●		○	○	
AFSC	ASD/EN	Directorate Of Engineering	○	○	●	●	○	○	○				
	WRDC	Wright Research & Devel Center		○									
	TEST WING	4950/3246TH Test Wings				●			○	○			

LEGEND

● Primary Responsibility for Function ○ Supports Function

* Includes MAC, SAC, TAC, PACAF, and AAC

TABLE 2-4. ORGANIZATIONS/PDD DATA TYPES MATRIX

AIR FORCE ORGANIZATIONS \ COMMODITIES			Structures (Mechanical)	Electronics	Avionics	Power Plant	Missiles	Armament	Electrical	Landing Gear	Space Systems
AFLC	OO-ALC	Ogden Air Logistics Center	○				●	●		●	
AFLC	OC-ALC	Oklahoma City Air Logistics Center	○			●	○				
AFLC	SM-ALC	Sacramento Air Logistics Center	○	●					●		●
AFLC	SA-ALC	San Antonio Air Logistics Center	○			●					
AFLC	WR-ALC	Warner Robbins Air Logistics Center	○	●	●		○				
AFLC	AGMC	Aero Guidance & Meteorology Center					○				○
AFLC	AMARC	Aero Maintenance & Regenration Center		○							
OTHER MAJCOMS	SPACECOM	Space Command		○							●
OTHER MAJCOMS	ESC	Electronic Security Command		●							
OTHER MAJCOMS	AFCC	AF Communications Command		○							○
AFSC	ASD	Aeronautical Systems Division	●	●	●	●			○		
AFSC	ESD	Electronics Systems Division		●	○						
AFSC	BMO	Ballistic Missile Office	○	○		○	●				
AFSC	AD	Armament Division	●				○	●			
AFSC	SD	Space Division									●
AFSC	AFFTC	AF Flight Test Center	○		○	○					
AFSC	TEST WINGS	4950th 3246th	●	●	○			●			
AFSC	WRDC	Aero Propulsion Laboratory				●					
AFSC	WRDC	Avionics Laboratory		○	●						
AFSC	WRDC	Flight Dynamics Laboratory	●								
AFSC	WRDC	Materials Laboratory	●	○							
SOA	AFOTEC	AF Operational Test & Evaluation Center	●			○					

LEGEND
● Primary Responsibility for Commodity
○ Supports Commodity
☐ Commodities supported by most organiztional entities

TABLE 2-5. ORGANIZATIONAL INTERFACES

	ORGANIZATIONS	AFLC				AFSC	MAJCOM		TEST/LABS	
		MM	MA	CR	AFALC	Product Division	Major Using Commands	Other MAJCOMs	Test Orgs	Labs
AFLC	MM	◑	◑	◑	◑	●	◑	◑	◑	○
	MA	◑	◑	○			●	○	○	○
	CR	◑	○	○	◑	◑				
	AFALC	◑		◑	○	○				
AFSC	Product Division	●		◑	◑	○	◑	○	●	◑
MAJCOMs	Major Using Commands	◑	●			○	○			
	Other MAJCOMs	◑	○			○	○	○		
TEST/LABS	Test Orgs	○	◑			●	○	○	○	
	Labs	○	◑			◑	○	○	◑	○

LEGEND

- ● Primary
- ◑ Major
- ○ Limited
- ▭ Organizations which engage in the most interfacing

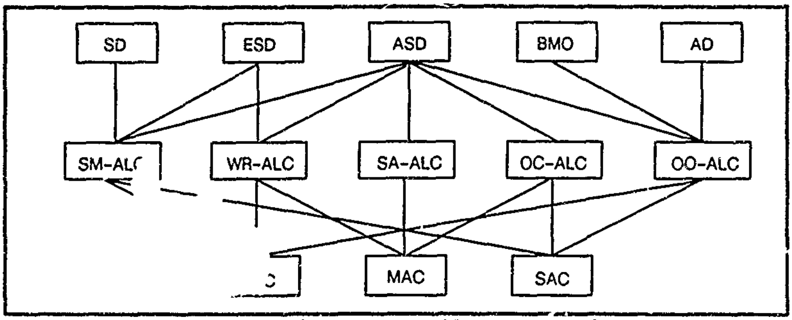


FIGURE 2-1. ORGANIZATIONAL INTERFACES

2.5 CONCLUSIONS

A summary of the organizations and the use of/requirements for PDD over the weapon system life cycle, as well as the different classes of PDD *Created*, *Used*, and *Modified* in support of the Post-Production phase, is shown in Table 2-6. The following conclusions are derived from this matrix:

- The ALC MM, MA, and CR directorates are the major Air Force users of PDD in support of weapon system modifications, spares reprocurement, repairs, and local manufacturing.
- During the Acquisition Phases, the SPOs/Product Divisions are responsible for PDD requirements definition and acquisition. They also ensure the technical accuracy of PDD at the IPRs, design reviews, and audits.
- Weapon system modification is the PDD application which requires the most coordination and interface among all the Air Force organizations
- The PDD data classes created, modified, and used by most Air Force organizations are engineering drawings/lists and specifications
- Using Commands require drawings, specifications, and manufacturing data to support base repairs and local manufacture.
- ALC/MM, Using Commands, and Test Wings create, modify and use the largest subset of PDD.

Finally, a chart depicting a hierarchical and organizational breakdown of all the Air Force PDD "players" is depicted in Figure 2-2 The shaded areas denote the primary and major PDD users within the Air Force environment.

TABLE 2-6. ORGANIZATIONS/PDD USAGE AND DATA REQUIREMENTS

AF Organizations		Acquisition Phases: Concept Exploration	Acquisition Phases: Demo/ Validation	Acquisition Phases: FSD	Acquisition Phases: Production	Post-Production Applications: Modifications	Post-Production Applications: Spares Reprocurement	Post-Production Applications: Repairs	Post-Production Applications: Local Mfg	Post-Production Applications: Support Activities**	PDD Data Classes: Analysis/ Design Data	PDD Data Classes: Engineering Data	PDD Data Classes: Specifications	PDD Data Classes: Process/Mfg Data	PDD Data Classes: Test Data
ALCs	MM	○	○	○	○	●	●	●	○	◐	C/M/U	C/M/U	C/M/U	U	U
	MA					◐	○	●	●	○		C/M/U	U	C/M/U	C/U
	CR		○	○	○	◐	◐		○	○	C/U	C/U	U	U	U
Product Divisions	ASD/ESD/SD	◐	●	●	◐	◐	◐	○	○		U	U	M/U	U	U
	Other Prod Divs	◐	◐	◐	◐	○	○	○	○		U	U	M/U	U	U
MAJCOMs	Major Using Cmds *	○			○	○		●	◐	○		C/U	U	C/U	
	Other MAJCOMs	○				○		◐	○			U	U	C/U	
Test Centers	Test Wings			○	◐	●				○	C/M/U	C/M/U	M/U	C/M/U	C/M/U
	Operational Test Centers		◐	◐	●	◐						U	U		C/M/U
Labs	WRDC		○	◐	◐	○					C/M/U	U	U		C/M/U
	Other Labs		○	○	○	○					C/M/U	U	U		

LEGEND

Data Usage	Data Requirements
● High	C - Create
◐ Medium	M - Modify
○ Low	U - Use

☐ Denotes organizations most involved in C/M/U of PDD, major applications and primary data classes

* Includes MAC SAC, TAC, AAC, and PACAF

** Inspection, Reverse Eng., Failure Analysis, Parts Substitution, and Troubleshooting

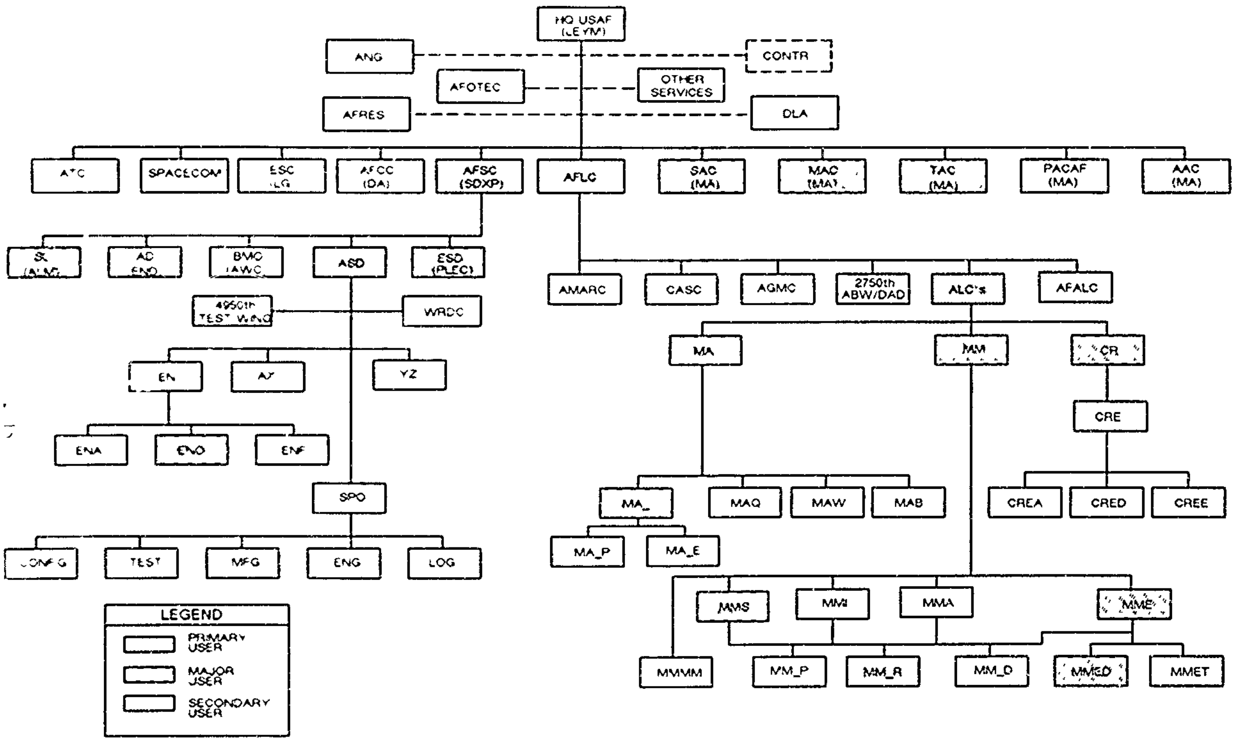


FIGURE 2-2. MAJOR USAF PDD "PLAYERS"

SECTION 3: IDEF$_0$ DIAGRAMS

3.1 INTRODUCTION

This section provides a high level overview of the acquisition, use, and management of Engineering Data using the IDEF$_0$ methodology IDEF$_0$ is a modeling technique developed during the Air Force Integrated Computer Aided Manufacturing (ICAM) project in the mid-1970s. Known as the ICAM Definition or IDEF$_0$ model, this activity model consists of a node tree diagram, functional diagrams, and narrative descriptions (See Appendix B for the narrative description of the IDEF$_0$ processes.) The model focuses on functions and depicts the specific steps and operations needed to perform an activity. It does not represent time flow, specific sequencing of activities, or data sources and destinations

The main focus of the IDEF$_0$ model is a functional description of the Air Force's acquisition and management of engineering data from a business perspective (The data flow diagrams [DFDs], as described in Section 3 and Appendix C, detail the contractor's engineering/design and manufacturing processes in the development of PDD and the Air Force's use of the data during post-production support)

The IDEF$_0$ model is decomposed into three major subfunctions Acquire Engineering Data, Use Engineering Data, and Manage Engineering Data The Air Force Systems Command (AFSC) is responsible for acquiring and managing engineering data for major acquisitions until Program Management Responsibility Transfer (PMRT). At that time, the Prime ALC assumes management control and uses the data to support post-production activities In this context, engineering data includes engineering drawings, associated lists, and other related documentation.

3.2 IDEF$_0$ RULES

Activities in an IDEF$_0$ model correspond to elements in the node tree diagram. The IDEF$_0$ model expands the information provided in the node tree by identifying Inputs, Controls, Outputs, Mechanisms (ICOMs), and the interrelationships between the activities

- **Inputs** - Data required to perform an activity
- **Outputs** - Products of an activity
- **Controls** - Conditions or circumstances that govern the mechanics of the activity
- **Mechanisms** - The organizations and/or the devices that perform or carry out the activity

$IDEF_0$ models use rectangular boxes to represent activities and arrows to represent the ICOMs as shown in Figure 3-1. The process name appears in each box and begins with an active verb. Each process is assigned an identification number, located in the lower right of the activity box, for control and reference purposes. Flow of information among activities is represented by arrows that interconnect the activity boxes. The ICOMs indicate the constraints on an activity and the information and materials that are used or produced by the activity.

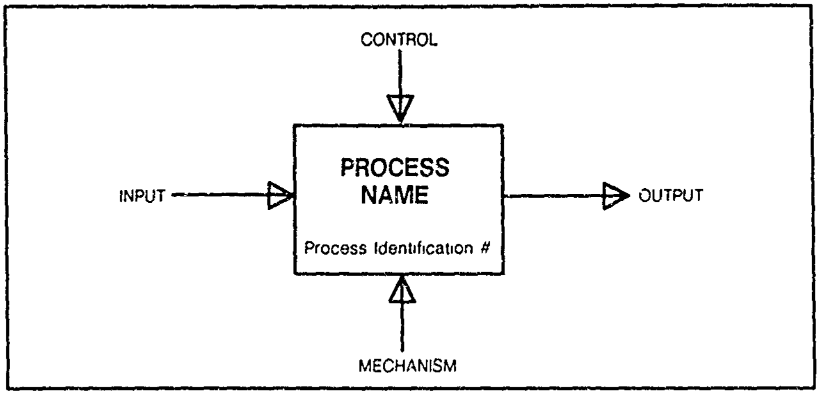


FIGURE 3-1. $IDEF_0$ DESCRIPTION

3.3 ENGINEERING DATA PROCESS - NODE A0

The node tree (See Figure 3-2) provides a high level overview of the entire Engineering Data process The context diagram A0 (See Figure 3-3) decomposes the Engineering Data process into the following major sub-functions Acquire Engineering Data, Use Engineering Data and Manage Engineering Data. In general, this node depicts several activities It shows the engineering data acquisition activities performed by AFSC with support from the ALCs (Node A1). It details receipt of the data by the ALCs in the form of aperture cards to support post-production activities, i.e , spares reprocurement, local manufacturing, repairs, and modifications (Node A2). Finally, it depicts the management, control, and distribution of the engineering data by the ALCs and MAJCOMs (Node A3)

3.4 ACQUIRE ENGINEERING DATA - BOX A1

Upon approval of the Statement of Operational Need (SON) by HQ USAF, the acquisition of engineering data is planned in support of the weapon system through the development of the Engineering Data Management Plan (EDMP) A data call is initiated by the System

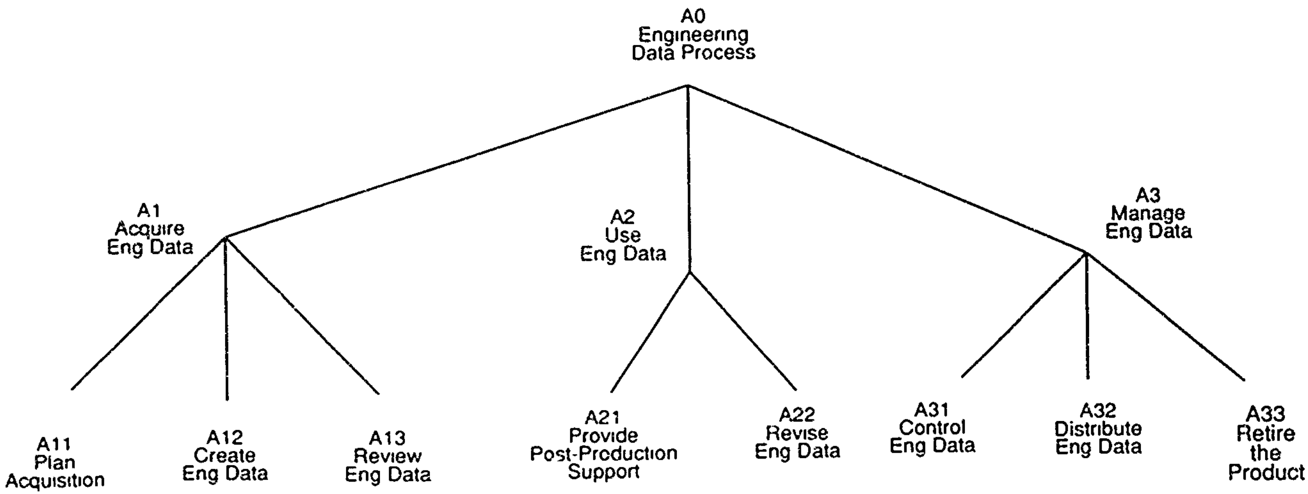


FIGURE 3-2. IDEF$_0$ NODE TREE

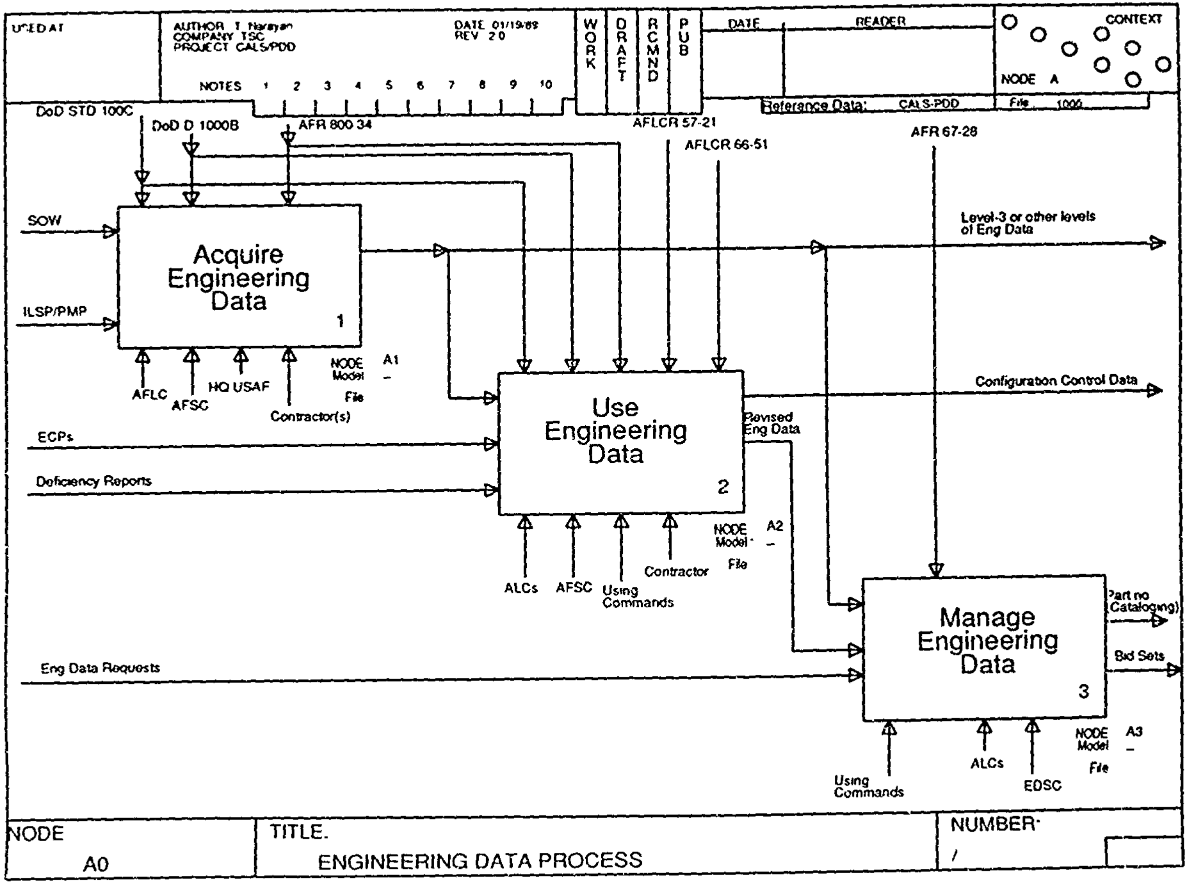


FIGURE 3-3. ENGINEERING DATA PROCESS IDEF$_0$ MODEL

Program Office (SPO) allowing the ALCs to define the engineering data requirements. Then, a contract is awarded and the engineering data is developed by contractors. The SPO conducts several reviews and audits throughout the acquisition life cycle. Finally, the engineering data is inspected/accepted by the ALCs. (See Figure 3-4)

Inputs:	Statement of Work (SOW), Integrated Logistics Support Plan (ILSP/ Program Management Plan (PMP)
Controls:	AFR 800-34, DoD-D-1000B, DoD-STD-1001
Outputs:	Level 3 or other levels of Engineering Data
Mechanisms:	HQ USAF, Contractor(s), AFSC, Air Force Logistics Command (AFLC)

3.5 USE ENGINEERING DATA - BOX A2

This function describes the activities that are performed during the Post-Production phase. The major post-production activities occurring at the ALCs are spares reprocurement, local manufacturing, repair, and modifications. In addition, some minor repair/local manufacturing are performed at the MAJCOMs. The contractors and the ALCs revise the engineering data to maintain the configuration of the weapon system throughout the weapon system lifecycle. (See Figure 3-5)

Inputs.	Level 3 or other levels of Engineering Data, Deficiency Reports, Engineering Change Proposals (ECPs).
Controls·	AFLCR 57-21, AFLCR 66-51, AFR 800-34, DoD-STD-100C, DoD-D-1000B
Outputs:	Revised Engineering Data, Configuration Control Data
Mechanisms.	AFLC, AFSC, Contractor, Using Commands

3.6 MANAGE ENGINEERING DATA - BOX A3

The ALCs manage engineering data to maintain and control the current configuration of the system. The engineering data is distributed by the ALC Engineering Data Service Centers (EDSCs) to support the spares reprocurement and sustain engineering activities Finally, the Aerospace Maintenance and Regeneration Center (AMARC) uses engineering data to support the reclamation of parts and product retirement, or sells the weapon system to foreign military organizations through the Foreign Military Sales (FMS) Program (See Figure 3-6)

Inputs.	Engineering Data Requests, Revised Engineering Data, Level 3 or other levels of Engineering Data

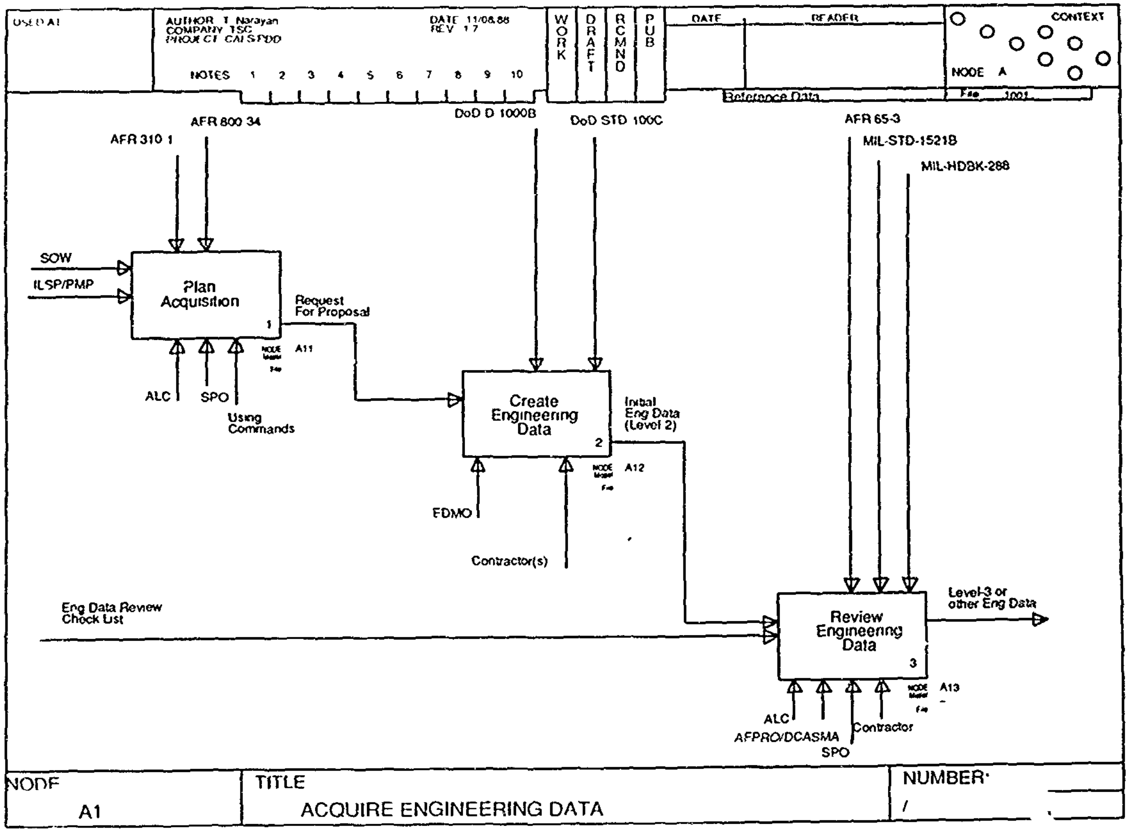


FIGURE 3-4. ACQUIRE ENGINEERING DATA IDEF$_0$ MODEL

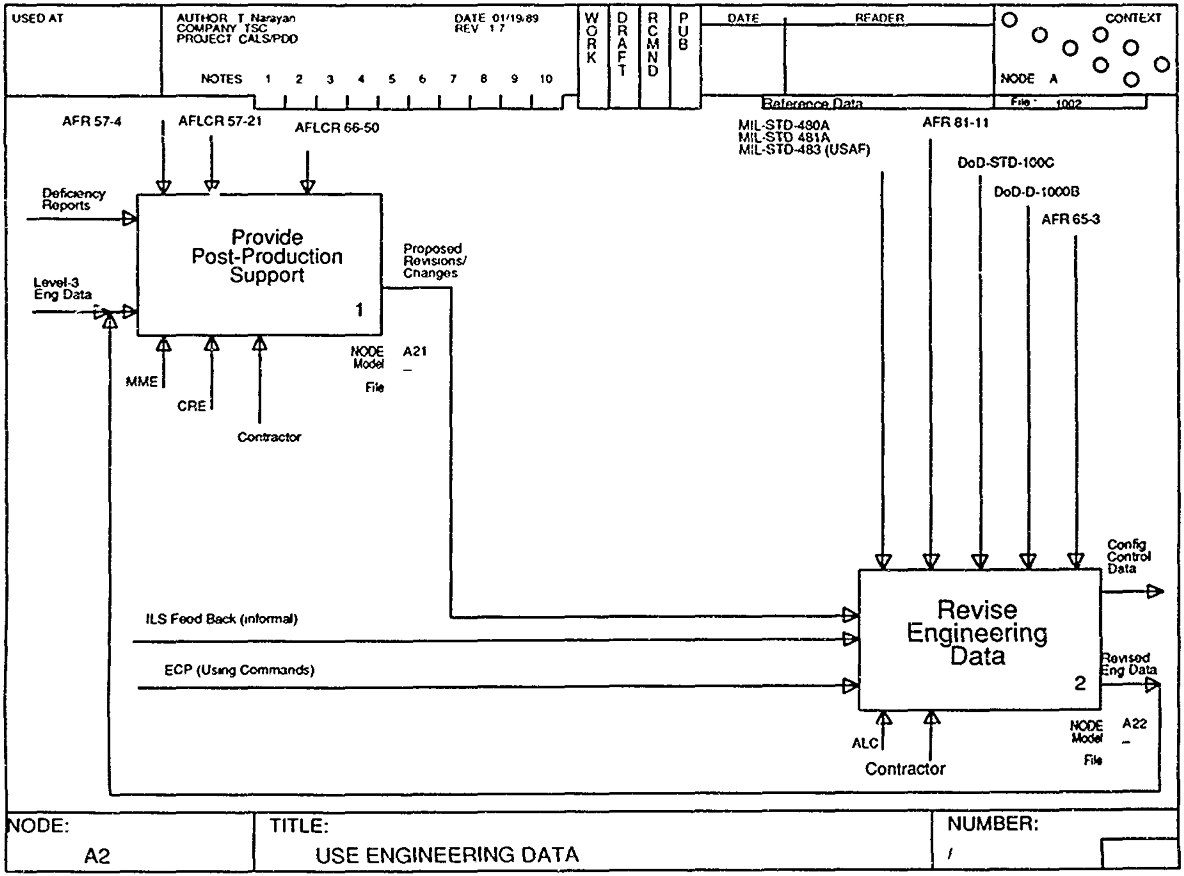


FIGURE 3-5. USE ENGINEERING DATA $IDEF_0$ MODEL

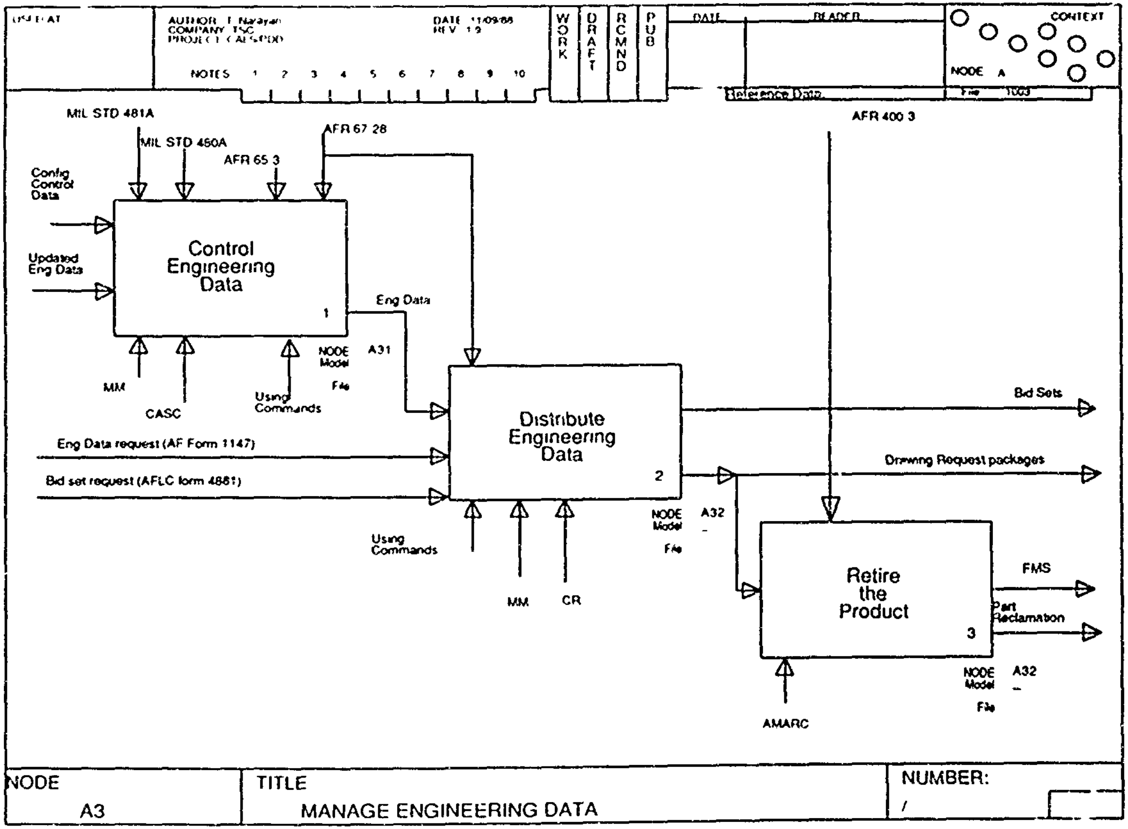


FIGURE 3-6 MANAGE ENGINEERING DATA IDEF$_0$ MODEL

Controls: AFR 67-28
Outputs: Part number (Cataloging), Bid Sets
Mechanisms: AFLC, Using Commands, EDSC.

3.7 CONCLUSIONS

Through the course of identifying the activities which acquire, use, and manage engineering data, a number of conclusions and "lessons learned" were developed. This section identifies and presents a discussion of these major underlying conclusions.

3.7.1 Use

In developing the Use Engineering Data process (Node A21), engineering data was identified in four distinct activities: reprocurement of spares, local manufacturing, repairs, and modifications. The relationship of each activity to engineering data is described below:

- **Spares Reprocurement** - Requires Level 3 drawings, lists, and specifications to develop bid sets for competitive reprocurement.
- **Modifications** - Require the use of engineering data when major revisions are made to accommodate changes in the mission requirements well after the production phase.
- **Local Manufacturing** - Requires engineering data for any organic manufacturing effort by the ALC and Using Commands to support weapon systems in "urgency of need" situations, or when parts cannot be reprocured.
- **Repair** - Requires engineering data to supplement Technical Orders (TOs) at the ALCs and MAJCOMs.

3.7.2 Policy and Planning Issues

- **Engineering Data Management Plan (EDMP)** - In developing the "Plan Engineering Data" process (Node A11), it became evident that the EDMP is a major document supporting the acquisition of engineering data by the SPOs and ALCs. The EDMP, which is a section of the PMP, defines the engineering data requirements in terms of the type of data and strategy used to acquire the data. It cites elements of acquisition strategy, operational requirements, maintenance concepts, and production contract requirements. The EDMP also identifies relevant instructions on In-Process Reviews (IPRs) and engineering data acceptance procedures, as well as describing how engineering data is acquired concurrently with other major program elements
- **Data Calls Generate Engineering Data Requirements** - The Data Call initiated by the SPO via AFLC Form 365 is the major vehicle used by the SPO and ALC to define and tailor engineering data requirements.

- **Key Regulations** – The major regulation for establishing policy and defining responsibility for the acquisition of engineering data is AFR 800-34. DoD-D-100C and DoD-D-1000B define the drawing practices and drawing requirements. AFSCP/AFLCP 800-34, 800-18 and 800-16 are Joint Command and DoD pamphlets which specifically focus on the acquisition, management, and identification of engineering data from requirements definition through delivery and acceptance by the Air Force.

3.7.3 Management and Review Issues

- **Configuration Management (CM)** – Configuration management is critical for weapon system maintenance as shown in the Control Engineering Data process (Node A31). CM is the process managing and controlling changes over the lifecycle of a weapon system As requirements change in the mission of the weapon system, CM manages the process of tracking and effecting changes, not only to the weapon system, but to the engineering data as well. A major problem faced by the Air Force is the management of the changes in a distributed environment among the ALCs, MAJCOMs, and Contractors. Consequently, CM is a major requirement for weapon system support by the ALC and MAJCOMs.

- **In-Process Reviews (IPRs) and Design Reviews** – The IPR allows the Air Force an opportunity to review "engineering drawings" prior to delivery by the Contractor. The IPR remains an effective check on the quality and content of engineering drawings. In contrast, the design reviews/audits (i.e , Preliminary Design Review, Critical Design Review, Functional Configuration Audit, etc.) focus on reviewing the larger scope of data to ensure the technical adequacy of PDD (design and manufacturing data)

3.7.4 Different Scope Between Engineering Data and PDD

- After preliminary analysis of both engineering and business functions (i.e., acquisition and program management), it was determined that a re-examination of the methodologies was required in order to perform the current environment analysis. The $IDEF_0$ methodology presents an excellent technique to depict the interrelationships among business activities, but is not sufficient to define the flow of data between the contractors and the Air Force Also, the source/destinations of the data or media used by the contractor and the Air Force to store the data can not be defined with $IDEF_0$. Thus, an additional modeling methodology was selected, the Gane and Sarson Data Flow Diagrams, which allows a more detailed examination of the Contractor and Air Force activities.

- Another lesson learned from this analysis is that the source of information (Contractor creation of PDD) and Air Force uses of that information (engineering data) have major differences in scope and breadth:

- **Contractor** - Creates PDD, including various models, analysis data, design data, material characteristics, geometry, manufacturing data, test data, processes, etc., to perform design, manufacturing, and test of weapon system development.

- **Air Force** - Receives and uses engineering data, such as engineering drawing, associated lists, specifications, and other related information.

SECTION 4: DATA FLOW DIAGRAMS (DFDs)

4.1 INTRODUCTION

This section presents a description of the high level activities and a data flow representation of the Design/Engineering, Manufacturing, and Post-Production Support phases of a weapon system's life cycle (See Figures 4-1 and 4-2), using the Gane and Sarson method of data flow diagramming. The major DFD objectives are. 1) to describe the flow of data between contractor and Air Force organizations and functions, 2) to provide data source and destination identification for each functional area, and 3) to allow the Air Force to identify PDD that can be accessed and used. The activities themselves have been identified in two ways. First, at a gross level, major activities are shown by using a node tree. Second, each activity is broken down into a series of processes needed to accomplish that activity. The DFDs present an additional level of detail not found in the $IDEF_0$ models by representing the contractor's creation and the Air Force's use of PDD during the Post-Production phase.

Because of the importance of the flow of PDD to support the spares reprocurement and sustaining engineering applications, the Post-Production Support activities (Section 4.4) are described in detail. It should also be noted that there is a direct relationship between the design/engineering and manufacturing DFD processes and the weapon system acquisition and life cycle phases as shown in Table 4-1. A detailed description of the remaining DFDs for the design/engineering and manufacturing processes can be found in Appendix C.

In certain instances the Gane and Sarson rules and procedures have been altered to allow for clearer presentation of additional information. Whereas the Gane and Sarson methodology does not consider automation status, data format/physical storage types, and data conditions, the DFDs have been tailored to depict the creation, storage, format, and level of PDD automation (See Table 4-2 for a complete breakdown of the data store codes used for all DFDs Also, refer to Appendix C, Section C.2, for a description of the Gane and Sarson DFD methodology.)

4.2 DESIGN/ENGINEERING DFDs

The data flow diagrams in this section provide a general overview of the processes, data stores, and data flows for the design and engineering of a weapon system These diagrams are not intended to define a specific contractor or acquisition program, but provide a generic description of the design/engineering process and data used by both Air Force

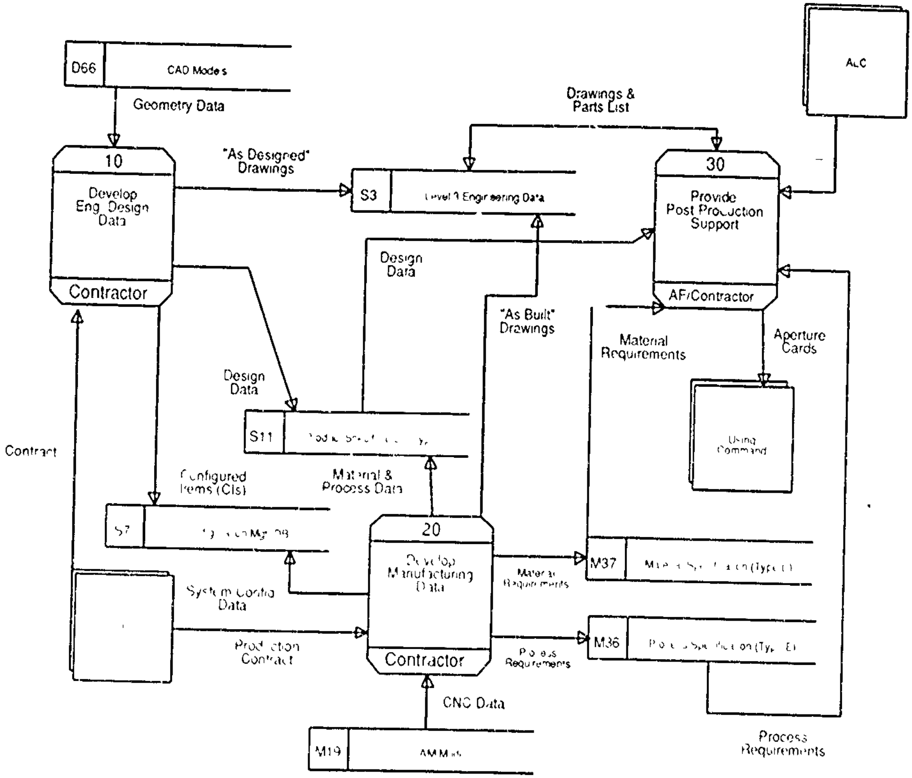


FIGURE 4-1. PDD DATA FLOW OVERVIEW

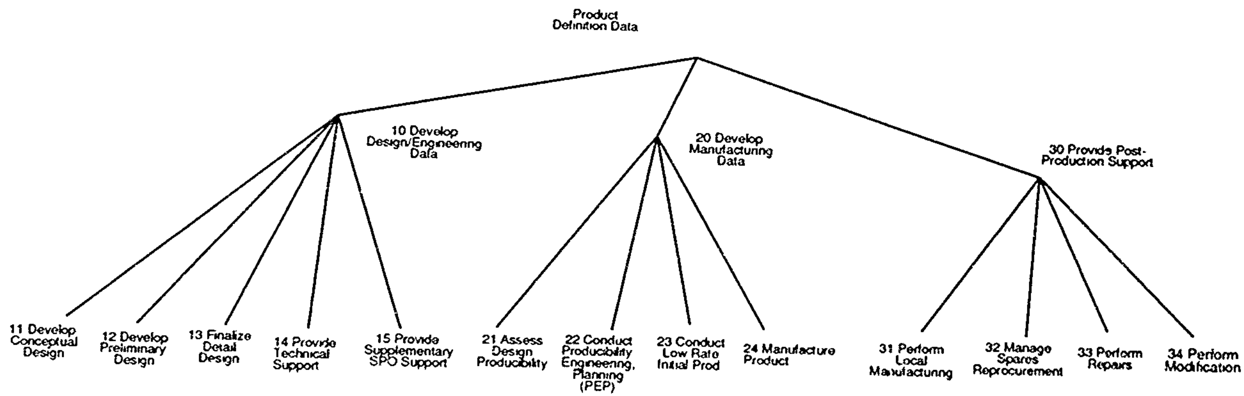


FIGURE 4-2. PRODUCT DEFINITION DATA NODE TREE

TABLE 4-1. ACQUISITION PHASES/DFD PROCESSES MATRIX

	Acquisition Life Cycle Phases / DFD Processes	Concept Explora-Tion	Demonstration Validation	Full Scale Development	Production	Operation and Support
10 DEVELOP ENG' DESIGN DATA	11 Develop Conceptual Design	✓				
	12 Develop Preliminary Design		✓			
	13 Finalize Detailed Design			✓		
	14 Provide Technical Support	✓	✓	✓	✓	
	15 Provide Supplementary SPO Support				✓	
20 DEVELOP MFG DATA	21 Assess Design Producibility	✓				
	22 Conduct Producibility Engineering (PEP)		✓			
	23 Conduct Low Rate Initial Production (LRIP)			✓		
	24 Produce Product				✓	
30 PROVIDE POST PRODUCTION SUPPORT	31 Perform Local Mfg					✓
	32 Reprocure Spares					✓
	33 Perform Repairs					✓
	34 Perform Modifications					✓

TABLE 4-2. DATA STORE LEGEND

CODE	DEFINITION	CATEGORY
A M E B	Automated Manual Either Manual or Automated Both Manual and Automated	Automation Status
1 2 3 4 5 6 7 8 9	Aperture Cards Drawings Hard Copy Reports 2D Vector Image 3D Vector Image Database Analytical Models (e g , FEM, Simulation) Air Force Form Raster Image	Data Formats
10 11 12 13	Microfiche Magnetic Media N/C Tape Optical Disc	Physical Storage Types
D M P S	Design/Engineering Data Manufacturing Data Post-Production Support Data Shared Data	Data Stores

and contractor. (Appendix C contains a detailed description of the design/engineering DFDs)

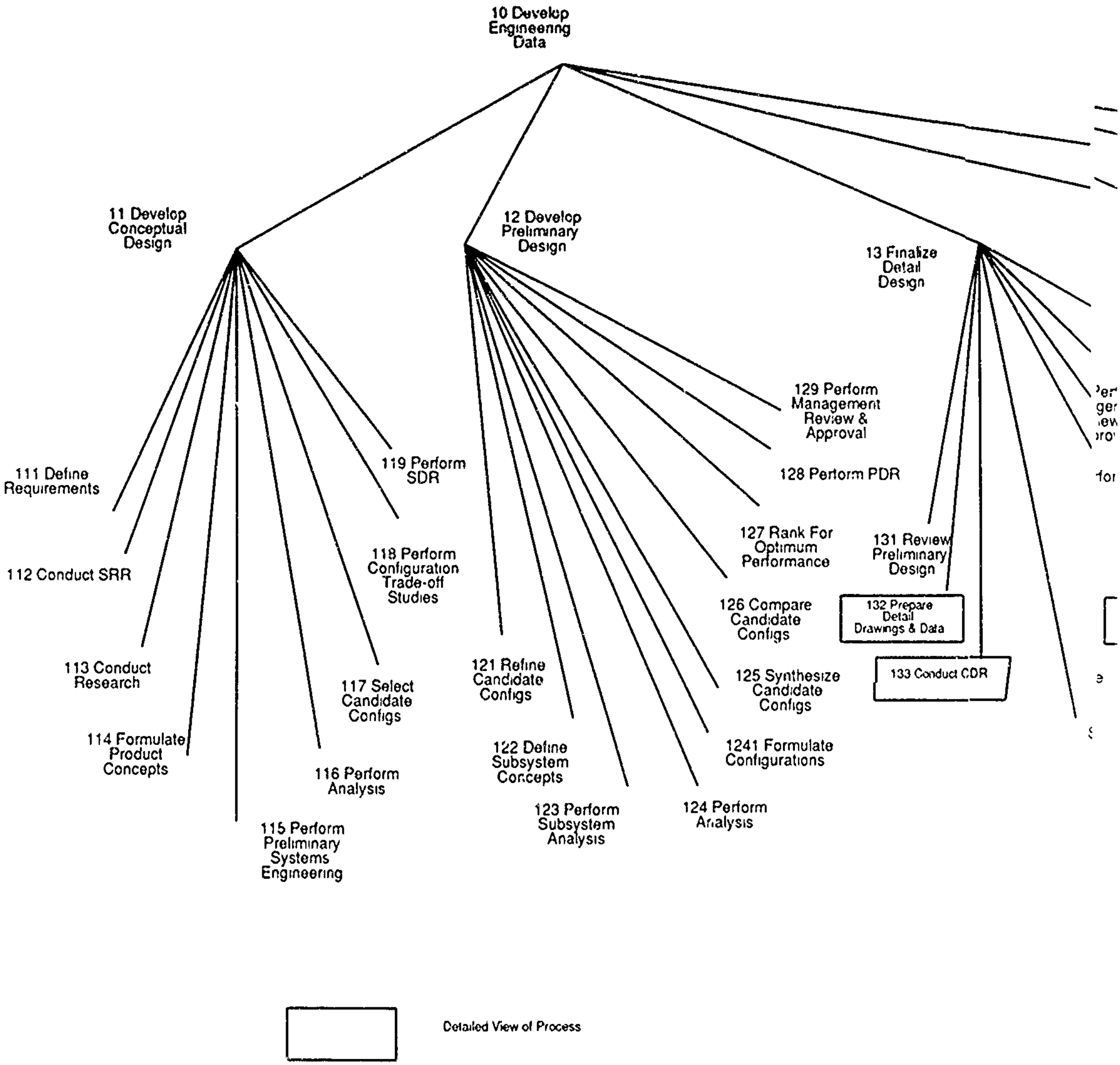
The following are summary descriptions of the high level processes depicted in the node tree diagram

LEVEL 10 - Develop Design/Engineering Data

In the Air Force acquisition process each phase is separated by a major schedule milestone As each phase is completed, a more refined system is formulated At the end of the third phase, Full Scale Development, a configuration is approved and cited in a production contract

Figures 4-3 and 4-4 are high level descriptions of the acquisition process up to the production contract, and show how PDD is created and used during the design/engineering process. The subsequent node (20 Develop Manufacturing Data) covers the production contract itself and is described in Section 4 3. Additionally, some activities are phase-independent and have been broken out separately (See Node 14 in Figure 4-3)

- **Process 11 - Develop Conceptual Design -** In order to establish a particular direction within the weapon system development cycle, a number of planning documents are developed, e g , Program Management Directive (PMD) These documents identify



10 Develop Engineering Data
11 Develop Conceptual Design
12 Develop Preliminary Design
13 Finalize Detail Design
111 Define Requirements
112 Conduct SRR
113 Conduct Research
114 Formulate Product Concepts
115 Perform Preliminary Systems Engineering
116 Perform Analysis
117 Select Candidate Configs
118 Perform Configuration Trade-off Studies
119 Perform SDR
121 Refine Candidate Configs
122 Define Subsystem Concepts
123 Perform Subsystem Analysis
124 Perform Analysis
1241 Formulate Configurations
125 Synthesize Candidate Configs
126 Compare Candidate Configs
127 Rank For Optimum Performance
128 Perform PDR
129 Perform Management Review & Approval
131 Review Preliminary Design
132 Prepare Detail Drawings & Data
133 Conduct CDR
Detailed View of Process

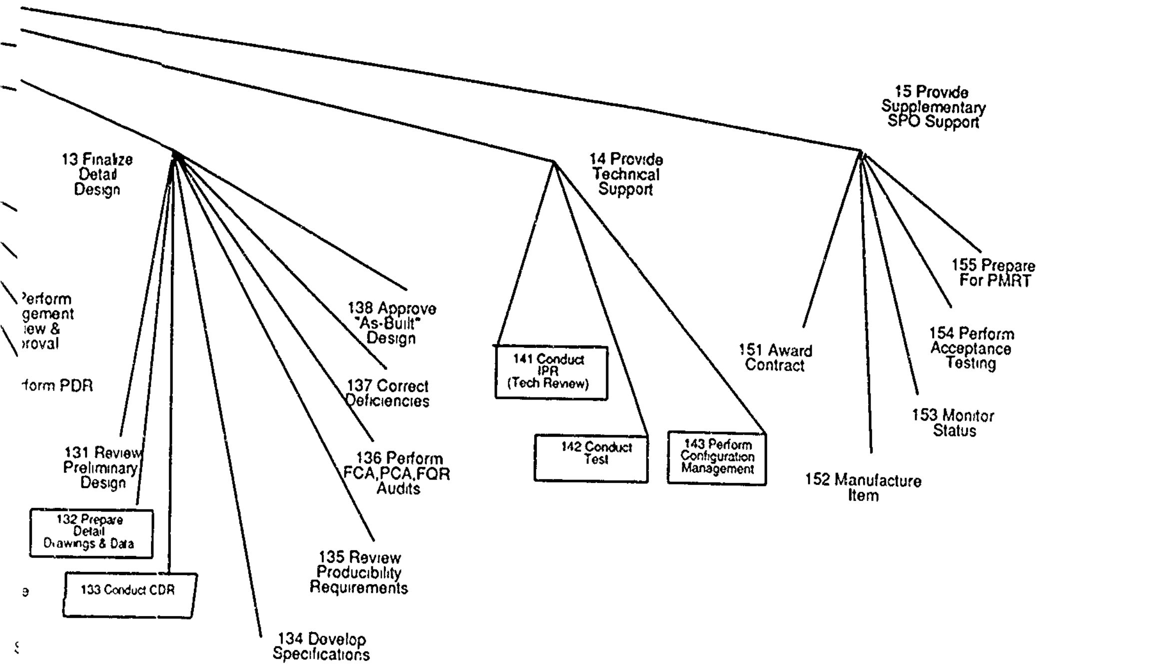


FIGURE 4-3.

DESIGN/ENGINEERING DATA NODE TREE

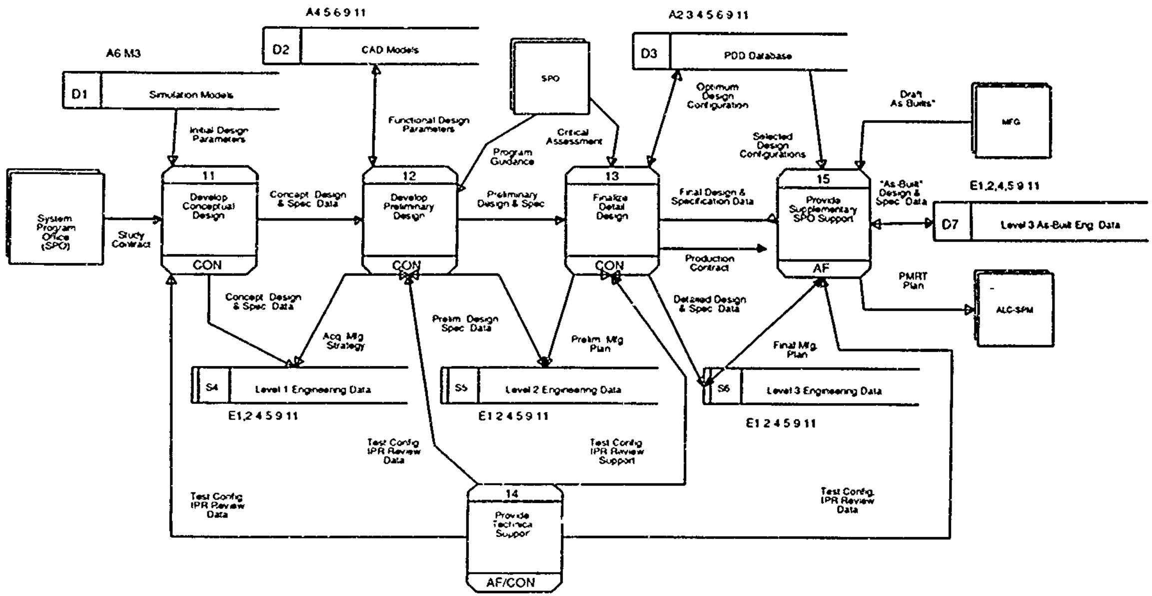


FIGURE 4-4. DEVELOP DESIGN/ENGINEERING DATA DFD

requirements, scope, and direction, and assist in the establishment of the initial elements of the System Program Office (SPO). These initial study contracts provide some of the first technical sources of engineering data, as well as more clearly define the possibilities which exist to meet the initial requirements document. At this time other efforts include the initial systems engineering which produces the Preliminary Operational Concept, Initial Functional Analysis, Mission and Requirements Analysis, and System Specification (Type A). These documents are used as a basis for some initial analysis (geometrical models, analytical models, etc.)

The resulting "Candidate Configurations" and any supplementary analyses are then reviewed by the SPO at the System Design Review (SDR). After this first major design review, the SDR-approved configurations are then used to formulate the demonstration/validation contract. This contract is used to demonstrate and/or validate these initial configurations.

- Process 12 - Develop Preliminary Design - Using the System Specification (Type A) developed during the Conceptual Design process and the preliminary engineering data, each configuration item (CI) is reviewed, refined, and broken down into subsystem components. Once identified, engineering and analysis data are generated for each subsystem component. This provides a more detailed basis for the Preliminary Design Review (PDR). Supplementing each detailed configuration is a synthesis of the design, as well as comparisons and a ranking of the overall performance/operational characteristics.

  The PDR allows the SPO to perform a formal technical review of enhanced designs developed during the Develop Conceptual Design process. Its purpose is to select the configuration which provides the best overall use of technology and resources for meeting system requirements Later design changes are based on PDR review comments Once authenticated, this design constitutes the core of the Development Specification (Type B) and Level 2 Engineering Data.

- Process 13 - Finalize Detail Design - The Development Specification (Type B) and Level 2 Engineering Data are used as input for the Finalize Detail Design process. At this point, a particular configuration has been selected, and engineering data is expanded to the point where production issues can be identified and resolved.

  Once the engineering reviews and analyses have been completed, detailed drawings are generated. These drawings, and a complete engineering package, are the source data for conducting the Critical Design Review (CDR). A specific CI, along with actual design criteria, is reviewed by the SPO at the CDR. Once this design is authenticated, a Product Specification (Type C) is generated to be used by the Contractor to perform production.

One of the last steps in determining the feasibility of the design is to perform audits. The three separate types of acceptance measures are the Functional Configuration Audit (FCA), the Physical Configuration Audit (PCA), and the Formal Qualification Review (FQR).

- **Process 14 - Provide Technical Support** - Several events occur throughout the technical progression of the systems engineering and design process such as Configuration Management, Test Support, and In-Process Reviews.

  Configuration management is performed by the SPO during the acquisition phase and by the ALC/SPM throughout the life cycle of the weapon system. It identifies and controls system elements (i.e., CIs), and allows for points of control, review, and distribution for changes to the system. The tracking function provides for Configuration Status Accounting (CSA). Configuration control is established via a governing body called the Configuration Control Board (CCB) whose role is to review, then approve or reject, incoming Engineering Change Proposals (ECPs).

  Test Support, usually identified early in the acquisition process in the Test and Evaluation Master Plan (TEMP), provides data in such areas as fatigue, fracture, and component failure to determine the active life cycle of components In addition, this data is required for determining spares provisioning. Depending on system requirements, testing can be carried out by the contractor, or by testing agencies within the Air Force. These include the Test Wings, Air Force Operational Test and Evaluation Center (AFOTEC), Air Force Flight Test Center (AFFTC), and other organizations.

  The In-Process Review (IPR) is a contract requirement in which the Air Force periodically reviews the formats of the engineering drawings. The IPR identifies to the contractor any problems and deficiencies in generating the drawings.

- **Process 15 - Provide Supplementary SPO Support** - During production, Program Management Responsibility Transfer (PMRT) planning takes place. Until PMRT takes place, the SPO maintains close coordination with the production contractor, and prepares the ALC/SPM for delivery of engineering data and receipt of the system The SPO also conducts program reviews and acceptance testing reviews, and performs other business functions such as accepting deliverables, financial tracking, and schedule tracking.

4.3 MANUFACTURING DFDs

The Manufacturing Data Flow Diagrams provide a general overview of the processes, data stores, and data flows for the manufacture of a weapon system. These diagrams are not intended to define a specific contractor or acquisition program, but provide a generic view of the manufacturing process and data used by both Air Force and Contractor A detailed description of the Manufacturing DFDs can be found in Appendix C

The following are summary descriptions of the high level processes shown in the node tree diagram.

LEVEL 20 - Develop Manufacturing Data

The node tree (See Figure 4-5) decomposes manufacturing into four major subprocesses. Assess Design Producibility, Conduct Producibility and Engineering Planning (PEP), Conduct Low Rate Initial Production (LRIP), and Manufacture Product.

Figure 4-6 provides an overview of the manufacturing process and the flow of engineering data During the manufacturing process, Air Force Systems Command (AFSC) is responsible for acquiring and managing manufacturing data, such as tooling, process, and material, for system acquisitions until PMRT, at which time the prime ALC assumes control of the manufacturing data.

- **Process 21 - Assess Design Producibility** - During the Concept Exploration Phase, it is necessary to assess the ability of a design to be manufactured. This requires evaluation of existing manufacturing technologies and their application to design production, product quality, production rate, and cost requirements. Production risks and alternatives are identified as well as the new technologies and materials required to produce a design. A new manufacturing strategy to produce the item is developed and preplanned improvements are incorporated into the system

- **Process 22 - Conduct Producibility and Engineering Planning (PEP)** - During the Demonstration and Validation phase of system acquisition, manufacturing and production criteria are established. The contractor develops producibility criteria to guide the design effort These criteria reflect a mixture of general and specific requirements applicable to the system being developed. The contractor conducts demonstrations of new technologies necessary for system production, assesses the production feasibility of the design, and creates an initial manufacturing plan. The contractor also creates a quality assurance plan that determines the initial requirements and specifications the product must meet during production. Finally, the contractor develops a plan that combines the producibility and engineering data on the product This plan contains the measures used to develop the engineering data, designs, special purpose manufacturing equipment, tooling, and computer models used to assess the producibility of the design.

- **Process 23 - Conduct Low Rate Initial Production (LRIP)** - The LRIP process initiates the production of an item During this acquisition phase, many methods applying to full-scale production are developed and used in the creation of a limited number of items Computer Aided Manufacturing (CAM) data is generated from Computer Aided Design (CAD) information provided by the system designers CAM data is used to model production, facility planning, and the development of Computer Numerical Control (CNC) production data In addition tooling, proc-

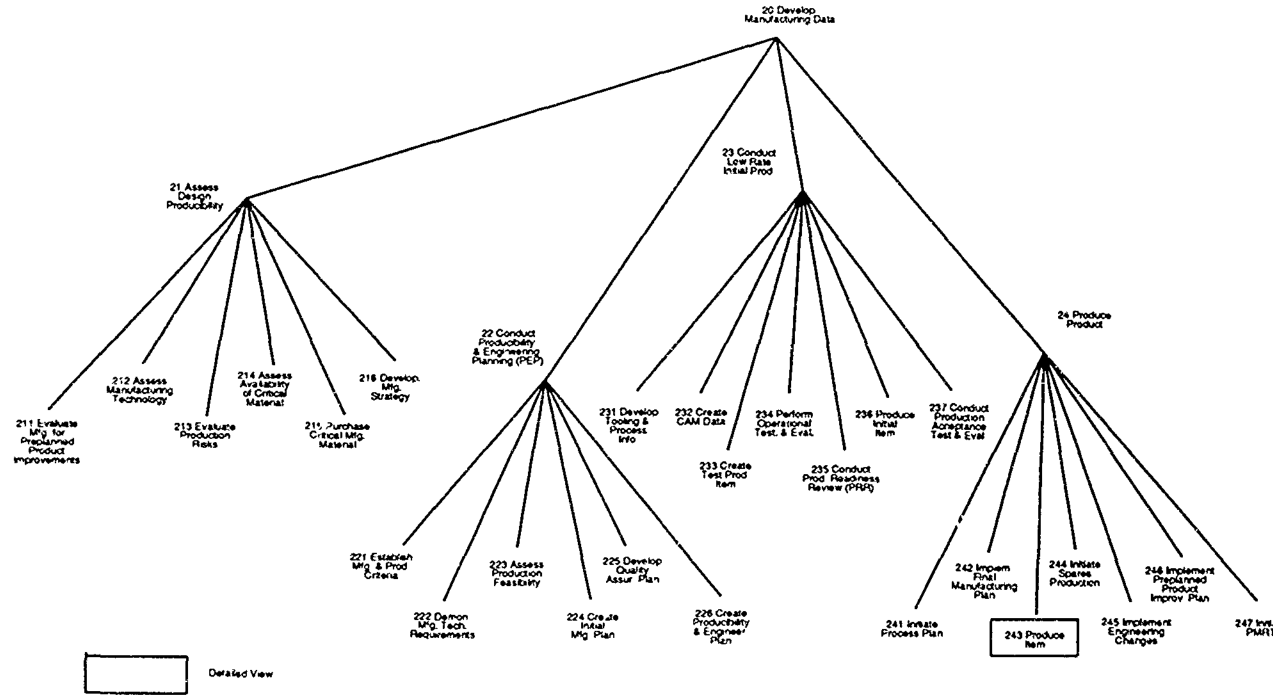


FIGURE 4-5. MANUFACTURE DATA NODE TREE

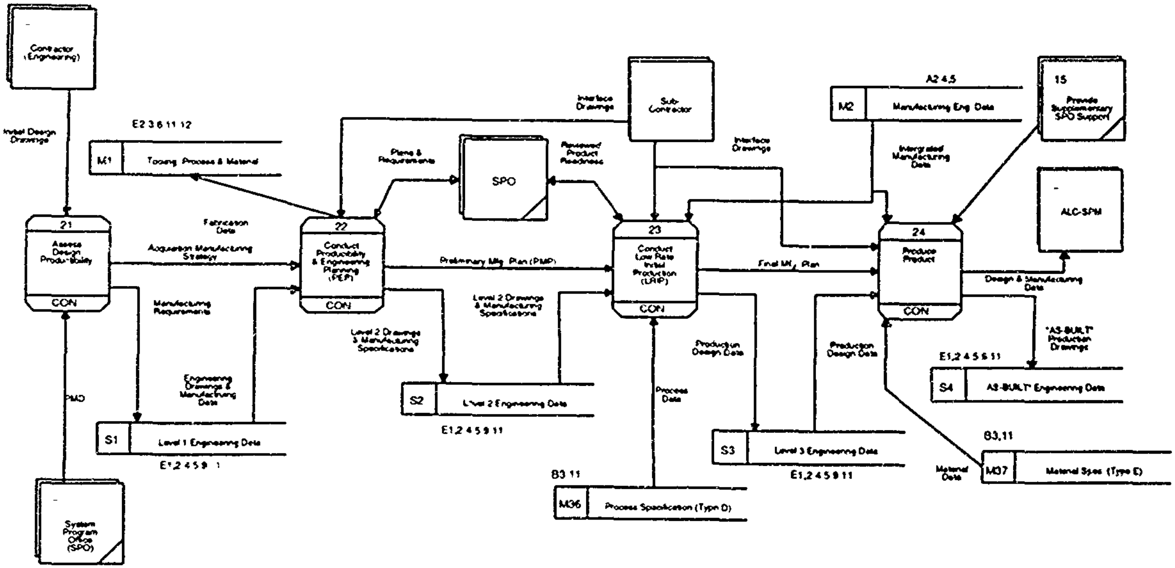


FIGURE 4-6. DEVELOP MANUFACTURING DATA DFD

ess, and material and inspection requirements are created and tested. A First Article or test item is created and is used for operational testing and evaluation. As a result, system effectiveness information is returned to both the design and manufacturing engineers.

The level of production readiness is also assessed and the capability of the manufacturer to produce the product is determined. A period of initial production can occur, during which the capabilities of full scale production are developed and assessed. This manufacturing effort creates prototype products that are tested to meet Development Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E) requirements.

- **Process 24 – Manufacture Product** – The actual manufacture of a product is the final phase in the acquisition cycle. Manufacturing facilities, processes, tooling, and test equipment are finalized, and the manufacturing plan is implemented. Components and raw material are acquired from vendors and sub-contractors, then assembled into the product Changes resulting from continued testing and evaluation can alter the design and manufacturing processes used. These changes are implemented to ensure a quality product that meets the desired requirements and specifications

  During manufacturing, the implementation of preplanned product improvements allows for phased growth in system capabilities, utility, and operational readiness. As production and delivery of a product declines, the contractor packages and delivers the engineering data for the product defined in the production contract. This engineering data is delivered to the prime ALC for support of the system (post-PMRT).

4.4 POST-PRODUCTION SUPPORT DFDs

The Post-Production Support DFDs provide a general overview of the processes, data stores, and data flows of local manufacturing, spares reprocurement, repair, and modifications These diagrams are not intended to depict any specific acquisition program, but provide a generic view of the ALC and MAJCOMs' post-production support activities

The node tree (Figure 4-7) provides an overview of the post-production process and the use of PDD The node decomposes post-production into four major sub-processes: Perform Local Manufacturing, Manage Spares Reprocurement, Perform Repair, and Perform Modifications.

LEVEL 30 – Provide Post-Production Support

Figure 4-8 presents an overview of the post-production support processes that are performed by the ALCs and MAJCOMs in support of weapon system depot and base-level

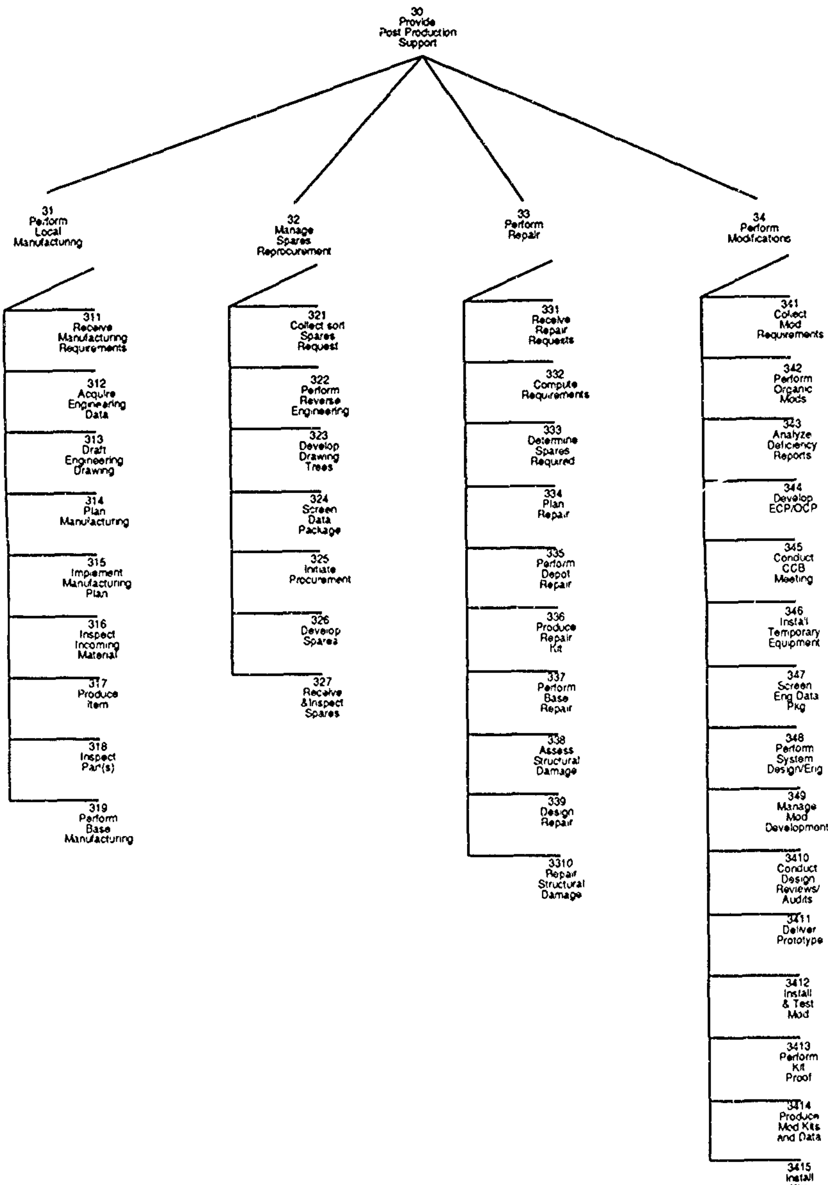


FIGURE 4-7. POST-PRODUCTION SUPPORT NODE TREE

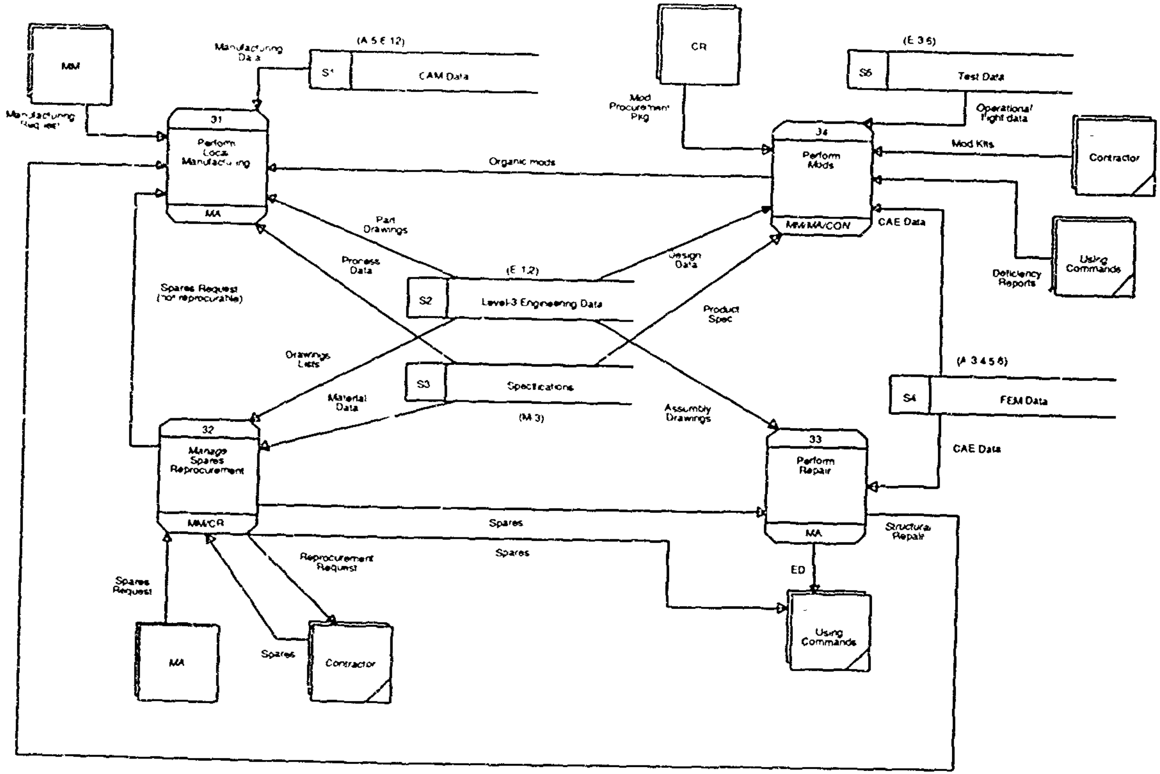


FIGURE 4-8. POST-PRODUCTION SUPPORT DFD

activities This diagram depicts the flow of engineering data and the relationships among the subprocesses· Perform Local Manufacturing, Reprocure Spares, Perform Repair, and Perform Modification.

Process 31 – Perform Local Manufacturing

The ALCs and Using Commands manufacture parts locally (using CAD/CAM and CNC) to support depot and base-level maintenance· 1) to meet an urgency of need maintenance requirement; or 2) when it is more economical to manufacture parts locally than to procure parts from a contractor, or 3) when the original contractor has gone out of business The Using Commands are responsible for the local manufacture of parts for items authorized as "base-manufacture" and in situations when the ALCs cannot meet the Using Commands' needs due to maintenance schedules and cost constraints

Local manufacturing requests are initiated by the ALC Depots and Using Commands by a Temporary Work Request The ALC Directorate of Maintenance (MA) requests engineering drawings and associated lists from the Engineering Data Support Center (EDSC) repository MA then develops a manufacturing plan that defines material, machining, schedule, and manpower requirements Tooling, dies, jigs, and fixtures are fabricated and the part is produced according to a manufacturing plan. Finally, the finished parts are inspected and sent to the original requester (ALC Depots or Using Commands) for installation on the aircraft The node tree (Figure 4-9) provides an overview of this subprocess The Data Flow Diagram overview is shown at Figure 4-10

- **Process 311 – Receive Manufacturing Requirements.** The Directorate of Maintenance (MA) receives requests for local manufacturing from the Directorate of Material Management (MM) or from Using Commands Based on the requirements, MA identifies drawings and lists specifications as well as other information required to complete the manufacturing request

- **Process 312 – Acquire Engineering Data.** Once the drawings and lists necessary to manufacture the item have been identified, this information is requested from the EDSC The engineering data is provided to MA in hard copy or aperture card format If drawings or other engineering data are not available for an item, then reverse engineering on the item is performed to generate the information Once the data package for an item has been assembled using AFLC Form 206, it is forwarded to the Engineering/Planning Branch (MA_E) for the development of a manufacturing plan

- **Process 313 – Draft Engineering Drawing.** If specific drawings are not available for an item, the Engineering Division (MME) is responsible for drafting the new drawings according to military standards and specifications Shape, size, allowable loads, and other geometric data is developed using both manual and computer aided drafting methods

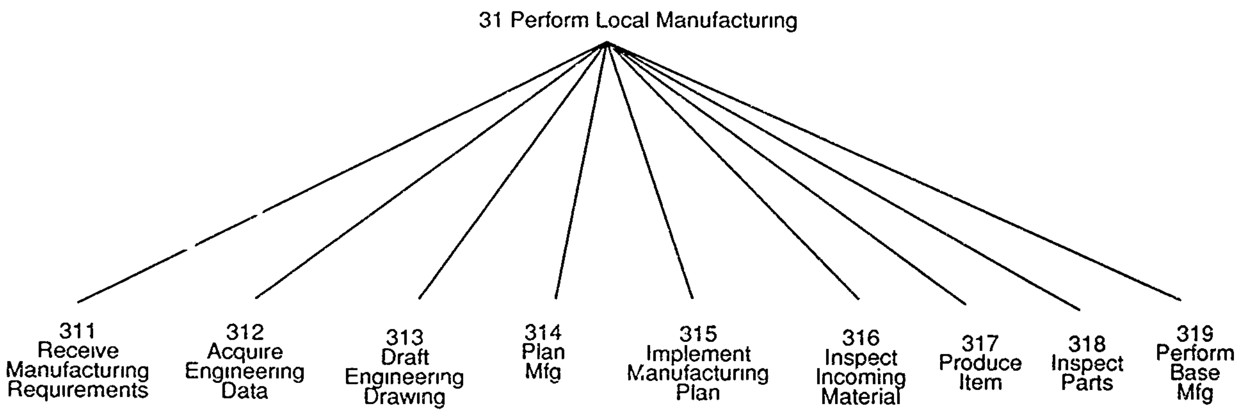
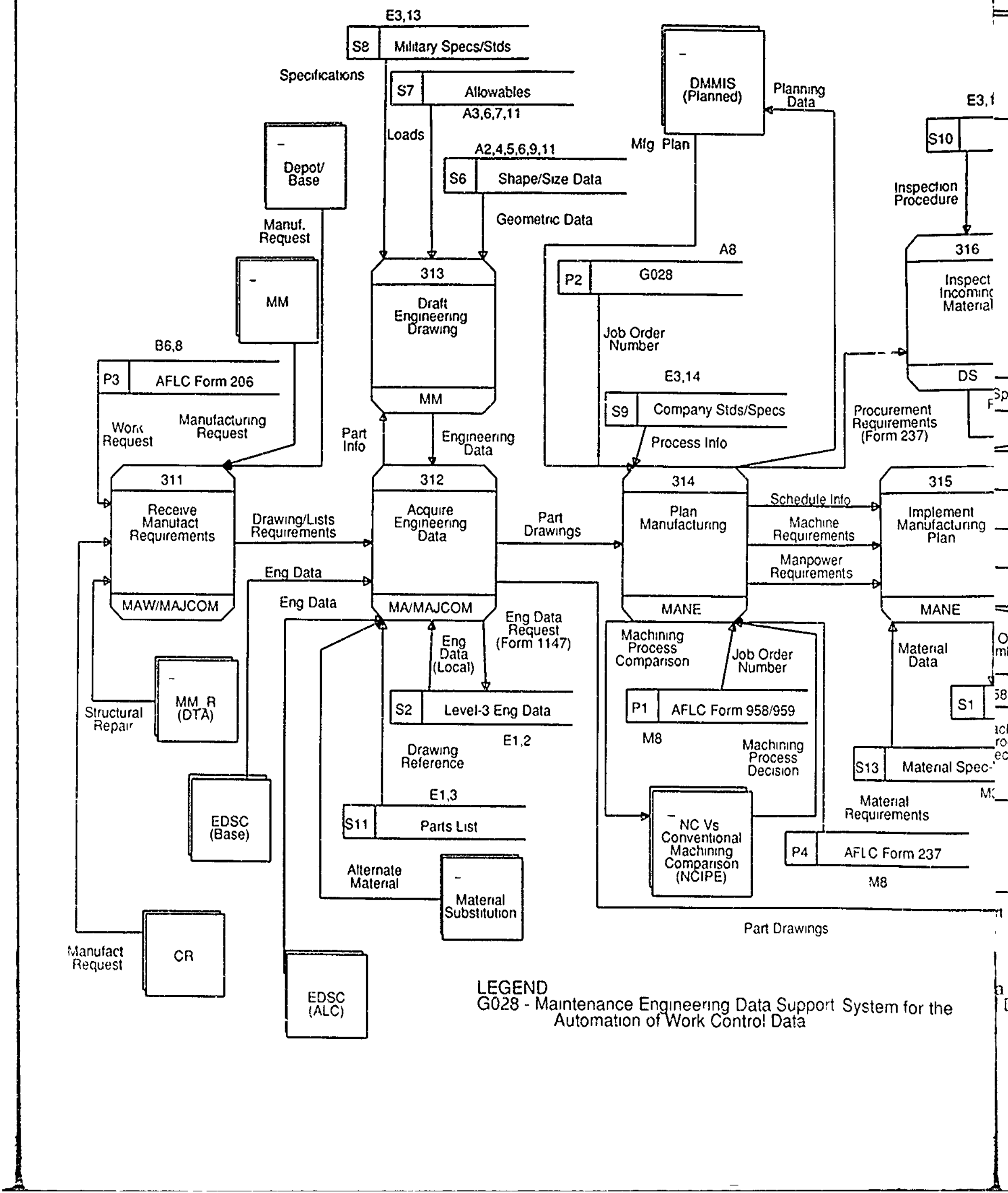


FIGURE 4-9. PERFORM LOCAL MANUFACTURING NODE TREE


E3,13
S8 Military Specs/Stds
Specifications
S7 Allowables
A3,6,7,11
Loads
DMMIS (Planned)
Planning Data
Mfg Plan
A2,4,5,6,9,11
S6 Shape/Size Data
Geometric Data
Depot/ Base
Manuf. Request
MM
313 Draft Engineering Drawing MM
A8
P2 G028
Job Order Number
E3,14
S9 Company Stds/Specs
Process Info
S10
Inspection Procedure
316 Inspect Incoming Material DS
Procurement Requirements (Form 237)
B6,8
P3 AFLC Form 206
Work Request
Manufacturing Request
Part Info
Engineering Data
311 Receive Manufact Requirements MAW/MAJCOM
Drawing/Lists Requirements
312 Acquire Engineering Data MA/MAJCOM
Part Drawings
314 Plan Manufacturing MANE
Schedule Info
Machine Requirements
Manpower Requirements
315 Implement Manufacturing Plan MANE
Eng Data
Eng Data
Eng Data (Local)
Eng Data Request (Form 1147)
Machining Process Comparison
Job Order Number
Material Data
S2 Level-3 Eng Data
E1,2
P1 AFLC Form 958/959
M8
S1
Structural Repair
MM_R (DTA)
Drawing Reference
Machining Process Decision
S13 Material Spec
EDSC (Base)
E1,3
S11 Parts List
NC Vs Conventional Machining Comparison (NCIPE)
Material Requirements
P4 AFLC Form 237
M8
Alternate Material
Material Substitution
Part Drawings
Manufact Request
CR
EDSC (ALC)
LEGEND
G028 - Maintenance Engineering Data Support System for the Automation of Work Control Data

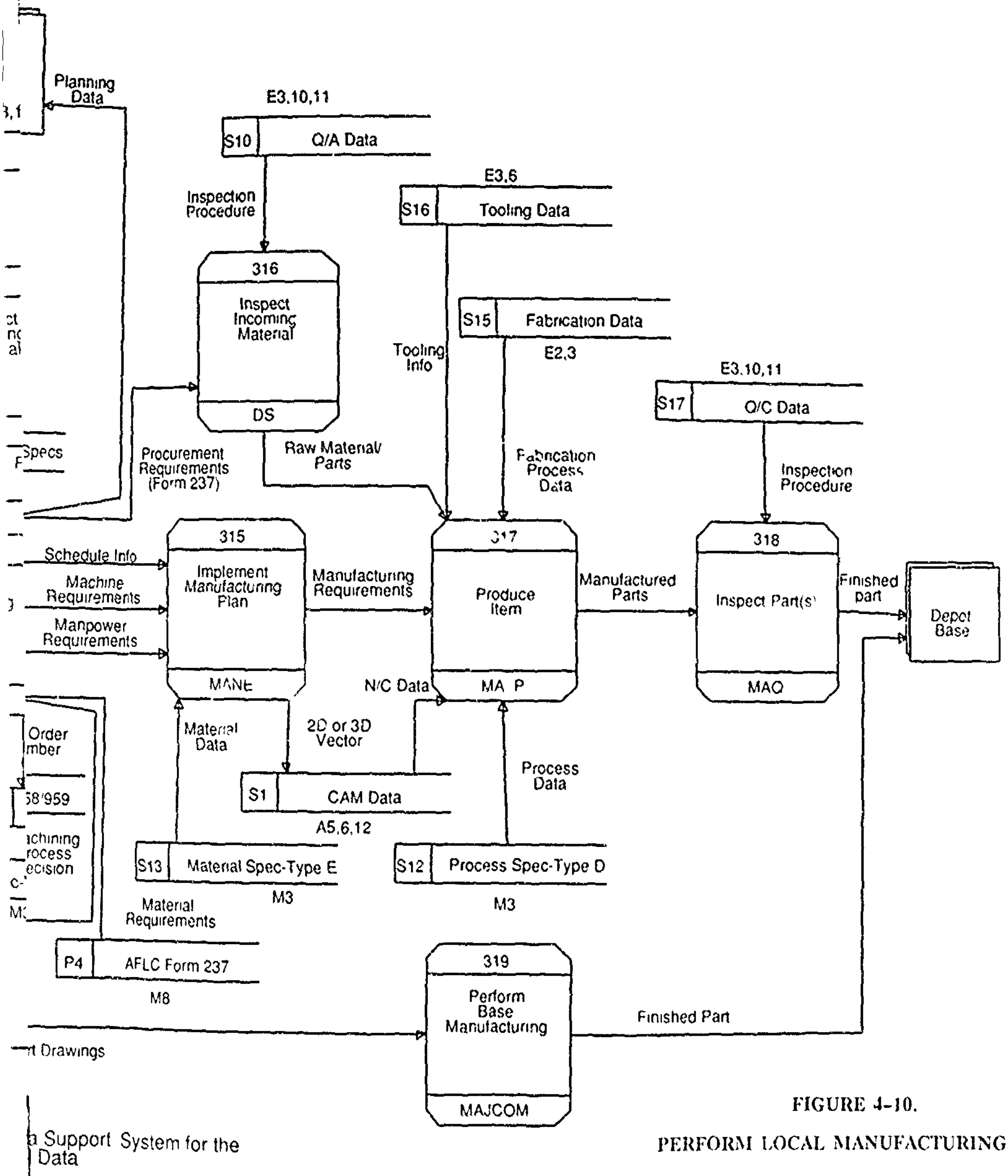


FIGURE 4-10.

PERFORM LOCAL MANUFACTURING DFD

- **Process 314 - Plan Manufacturing.** Raw materials, machine requirements, scheduling, and manpower requirements are identified. Material or parts not available to MA are requested on AFLC Form 958/959 (Work Control Document Package) through the Directorate of Distribution (DS), which then acquires the appropriate parts or raw material to support local manufacturing efforts. From the requirements compiled for the item a manufacturing plan is developed which considers part routing, operation descriptions, quality assurance, work verification, and item testing.

- **Process 315 - Implement Manufacturing Plan.** The manufacturing plan is implemented by the consolidation and creation of appropriate jigs, fixtures, tools, machines and material During the implementation phase of local manufacturing, the Numerical Control data is placed on tape for use by N/C machining equipment Specific equipment and shop facilities are set aside for the manufacture of the part and manpower is allocated to begin the process of manufacturing the item.

- **Process 316 - Inspect Incoming Material.** The Directorate of Distribution (DS) receives all incoming raw material and parts The material and parts are inspected using Quality Assurance (QA) data provided by MA, and are then delivered to MA for use in local manufacturing

- **Process 317 - Produce Item.** The Production Branch (MA_P) manufactures the requested items according to the manufacturing plan developed for the item The Product, Material, and Process specifications along with the engineering drawings, N/C data, and associated lists are used by the manufacturing shop floor to fabricate and test the requested item Once the item has been manufactured it is transferred to the Quality Assurance Division (MAQ) for inspection and testing

- **Process 318 - Inspect Part.** The MAQ division verifies and tests the product to determine whether the item meets all specified standards and requirements The manufactured part can be inspected using destructive and non-destructive inspection tests for strength, geometric accuracy, finish, corrosion protection, production stress defects, etc The tests use the quality control data provided on the item as well as information available within MAQ group After inspection, the part is then sent to the original requester (Using Command or ALC Directorate)

- **Process 319 - Perform Base Manufacturing.** Some items are manufactured at MAJCOM base local manufacturing facilities These parts are usually less complicated to produce than items manufactured at ALC facilities The Field Maintenance Squadrons (FMS) obtain part drawings and engineering data from the base level EDSC, ALC EDSCs, or the original contractor The MAJCOMs manufacture the part to meet intermediate maintenance requirements using material, equipment, and manpower at the base

Process 32 – Manage Spares Reprocurement

The ALC Item Management Division (MMI) is responsible for periodically purchasing Items/Economic Order Quantity (EOQ) and as needed replacement parts from contractors on a competitive basis For first time reprocurements, the Directorate of Competition Advocacy (CR) performs screening analysis to ensure adequate engineering data for competitive reprocurements. Screening analysis includes the development of indentured data lists, engineering drawing "trees", and master bid sets. For subsequent reprocurements, MMI initiates Procurement Requests (PRs) directly with the Directorate of Contracting and Manufacturing (PM). If the original engineering data is lost, damaged, or missing, reverse engineering is performed by the CR, MA, and MM directorates to reconstruct the design from the original end-item. CR also has the capability to create a new engineering data package for less complex items.

The spares reprocurement bid set is sent out to industry for competitive bids and subsequent award. Should a reprocurement effort not receive bids, the manufacture of the item may be done organically, depending upon on the criticality of the part The ALC Directorate of Distribution (DS) then receives and inspects the spares and distributes shop replaceable units (SRUs) to the Depot and line replaceable units (LRUs) to the Using Commands. The node tree (Figure 4-11) provides an overview of this subprocess. The Data Flow Diagram overview is shown at Figure 4-12

- **Process 321 – Collect/Sort Spares Request.** MMI serves as the initiator for three types of spares requests Item Managers in the MM_D organization initiate the first time spares being reprocured If necessary, CR screens the bid set package For as-needed spares, MA initiates a spares request directly to the Item Managers. In addition, requests originate from the Using Commands or through MA on an as-needed basis

- **Process 322 – Perform Reverse Engineering.** For those items with no available engineering data, a reverse engineering process is initiated. Reverse engineering is the process whereby a part or component is disassembled, inspected, and analyzed in order to obtain both quantitative and qualitative data This data then forms the basis of an engineering data package. This activity is initiated by CR and supported by MM and MA

- **Process 323 – Develop Drawing Tree.** Once a set of engineering drawings are completed, a drawing tree (i e , data list) is developed A drawing tree identifies the hierarchical relationship between drawings and configured items (CIs) within the weapon system. The drawing tree information is stored in D049.

- **Process 324 – Screen Data Package.** The Directorate of Competition Advocacy (CR) prepares the Level 3 Engineering Data package and uses the Screening Analysis Work Sheet (AFLC Form 761) to screen and validate it. The Automated

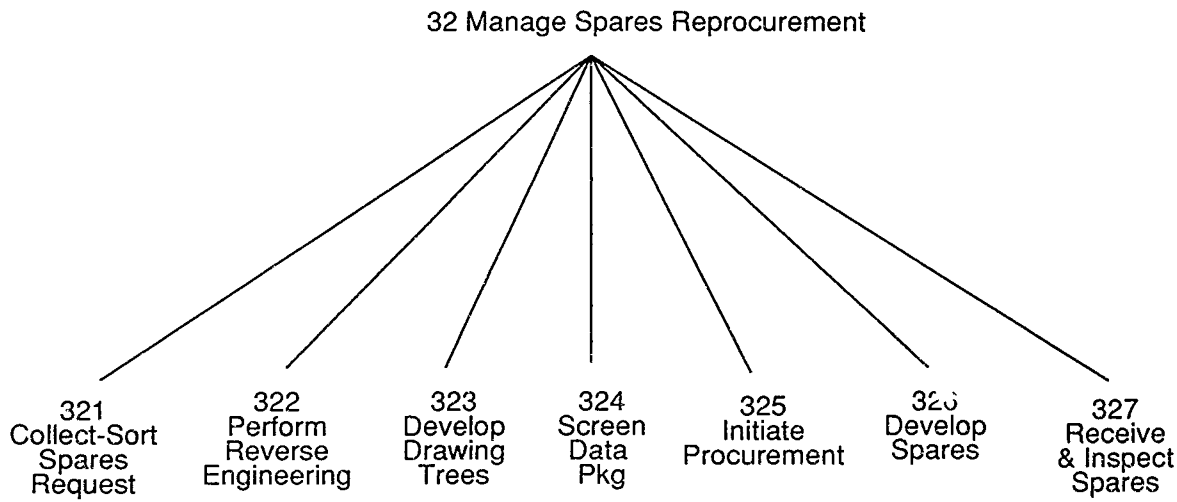
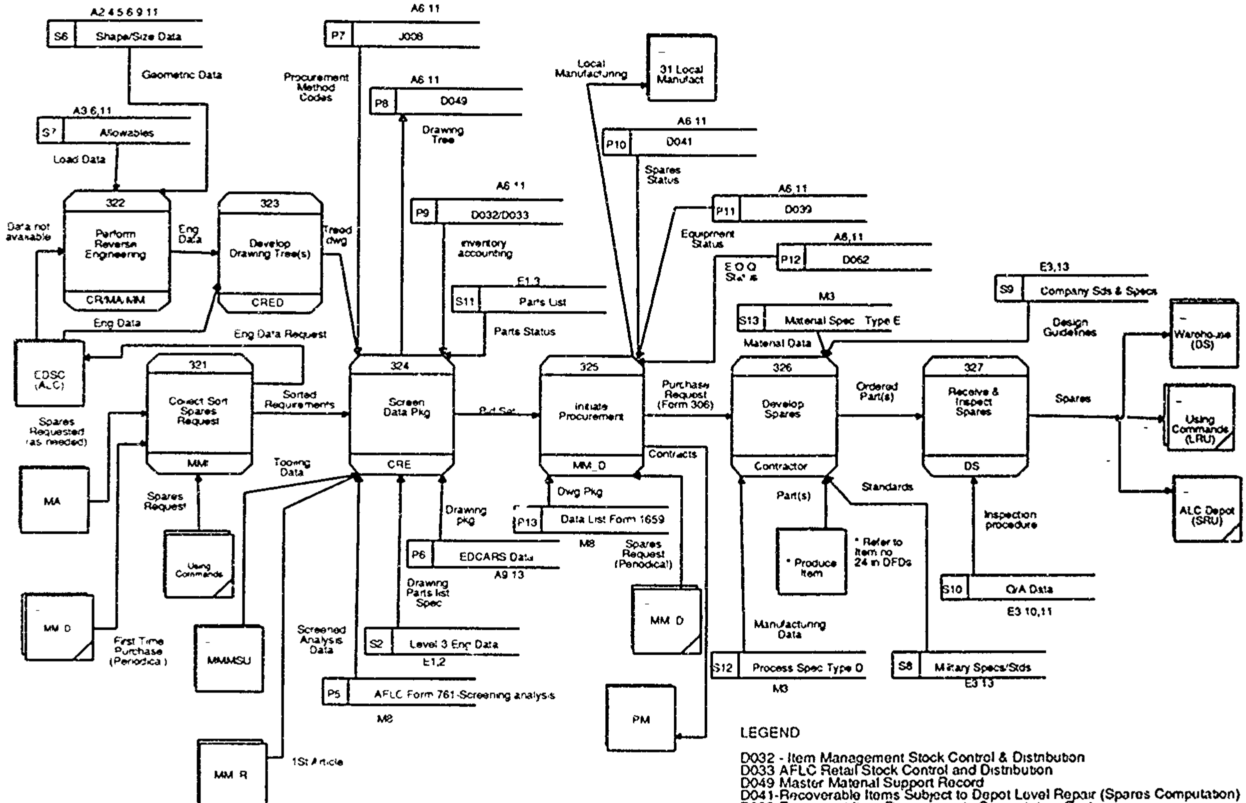


FIGURE 4-11. MANAGE SPARES REPROCUREMENT NODE TREE



LEGEND

D032 - Item Management Stock Control & Distribution
D033 AFLC Retail Stock Control and Distribution
D049 Master Material Support Record
D041-Recoverable Items Subject to Depot Level Repair (Spares Computation)
D039-Equipment Item Requirements Computation System
D062-E O Q Buy/Budget Computation System
J008-Screening Analysis for Procurement Method Code
AFLC Form 761-Screening Analysis Work Sheet
AF Form 1147-Request for Engineering Data

FIGURE 4-12. MANAGE SPARES REPROCUREMENT DFD

Screening Analysis For Procurement Method Code System (J008) is used to identify the G code (competitive) and H code (sole source) information. The D049 system (Master Material Support Record) maintains current identification of parts, material, and engineering drawing tree information, which are part of recoverable items subject to depot level repair. The D033 (AFLC Retail Stock Control and Distribution Central Material Locator Management System) provides inventory accounting for all stock items in support of repair activities and includes the accounting of materials issued to MA. Once screened by these systems, the bid sets are assembled using the engineering drawings and other associated data.

- **Process 325 - Initiate Procurement.** A number of activities are involved in the initiation of procurements In the majority of cases the Item Manager in MM_D will send the PR (AFLC Form 306) for contract award to PM In order to effectively prepare this information, MM_D uses the following systems to formulate coordinated, effective, and economic buys:

  - D041 Recoverable Items Subject for Depot Level Repair (Spares Computation)

  - D039 Equipment Item Requirements Computation System

  - D062 Economic Order Quantity (EOQ) Buy/Budget Computation System

  Local manufacturing is an alternative to initiating a PR to perform short-run production for situations in which there is no engineering data available, or an urgent turn around time is required

- **Process 326 - Develop Spares.** The contractor selected to produce spares will ordinarily be supplied with Engineering Drawings (Level 2 or 3), Material Specification (Type E), Process Specification (Type D), Applicable MIL-STDs, and Q/A and Q/C Standards It is the contractor's obligation to produce and deliver the spares as agreed upon in the contract

- **Process 327 - Receive and Inspect Spares.** The Directorate of Distribution and Supply (DS) is responsible for conducting inspection of the spares Once approved, DS allocates the spares components to the DS warehouse, Using Commands or Depots

Process 33 - Perform Repair

Repairs are performed by ALCs and MAJCOMs to support depot and base-level maintenance The ALCs and MAJCOMs refer to engineering drawings, parts lists, specifications, and analysis data when the Technical Order (TO) does not provide sufficient information to support the repair process Base level repair is performed on those items or systems which require immediate attention due to damage or wear ALC/MM also performs analysis for the Damage Tolerance Assessment (DTA) and structural damage repair in support of the repair process. The node tree (Figure 4-13) provides an overview of this subprocess. The Data Flow Diagram overview is shown at Figure 4-14.

- **Process 331 - Receive Repair Requests.** Repair requests are initiated from the base or depot where the source of the problem is identified during periodic DTA inspections and depot maintenance. The request is currently transmitted using AFLC Form 256 and with AFLC Form 958/959.

- **Process 332 - Compute Requirements.** This activity defines the assessment and formulation of repair requirements by ALC/MA or the MAJCOM Using input from the original repair requirements and an assessment of any structural damage, an automated system (D073-Repair Requirement Computation) is used to identify repair requirements in terms of manpower, scheduling requirements, and time The ALC and MAJCOM will determine, based on the repair requirement, whether to perform the repair at the base or depot

- **Process 333 - Determine Spares Required.** MA reviews the spares requirements and the status of spares DS then delivers the spares or material required to perform the job to MA

- **Process 334 - Plan Repair.** MA is responsible for the planning and scheduling of the repair The planning activity identifies the RCC (Resource Control Center) that will be required for the repair work RCCs are allocated along functional lines, i e, heat treatment, plating, machine work, etc The scheduling activity attempts to optimize equipment configuration and plant layout Major factors in scheduling consists of job priority, availability of stock, number of items required, etc

- **Process 335 - Perform Depot Repair.** The repairs performed at the depot involve a number of activities including disassembly of a system/component, detailed examination for structural integrity, refurbishment of worn components, and complete replacement of worn or defective items In order to perform these activities, engineering data must be available to support the replacement, assembly, or fabrication activities during the repair process.

- **Process 336 - Produce Repair Kit.** MA is responsible for the assembly of a repair kit for those repairs which are performed by base level maintenance The repair kit may consist of new parts, special tooling, specifications, applicable Technical Orders, (TOs) and other pertinent engineering instructions.

- **Process 337 - Perform Base Repair.** Bases require the use of engineering drawings and parts lists (when the pertinent information is not available in the Technical Orders) Base level maintenance requests drawings from the base level EDSC, ALC EDSC, or the prime contractor Using the drawings and/or TOs, the base repair requirements are defined and implemented

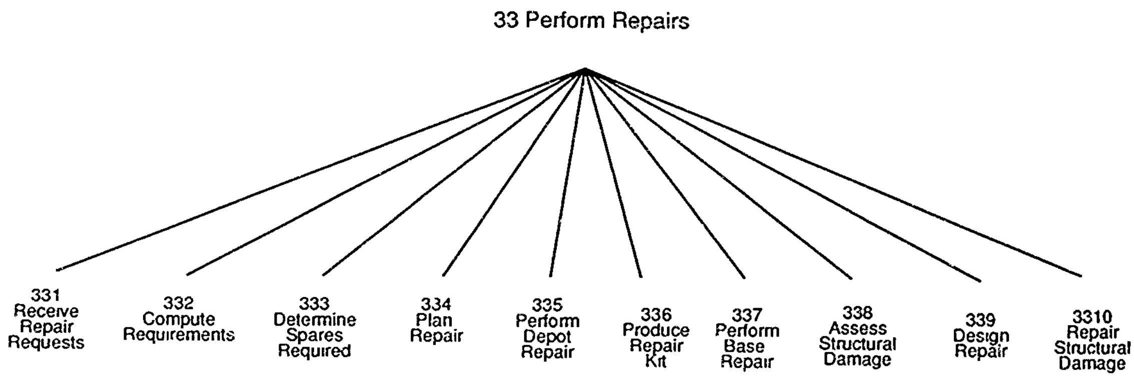
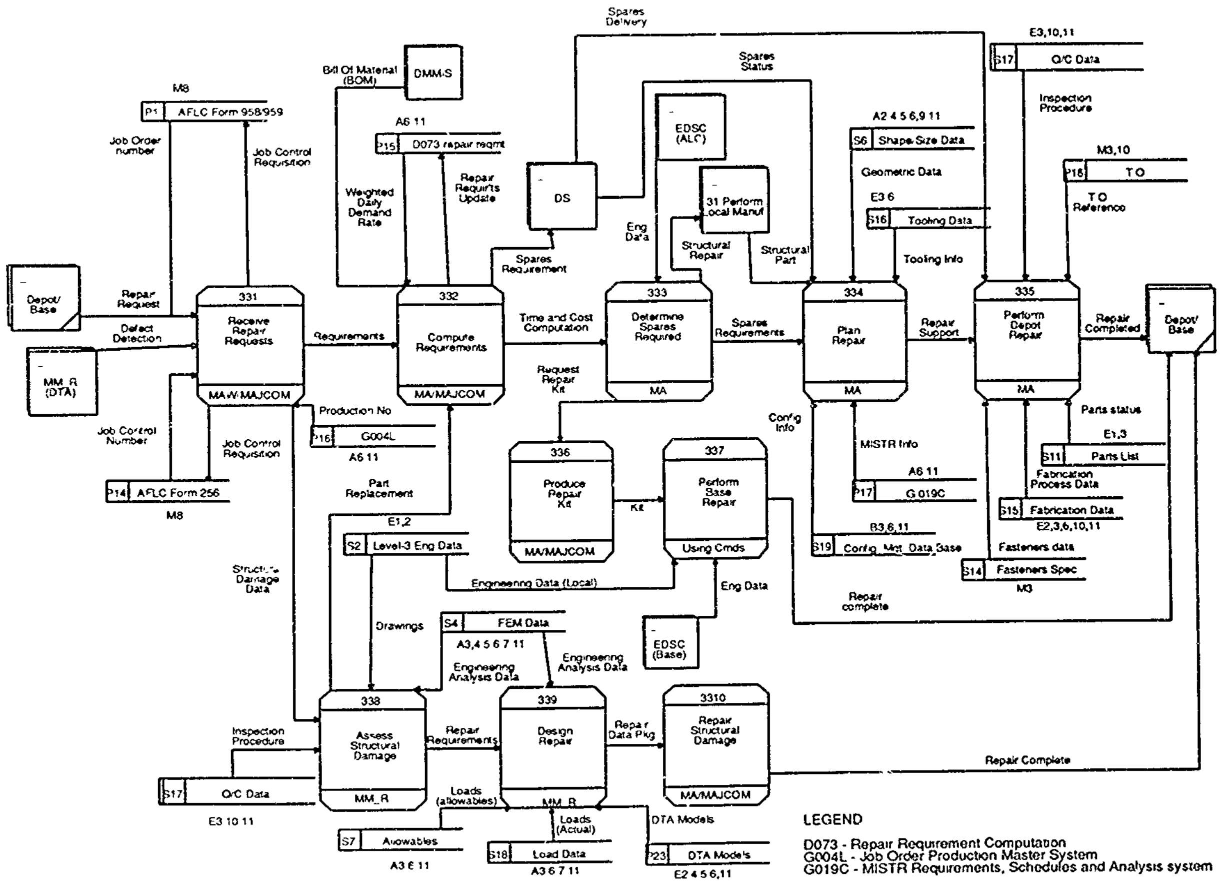


FIGURE 4-13. PERFORM REPAIRS NODE TREE



LEGEND

D073 - Repair Requirement Computation
G004L - Job Order Production Master System
G019C - MISTR Requirements, Schedules and Analysis system

FIGURE 4-14. PERFORM REPAIRS DFD

- **Process 338 – Assess Structural Damage.** Structural damage which consists of damage to the major assemblies of the system (e.g., fuselage, wings, tail, landing gear) may be assessed at either base or depot level. This assessment determines the overall level of repair and evaluation of damage. Methods used to perform the assessment consist of Damage Tolerance Assessment (DTA), Non-Destructive Test (NDT), or Destructive Test (DT). The NDT includes ultraviolet light, magnetic particles, industrial x-ray, or die penetrant.

- **Process 339 – Design Repair.** MM_R uses analysis information (e.g., DTA loads, allowables) to design the structural damage repair. A repair data package is assembled that includes the required drawings, lists, specifications, structural analysis data, etc., to perform the repair.

- **Process 3310 – Repair Structural Damage.** The repair o' the structural components is performed by MA. Upon completion of the repair, the system or component is returned to the originating base or returned to stock as a refurbished spare

Process 34 – Perform Modifications

Modifications may be initiated by Using Commands, which identify deficiencies cited by Deficiency Reports (MDR/QDR/TDR), or by HQ USAF, which defines a new operational capability due to Reliability and Maintainability (R&M), safety of flight problems, or a new mission threat There are three major classes of modifications. 1) Class II – research and development modifications which are temporary and for flight test purposes only, 2) Class IV – R&M, material deficiency, or safety of flight modifications, and 3) Class V – new operational capability The ALC/SPM is responsible for performing an engineering analysis (e g., loads, stress analysis) of the deficiency report findings Once a deficiency has been identified, an ECP is developed by the ALC or contractor defining the tasks and requirements to perform the modification Based on the ECP content (level of technical tasks, costs, schedules etc.), the CCB then decides whether to have the modification performed by the contractor, ALC depot, Test Wing, or not at all

If the modification is to be performed organically (in-house by the ALC or Test Wing), then the Air Force may be responsible for the design, analysis, manufacture, installation, and test of the modification kits The ALCs and Test Wings usually require the use of CAD/CAM/CAE capabilities to perform the modification. Organic modifications may be minor in nature compared to contractor modifications

For contractor modifications (typically Class IV or V), the ALC/MM division is responsible for assembling a Modification Engineering Data package. The CR directorate then screens the package to ensure that the engineering data can support the competitive procurement of the modification. Upon award of the contract, MM is responsible for monitoring the design and development of the modification, and conducting design reviews (PDR, CDR, etc)

The contractor is responsible for the design/engineering and manufacturing of the kits (modification item) necessary to support the modification. The major modification activities are generally the same as those performed during a new acquisition program (See Sections 4.2 and 4.3). The contractor develops the modification, installs and tests the kit on a prototype aircraft, and then develops the modification package for "kit proofing" by the Air Force. The ALC uses an Air Force test organization to test the modification kit. The contractor is then responsible for developing a Time Compliance Technical Order (TCTO) (containing instructions for kit installation) and delivery of the modification kits to the Air Force. Finally, the kits are installed on the weapon system by the ALCs, Using Commands, or a Contractor. The node tree (Figure 4-15) provides an overview of this subprocess. The Data Flow Diagram overview is shown at Figure 4-16.

- **Process 341 - Collect Modification Requirements Data.** The Engineering and Reliability Branch (MMAR) receives Quality Deficiency Reports (QDR), Tear Down Deficiency Reports (TDR) and Material Deficiency Reports (MDR) indicating the problems encountered during the operation of a weapon system. In addition, the original prime contractor may generate Engineering Change Proposals (ECPs) for the rectification of problems or the enhancement of the weapon system. Requirements for weapon system modification also can also result from new operational capabilities provided by HQ USAF. As a result of technical reports and new operational capabilities, requirements are collected for weapon system modification.

- **Process 342 - Perform Organic Modifications.** The modifications undertaken by the Air Force are called organic modifications. These modifications are designed and manufactured by the Air Force, and are usually initiated by an Organic Change Proposal (OCP). The Directorate of Material Management (MM), through the Operations and Support Branch (MMED), designs/drafts the engineering changes for the modification. The Directorate of Maintenance (MA) through the Production Branch (MA_P) manufactures the prototype modification and "kits" for installation. The Specialized Engineering Branch (MMET) is responsible for the testing of organically created modifications.

- **Process 343 - Analyze Deficiency Reports.** The Engineering and Reliability Branch (MM-R) at each ALC reviews the deficiency reports and operational capability requirements for each modification. From the review of these reports a set of requirements is determined for each modification. The process of MDR review and investigation is described in the USAF Material Deficiency Reporting and Investigating System Technical Order (T.O. 00-35D-54). As a result of this review and investigation process, the System Program Manager (SPM) issues a Material Improvement Program (MIP).

- **Process 344 - Develop ECP/OCP.** As a result of the MIP, an ECP or OCP is developed for the modification. The Modification Policy Group and the Program

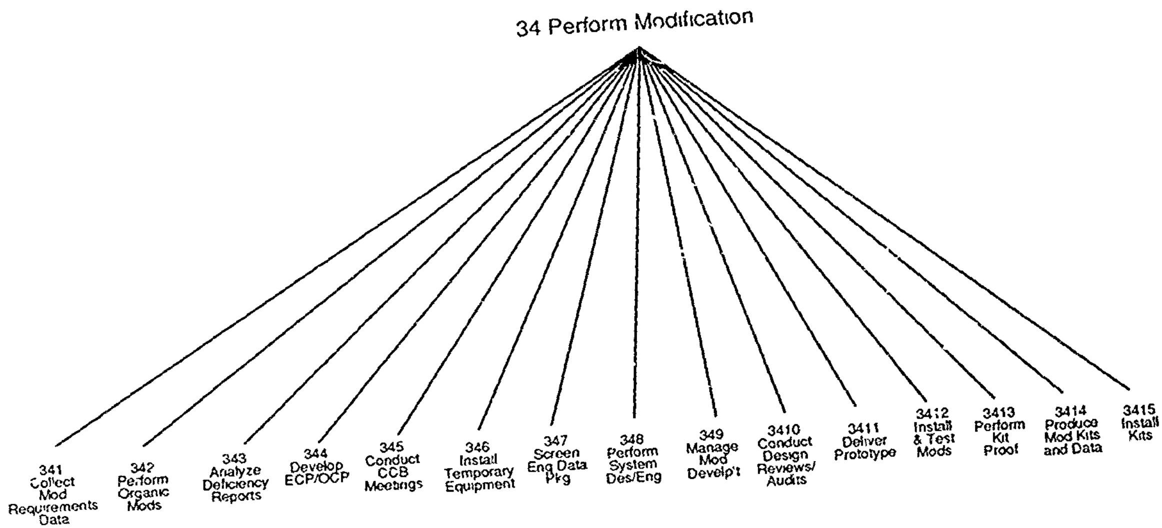
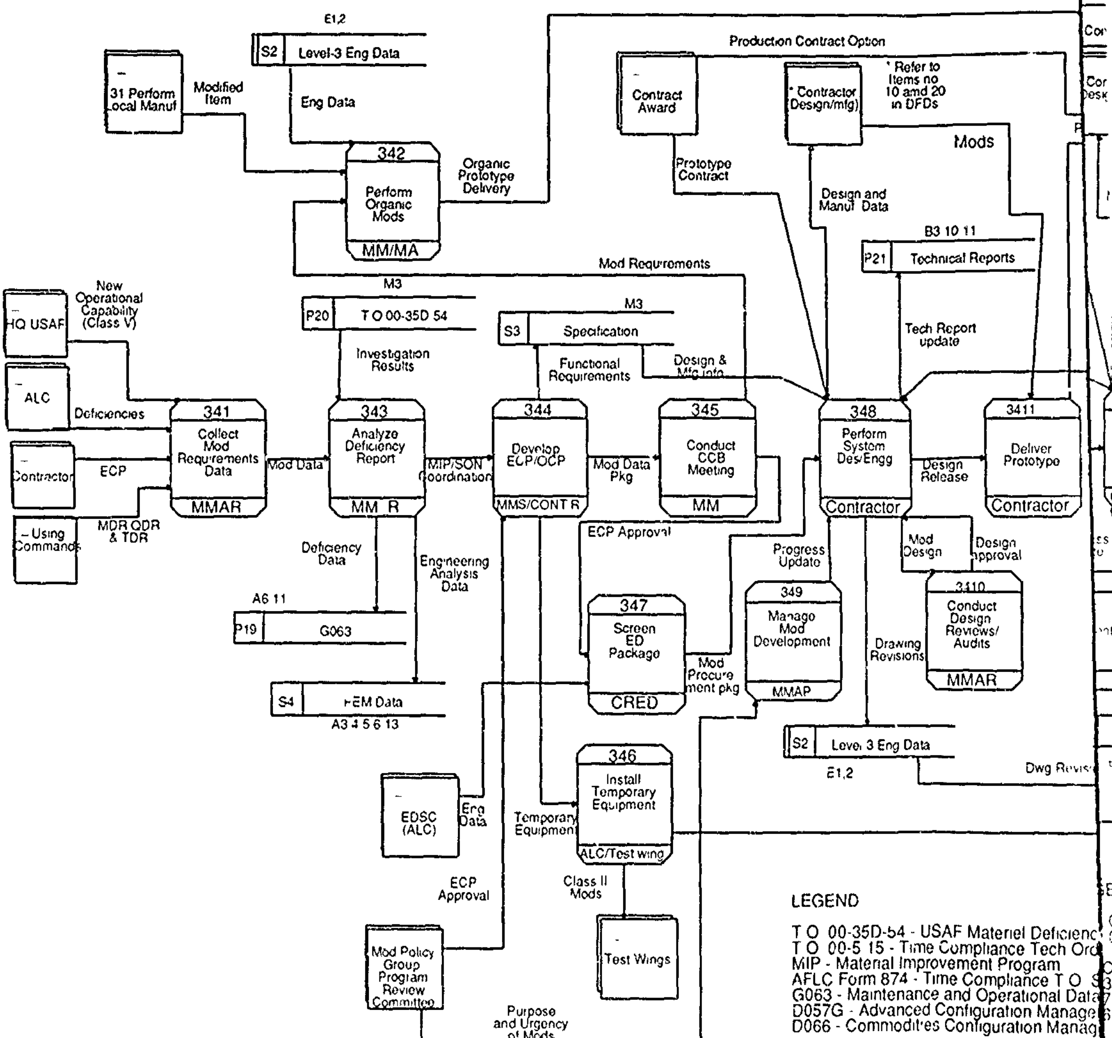
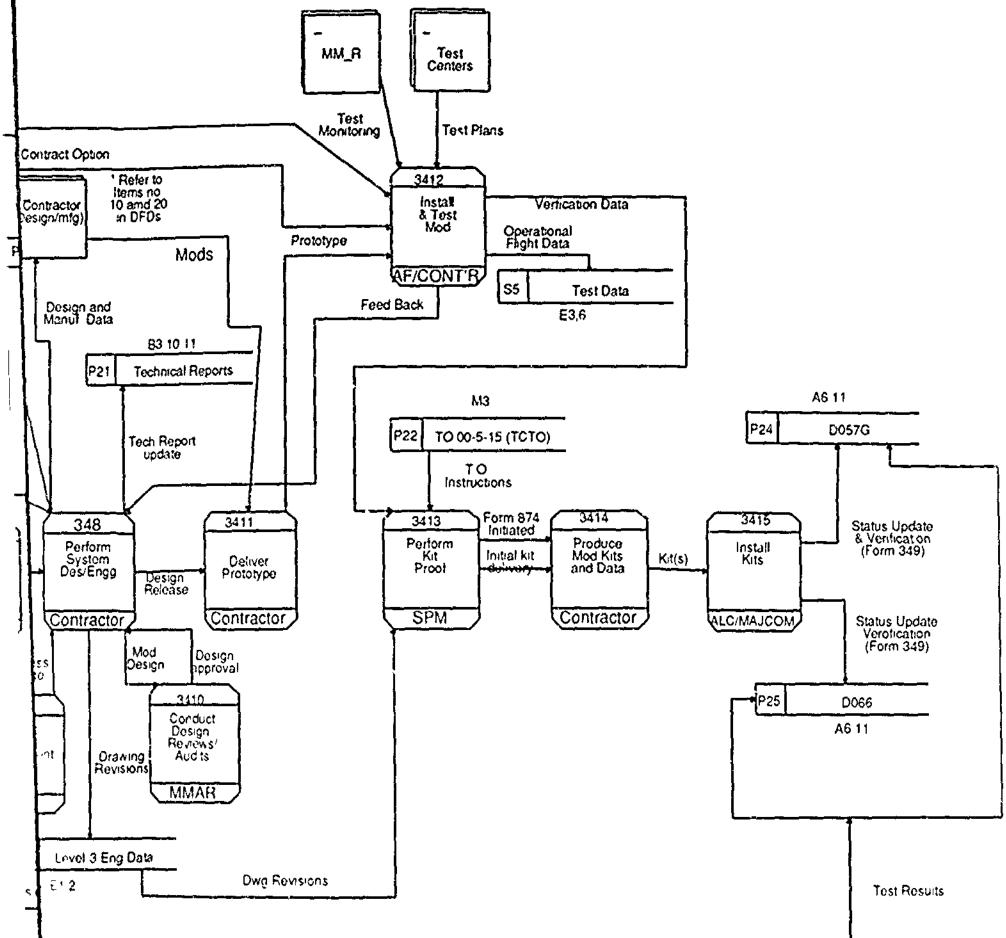


FIGURE 4-15. PERFORM MODIFICATIONS NODE TREE



LEGEND

T O 00-35D-54 - USAF Materiel Deficienc
T O 00-5 15 - Time Compliance Tech Ord
MIP - Material Improvement Program
AFLC Form 874 - Time Compliance T O
G063 - Maintenance and Operational Data
D057G - Advanced Configuration Manage
D066 - Commodities Configuration Manag



END
00-35D-54 - USAF Materiel Deficiency Reporting and Investigating System
00 5-15 - Time Compliance Tech Order
Material Improvement Program
C Form 874 - Time Compliance T O Supply Data Requirements
3 - Maintenance and Operational Data Access System
7G - Advanced Configuration Management System
6 Commodities Configuration Management System

FIGURE 4-16.

PERFORM MODIFICATIONS DFD

Review Committee (PRC) determines the purpose (safety of flight, mission capability, product improvement, etc.) and urgency of the modification. A System/Segment Specification (Type A) is developed defining the functional requirements of the modifications, and an engineering data package is assembled for the modification.

- **Process 345 - Conduct CCB Meeting.** The Configuration Control Board (CCB) is the policy and management committee within an ALC which monitors the changes made to a weapon system. The CCB reviews ECPs and makes recommendations and approves funding for these modifications.
- **Process 346 - Install Temporary Equipment.** Some organic modifications undertaken by the Air Force are temporary in nature (i.e , Class II). These modifications are typically performed to support research, development, test, and evaluation programs prior to the development and installation of modification "kits" on the weapon system fleet.
- **Process 347 - Screen Engineering Data Package.** The CRE division performs the screening analysis to ensure that the Air Force has adequate engineering data for competitive procurement of the modification. CRE also creates a hierarchy of the drawing "trees" in developing the master bid set The System Program Manager (SPM) then initiates a Procurement Request for competitive bidding on the modifications.
- **Process 348 - Perform System Design/Engineering.** Modification System Specification (Type A) is reviewed, refined, and broken down into subsystem components. Once identified, engineering and analysis data is generated for each subsystem component This provides the detailed engineering and design information reviewed at IPRs and design reviews/audits The final design is developed from the preliminary engineering and design data and is then released to the manufacturing group for modification kit development
- **Process 349 - Manage Modification Development.** The Production Management Branch (MMAP) is responsible for monitoring the development of the modification programs Modification Policy Groups are formed to review the progress of modifications and coordinate modification activities
- **Process 3410 - Conduct Design Reviews.** There are two important reviews which all major modifications must undergo, the first is the Preliminary Design Review (PDR), and the second is the Critical Design Review (CDR). The PDR results in the selection of a configuration which provides the best overall use of technology and resources towards meeting the requirements of the modification. Subsequent to review and approval, Level 2 Engineering Data and the Development Specification (Type B) are created The drawings together with the engineering data pack-

age, are used to conduct the CDR. At the CDR, a specific configuration is presented along with actual design criteria. Once this design is authenticated, a Product Specification (Type C) is generated which will be used during production.

- **Process 3411 - Deliver Prototype.** Once the design is released for manufacturing, the contractor develops a manufacturing plan and schedules the development of the modification prototype. A "first article" or test item is created during the prototype development. The weapon system is then used for operational testing and evaluation

- **Process 3412 - Install and Test Modifications.** The AFFTC, AFOTEC or the prime ALC tests and evaluates the weapon system modifications. The test organization uses the test plans and specifications to perform modification tests The operation flight data is recorded in the form of test reports. The primary purpose of operational testing and evaluation of modifications is to reduce the risks associated with the engineering, design, and development of new or modified systems

- **Process 3413 - Perform Kit Proof.** Once a modification has been designed, manufactured, and tested the contractor prepares a modification kit as per TCTO TO-00-5-15. The modification kit contains the material and instructions necessary for the installation of the modification, and is delivered to the Air Force. The Air Force then tests the kit to determine if it meets all the requirements defined in the specifications

- **Process 3414 - Produce Mod Kits and Data.** After the testing and verification of the modification kit (kit proofing) the Air Force authorizes the production of modification kits for the weapon system The contractor manufactures and delivers the modification kits to the Air Force

- **Process 3415 - Install Kits.** Once modification kits are received from the contractor they can be installed by an ALC, base level MAJCOM, or a designed contractor The Automated Commodity Configuration Management System (D066) and the Advanced Configuration Management System (D057G) are used by the Air Force to update the configuration status of the weapon system.

4.5 DFD CONCLUSIONS

This section summarizes the major findings from developing the DFDs for the Design/Engineering, Manufacturing, and Post-Production Support phases. To better identify and analyze the various types of data stores, two types of matrices were constructed In both types of matrices, each process name and node number is identified The Design/Engineering, Manufacturing, and Post-Production processes begin with the numeral 1, 2, and 3 respectively. An additional identifier describes the data store as shared (S), manufacturing (M), or design/engineering (D) (Codes and definitions for both data format and storage types are listed in Table 4-2)

4.5.1 Data Format/Storage Characteristics Matrices

The matrices presented in Tables 4–3 through 4–5 depict the data store formats and physical storage types used throughout the life–cycle. For each data store, the appropriate data format and storage categories are identified by the following codes: (A) Automated, (B) Both Manual and Automated, (M) Manual, or (E) Either Manual or Automated. One matrix each was constructed for the Design/Engineering, Manufacturing and Post–Production phases. (Refer to Appendix C for the identification of the specific data stores and data format/storage types.)

- **Tables 4–3 and 4–4.** The *Design/Engineering Data Store Format and Storage* (Table 4–3) and *Manufacturing Data Store Format and Storage* Matrices (Table 4–4) present the data stores in terms of the associated data format types and storage characteristics. Study of these matrices show the following:
  - Predominant use of hard copy report in either automated or manual modes.
  - The Level 1 through Level 3 Engineering Data store is used across several data format types.
  - The primary data format types include aperture cards, drawings, 2D and 3D vector image, and raster image. The primary storage is magnetic media.

- **Table 4–5.** The *Post–Production Data Formats and Storage* Matrix depicts the data format and storage codes for those data stores accepted and used by the Air Force in support of the Post–Production phase. These data stores are defined as those stores necessary to support logistics throughout the weapon system life cycle. Conclusions from this matrix are:
  - Data is generally accepted by the Air Force in hard copy report format (specifications, parts list, QA data, QC data) and the data is used to support post–production support activity in various ADP batch systems.
  - Level 3 Engineering Data is used in every major phase of Post–Production.
  - The primary stores and formats are: engineering data (either aperture card or drawings), specifications (manual hard copy report), Finite Element Model (FEM) data (automated – hard copy reports, 2D/3D vector, database and analysis models), parts lists (manual – aperture cards and hard copy reports), and QC data (either hard copy reports, microfiche, or magnetic media).

4.5.2 Acquisition Life Cycle Matrices

In this section the matrices are used to analyze the characteristics of the phase in which the individual data store is created, modified, or used. This approach is useful in identi-

TABLE 4-3. DESIGN/ENGINEERING DATA STORE FORMAT AND STORAGE

Process	Data/Storage Types / Data Stores	Data Formats 1	2	3	4	5	6	7	8	9	Physical Storage 10	11	12	13
11	D2 - SSR Review Minutes			E								E		
	D6 - Concept Data		E	E			E		E					
	D7 - System Definition Products			E										
	D8 - Systems Analysis Data		A	A			A					A		
	D9 - SDR Review Minutes			E			E							
	S5 - System Specification (Type A)			B								B		
	S1 - Level 1 Engineering Data	E	E		E	E				E		E		
	D5 - Study Contracts			E								E		
	D4 - Systems Engineering Management Plan			E								E		
	D3 - Initial Analysis Data			E								E		
	D10 - Dem Val Contract			E								E		
	D1 - Requirements			E								E		
12	S5 - System Specification (Type A)			B								B		
	S1 - Level 1 Engineering Data	E	E		E	E				E		E		
	D1 - Requirements			E			E							
	D11 - FEM Data						A	A						
	D13 - Shape/Size Data		A		A	A	A							
	D12 - Performance Models			E			E							
	D14 - Environment Constraints			M								M		
	S6 - Development Specification (Type B)			B								B		
	S2 - Level 2 Engineering Data	E	E		E	E				E		E		
	D65 - FSD Contract			E								E		
	D19 - PDR Minutes			E								E		
	D10 - Dem. Val Contract			E								E		
	D15 - Design Sheets			E								E		
	D17 - Comparison Reports			E								E		
	D18 - Ranking Criteria			E								E		
	D16 - Synthesis			E								E		
13	D13 - Shape/Size Data		E		E	E	E			E		E		
	S2 - Level 2 Engineering Data	E	E		E	E				E		E		
	D20 - Loads Data			A			A					A		
	S6 - Development Specification (Type B)			B								B		
	D21 - Allowables			A			A					A		
	D22 - Drawing Data Base	E	E		E	E				E		E		
	S7 - Configuration Data Base						A							
	D65 - FSD Contract			E								E		
	D24 - Military Standards			E										E
	D23 - Company Standards			M										
	D25 - Design Specification													
	S3 - Level 3 Engineering Data		E	E	E	E	E			E		E		E
	S11 - Product Specification (Type C)			B								B		
132	S2 - Level 2 Data Package			M										
	D26 - Parts List	E	E				E			E	E			
	D27 - Drawing Specifications & Standards			B										
	D28 - Analysis Information			A			A					A		
	D29 - Detail Drawings	E	E		E	E				E		E		
	D30 - Control Drawings	E	E		E	E				E		E		
	D33 - Assembly Drawings	E	E		E	E				E		E		
	D31 - Undimensioned Drawings	E	E		E	E				E		E		
	D34 - Special Purpose Drawings	E	E		E	E				E		E		
	D35 - Add'l Design Information			M										
	D36 - Drawing Requirements Manual			M										
	D65 - FSD Contract			M			A		A					
	D22 - Drawings	E	E		E	E				E		E		
	D32 - Diagramatic Drawings	E	E		E	E				E		E		
133	S11 - Product Specification (Type C)			B								B		
	D22 - Drawings	E	E		E	E				E		E		
	D37 - Test Performance Data			B			B							
	D38 - Review Package			M										
	S6 - HWCI Development Specification			B								B		
	D25 - Design Specification		A		A	A	A			A				
	D39 - CDR Minutes			E			E							
141	D40 - CDRLs						B		B					
	D41 - Regulations			B			B							
	D42 - [illegible] Data Base						A					A		
1[illegible]	D[illegible] - Control Drawings	E	E		E	E				E		E		
	D[illegible] - Assembly Drawings	E	E		E	E				E		E		

141	D42 - Discrepancy Data Base						A					A		
132	D30 - Control Drawings	E	E		E	E				E		E		
	D33 - Assembly Drawings	E	E		E	E				E		E		
	D31 - Undimensioned Drawings	E	E		E	E				E		E		
	D34 - Special Purpose Drawings	E	E		E	E				E		E		
	D35 - Add l Design Information			M										
	D36 - Drawing Requirements Manual			M										
	D65 - FSD Contract			M			A		A					
	D22 - Drawings	E	E		E	E				E		E		
	D32 - Diagramatic Drawings	E	E		E	E				E		E		
133	S11 - Product Specification (Type C)			B								B		
	D22 - Drawings	E	E		E	E				E		E		
	D37 - Test Performance Data			B			B							
	D38 - Review Package			M										
	S6 - HWCI Development Specification			B								B		
	D25 - Design Specification		A		A	A	A			A				
	D39 - CDR Minutes			E			E							
141	D40 - CDRLs						B		B					
	D41 - Regulations			B			B							
	D42 - Discrepancy Data Base						A					A		
	D22 - Engineering Drawings		E		A	A				A	A			
	D43 - Contract			E								E		
142	D25 - Design Data		E	E			E		E			E		
	D45 - Test Requirements			E			E							
	D49 - Test Plan			M										
	D46 - Test Procedures			M										
	D47 - Test Data Sets			E			E		E			E		
	D48 - Test Results			E			E							
	D44 - TEMP			E										
143	D54 - Configuration Management Plan			B								B		
	S7 - Configured Item						A							
	D50 - ACSNs			M			A		A					
	D51 - ECPs			M			A		A					
	D52 - OCPs			M			A		A					
	D53 - Waivers Deviations & NOR s			M			A		A					
	D55 Deficiency Notice						A		M					
	D56 - Applicable Specification			M										
	D43 - Contract			E								E		
15	D57 - Proposal			E								E		
	D58 - Selection Criteria			E								E		
	D59 - Source Selection Analysis			E								E		
	D60 - Pre-Award Survey			E								E		
	D61 - Production Contract			E								E		
	D62 - "AS-Built" Drawings	E	E		E	E				E		E		
	D63 - Acceptance Test Data			E								E		
	D64 - Acceptance Test Standards & Proced			E								E		

☐ Primary data stores, formats, and physical storage

DATA STORE LEGEND		
A M E B	Automated Manual Either Manual or Automated Both Manual and Automated	Automation Status
1 2 3 4 5 6 7 8 9	Aperture Cards Drawings Hard Copy Reports 2D Vector Image 3D Vector Ima Database Analytical Models (e g , FEM Simulation) Air Force Form Raster Image	Data Formats
10 11 12 13	Microfiche Magnetic Media N/C Tape Optical Disc	Physical Storage Types
D M P S	Design/Engineering Data Manufacturing Data Post-Production Support Data Shared Data	Data Stores

TABLE 4-4. MANUFACTURING DATA STORE FORMAT AND STORAGE

Process	Data Stores \ Data/Storage Types	1	2	3	4	5	6	7	8	9	10	11	12	13
		Data Formats									Physical Storage			
21	S1 - Level 1 Engineering Data	E	E		E	E				E		E		
	M3 - Mfg Facilities & Equip Req & Alt			E								E		
	M4 - Critical Manufacturing Material			E								E		
	M5 - Pre-Planned Product Improvements Plans			E								E		
	S5 - System Specification (Type A)			B								B		
	M6 - Production Risk Assessment			E								E		
	M7 - Estimated Manufacturing Cost			E								E		
	M9 - Purchase Requirements			E								E		
	M10 - Mfg Management Strategy Plan			E								E		
	M11 - Compt & Alt Mfg Plans & New Tech			E								E		
22	M1 - Tooling Process & Material		E	E			E					E	E	
	S2 - Level 2 Engineering Data	E	E		E	E				E		E		
	S6 - Development Specification (Type B)			B								B		
	M12 - Production Competition Plan			E								E		
	M13 - Initial Production Schedule			E			E							
	M14 - Feasibility Assessment			E								E		
	M15 - Initial Manufacturing Plan			E								E		
	M16 - Quality Assurance Plan			E								E		
	M17 - Producibility & Engineering Plan			E								E		
	M18 - Production Readiness Review Plan			E			E							
23	S3 - Level 3 Engineering Data	E	E		E	E				E		E		
	S11 - Product Specification (Type C)			E			E							
	M19 - CAM Models						A						A	
	M20 - Configuration Management Database			B			B							
	M21 - Inspection Test Data		E	E			E			E	E	E		
	M22 - Operational Test Data			E			E					E		
	M23 - Operational Testing & Eval Report			E								E		
	M24 - Q/C Data		E	E			E				E	E		
	M25 - Bill of Material			B			B		B		B	B		
	M36 - Initial Process Spec (Type D)			B								B		
	M37 - Initial Material Spec (Type E)			B								B		
24	S4 - Level 3 "As-Built" Eng. Drawings	E	E		E	E				E		E		E
	M26 - CIM Models				A	A	A							
	M28 - Non-Process Specifications			B								B		
	M36 - Final Process Specification (Type D)			B								B		
	M37 - Final Material Specification (Type E)			B								B		
243	M29 - Production Schedule			F			E							
	M30 - Production Test Data			E			E							
	M3 - Parts Lists			E			E							
	M32 - Drawings			E	E	E								
	M33 - Tooling Data			E			E							
	M34 - Process Data											A		

DATA STORE LEGEND		
A	Automated	Automation Status
M	Manual	
E	Either Manual or Automated	
B	Both Manual and Automated	
1	Aperture Cards	Data Formats
2	Drawings	
3	Hard Copy Reports	
4	2D Vector Image	
5	3D Vector Image	
6	Database	
7	Analytical Models (e g FEM, Simulation)	
8	Air Force Form	
9	Raster Image	
10	Microfiche	Physical Storage Types
11	Magnetic Media	
12	N/C Tape	
13	Optical Disc	
I	Design/Engineering Data	Data Stores

24	[illegible] Specifications			B	A	A	A					B		
	M3[illegible] Process Specification (Type D)			B								B		
	M37 - Fine Material Specification (Type E)			B								B		
243	M29 Production Schedule			E			E							
	M30 Production Test Data			E			E							
	M31 Parts Lists			E			E							
	M32 - Drawings			E	E	E								
	M33 - Tooling Data			E			E							
	M34 - Process Data											A		

DATA STORE LEGEND		
A	Automated	Automation Status
M	Manual	
E	Either Manual or Automated	
B	Both Manual and Automated	
1	Aperture Cards	Data Formats
2	Drawings	
3	Hard Copy Reports	
4	2D Vector Image	
5	3D Vector Image	
6	Database	
7	Analytical Models (e.g., FEM Simulation)	
8	Air Force Form	
9	Raster Image	
10	Microfiche	Physical Storage Types
11	Magnetic Media	
12	N/C Tape	
13	Optical Disc	
D	Design/Engineering Data	Data Stores
M	Manufacturing Data	
P	Post-Production Support Data	
S	Shared Data	

☐ Primary data stores, formats, and physical storage

TABLE 4-5. POST-PRODUCTION DATA FORMATS AND STORAGE

Process	Data/Storage Types / Data Stores	Data Formats 1	2	3	4	5	6	7	8	9	Physical Storage 10	11	12	13
31	P1 - AFLC Form 958/959								M					
	P3 - AFLC Form 206						B		B					
	P2 - G028 Work Control Data								A					
	S8 - Military Stds			E										E
	S7 - Allowables			A			A	A				A		
	S6 - Shape/Size Data		M		A	A	A			A		A		
	S9 - Company Stds/Specs			M								M		
	S11 - Parts List	M		M										
	P4 - AFLC Form 237								M					
	S13 - Material Spec (Type E)			M										
	S12 - Process Spec (Type D)			M										
	S10 - Q/A Data			E							E	E		
	S16 - Tooling Data			E			E							
	S17 - Q/C Data			E							E	E		
	S1 - CAM Models					A	A						A	
	S? - Level 3 Engineering Data	E	E											
	S15 - Fabrication Data		E	E										
32	S6 - Shape/Size Data		E		E	E	E			E		E		
	S7 - Allowables			A			A					A		
	P7 - J008 Procurement Codes						A					A		
	P8 - D049 Master Material Record						A					A		
	P9 - D032/D033 Stock Control						A					A		
	S11 - Parts List	E		E										
	P13 - Data List Form 1659								M					
	P5 - EDCARS Data									A				A
	S2 - Level-3 ED	E	E											
	P5 - AFLC Form 761								M					
	P10 - D041 Spares Computation						A					A		
32	P11 - D039 Equip Computation						A					A		
	P12 - D062 EOQ Buy						A					A		
	S13 - Material Spec. (Type E)			M										
	S12 - Process Spec (Type D)			M										
	S10 - Q/A Data			E							E	E		
	S8 - Military Specs/Stds			E										E
	S9 - Company Stds & Specs			E										E
33	P - AFLC Form 958/959								M					
	P14 - AFLC Form 256								M					
	S4 - FEM Data			A			A							
	S18 - Load Data			A			A					A		
	S2 - Level-3 Engineering Data "as-built"													
	P16 - G004L Job Production system						A					A		
	P15 - D073 Repair Requirement						A					A		
	S6 - Shape/Size Data		A		A	A	A			A		A		
	S7 - Allowables			A			A	A				A		
	P17 - G019C-MISTR Reqm t						A					A		
	S19 - Config Management Data			B			B					B		
	S17 - Q C Data			E								E		

Group	Data	1	2	3	4	5	6	7	8	9	10	11	12	13
	S19 - Config Management Data			B			B					B		
	S17 - Q/C Data			E								E		
	P10 - D041 Spares Computation						A					A		
32	P11 D039 Equip Computation						A					A		
32	P12 - D062 EOQ Buy						A					A		
32	S13 - Material Spec. (Type E)			M										
32	S12 - Process Spec (Type D)			M										
32	S10 - Q/A Data			E							E	E		
32	S8 - Military Specs/Stds			E										E
32	S9 - Company Stds & Specs			E										E
33	P1 - AFLC Form 958/959								M					
33	P14 - AFLC Form 256								M					
33	S4 - FEM Data			A			A							
33	S18 - Load Data			A			A					A		
33	S2 - Level-3 Engineering Data "as-built"													
33	P16 - G004L Job Production system						A					A		
33	P15 - D073 Repair Requirement						A					A		
33	S6 - Shape/Size Data		A		A	A	A			A		A		
33	S7 - Allowables			A			A	A				A		
33	P17 - G019C-MISTR Reqm t						A					A		
33	S19 - Config Management Data			B			B					B		
33	S17 - Q/C Data			E								E		
33	P18 - Tech Order			M							M			
33	S11 - Parts List	M		M										
33	S15 - Fabrication Data		E	E			E				E	E		
33	S14 - Fasteners Spec			M										
33	S16 - Tooling Data			E			E							
33	P23 - DTA Models		E		E	E	E	E				E		
33	S18 - Load Data			A			A	A				A		
34	P19 - MODAS (G063)						A							
34	S4 - FEM Data			A	A	A	A	A				A		
34	S3 - Specs (Type A-E)			M										
34	P21 - Technical Reports			B							B	B		
34	P20 - T O 00-35D-54			M										
34	S2 - Level-3 Engineering Data	E	E											
34	S5 - Test Data			E			E							
34	P22 - TO 00-5-15 (TCTO)			M										
34	P24 - D057G (Adv Config Mgt Sys)						A					A		
34	P25 - D066 (Commod Config Mgt Sys)						A					A		

☐ Primary data stores, formats, and physical storage

DATA STORE LEGEND

A	Automated	Automation Status
M	Manual	
E	Either Manual or Automated	
B	Both Manual and Automated	
1	Aperture Cards	Data Formats
2	Drawings	
3	Hard Copy Reports	
4	2D Vector Image	
5	3D Vector Image	
6	Database	
7	Analytical Models (e g FEM, Simulation)	
8	Air Force Form	
9	Raster Image	
10	Microfiche	Physical Storage Types
11	Magnetic Media	
12	N/C Tape	
13	Optical Disc	
D	Design/Engineering Data	Data Stores
M	Manufacturing Data	
P	Post-Production Support Data	
-	Shared Data	

fying at what time a particular data store is available and the frequency of each of the high level processes.

- **Tables 4-6 through 4-8.** These matrices are generated from the DFDs which identify the data store, and list the storage and data format characteristics. They identify the creation, modification, and use of each data store throughout the acquisition and life cycle. In the context of the matrix, Create, Modify, and Use are defined as follows:

  - *Create (C)* – Process whereby new data is developed or created in hard copy or digital format by the Air Force organization or contractor.
  - *Modify (M)* – Process in which the original data is modified.
  - *Use (U)* – Process of accessing new or previously modified data for the purpose of planning, analysis, review, or engineering changes

- **Table 4-6.** The *Design/Engineering Data Store Use During Acquisition Cycle* matrix depicts the data stores used to support the Design/Engineering activity Within the engineering acquisition phase are three major activities. Conceptual, Preliminary, and Detail Design Two support activities (Technical Support and Supplementary SPO Support) occur concurrently with the acquisition phase and are labeled Processes 14 and 15 Findings are as follows.

  - The Develop Conceptual Design, Develop Preliminary Design, and Finalize Detail Design (Processes 11-13) are predominantly characterized by the creation and use of engineering data
  - The Technical and SPO Support (Processes 14 and 15) encompass all three activities (Create, Modify, and Use).
  - The Detail Design (Process 13) primarily employs existing data for the production phase (Node 20)

- **Table 4-7** The *Manufacturing Data Store Use During Acquisition Cycle* matrix depicts the manufacturing data stores throughout manufacturing activities. Analysis shows the following.

  - Assess Design Producibility, Conduct Producibility, Engineering and Planning, and Conduct LRIP (Processes 21-23) primarily show the creation of data during the manufacturing process
  - Manufacture Product (Process 24) creates new manufacturing data and uses/modifies additional support data to support the production phase
  - Produce Item (Process 243) uses primarily tooling data, bill of materials (BOM), process data, and production data

TABLE 4-6.
DESIGN/ENGINEERING DATA STORE USE DURING ACQUISITION CYCLE

Process	Data Stores \ Process	Develop Conceptual Design 11	Develop Preliminary Design 12	Finalize Detail Design 13	Provide Technical Support 14	Provide Supplem. SPO Supp. 15
11	D1 - Requirements	C/U				
	D2 - SRR Review Minutes	C/U				
	D3 - Initial Analysis Data	C/U				
	D4 - SEMP	C/U				
	D5 - Study Contracts	C/U				
	D6 - Concept Data	C/U/M				
	D7 - Systems Definition Products	C				
	D8 - Systems Analysis Data	C				
	D9 - SDR Review Minutes	C/U				
	S5 - Systems Specification (Type A)	C				
	S1 - Level 1 Engineering Data	C				
	D10-Dem/Val Contract	C				
12	S5 - System Specification (Type A)		U			
	D1 - Requirements		U			
	D11- FEM Data		C			
	D12- Performance Models		C/U			
	D13- Shape/Size Data		C/U			
	D14- Environmental Constraints		C/U			
	D15- Design Sheets		C/U			
	S1 - Level 1 Engineering Data		U			
	D16- Synthesis		C/U			
	D17- Comparison Reports		C/U			
	D18- Ranking Criteria		C/U			
	D19- PDR Minutes		C/U			
	S6 - Development Specification (Type B)		C			
	S2 - Level 2 Engineering Data		C			
	D65- FSD Contract		C/M			
	D10- Demonstration/Validation Contract		M/U			
	D66-CAD Models		C/U			
13	D65- FSD Contract			M/U		
	S2 - Level 2 Engineering Data			M/U		
	S6 - Development Specification (Type B)			U		
	D13- Shape/Size Data			M/U		
	D20- Loads			M/U		
	D21- Allowables			C/U		
	D22- Drawing Data Base			C/U		
	S7 - Configuration DB			C/U		
	D23- Company Standards			U		
	D24- Military Standards			U		
	D25- Design Specification			C/U		
	S3 - Level 3 Engineering Data			C		
	S11 - Product Specification (Type C)			C		
132	S2 - Level 2 Data pkg			U		
	D26- Parts List			C/U		
	D27- Drawing Specs & Standards			U		
	D28- Analysis Information			M/U		
	D29- Detail Drawing			C/U		
	D30- Control Drawing			C/U		
	D31- Undimensioned Drawing			C/U		
	D32- Diagrammatic Drawings			C/U		
	D33- Assembly Drawings			C/U		
	D34- Special Purpose Drawings			C/U		
	D35- Additional Design Information			C/U		
	D36- Drawing Requirement			M/U		
	D65- FSD Contract			U		
	D22- Drawings			M/U		
133	S11- Product Specification (Type C)			C/U		
	D22- Drawings			U		
	D37- Performance Test Data			U		
	D38- Review Package			C/U		
	S6 - HWCI Development Specification			U		
	D25- Design Specification			M		
	D39- CDR Minutes			C/U		
	D40- CDRLs				U	
	D23 - Company Standards			U		
	D24- Military Standards			U		
	D25- Design Specification			C/U		
	S2 - Level 2 Engineering Data			C		

	D23- Company Standards			U		
	D24- Military Standards			U		
	D25- Design Specification			C/U		
	S3 - Level 3 Engineering Data			C		
	S11 - Product Specification (Type C)			C		
132	S2 - Level 2 Data pkg			U		
	D26- Parts List			C/U		
	D27- Drawing Specs & Standards			U		
	D28- Analysis Information			M/U		
	D29- Detail Drawing			C/U		
	D30- Control Drawing			C/U		
	D31- Undimensioned Drawing			C/U		
	D32- Diagrammatic Drawings			C/U		
	D33- Assembly Drawings			C/U		
	D34- Special Purpose Drawings			C/U		
	D35- Additional Design Information			C/U		
	D36- Drawing Requirement			M/U		
	D65- FSD Contract			U		
	D22- Drawings			M/U		
133	S11- Product Specification (Type C)			C/U		
	D22- Drawings			U		
	D37- Performance Test Data			U		
	D38- Review Package			C/U		
	S6 - HWCI Development Specification			U		
	D25- Design Specification			M		
	D39- CDR Minutes			C/U		
141	D40- CDRLs				U	
	D41- Regulations				U	
	D42- Discrepancy Data Base				C/U	
	D22- Engineering Drawings				C/M	
	D43- Contract				U	
142	D44- TEMP				C	
	D45- Test Requirements				C/U	
	D46- Test Procedures				C/U	
	D47- Test Data Sets				C/U	
	D48- Test Results				C/U	
	D25- Design Data				U	
	D49- Test Plan				C/U	
143	D43- Contract				U	
	D50- ACSNs				C/M/U	
	D51- ECPs				C/M/U	
	D52- OCPS				C/M/U	
	D53- Waivers Deviations & NOR				C/M/U	
	D54- Configuration Management Plan				C/U	
	S7 - Configured Items				M/U	
	D55- Deficiency Notice				C/U	
	D56- Applicable Specifications				U	
15	D57- Proposal					U
	D58- Selection Criteria					C/U
	D59- Source Selection Analysis					C/U
	D60- Pre-Award Survey					C/U
	D61- Production Contract					C/U
	D62- As-Built Drawings					M/U
	D63- Acceptance Test Data					C/U
	D64- Acceptance Test Standards & Procedures					C/U

LEGEND	
Application	Data Stores
C - Create M - Modify U - Use	D - Design/Engineering Data M - Manufacturing Data P - Post Production Support Data S - Shared Data

TABLE 4-7. MANUFACTURING DATA STORE USE DURING ACQUISITION CYCLE

Process	Data Stores \ Process	Assess Design Prod. 21	Conduct Prod. & Eng. Plan. 22	Conduct Low Rate Init. Prod. 23	Manufacture Product 24	Produce Item 243
21	S1 - Level 1 Engineering Data	C	U			
	M3 - Mfg. Facilities & Equip. Req. & Alt.	C	U			
	M4 - Critical Manufacturing Material	U				
	M5 - Pre-Planned Product Improvements Plans	C				
	S5 - System Specification (Type A)	C				
	M6 - Production Risk Assessment	C				
	M7 - Estimated Manufacturing Cost	C				
	M9 - Purchase Requirements	C				
	M10 - Mfg. Management Strategy Plan	C				
	M11 - Compt. & Alt. Mfg. Plans & New Tech.	C				
22	M1 - Tooling, Process, & Material		C	M/U	U	
	S2 - Level 2 Engineering Data		C	U		
	S6 - Development Specification (Type B)		C	U		
	M12 - Production Competition Plan		C	U		
	M13 - Initial Production Schedule		C/U			
	M14 - Feasibility Assessment		C			
	M15 - Initial Manufacturing Plan		C			
	M16 - Quality Assurance Plan		C			
	M17 - Producibility & Engineering Plan		C			
	M18 - Production Readiness Review Plan		C			
23	S3 - Level 3 Engineering Data			C	U	
	S11 - Product Specification (Type C)			C	U	U
	M19 - CAM Models			C/U	U	U
	M20 - Configuration Management Database			C	M	M/U
	M21 - Inspection Test Data			C/U	M	U
	M22 - Operational Test Data			C/U	M	M/U
	M23 - Operational Testing & Eval. Report			C	U	
	M24 - Q/C Data			U	U	
	M25 - Bill of Material			C	U	U
	M36 - Initial Process Spec. (Type D)			C		
	M37 - Initial Material Spec. (Type E)			C		
24	S4 - Level 3 "As-Built" Eng. Data				C	
	M26 - CIM Models				C	U
	M28 - Non-Process Specifications				C	U
	M36 - Final Process Specification (Type D)				M	U
	M37 - Final Material Specification (Type E)				M	
243	M29 - Production Schedule					M/U
	M30 - Production Test Data					U
	M31 - Parts Lists					U
	M32 - Drawings					M/U
	M33 - Tooling Data					U
	M34 - Process Data					U

Legend: Application	Data Stores
C - Create	D - Design/Engineering Data
M - Modify	M - Manufacturing Data
U - Use	P - Post Production Support Data
	S - Shared Data

- **Table 4-8.** The *Contractor/Air Force Post-Production Support Matrix* is a summary of the critical data stores created in the acquisition phases that are used to support local manufacturing, spares reprocurement, repairs, and modification during the post-production phase. This matrix illustrates major sources of information developed by the Contractor during the Design/Engineering and Manufacturing activities that are required by the ALCs. Listed below are the major observations from Table 4-8:

  - Modifications require the use of the original engineering data, create new engineering data, or modify existing engineering data.

  - Local manufacturing primarily uses and creates the data that is developed during the manufacturing process.

  - Spares reprocurement primarily requires the use of Level 3 Engineering Data "As-Designed" and specifications.

  - Repairs primarily require the use and creation of design/engineering data and Level 3 "As-Built" data.

4.5.3 Summary

A number of broad conclusions can be drawn from this analysis of DFDs:

- The major PDD Data Classes include:

  - *Analysis/Design Data* (models, loads, stress, properties, allowables).

  - *Engineering Data* (engineering drawings, parts lists, size/shape data).

  - *Specifications* (System, Development, Product, Material and Process - Type A-E).

  - *Process/Manufacturing Data* (tooling, fabrication, assembly data, numerical control).

  - *Test Data* (test plans, specifications, operational flight data).

- Shared data stores exist between the design/engineering activities. Also, a number of processes in both Design/Engineering and Manufacturing require coordination between dependent processes. One example is the Production Readiness Review (PRR). Producibility data has a direct correlation to the technical content of Level 3 Engineering Data.

- Shared data stores also exist among all three PDD processes (Design/Engineering, Manufacturing, and Post-Production Support). In describing the relationship

TABLE 4-8. CONTRACTOR/AF POST-PRODUCTION SUPPORT MATRIX

Contract. Functions	Process / Data Stores/Flows	Local Manufact.	Spares Reproc.	Repairs	Mods
DESIGN/ENG	Stress Analysis Data	U		C/U	C/M/U
	Load Data	U		C/U	C/M/U
	Damage Tolerance Analysis Data	U		C/U	C/M/U
	Performance Test Data				C/M/U
	Environmental Reports				C/M/U
	Technical Reports	U		U	C/M/U
	Shape/Size Data	C/M/U	C/U	C/U	C/M/U
	Allowables	U	U	C/U	C/M/U
	Level 3 Engineering Data "As-Designed"	U	C/U	U	C/M/U
MANUFACTURING	CAM Models	C/M/U			C/U
	Inspection Test Data	U			C/M/U
	Quality Control (QC) Data	U			C/M/U
	Process Specification (Type D)	U	U		C/M/U
	Material Specification (Type E)	U	U	U	C/M/U
	Tooling Data	C/U		U	C/M/U
	Fabrication Data	C/U	C/U	U	C/M/U
	Fasteners Specification			U	C/M/U
	Quality Assurance (QA) Data	U	U		C/M/U
SHARED	Company Standards/Specs	U	U	U	U
	Military Specifications	U	U	U	U
	Development Specification (Type B)		U	U	C/M/U
	Product Specification (Type C)	U	U	U	C/M/U
	Level 3 Engineering Data "As-Built"	U		C/U	C/M/U
	Configuration Management Data	U	U	C/U	C/M/U
	Parts List	C/M/U	C/U	C/U	C/M/U

LEGEND
M - Modify
U - Use
C - Create
Data sets required to support post-production processes

among these activities, it can be concluded from the DFDs that engineering data and specifications are common data stores for the following major processes:

- *Conceptual Design/Design Producibility* – Level 1 Engineering Data and System Specification (Type A).
- *Preliminary Design/Producibility and Engineering Plan (PEP)* – Level 2 Engineering Data and Development Specification (Type B).
- *Detail Design/Low Rate Initial Production* – Level 3 "As-Built" Drawings and Product Specification (Type C).

- An analysis of data stores for Design/Engineering, Manufacturing, and Post-Production phases include the following data stores: FEM data, process and material specifications, test data, Q/A data, Q/C data, military standards and specifications, allowables, shape/size data, analysis data, company standards and parts lists.
- It can be concluded from the DFDs that there are several opportunities during the Design/Engineering and Manufacturing phases, as well as during the Post-Production phase, for the Air Force to "access" and/or "take delivery" of PDD such as specifications (Type A-E), technical reports, analysis models, engineering drawings, parts lists and bills of material (BOM) information.

SECTION 5: PDD DIMENSIONS

5.1 INTRODUCTION

The PDD Dimensions section contains quantitative information gathered in the development of the organizational assessment, $IDEF_0$ models, and data flow diagrams of the current engineering data environment within the Air Force. This information provides a quantitative view of the current engineering data, and what projected data volumes the Air Force can expect in the future.

5.2 ENGINEERING DATA SERVICE CENTER (EDSC) STATISTICAL INFORMATION

In FY 87, the Air Force managed over 28 million aperture cards on paper, aperture cards, or optical disc (Engineering Data Computer Assisted Retrieval System [EDCARS]) at the five Air Logistics Center Engineering Data Support Centers (ALC EDSCs), as depicted in Table 5-1. Of the 28 million drawings currently in inventory, 4.75 million have been used for reprocurement in the past three years and have been designated "active". These active drawings are currently being loaded into EDCARS.

TABLE 5-1. ENGINEERING DATA STORED AT EACH ALC EDSC

ALC	(THOUSANDS)		(THOUSANDS/MONTH)		
	Total Cards	Active Cards	New	Updated	Total
OC*	4,200	900	3.3	10.0	13.3
OO*	6,000	600	7.5	22.5	30.0
SA*	5,650	850	6.5	19.4	25.9
SM*	5,800	1,750	6.6	20.0	26.6
WR	6,600	650	18.4	55.3	73.7
Total:	28,250	4,750	42.3	127.2	169.5

Source: ALC Form 24 Reports (FY 87)

*New and Updated aperture card figures were calculated based on a 75% updated to 25% new ratio provided by WR-ALC for FY-87.

Each ALC is responsible for the maintenance of the weapon system engineering data or commodities assigned to its respective EDSC. Based on interviews with the ALC/MMED staff, each ALC receives approximately 34,000 aperture cards per month, of which approximately 25% are new and 75% are revisions. The EDSC at each ALC receives and processes requests for approximately 23,000 aperture cards monthly for use at the ALC. There are four principle users of engineering data at each ALC: 1) Directorate of Competition Advocacy (CR) for reprocurement bid set assessment and assembly; 2) Directorate of Materiel Management (MM) for repairs and modifications; 3) Directorate of Maintenance (MA) for the organic manufacture of parts; and 4) miscellaneous users such as the Directorate of Contracting and Manufacturing (PM), Field Maintenance Squadrons (FMS), and other DoD Agencies. An additional 1-2% (200-300 cards) are processed a month to support requests by other ALCs and MAJCOMs. See Table 5-2 for a summary of this information.

The Engineering Data Request Report (AFLC Form 24) which is provided by the ALC EDSCs on a quarterly basis shows that CR requests approximately 18,000 aperture cards per month, MM and MA each request approximately 2,000 aperture cards per month, while all other organizations request approximately 1,000 aperture cards per month.

In addition to the requests made by the various ALC organizations, 600,000 aperture cards are duplicated per month for reprocurement bid sets and updates for MAJCOMs (See Table 5-3). Of the 600,000 cards, 35,000 cards are sent monthly as automatic updates to MAJCOMs, while 565,000 are used for bid sets.

TABLE 5-2. ALC ENGINEERING DATA REQUESTS

ALC	(THOUSANDS PER MONTH/PER YEAR)				
	CR	MA	MM	Other	Total
OC*	17.97/216.0	2.1/25.6	1.6/2.3	1.1/13.8*	22.8/273.4
OO*	17.97/216.0	2.1/25.6	1.6/2.3	1.1/13.8	22.8/273.4
SA	20.75/249.0	2.4/28.8	1.1/12.8	1.6/19.5	25.8/310.1
SM	18.58/223.0	2.6/31.0	2.3/27.0	0.9/11.0	24.3/292.0
WR	14.58/175.0	1.4/17.0	1.3/15.0	0.9/11.0	18.2/218.0
Total:	89.85/1,079	10.6/128.0	7.9/59.4	5.6/69.1	113.9/1366.9

Source: ALC Form 24 Reports (FY 87)
*Estimated sizes based on the average data from the three other ALCs.

TABLE 5-3. MAJCOM EDSC STATISTICS

MAJCOM	Number of EDSCs	Number of Cards Total/per Base	Number of Cards Viewed Total/per Base
MAC	11	6.5M/590K	8.47K/770
SAC	5	1.4M/280K	0.710K/142
TAC	27	8.1M*/300K*	15.5K*/575**
TOTAL:	43	16.0M/1170K	24.7K/1,487

* Estimated on 300K cards per TAC base EDSC, using F-15 aperture card number.
** Based on 575 cards viewed per month at each base EDSC.

5.2.1 MA Directorate Utilization

Engineering data use at MAs in the ALCs and a base level EDSC is summarized below. Note that data on base-level EDSCs is limited at this time to information compiled from a log of drawing requests from a SAC EDSC located at Pease AFB and summary statistics received from SAC and MAC:

- Each ALC/MA Directorate utilizes approximately 0.5% of the total engineering data stored at an ALC EDSC per year to support reprocurement and sustaining engineering. This is based on an average ALC EDSC containing 5.6 million aperture cards, and an average MA Directorate requesting 25,600 aperture cards per year.
- Field maintenance service at Pease AFB utilizes 0.4% of the total engineering data at a base-level EDSC to support repairs, local manufacturing, and other uses (trouble shooting, reverse engineering, technical analysis, etc.). This is based on the base-level EDSC containing 500,000 aperture cards, and an average maintenance unit requesting 2,000 aperture cards per year.
- The base-level EDSC at Pease AFB (SAC, 509 BMW) manages approximately 500,000 aperture cards, of which approximately 350,000 are for the F/B-111 and approximately 150,000 are for the K/C-135.
- The base-level EDSC at Pease AFB receives approximately 3,000 new or updated aperture cards per quarter, while an average ALC EDSC receives approximately 100,000 new or update aperture cards per quarter.

5.2.2 EDSC Users

Analysis of the AFLC Form 24 reports indicates:

- The CR Directorate receives 79% of the information requested from an ALC EDSC. The MA, MM Directorates and other users (DS, PM, etc.) receive 9%, 7%, and 5% respectively.
- Base-level EDSC use information provided by Pease AFB shows that the Field Maintenance Squadron (FMS) uses 62% of the engineering data. The General Dynamics field representative, 509 BMW, and other users (New Hampshire Air National Guard, QA, etc.) access 25%, 7%, and 6% of EDSC information respectively.

5.2.3 Applications and Number of Cards

Table 5-4 presents statistics on the application, use, and number of aperture cards present at an average ALC EDSC and a SAC EDSC. Highlights of this table are summarized below:

- Engineering data applications at an ALC are primarily for spare parts reprocurement, other applications include: technical research, repair/local manufacturing, and miscellaneous (Directorate of Distribution, Directorate of Contracting and Manufacturing, etc.).
- Engineering data applications at the SAC base are primarily for technical research (material specifications, process specifications, fastener specifications, etc.) in support of repairs. Other applications include: direct support of local manufacture and miscellaneous (New Hampshire Air National Guard, QA, etc.).
- Both the ALC and base EDSCs view 60-70% of the aperture cards for information, and modify or print the remaining 30-40%.
- ALCs primarily use engineering data for spares reprocurement, while bases primarily use engineering data for repairs.
- ALCs and bases view a greater percentage of engineering data they modify or print.

5.3 EDCARS DRAWING SIZES AND STORAGE STATISTICS

The purpose of EDCARS is to digitally store engineering data for automated retrieval and production of reprocurement bid sets. The file sizes for "C" and "E" size drawings stored in EDCARS were provided by WR-ALC EDSC based on the examination of F-15 engineering drawings. An average "C" size drawing is estimated to be approximately

TABLE 5-4. EDSC DRAWING UTILIZATION STATISTICS

	CRITERIA	ALCs*	SAC**
APPLICATIONS	Technical Research/Repair	7 %	79 %
	Local Mfg	9 %	19 %
	Spares Reprocurement	79 %	N/A
	Other	5 %	2 %
DATA USE	Viewed (Information Only)	63 % ***	71 %
	Modified or Printed	37 % ***	29 %
NO. OF CARDS	EDSC	5,650 K	500 K

* Based on an average of information provided by ALC Form 24 reports and ALC interviews.
** Based on useage statistics provided by the Pease AFB EDSC.
*** Data only includes MM, no data was available for MA.

45,000 bytes, in contrast to an average "E" size drawing of 246,000 bytes (See Table 5-5). An estimated file size of 93,500 bytes for a "C" size drawing stored in EDCARS was provided by AT&T. The average drawing size for a weapon system has been determined to be a size "C" based on an examination of drawing sizes for existing weapon systems. For purposes of database sizing, an average "C" size drawing is assumed to have a file size of 70,000 bytes. This is the calculated difference between the 45 kilobyte file (See Table 5-5) and the 93.5 kilobyte file size provided by AT&T.

Approximately 4-5 aperture cards per drawing is estimated to be the baseline from information received from the ALCs. Based on the 5 cards per drawing ratio, an estimated total volume (i.e., disk space) for all engineering drawings has been calculated to be 382.5 gigabytes (See Table 5-6). Of the projected 382.5 gigabytes of data only 67.2 gigabytes is considered "active" information based information.

5.4 MISCELLANEOUS PDD STATISTICS

This section summarizes various statistics and dimensions of PDD that were collected from Air Force source documents or interviews:

- The average lead time to procure spares from outside contractors is approximately 280 days or nine months.
- The average time to process AFLC Form 206 for local manufacturing is 164 days or five months.

TABLE 5-5. EDCARS DATA FILE SIZES*

DRAWING SIZE	(SIZE IN THOUSANDS OF BYTES)		
	LOW	AVERAGE	HIGH
C	20.0	45.0	115.0
E	185.0	246.0	719.0

* Based on data provided by WR-ALC EDCARS manager.

TABLE 5-6. ESTIMATED FILE SIZES FOR EDCARS DATA*

ALC	(MILLIONS OF CARDS/GIGABYTES)	
	TOTAL CARDS	ACTIVE CARDS
OC	4.2/60.1	0.9/12.6
OO	6.0/70.0	0.6/8.4
SA**	5.7/79.2	0.85/11.9
SM	5.8/81.2	1.8/25.2
WR	6.6/92.0	0.65/9.1
TOTAL	28.3/382.5	4.75/67.2

* File sizes based on 70 kilobytes per each "C" size drawings.
** Information on SA-ALC EDSC is estimated from data on other ALC EDSCs.

- Space Command is planning to deliver over three million drawings to SM-ALC/MMED for the Space Shuttle and the SDI programs.
- Based on discussions with ALC EDSC managers, 66% of the ALC EDSC information are engineering drawings (i.e., graphics) and 33% are specification/standards (i.e., text).
- SM-ALC is adding approximately 2,500 drawings per year into a CAD (vector graphics) data base.
- Current processing time (number of hours) to perform local manufacturing tasks is described in Table 5-7.
- Local manufacturing for FY 87 averaged 162K items at a cost of $18.1M per ALC (See Table 5-8).
- The results of a test conducted by WR-ALC to convert a 2D raster drawing into a machined part indicate:
  - Conversion of 2D drawing to 3D wireframe drawing takes 220 hours
  - Creation of the tool paths and post-processing of fixtures takes 300 hours.

TABLE 5-7. PROCESSING TIMES FOR LOCAL MANUFACTURING

PROCESS	HOURS
Production Planning	5
Material Research	2
Data Input	80
Engineering Analysis	N/A
Material Selection	N/A
N/C Programing	60
Fixture/Tool Design	60
Scheduling	5
Manufacture Fixtures	25
Set-Up	8
Program Verification	70
Manufacture Parts	60
Total	345

TABLE 5-8. LOCAL MANUFACTURE OF ITEMS

***ALC	Cost Avoid.	Number of Mfg. Items	CP*		SSD**		TOTAL	
			Quantity	Cost	Quantity	Cost	Quantity	Cost
OO	--	188 K	--	--	--	--	188 K	--
SA	--	100 K	6.6 K	$966 K	93.4 K	$11.3 M	100 K	$12.3 M
SM	$741 K	198 K	--	--	--	$18.8 M	198 K	$18.8 M
WR	$112 K	162 K	20.7 K	$5.2 M	141.6 K	$18.0 M	162 K	$23.2 M
AVG.	--	162 K	--	--	--	--	162 K	$18.1 M

* Centrally Procured Items
** Support Sock Fund items.
*** No data provided by OC-ALC.

- The total time to convert to CAD/CAM is 520 hours.

- To machine and produce the part took 10 hours.

5.5 ENGINEERING DATA REQUIREMENTS

In addition to the general estimates on the number of aperture cards at each ALC, an estimate of the current number of aperture cards per weapon system has been made (See Table 5-9). Based on data supplied by the ALC EDSCs, an average weapon system has approximately 250,000 aperture cards. Newer weapon systems, such as the B-1B, may contain additional drawings not found in older weapon systems. The B-1B has an estimated 1.5 million drawings yielding around six million aperture cards. From data supplied by ALC EDSCs on existing weapon systems, 45% (2.7 million cards) of the total aperture cards on the B-1B are considered active and are planned to be entered into EDCARS.

Based on the yearly growth of aperture cards and the expected addition of new weapon systems (ATF, C-17, and B-1B) the total number of aperture cards in 10 years should be approximately 83.7 million (See Table 5-10), with 37.7 million expected to be active.

TABLE 5-9.
ESTIMATED NUMBER OF APERTURE CARDS BY WEAPON SYSTEM

Weapon System:	Number:	(Cards in Thousands/Size in Gigabytes)			
		Active:		Total:	
A-7*	31	99.0	1.39	220.0	3.08
A-10*	451	105.0	1.47	233.0	3.26
B-1	100	2,700.0	37.80	6,000.0	84.00
B-52	263				
FB-111*	62	105.0	1.47	257.0	3.60
C-5°	76	66.8	0.94	148.5	2.08
C-10	56				
C-12	75				
C-21	79				
C-130●	354	150.0	2.10	250.0	3.50
KC-135●	608	67.5	0.95	150.0	2.10
C-141●	255	150.0	2.10	250.0	3.50
E-3	33				
F-4**	596	115.0	1.61	250.0	3.50
F-5°	96	35.2	0.49	78.2	1.09
F-15●	732	180.0	2.52	308.4	4.31
F-16**	1000	56.0	0.80	125.0	1.75
F-111*	334	105.0	1.47	257.0	3.60
H-1	100				
H-3	51				
H-53	40				
OV-10	77			21.0	
T-33	54				
T-37°	609	7.2	0.10	16.0	0.22
T-38°	810	10.8	0.15	24.1	0.34
T-40	100				
TOTAL:		3,952.5	55.36	8,988.2	119.93

▨ Unconfirmed or Estimated Figures
* Data received from SM-ALC EDSC.
** Data received from OO-ALC EDSC.

☐ No information from ALC-EDSC.
○ Data received from SA-ALC EDSC.
● Data received from WR-ALC EDSC.

TABLE 5-10. PROJECTED ENGINEERING DATA REQUIREMENTS

ALC	(APERTURE CARDS IN MILLIONS/GIGABYTES)		
	1-3 YEARS	3-5 YEARS	5-10 YEARS
OC	10.3/144.2	12.9/180.6	19.0/266.0
OO	7.0/ 98.0	11.0/154.0	15.0/210.0
SA	7.13/ 99.8	10.12/141.7	14.9/208.6
SM	7.3/102.2	13.3/186.2	19.5/273.0
WR	8.27/115.8	10.4/145.6	15.3/214.2
TOTAL	40.0/560.0	57.72/808.1	83.7/1171.8

* Average increase in aperture cards per year is estimated to be 8%. This is based on average EDSC growth per year, plus the estimated addition of major weapon systems.

5.6 MAJOR FINDINGS

The information in this section presents a quantitative description of the current Air Force environment. Currently the ALC EDSCs manage over 28 million aperture cards, while the MAJCOMs (SAC, TAC, MAC) manage over 16 million aperture cards at base EDSCs, for a total of over 44 million aperture cards. The ALCs receive 42,000 new and 127,000 updated cards per month on existing and new weapon systems.

Information retrieved from the ALC EDSCs is used primarily by the CR directorate for the review and compilation of reprocurement packages. Engineering data acquired from base-level EDSCs are primarily used for repairs by the field maintenance service. These usage statistics indicate that the data is primarily viewed or used in non-editable forms, thus raster technology may be sufficient for these purposes.

SECTION 6: CONCERNS, ISSUES, AND FINDINGS

6.1 INTRODUCTION

This section of the report documents the concerns, issues, and findings identified from analysis of the IDEF0, DFDs, organization assessment, and from meetings with Air Force personnel and industry concerning the acquisition, management, and use of PDD.

6.2 METHODOLOGY

The information gathered from these meetings has been organized into three general areas: concerns, issues, and findings. Each of these areas have been divided into organizational, technical, and management categories. The structure of each report section consists of the identification of the major concern, issue, and finding which is further defined by the reported causes, attributes, or other supporting information. In addition, matrices summarizing the concerns, issues, and findings are also presented. The following describes each of the areas and categories presented by the matrices:

General Areas:

- **Concerns** - Current activities that limit and restrict the acquisition, use, and management of PDD and provide a potential automation opportunity.
- **Issues** - An activity which may have a constraining effect on the acquisition, use, and management of PDD.
- **Findings** - Facts about current activities collected from site visits, interviews, Air Force studies, and reports which contribute to the understanding of the current Air Force environment.

Categories:

- **Organizational** - Relationships among organizations that result in ineffective interaction and coordination between institutional entities.
- **Technical** - Activities which provide a potential automation opportunity and currently limit the ability to acquire, use, and manage PDD.
- **Management** - Factors which cause ineffective management direction and administration in defining requirements, policies, and standards.

6.3 CONCERNS

In developing the Current Environment Report, a number of concerns with the acquisition, use, and management of PDD were compiled. Table 6-1 summarizes each concern as it relates to the organizational, technical, and managerial categories.

TABLE 6-1. ORGANIZATIONAL, TECHNICAL AND MANAGEMENT CONCERNS

	ORGANIZATIONAL	TECHNICAL	MANAGEMENT
CONCERNS:			
• Inadequate Configuration Management of Engineering Data	✓	✓	✓
• Ineffective IPRs		✓	✓
• Inaccurate Engineering Data Package Validation Procedures		✓	
• Only Sample Analytical Results Reported to ALCs		✓	✓
• Slow Response to Drawing Requests	✓	✓	
• Missing/Incomplete Engineering Data	✓	✓	✓
• Acquisition Program (DRED/DOED) (DRED/DOED) Shortfalls	✓	✓	✓

☐ Identifies important areas to be addressed in the PDD Automation Plan.

6.3.1 Inadequate Configuration Management of Engineering Data

Currently the Air Force has no viable configuration management system for engineering data. Consequently, the engineering data available on a weapon system may or may not reflect the current configuration of the system. As shown in the matrix, a broad spectrum of sources contribute to the data configuration concern: incomplete engineering data packages, weapon system changes or modifications, compilation of unauthorized drawing stores, and lack of communication/transfer of information.

Incomplete engineering data packages are a major contributor to poor engineering data configuration. They are the result of poor acquisition practices or of information becoming lost, damaged, or destroyed during storage or use. An additional source of configuration concerns are changes or modifications that are performed on a weapon system. Frequently, the engineering data managed by the Air Force is not changed to reflect the new configuration. In addition, some ALC organizations make changes to drawings which are maintained in unauthorized and uncontrolled drawing files. Serious configuration management concerns can result when the latest versions of the drawings are not in the ALC Engineering Data Support Center (EDSC). This lack of current and complete engineering data impacts the modification, local manufacturing, repair and engineering support of a weapon system. Another configuration management concern is the lack of communication and/or transfer of information between the contractor and ALCs on ECPs/OCPs.

6.3.2 Ineffective In-Process Reviews (IPRs)

The In-Process Reviews (IPRs) are a series of technical reviews conducted to ensure the quality, accuracy, and completeness of engineering drawings received by the Air Force. From a study conducted by the Air Force on engineering data acquisition, and from the interviews conducted, three concern areas seem generally applicable to most IPRs: 1) sampling methods, 2) area of IPR concentration, and 3) communication of concerns to the contractor.

Because of the complexity of most weapon systems it is impossible for the System Program Office (SPO) to review every engineering drawing for a weapon system. The Engineering Data Management Officer (EDMO) within a SPO uses a sampling process to select drawings for review. Currently, most EDMOs use a "random" sampling method to select drawings for review. In some instances contractors are allowed to select the drawings for the sample.

The primary purpose of IPRs are to assure the technical quality, accuracy, and completeness of engineering data. In some cases, however, these reviews have concentrated on format instead of technical content. This emphasis on format may jeopardize the evaluation of the technical accuracy and adequacy of the engineering data to support competitive reprocurements, modifications, repair, and local manufacturing.

It is the responsibility of the contractor not only to produce quality drawings but to maintain the level of quality in a consistent manner. The subsequent IPR's are a way of measuring that commitment. In the course of the investigation, it was found that quality is a function of the amount of time developing a drawing, level of expertise employed, and criticality of the drawing. To simply review a small sample may not provide an accurate picture of the quality of both content and format.

Finally, concerns are not accurately communicated to the contractor by the SPO/EDMO, which voids the benefits of the IPR. The preparation and distribution of discrepancy reports to the contractor is critical to accurately communicating the concerns encountered at the IPR and to have the changes incorporated into the drawings.

6.3.3 Inaccurate Engineering Data Package Validation Procedures

In some cases, Air Force Design Reviews (i.e., IPRs, design reviews, audits) are not rigorous enough to reveal inaccurate, incomplete, or inconsistent engineering data packages A common concern described by System Program Managers (SPMs) and EDMOs is lack of an accurate procedure for assessing the completeness of an engineering data package and the drawing practices used by the contractor. Frequently engineering data packages are accepted with missing or incomplete information due to the vast number of drawings, limited time, sampling methods used at IPRs, and lack of engineering data requirements.

In addition to accepting incomplete data packages, drawings received must be checked to determine if they meet Air Force drawing practice standards. In support of the SPO the Air Force Plant Representative Office (AFPRO) and Defense Contract Administrative Service (DCAS) inspectors expend extensive manual effort to ensure that the prime contractor and sub-contractors meet the standards.

6.3.4 Only Sample Analytical Results Reported to ALCs

In the design of an aircraft, stress and Finite Element Model (FEM) design data are used to calculate loads in support of performance specifications. The design data is required to support the analysis for repairs and modifications, but is only provided in sample form through technical reports. The concern results from the SPOs not understanding the ALC's requirement for analysis/design data.

6.3.5 Slow Response to Drawing Requests

Interviews with users of engineering data have revealed that a common concern is the slow response time of ALC EDSCs to drawing requests. It takes from several days to several weeks for the ALC EDSC to respond to a request for engineering drawings. The long response time results from the labor intensive process of locating and duplicating information because most drawings are still stored in the manual file system.

Many MAJCOM bases (approximately 50) have base level EDSCs. These facilities support the day-to-day use of engineering drawings and lists by the Field Maintenance Squadron (FMS) supporting the base. When drawings or other engineering information are not available at the base EDSC, the data is requested from the ALC/EDSC managing the data. This relatively slow response to information requests can impact the availability of mission capable systems. Another common concern encountered is the poor quality of hard copy (paper) duplications of drawings and lists. In some instances these duplicate documents are unusable. In addition to the concerns encountered with the requisitioning information, base level EDSCs have noted that the ALC update to the engineering data is slow and excessive backlogs have occurred.

In some cases the slow update process has caused weapon system engineering data configuration concerns and some base level EDSCs have contacted the prime weapon system contractor to acquire the engineering data necessary to repair and maintain the system. The information presented here suggests that there are organizational, managerial, and technical concerns with the distribution and management of engineering drawings and lists.

6.3.6 Missing/Incomplete Engineering Data

During the acquisition of a weapon system the reviews and audits (e.g., PDR, CDR, PCA, etc.) of the engineering data do not ensure the technical adequacy, correctness and completeness of the engineering data package. In addition, when the engineering data packages are received at the EDSC from the contractor, the package contents are frequently only inspected in comparison to the packing list rather than the indentured data list which identifies a hierarchical breakdown of drawing relationships for a system. This frequently results in the Air Force accepting incomplete engineering data packages.

Engineering data can be lost, damaged, or destroyed, also resulting in incomplete data packages. Currently, most information at an EDSC is stored, managed, and retrieved from manual file systems; only a small percentage of current engineering data is stored on EDCARS. Because most of the engineering data is still managed manually, concerns occur during filing, handling, or use of this information.

The tracking of data purchased at the SPO and EDSC can result in duplicate data purchases. In some instances the acquisition of duplicate data has cost thousands of dollars.

6.3.7 Acquisition Program Shortfalls (DRED and DOED)

Acquisition programs often have funding concerns which impact the purchase of weapon systems. Frequently the acquisition of engineering data is deferred, not purchased, during funding cuts on some weapon system acquisition programs. Two acquisition programs allow the deferred purchase of engineering data, the Deferred Requisitioning of Engineering Data (DRED) program and the Deferred Ordering of Engineering Data (DOED) program. Under DRED the contractor prepares the engineering data during the design and initial production phases of the program, but the delivery is deferred until an unspecified date. Under DOED the contractor delivers the engineering data when ordered by the Air Force, but is not required to deliver the data during the initial acquisition program. These programs frequently meet the short term needs of the acquisition SPO, but can impact impact and restrict the long term logistical support of a weapon system.

The DRED program has been used for the acquisition of engineering data for a number of weapon system programs (e.g., B1-B, C-5, E-3A, F-5, F-15, and NAVSTAR GPS), which causes a number of concerns for the ALCs. In DRED programs engineering data is not initially available at an ALC after Program Management Responsibility Transfer (PMRT) of a weapon system, which causes organic support concerns. Since the engineering data is not available, the Air Force must sole source repairs and local manufacturing to the original manufacturer of the component. In addition, competitive reprocurement of spare parts or support equipment is not possible without the engineering data for the system. Finally, the SPOs have experienced significant engineering data configuration concerns because engineering data is not prepared by the contractor or, if prepared, is done so during the early phases of weapon system acquisition.

DOED programs share many of the the same disadvantages as DRED programs, such as; engineering data unavailable after PMRT, use of interim contractor support for items designated for Air Force support, significant data configuration concerns, system vendors going out of business prior to delivery of engineering data, data acquisition as a residual PMRT activity, and the lack of data reducing competitive reprocurement of parts. The availability, quality, and accuracy of engineering data acquired through DOED programs, however, is usually slower and poorer than under DRED programs because engineering data is not prepared during weapon system acquisition. The financial losses due to lack of competitive reprocurement, sustaining engineering support, poor configuration management, and additional effort expended at IPRs would appear to negate the positive financial aspect of these programs.

6.4 ISSUES

In developing the Current Environment Report, a number of issues concerning the acquisition, use, and management of PDD were compiled. The issues discussed are presented as they relate to the current Air Force environment. Table 6-2 summarizes each issue as it relates to the organizational, technical, and management categories.

TABLE 6-2. ORGANIZATIONAL, TECHNICAL AND MANAGEMENT ISSUES

	ORGANIZATIONAL	TECHNICAL	MANAGEMENT
ISSUES:			
• Limited Rights to Data	✓		✓
• AFLC/AFSC Engineering Data Acquisition Conflicts	✓	✓	✓
• Lack of Robust Data Exchange Standards		✓	
• EDMO Staffing and Training	✓		✓
• EDCARS Limitations		✓	
• Engineering Data Pricing Problems			✓
• Different Levels of Engineering Data in Repositories		✓	
• Engineering Data Not Useful for Sustaining Engineering Support			✓
• Engineering Data Funding Cuts			✓

6.4.1 Limited Rights to Data

One of the major issues of the current environment is limited rights to data. Presently, the effective use of engineering data to reprocure spares competitively can be restricted by the amount of data containing limited rights clauses. The use of the Orr Clause in the acquisition of engineering data or the challenge of these rights by the EDMO has severely limited the use of competition in procurements. The Orr Clause eliminates limited rights on engineering data for a system after seven years, and gives all rights to the Air Force.

During the acquisition of engineering data, use of the Orr Clause would reduce the need for challenging data rights. However, one Air Force study concluded that SPOs do not use the Orr Clause because contractors consider it a "severe" and limiting contractual requirement. It is also clear that limited rights to data are not being challenged effectively due to the high level of sole source procurements, although challenges have been more successful over the past few years.

With the acquisition of digital PDD the need for the clarification of data rights issues is even greater, especially if contractor maintained data bases are involved. The issue of data rights in the future Air Force environment will be very important to ensure alternate sources of a product and reduce costs by the use of competitive reprocurement.

6.4.2 AFLC/AFSC Engineering Data Acquisition Conflicts

A key issue in the acquisition of engineering data is the "buy all versus buy some of the data" controversy. Many SPO Program Managers and EDMOs at Product Divisions feel that it is not necessary to purchase all engineering data for a weapon system. The SPOs would rather procure engineering data by classes, i.e., reprocurement data, local manufacturing data, repair data, etc., based on the weapon system requirements.

In discussions with the MM, MA, and CR Directorates the ALCs felt that all available data should be purchased by the Air Force in most situations. In addition, the repair, modification, and local manufacturing of systems require that the engineering data be available to ensure the proper sustaining engineering support of the system.

6.4.3 Lack of Robust Data Exchange Standards

The Air Force must examine existing exchange formats and how these will impact the acquisition of digital engineering data. In MIL-STD-1840A (CALS Standard) the acceptance of digital engineering data is specified in MIL-D-28000, which defines the use of Initial Graphics Exchange Standard (IGES) for the digital transfer of engineering data The IGES format only allows the limited exchange of two dimensional CAD/CAM data Drawings converted from the IGES format require a great deal of user intervention to restore the drawing to a usable format (unless direct translations are used) In addition, there are several related exchange standards, such as. Electronic Data Interchange (EDIF), VHSICS High Level Description Language (VHDL), and others that are not even addressed by MIL-STD-1840A.

The Product Data Exchange Standard (PDES) is the future neutral exchange standard PDES addresses the exchange of shape, size, functional and operational characteristics, configuration data, and non-shape data. This standard, however, is still under development and will not be available until the mid-1990s. The key issues are:

- The lack of a comprehensive and robust exchange standard for use now with the acceptance of digital engineering data.
- Can PDES meet the future Air Force requirements for a more universal exchange standard and data schema?

6.4.4 EDMO Staffing and Training

The EDMO presently is matrixed within a Product Division to a SPO for acquisitions requiring engineering data support. Although the Product Divisions may have several hundred programs in various phases of acquisition, the ratio is approximately one EDMO to five SPOs.

The EDMO plays a critical role during the Full Scale Development (FSD) phase. It is during this phase that Level 3 Engineering Data is acquired and engineering data requirements identified earlier in the effort are translated into the production contract. The EDMO primarily ensures the contractor's compliance with applicable drawing format standards, and also has responsibilities in the review of engineering data through the IPR's. However, EDMOs have concerns performing reviews, and screen drawings predominantly for format rather than technical content due to the large volume of drawings and their lack of technical training.

6.4.5 EDCARS Limitations

Presently, EDCARS stores and maintains engineering data in a raster form on optical disc for the retrieval and production of reprocurement bid sets. However, EDCARS currently maintains only a small fraction of the total engineering data managed at the ALC/EDSCs. EDCARS is presently loading "active" data (i.e., data used within the last three years for reprocurement) and all data for new weapon systems (e.g., ATF, C-17, B-1B, etc.). Since the primary mission of EDCARS is to support reprocurement activities using raster data, its support to other ALC organizations (i.e., sustaining engineering community) other than CR is an issue. To add flexibility and greater usefulness to EDCARS a number of enhancements are currently being examined by segments of the Air Force community.

6.4.6 Engineering Data Pricing Problems

Cost benefits accrued by correctly procuring engineering data can only be calculated when engineering data costs are identified. More often than not, the entire set of engineering data (drawings, lists, and engineering data) are not separately priced (NSP). This fact makes it difficult to project the relative savings if the data is purchased, or in calculating cost avoidance of non-mission capable (NMC) or partially-mission capable (PMC) weapon systems.

6.4.7 Different Levels of Engineering Data in Repositories

Since 1980, Level 1 to Level 3 Engineering Data has been purchased to support competitive reprocurement under DoD-STD-100C and DoD-D-1000B. Before 1980 the regulations required drawing categories (A-K) to support Technical Orders, government manufacturing, reprocurement, commercial items, etc. In addition, contractors often only deliver Level 2 1/2 drawings instead of Level 3, which are required by DoD-D-1000B.

Acquiring various levels of engineering data has allowed the Air Force to optimize the acquisition dollar by procuring engineering data at the level which is required for maintenance/reprocurement. A number of assumptions are made as to the trade-off in not buying Level 3 data, or buying varying levels of data for different configuration items (CIs). What compromises this plan is that market sources can become so scarce as to force the ALC into the position of manufacturing its own spares.

6.4.8 Engineering Data not Useful for Sustaining Engineering Support

A major objective of acquiring Level 3 Engineering Data is to reduce the long term costs of weapon system support through competitive reprocurements. Level 3 Engineering Data may not address repairs or local manufacturing requirements. Frequently, information that is required for repair or local manufacturing activities is not purchased (e.g., the provisioning list is substituted for the assembly list, or design data is not purchased to support repairs). It is necessary that information required for the repair and local manufacture of components and parts be purchased along with information for the competitive procurement of parts and support equipment. A typical example that requires data in addition to Level 3 data would be a repair activity which involves the tear-down and inspection of a component, local manufacture of one or more sub-components, and the subsequent reassembly of the item.

6.4.9 Engineering Data Funding Cuts

A generalization presented by most ALCs concerned the SPOs' attempt to achieve the highest ratio of systems per dollar spent, possibly at the expense of logistic support items (i e , drawings, associated lists, specifications, etc.) The statement that the SPO makes a conscious decision to trade the ALC data requirements for additional end-items may not be straightforward either. A clearer statement of the situation would be that data items are traded off due to budget, scheduling, mission requirements, and data criticality factors. Should the SPO incur budget cuts prior to obligation of funds, it may try to optimize the available money by levying cuts through the reduction of Level 3 Engineering Data acquisition to Level 2 data. The shortfalls in data items may be the only option to meet mission requirements, while attempting to defer funding for subsequent support areas.

6.5 MAJOR FINDINGS

From meetings with Air Force and contractor personnel a number of findings were compiled concerning the acquisition, use, and management of PDD. The findings compiled are presented as they relate to the current Air Force engineering data environment. Table 6-3 summarizes the findings in relation to the organizational, technical, and management categories.

TABLE 6-3. ORGANIZATIONAL, TECHNICAL AND MANAGEMENT FINDINGS

	ORGANIZATIONAL	TECHNICAL	MANAGEMENT
FINDINGS:			
• Greater Use of Engineering Data by MAJCOMs		✓	
• Re-keying Drawings into CAD Systems		✓	
• Emerging Software Technology in New Weapon Systems	✓	✓	✓
• AFLC CAD/CAM Systems			✓
• Using Commands Have Limited Subsets of Drawings		✓	✓
• Local Recreation of Drawings at Using Commands		✓	
• Engineering Data Important for Weapon Systems (7-10 Years)		✓	
• N/C Machining Standardization		✓	
• Modifications Contracted Out		✓	

6.5.1 Greater Use of Engineering Data by MAJCOMs

From interviews with several MAJCOM bases, it is clear there is an increasing trend towards MAJCOMs using drawings, lists, and specifications to support repairs and local manufacturing. The base level maintenance performed is well beyond the simple replacement of parts, as well as above the base Source, Maintenance and Recoverability (SMR) code authorization. In some cases, this activity is required to maintain the high mission status rates which are placed upon the organization. In addition, local manufacture of parts above authorization may be due to an extraordinary capability (i.e., possession of numerical control [N/C] machine equipment), which is not part of the authorized inventory. Another factor that contributes to this trend is that the turnaround time required by the ALCs to perform the maintenance does not meet the requirements of the MAJCOMs. Thus, the operating MAJCOM will perform the local manufacturing above authorization should the ALC have sufficient backlog to impede the MAJCOM's mission.

6.5.2 Re-keying Drawings into CAD Systems

The ALC MM and MA directorates presently do not purchase engineering data in IGES form and are unable to use EDCARS raster data in their CAD systems. These directorates are re-keying this information into their CAD systems for: 1) analysis of modifications, 2) re-designing of parts or components, or 3) the generation of N/C tapes.

Discussions with the 4950th Test Wing at Wright-Patterson AFB revealed that CAD data is purchased from aircraft manufacturers in IGES format. This eliminates the concern of re-keying data into their CAD system; however, they stated it takes between 1 to 24 hours, depending on the complexity of the drawing, to convert an IGES file into a usable form. After conversion these CAD files still require operator intervention to make the CAD data usable by engineers for system redesign or N/C tool path generation.

6.5.3 Emerging Software Technology in New Weapon Systems

By 1990, embedded software in weapon systems will comprise half of the effort required to field a system. The increase in the complexity and evolution of computers in weapon systems, and the trend towards "intelligent weapon systems", will drive the need for increased use and management of software-related product data. Estimates in the number of embedded systems in the Air Force inventory will grow from 10K in 1980, to 60K in 1984, to 160K in 1988, to 280K in 1990.

6.5.4 AFLC CAD/CAM Systems

A survey performed by the CAD/CAM/CAE Working Group in conjunction with HQ AFLC/MMT addressed the number of CAD/CAM systems currently within the ALCs. The survey shows that the MM, MA, and CR directorates possess approximately 500, 130, and 40 CAD/CAM systems respectively. In addition, there are 190 various Computer Numerical Control (CNC) machines throughout the ALCs and the Aerospace Guidance and Metrology Center (AGMC) Typically, the CAD/CAM systems encompass the ability to perform geometrical, wireframe, and surface and solids modeling.

6.5.5 Using Commands have Limited Subsets of Drawings

Base level EDSCs use engineering data for base maintenance, repairs, and local manufacturing activities Currently the base level EDSCs maintain only Contractor Design Activity (CDA) drawings, and do not maintain the subcontractor or Government Design Activity (GDA) drawings. However, base maintenance activities often require the use of the subcontractor or GDA drawings and contact the weapon systems prime ALC or the prime contractor to obtain the missing subcontractor or GDA information.

6.5.6 Local Recreation of Drawings at Using Commands

Base level maintenance facilities create drawings from parts when the original engineering data is not available. A number of drawings were replicated in those instances where. a) the drawing was not immediately available through conventional sources (e.g., base, EDSC, ALC or contractor), b) there was an immediate need for manufacture/procurement of the part, and c) the part did not require complex process or tooling techniques.

6.5.7 Engineering Data Important for Weapon Systems (Greater than 7-10 Years Old)

The engineering data requirements for a weapon system change as the system grows older. In newer weapon systems (under 7 years old) engineering data is primarily for reprocurement of spare parts, while in older systems (over 7 years old) the data may be required for modifications, repair, and/or local manufacture. In addition, the importance of engineering data has increased with the current emphasis on using existing systems beyond their projected life cycle through major modification programs (e.g., F-111, F-4, etc.), and limiting the number of new weapon systems acquisitions.

6.5.8 N/C Machining Standardization

ALCs are currently standardizing on the Binary Cutter Location (BCL) N/C format. BCL will allow the ALC to exchange N/C tooling information using a neutral format. Currently, not all ALC facilities have equipment capable of using BCL N/C tapes; however, an upgrade to existing equipment is underway.

6.5.9 Modifications Contracted Out

Currently, most modifications to weapon systems are contracted out versus being performed organically at the ALCs. Usually, resource constraints (e.g., skills, equipment, cost and manpower) require the ALCs to contract out the modifications. The work performed at the ALCs represents 10-20% of the modifications performed each year.

6.6 CONCLUSIONS

The analysis of the current PDD environment has involved the development of an organizational assessment, $IDEF_0$ diagrams, data flow diagrams, and the identification of the engineering data dimensions/volumes. This analysis has identified several concerns and issues, as well as a series of findings. These areas have been divided into organizational, technical, and management categories. The critical areas currently limiting the acquisition, use, and management of PDD and identify potential automation opportunities are the "concerns" that fall into the "technical" category.

The major observations from the concerns, issues, and findings can be classified into three major areas:

- **Ineffective Configuration Management Practices** - The major source of this concern is the incomplete engineering data packages that are accepted by the Air Force at PMRT. In addition, the current configuration of the weapon system is not reflected in the latest version of the drawings due to: 1) lost and missing data, 2) uncontrolled local drawing files, and 3) lack of controlled update procedures on ECPs/OCPs between the Air Force and contractors.

- **Engineering Data Acquisition Methods** - The initial engineering data acquisition is critical to successful logistics and engineering support. Currently, the concerns exist due to three major factors: 1) inconsistent data formats (i.e., primary emphasis on reprocurement data not sustaining engineering support data), 2) IPRs focus on drawings format not the technical accuracy and completeness of the drawings, and 3) current acquisition DRED/DOED acquisition methods cause data unavailability concerns.

- Manual Distribution/Access Procedures - The source of this concern is attributed to the extensive manual process of managing and maintaining the aperture cards. This causes delays in responding to user requests for drawing at the ALCs and backlogs of updates/new engineering data to be distributed by the ALC to MAJCOM bases.

A matrix that provides an overview of the major findings is presented in Table 6-4. The shaded areas in the matrix highlight the key concerns, issues, and findings and illustrates that the technical category is the primary area of emphasis to be addressed in the PDD Automation Plan.

TABLE 6-4. OVERVIEW OF MAJOR CONCERNS, ISSUES, AND FINDINGS

	ORGANIZATIONAL	TECHNICAL	MANAGEMENT
CONCERNS:			
• Inadequate Configuration Management of Eng. Data	✓	✓	✓
• Ineffective IPRs		✓	✓
• Inaccurate Engineering Data Package Validation Procedures		✓	
• Only Sample Analytical Results Reported to ALCs	✓	✓	✓
• Slow Response to Drawing Requests	✓	✓	✓
• Missing/Incomplete Engineering Data		✓	✓
ISSUES:			
• AFLC/AFSC Engineering Data Acquisition Conflicts	✓	✓	✓
• Lack of Robust Data Exchange Standards		✓	
• Engineering Data not Useful for Sustaining Engineering Support		✓	✓
• Different Levels of Engineering Data in Repositories		✓	
FINDINGS:			
• Engineering Data Important for Weapon Systems (7–10 Years)		✓	
• Greater Use of Engineering Data by MAJCOMS		✓	
• Rekeying Drawings into CAD Sytems		✓	

☐ Identifies important areas to be addressed in the PDD Automation Plan.

APPENDICES

ORGANIZATIONAL ASSESSMENT

IDEF$_0$ DIAGRAMS

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ORGANIZATIONAL ASSESSMENT

APPENDIX A: ORGANIZATIONAL ASSESSMENT

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A.1 INTRODUCTION

The appendix describes the roles and responsibilities of the major Air Force organizations which support the acquisition, use, and management of PDD. It details the descriptions of the staff and resource functions, organizational roles and responsibilities, and the Air Force organizations mapped to several functions in matrix analysis.

A.1.1 Purpose

The purpose of the organizational environment assessment is to describe the roles and responsibilities of the major Air Force organizations. In addition, this assessment is meant to be a reference document to be consulted on an as needed basis. It is intended to be used in conjunction with the $IDEF_0$ models (Section 3 and Appendix B), PDD Data Flow Diagrams (Section 4 and Appendix C), and to provide a context for the development of a PDD Automation Plan. A depiction of the current organizations accomplishes the following:

- Clarifies the responsibilities of various Air Force staff functions and organizations in the acquisition, use, and management of PDD.
- Provides a background for the identification of PDD use and application requirements within the Air Force environment.
- Provides a baseline that identifies a constituency of users which require digital PDD in the future environment.

A.1.2 Methodology

The data necessary for the assessment of the PDD organizational environment was based on a review of the applicable documentation and by conducting site visits/interviews. The documentation consisted of a review of Air Force regulations, mission and organization regulations, and other relevant documentation. A list of these documents is presented in Appendix E. The narrative descriptions have been drawn from these sources and are presented here for the convenience of the reader.

A.1.3 Scope

The organizational assessment focuses on the Air Force organizations principally involved in the acquisition, use, and management of PDD as follows:

- Air Force Logistics Command (AFLC) – focusing specifically on the Air Logistic Center (ALC) organizations;
- Air Force Systems Command (AFSC) – Product Divisions and System Program Offices (SPOs);

- **Major Commands (MAJCOMs) - Major Using Commands and MAJCOMs; and**
- **Air Force Test Organizations and Laboratories.**

A.1.4 Organization

Section A.2 describes the responsibilities of the key Air Force staff and resources. Section A.3 defines the roles and responsibilities of AFLC, AFSC, MAJCOMs, and other organizations. Section A.4 presents a series of matrices that depicts the MAJCOMs in relation to the $IDEF_0$ functions.

A.2 STAFF/RESOURCE FUNCTIONS

The following are functional descriptions of the key staff and resources that support PDD requirement definitions, engineering support, logistics functions, and operational support:

- Key Staff include:
  - Engineering Data Management Officer (EDMO)
  - System Program Manager (SPM)
  - Equipment Specialist (ES)
  - Item Manager (IM)
  - Engineer/Maintenance Planner
  - Drafting/Designer
  - Engineer
  - AF Plant Representative Office/Defense Contract Administration Services (AFPRO/DCAS)
- Resources are:
  - Engineering Data Service Centers (EDSCs)

A.2.1 Engineering Data Management Officer (EDMO)

EDMOs are responsible for planning, coordinating, and managing the acquisition of engineering data. They also develop an Engineering Data Management Plan (EDMP) and associated Contractor Data Requirements List (CDRL). The EDMO defines the type and class of data to be purchased and develops the Statement of Work which establishes the engineering data review and acceptance events. The EDMO coordinates the EDMP and CDRL with the SPM to assure proper interfaces with the Configuration Management Plan (CMP), i e , the effect of Engineering Change Proposals, Waivers, and Deviations. The EDMO is also responsible for determining when and how the configuration baseline is to be established and controlled for the life of the development and production of the equipment The EDMOs reside within the AFSC Product Divisions and provide support to the SPOs in the acquisition of new weapon systems. EDMOs are also located in the ALC's Competition Advocacy (CR) directorate and provide support to the Product Division EDMOs on new acquisition programs, spare part reprocurements, and modification programs.

A.2.2 System Program Manager (SPM)

The SPMs are located in the ALC System Program Management Division (MMS) and the Acquisition Division (MMA). The SPM is designated by the Air Force Implementing Command that has been assigned program management responsibility by the HQ USAF Program Management Directive (PMD). The SPM establishes, directs, and controls the acquisition of engineering data for their particular program from the contractors, and ensures technical accuracy of the engineering data. The SPM coordinates all engineering changes, new sources of procurement, etc. Within AFLC, the SPM has prime responsibility for operational engineering support to the AFSC SPO and is the coordinating point for item management support actions on component items with application to support systems. The SPM office requires the use of analysis/design data, engineering drawings, lists, specifications, manufacturing, and test data to perform sustaining engineering and reprocurement activities.

A.2.3 Equipment Specialist (ES)

The ES commences responsibility during the conceptual phase and continues until the product is retired. The ES plays an active and influential role in design and development phases by studying and planning ALC maintenance concepts and repair techniques to influence the design and improve reliability, maintainability, and supportability. The responsibilities of the ES also include analyzing test program results for maintenance implications and representing the Directorate of Materiel Management (MM) in design reviews, engineering inspections, and other reviews. The ES also assists the Product Management Branch (MM_P) in the establishment of repair requirements for repairable items. The equipment specialists reside within the System Program Management Division (MMS), Acquisition Division (MMA), Item Management Division (MMI), and the Engineering and Reliability Branch (MM_R) Branch.

A.2.4 Item Manager (IM)

The IM is responsible for projecting the quantities, sources, and dollar amounts for materiel requirements in support of system acquisition and spares reprocurement activities. The IM requires the use of engineering drawings and specifications to perform the required functions The IMs provide support to major items on a weapon system and reside within ALC/MM Item Management Division (MMI), Requirements and Distribution Branch (MM_D), System Program Management Division (MMS), and the Acquisition Division (MMA).

A.2.5 Engineer/Maintenance Planner

The Engineer/Maintenance Planners reside in the Engineering/Planning Branch (MA_E) and provide support in planning and executing the local manufacturing and repair functions. The Engineer/Maintenance Planners perform research in defining the technical requirements, determining the engineering drawing/process requirements, identifying labor and materiel requirements, and scheduling the workloads.

A.2.6 Drafting/Designer

The Drafting/Designers reside within the ALC Operations and Support Branch (MMED) and provide engineering support to the Engineering Division (MME), SPM, and the MA_E organizations. The drafting/design functions include producing engineering drawings/revisions, ECOs, Advance Engineering Change Orders (AECOs), and prototype drawings.

A.2.7 Engineers

There are several types of Engineers (e.g., mechanical, electrical) within the ALC MM, MA, and CR directorates. Typically, the Engineers reside within MM_R and perform a variety of engineering functions, such as: engineering analysis, deficiency analysis, Engineering Change Order (ECO) development, specification development, design review support, and testing in support of modifications and repair. Engineers also reside in MA_, Product Divisions (e.g., Airborne Electronics, Landing Gear), and MAB/MAK, Aircraft Division, in support of Computer-Aided Manufacturing (CAM), numerical control (N/C) part programming, and machining in support of modifications and local manufacturing

A.2.8 AF Plant Representative Office/Defense Contract Administration Services (AFPRO/DCAS)

The AFPRO/DCAS inspectors are involved in the acquisition of engineering data by surveying the contract's performance from award through acceptance and delivery of items. The AFPRO/DCAS inspectors (government service civilians) are responsible for protecting the government's interests at the contractors plants.

The AFPRO/DCAS inspectors support the EDMOs during the In-Process Review (IPR), commit contractor resources, verify engineering data updates, and conduct the Physical Configuration Audit (PCA). They also inspect new drawings, quality check the aperture cards and provide recommendations on final acceptance and delivery of the engineering data using DD Form 250 (Material Inspection and Receiving Report). The AFPRO inspector resides at a large defense contractor's facility (e.g., new acquisitions), while the DCAS inspector monitors smaller contractors (e.g. spares reprocurement acquisitions) within a given region, entering a plant only occasionally.

A.2.9 Engineering Data Service Center (EDSC)

The EDSCs are manual repositories for storing and maintaining engineering data acquired by Air Force weapon systems. The EDSCs maintain engineering data aperture cards/

hardcopy drawings (in manual tub files) and produce millions of reproductions annually. The EDSCs are responsible for completing a quality audit review before accepting data received under DD Form 250, removing obsolete data from the active files and maintaining the data in an obsolete storage area. The EDSC maintains a reserve deck file for sets of data and the master rights-in-data file. Each ALC EDSC maintains the engineering data for the assigned weapon system and commodities in support of reprocurement of spares, local manufacturing/repairs, modifications, and engineering support.

Base level EDSCs at the MAJCOMs provide engineering data support to all installation activities which require engineering data support. The EDSCs at the bases only contain Contractor Design Activity (CDA) drawings, not Government Design Activity (GDA) or subcontractor drawings. The applicable MAJCOM approves the establishment of a base level EDSC and designates its category (I–IV) based on the data requirements and mission of the MAJCOM. The following are the categories of the EDSCs:

- Category IV – Required when the mission requires a complete range of engineering data for assigned weapon systems, (i.e., ALCs and some MAJCOMs).
- Category III – Established where the mission normally needs special or limited sets of engineering data, and the installation is only authorized to maintain limited files of engineering data.
- Category II – Required when the installation normally needs individual engineering drawings to support its mission, but is not authorized to keep files of the engineering data.
- Category I – Established where the mission does not normally need engineering data support.

EDSCs are located at the five ALCs, Aerospace Guidance and Metrology Center (AGMC), Aerospace Maintenance and Regeneration Center (AMARC), and the 2750TH Air Base Wing at Wright Patterson AFB. There are sixty-eight base level MAJCOM EDSC facilities located within the following organizations. Strategic Air Command (SAC), Military Airlift Command (MAC), Tactical Air Command (TAC), Pacific Air Forces (PACAF), Alaskan Air Command (AAC), Air Force Communications Command (AFCC), and Space Command (SPACECOM). EDSCs are also located at the Air Force Technical Applications Center (AFTAC) and the Air Force Flight Test Center (AFFTC).

A.3 ORGANIZATIONAL ROLES AND RESPONSIBILITIES

This section describes an overview of the roles and responsibilities of the major organizations that support the acquisition, use, and management of engineering data.

A.3.1 Headquarters Air Force Logistics Command (HQ AFLC)

HQ AFLC is responsible for establishing distribution and control policies for engineering data and defining the engineering data acquisition requirements in the PMD. AFLC is responsible for performing all major maintenance, overhaul, repair, modifications, and upgrade on Air Force weapon systems. It also provides policy and management direction to the five ALCs. The Aerospace Guidance and Metrology Center (AGMC), Aerospace Maintenance and Regeneration Center (AMARC), Cataloging and Standardization Center (CASC), 2750th ABW, and Air Force Acquisition Logistics Center (AFALC) are direct reporting units of AFLC. An overview of the AFLC organizations is depicted in Figure A-1.

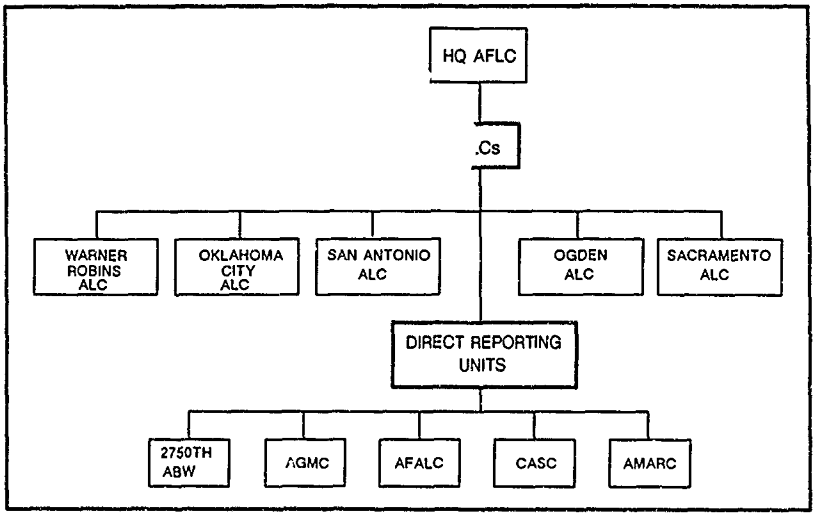

FIGURE A-1. AFLC ORGANIZATION CHART

HQ AFLC/MM, is responsible for designating the prime ALC/MMA, as the focal point for engineering data acquisition policy. HQ AFLC/MMM, Directorate of Materiel Requirements, conducts engineering technical reviews of modification proposals, determines the maintenance requirements for modifications, establishes priorities for approving Engineering Change Proposals (ECPs), and ensures that full consideration is given to the acquisition of engineering data sufficient to allow competitive procurement for replenishing spare parts.

HQ AFLC/MMT, Directorate of Reliability, Maintainability, and Technology Policy, administers engineering data distribution and control for AFLC EDSCs by collating the AFLC Form 24 (Engineering Data Support Report) which identifies the engineering data request and usage statistics. MMT is responsible for regulations and policies for engineering data management and control. They are also responsible for planning the future enhancements and defining policy direction for EDCARS.

The Directorate of Work Load Management, HQ AFLC/MAW, reviews and approves the technology/family group of commodities and assigns depot repairable items to the appropriate Technology Repair Center (TRC) for the ALCs and AGMC.

A.3.1.1 Air Logistic Centers (ALCs)

The following is a description of the five ALCs. This description details TRC responsibilities and assigned aircraft to each individual ALC. A summary chart of the ALCs versus weapon systems/commodities is shown in Table A-1.

- **Ogden Air Logistics Center (OO-ALC)** - The Ogden Air Logistics Center (OO-ALC) provides logistics support for the entire Air Force inventory of all intercontinental ballistic missiles, as well as the F-16, F/RF-4, OV-10, and C-130 aircraft. The Industrial Products and Landing Gear Division of OO-ALC is one of the most widely diversified manufacturing and overhaul operations in the USAF. The center also has responsibility for all photographic and reconnaissance equipment, and aerospace training equipment for all weapon systems as well as management of the Maverick air-to-surface missile, GBU-15 guided bombs, the Emergency Rocket Communication System, and the MX missile The center is the logistics manager for all air munitions, solid propellants, and explosive devices used throughout the Air Force.
- **Oklahoma City Air Logistics Center (OC-ALC)** - The Oklahoma City Air Logistics Center (OC-ALC) is responsible for depot maintenance on the B-52, E3-A, C/KC-135, B1-B, A-7D, C-18, C-22, C-25, C-137, and jet engines. OC-ALC repairs over 1,000 engines per year in the world's largest aircraft maintenance and jet engine overhaul plant, as well as the repair and manufacturing of diversified accessories for engines. The center is the exclusive TRC for hydraulic/pneudraulic transmissions, air-driven accessories, oxygen components, engine instruments, and automatic flight control instruments.
- **Sacramento Air Logistics Center (SM-ALC)** - The Sacramento Air Logistics Center (SM-ALC) is responsible for performing depot level support for the F-111, FB-111, EF-111, A-10, A-7, and F-4D aircraft. SM-ALC also has SPM responsibility for the Advanced Tactical Fighter (ATF). Sacramento is the TRC for ground communication/electronics (C-E) equipment, space management, electronic components, hydraulic/pneudraulic fluid-driven accessories, and flight control instruments.
- **San Antonio Air Logistics Center (SA-ALC)** - The San Antonio Air Logistics Center (SA-ALC) provides depot maintenance support for 4,700 different commodities which include aircraft, engines, and exchangeables San Antonio manages a num-

ber of different weapon systems including the C-5A, T-38, F-5, F-5E (international fighter), and F-106 aircraft. SA-ALC also has SPM responsibility for the C-17. As a specialized repair activity, SA-ALC performs modernization and heavy depot maintenance on C-5s, B-52s, and C-130s. It is the exclusive TRC for electronic aerospace group equipment, electro-mechanical support equipment, and nuclear components, and is one of the two repair centers for jet engines and components.

A Special Weapons Center EDSC repository (separate from the aircraft EDSC) is maintained by the SWRC, Cataloging and Standardization Branch, for nuclear ordnance items and related equipment.

TABLE A-1. ALC WEAPON SYSTEMS AND COMMODITIES

ALCs	WEAPON SYSTEMS	MAJOR COMMODITIES
OO-ALC	F-16 F/RF-4 GBU-15 GUIDED BOMBS MX MISSILE MAVERICK AIR-TO-SURFACE MISSILE	LANDING GEAR PHOTOGRAPHIC, RECONNAISSANCE EQUIPMENT AEROSPACE TRAINING EQUIPMENT
OC-ALC	B-52 B1-B E3-A E-4 C/KC-135 KC-10 A-7D C-18 C-22 C-25 C-137	JET ENGINES HYDRAULIC/PNEUDRALIC TRANSMISSIONS AIR-DRIVEN ACCESSORIES OXYGEN COMPONENTS ENGINE INSTRUMENTS AUTOMATIC FLIGHT CONTROL INSTRUMENTS
SM-ALC	F-111 FB-111 EF-111 F-4D F-106 A-10 ATF	GROUND COMMUNICATION-ELECTRONICS EQUIPMENT SPACE MANAGEMENT ELECTRONIC COMPONENTS HYDRAULIC/PNEUDRALIC FLUID-DRIVEN ACCESSORIES FLIGHT CONTROL INSTRUMENTS
SA-ALC	C-5 C-17 F-5 F-5E OV-10 T-38	ELECTRONIC AEROSPACE GROUP EQUIPMENT ELECTRO-MECHANICAL SUPPORT EQUIPMENT NUCLEAR COMPONENTS JET ENGINES AND COMPONENTS
WR-ALC	C-130 C-140 C-141 F-15 HH-53 HH-3	AIRBORNE ELECTRONIC WARFARE EQUIPMENT GYROSCOPES LIFE SUPPORT EQUIPMENT AIRBORNE COMMUNICATIONS NAVIGATION EQUIPMENT AIRBORNE BOMB-AND-GUN-DIRECTING SYSTEMS TARGET ACQUISITION SYSTEMS

- **Warner Robins Air Logistics Center (WR-ALC)** – WR-ALC is an industrial complex engaged in depot level repair and overhaul for the F-15 fighter aircraft; C-130, C-140, and C-141 cargo aircraft; and HH-5 series helicopters. It is the TRC for airborne electronics, gyroscopes, industrial products, and life support equipment. Responsibilities include the management and repair of airborne communications and navigation equipment, airborne bomb-and-gun-directing systems, target acquisition systems ranging from radars to integrated fire control systems, and all Air Force airborne electronic warfare equipment. The center also manages the support of joint services systems, such as: Joint Tactical Information Distribution System (JTIDS) and Navstar Global Positioning System.

A.3.1.2 ALC Branches

This section describes the primary supporting branches to the Acquisition Division (MMA), Engineering Division (MME), Item Management Division (MMI), System Program Management Division (MMS), Resources Management Division (MAW), Quality Assurance Division (MAQ), Aircraft Division (MAB), Product Division (MA_), and the Engineering Data Management Division (CRE) within an ALC. Figures A-2, A-3, and A-4 illustrate the ALC divisions and branches within the MM, MA, and CR directorates, respectively.

Directorate of Materiel Management (MM)

MM is responsible for engineering management, development, and control of the design, performance, and reliability of assigned systems and equipment. MM determines the requirements for all parts of ALC systems and commodities. The following branches within MM manage and use engineering data.

- **Production Management Branch (MMAP)** -- Upon receipt of a complete and procurable modification data package, MMAP performs modification management

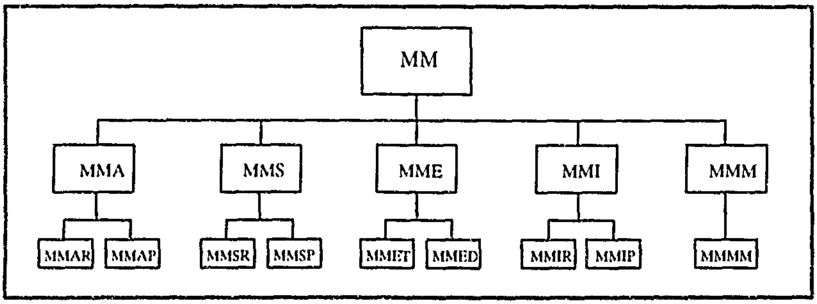

FIGURE A-2. DIRECTORATE OF MM ORGANIZATION CHART functions for Class IV and V modifications until the modification is accomplished. MMAP develops and maintains the Programmed Depot Maintenance Program (PDMP) in conjunction with MMAR, MMAM and the Using Commands. MMAP is also responsible for ensuring the availability of engineering data required concurrently with modification and maintenance, and reviewing, assembling, and delivering the complete modification data package to the ALC, D/PM contracting officer, or depot repair facility.

- **Engineering and Reliability Branch (MMAR)** - MMAR defines the repair data requirements needed for structural damage repair programs and provides specific data package characteristics for aircraft structures in support of work specification preparation. MMAR provides representation at the Preliminary Design Reviews (PDR), Critical Design Reviews (CDR), Physical Configuration Audits (PCA), and Functional Configuration Audits (FCA). MMAR evaluates contractor-prepared Engineering Change Proposals (ECPs) and assists in the determination of the requirements for engineering data necessary for maintenance, overhaul, and local manufacturing purposes.
- **Operations and Support Branch (MMED)** - MMED establishes engineering data distribution and control according to Air Force policy and procedures. MMED is responsible for micro-filming, preparing, reproducing, requisitioning, filing, and disposing of the engineering data. MMED is also responsible for the requisition and distribution of drawings, specifications, standards, and related documents to the individual ALC directorates as well as the EDSCs at the MAJCOM bases. MMED prepares Bid set data packages, maintains control over engineering drawings and related data item descriptions (which includes modifying, revising, and preparing new data items), and provides the ALC a focal point for data rights in engineering data. MMED performs design and drafting functions including engineering drawings and revisions, ECOs, AECOs, and prototype and feasibility drawings.
- **Specialized Engineering Branch (MMET)** - MMET tests new systems and equipment in support of assigned weapons, support systems, programs, and projects. MMET conducts testing for the identification of design changes, manages organic engineering flight testing, and develops justification for engineering test capabilities.
- **Engineering and Reliability Branch (MMIR)** - MMIR is responsible for evaluating contractor-prepared ECPs and providing initial raw data for Class IV and V modifications that are required to prepare master configuration status records. MMIR coordinates and participates in data calls for determinations concerning the design adequacy of procurement data packages.
- **Production Management Branch (MMIP)** - MMIP is responsible for performing modification management functions for Class IV and V modifications and manag-

ing the PDMP. MMIP ensures the availability of engineering data required concurrently with modification and maintenance, and reviews, assembles, and delivers the complete engineering data package to the ALC PM contracting officer or depot repair facility.

- **Engineering and Reliability Branch (MMSR)** – MMSR determines the engineering data requirements for the system engineering processes, participates in design reviews, and approves or disapproves procurement method codes. MMSR determines the design accuracy of proposed data packages, and provides engineering analysis and approval or disapproval of ECPs and PDM work packages. In addition, MMSR ensures the adequacy of repair data needed for structural damage repair programs, sets up the Class IV modifications programs and determines the requirements for engineering data necessary for maintenance, overhaul, and local manufacturing purposes

- **Production Management Branch (MMSP)** – MMSP will, upon receipt of a complete and procurable modification data package (from MMSR), perform modification management functions for Class IV and V modifications until the modification is accomplished MMSP also ensures availability of engineering data required concurrently with modification and maintenance and reviews, assembles, and delivers the complete data package to the ALC, D/PM contracting officer, or depot repair facility

- **Maintenance Modification Branch (MMMM)** – MMMM analyzes planning documents and data for assigned items and systems to determine the impact of logistics support on maintenance and modification phases MMMM controls and directs the management of resources for Depot Level Maintenance Requirements, performs maintenance functions for provisioning, and provides technical support in resolving problems related to data system design logic, system implementation/operation, and product use

Directorate of Maintenance (MA)

MA is responsible for managing the organic depot-level maintenance production facilities in the modification, local manufacturing, and repair of Air Force equipment Across the five ALCs and AGMC there exist twenty TRCs which provide support for depot maintenance using a particular technology (e.g., landing gear, avionics, etc) across a variety of weapon systems The following branches within MA manage and use engineering data

- **Resources Management Division (MAW)** – MAW serves as the directorate representative on depot maintenance for local manufacturing and repairs MAW develops the directorate posture with regards to facilities, equipment, and skills for workloading MAW negotiates, schedules, plans, and monitors the depot maintenance support MAW forwards approved AFLC Form 206 (local manufacturing requests) to the appropriate, responsible MA_E, Engineering/Planning Branch

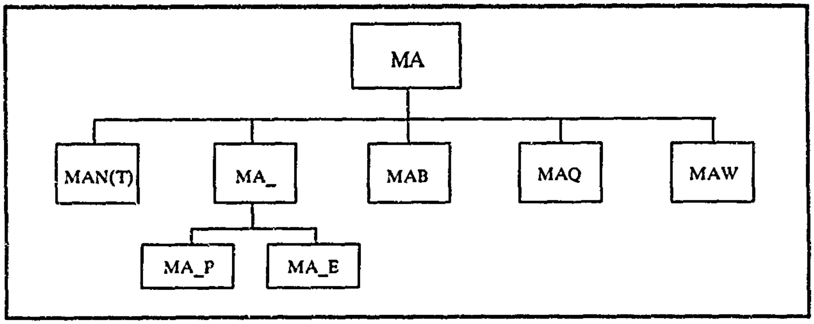

FIGURE A-3. DIRECTORATE OF MA ORGANIZATION CHART

- **Quality Assurance Division (MAQ)** - MAQ participates in preproduction and operational planning and recommends improved quality methods for application to maintenance workloads. MAW is responsible for researching and reviewing engineering drawings and specifications to establish dimensional and process requirements which control critical or significant characteristics of a part. MAQ then selects those which must be considered and evaluated for product integrity and recommends depot maintenance engineering data changes.

- **Aircraft Division (MAB)** - Within the ALC/MA organization structure is the division that provides overall maintenance support to the prime weapon systems (e.g., F-111, F-15, C-5, B-52, etc.). MAB provides support to the prime weapon system for modifications and repairs.

- **Production Branch (MA_P)** - MA_P operates the local manufacturing and repair facilities and ensures the application of supporting procedures pertaining to the directorate maintenance operation.

- **Engineering/Planning Branch (MA_E)** - MA_E plans, estimates, and schedules the labor, cost, raw materials, and requirements to perform local manufacturing and performs cost comparison for various manufacturing processes.

Directorate of Competition Advocacy (CR)

The primary mission of the CR organization is to acquire Level 3 Engineering Data packages for the competitive reprocurement of weapon systems, spare parts, and modification programs CR also supports the SPM and IM organizations during the initial acquisition and modification/repair program planning to ensure proper consideration is given to competition. The following branches within CR manage and use engineering data.

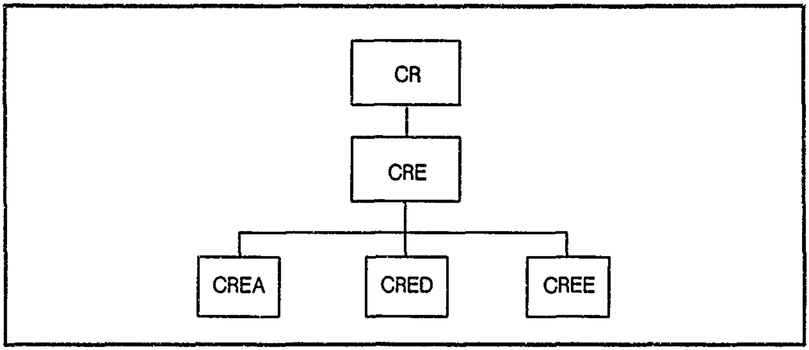

FIGURE A-4. DIRECTORATE OF CR ORGANIZATION CHART

- **Acquisition Methods Branch (CREA)** - CREA reviews requisitioned data or code H (sole source procurements) replies from HQ AFLC, reviews data for deficiencies, requests ECOs from the MM_R branch, and validates data for technical adequacy and completeness. CREA is responsible for screening the AFLC 761 reprocurement data package which is performed by engineering technicians and equipment specialists.
- **Breakout Management Branch (CRED)** - CRED is responsible for engineering data IPRs, reviewing engineering data for deficiencies, approving data for MMED, preparing bid sets, and developing ECOs.
- **Engineering Support and Data Acquisition Branch (CREE)** - CREE performs reverse engineering which is the process whereby a part, component, or end item is examined to the point where engineering data can be formulated. Other tasks that CREE performs includes miscellaneous technical support requests, handling requests from the Defense Logistics Agency, and performing cost studies.
- **Other ALC Directorates** - This section describes additional directorates within an ALC that support the management of engineering data
  - **Directorate of Contracting and Manufacturing (PM)** - PM is responsible for establishing contractual relations with industry for the acquisition, maintenance, and modification of aircraft, airborne systems, special purpose vehicles, and spare parts. PM is responsible for the execution of the PR for the acquisition of engineering data, evaluating potential firms for contract award, administering the performance of the contract, and accepting the final products.

- **Directorate of Distribution (DS)** - DS is responsible for the receipt, storage, packaging and shipment, materiel quality control, and transportation of all parts and equipment. DS also performs transportation, packaging, materials handling, and procurement management functions.

A.3.1.3 Direct Reporting Units

The following are the direct reporting units to AFLC:

- **Aerospace Guidance and Metrology Center (AGMC)** - AGMC is the single center within the Air Force and DoD for repairing and providing engineering services for inertial guidance and navigation systems for missiles, aircraft, and aircraft displacement gyroscopes. The center operates the Air Force Measurement Standards Laboratories and supports Precision Measurement Equipment Laboratories worldwide. The Directorate of Maintenance (MA) is responsible for the engineering management of the organic depot maintenance and restoration of Air Force and DoD guidance and metrology equipment to a serviceable condition.

  The AGMC EDSC maintains record copies of engineering data for its equipment and serves as the EDSC for organizations located at Newark Air Force Base.

- **Aerospace Maintenance and Regeneration Center (AMARC)** - AMARC is the DoD single manager for processing and maintaining aerospace vehicles, communication-electromagnetic-meteorological equipment (CEM), and government owned special tooling and special test equipment (ST/STE) in extended storage. AMARC is responsible for the preparation of aerospace vehicles for withdrawal from storage for one-time flight or surface shipment, retirement and reclamation of aerospace vehicles, CEM, engine and components, and accomplishing intermediate maintenance as directed/approved by HQ AFLC.

  Each aircraft undergoes a preservation process before it is stored at AMARC. About half of the 2,500 stored aircraft are returned to service. Some are sent back to the US military and others are sold to foreign governments. The remaining 50 percent of the stored aircraft undergo a parts reclamation process, which is a major source of parts for AFLC. Also, AMARC has numerous special repair activity projects such as modifying pylons to launch different weapon systems.

  The AMARC EDSC maintains record copies of engineering data for modifications and product retirement.

- **The Cataloging and Standardization Center (CASC)** - CASC ensures all reference numbers are related properly to the national stock number (NSN) and verifies the catalog management data are compatible in the Federal Catalog System and Air Force data systems. This ensures materiel and engineering integrity throughout the life cycle phases of each weapon system. CASC screens engineering drawings in support of the provisioning process, conducts a technical review of item characteristics information, processes Provisioning Parts Lists (PPLs), and evaluates design change notices. CASC also prepares and coordinates with ALC engineering activities and provides support for technical analysis, design standards, and specifications.

- **Air Force Acquisition Logistics Center (AFALC)** – AFALC appoints an engineering data focal point that assumes the duties of the supporting command EDMO (when a prime ALC EDMO has not been appointed). AFALC is responsible for ensuring fielded systems are supportable and are identifying logistics concerns early in the design to influence life cycle cost. The Deputy for Engineering and Reliability (AFALC/ER) is responsible for managing engineering and technical logistics support for emerging technologies for all acquisition program phases to influence design and to ensure the fielding of cost effective, reliable, and maintainable systems and equipment.

A.3.2 Headquarters Air Force Systems Command (HQ AFSC)

HQ AFSC is responsible for the design, development, acquisition, and delivery of Air Force weapon systems. AFSC supports the MAJCOMs' needs by the application of advanced technology in the development and enhancement of weapon systems. AFSC supports the research, development, testing, and implementation of weapon systems throughout their life cycle. AFSC provides guidance and direction to the product divisions, laboratories, and development and test centers.

A.3.2.1 Product Divisions

The five Product Divisions which support AFSC in the acquisition of weapon systems and associated engineering data are: Aeronautical Systems Division, Electronic Systems Division, Space Division, Ballistic Missile Office, and Armament Division.

- **Aeronautical Systems Division (ASD)** – ASD directs the design, development, and acquisition of aerospace systems, such as fighters, bombers, transports, aerial tankers, tactical reconnaissance aircraft, long- and short-range air-to-surface missiles and aircraft engines The division's responsibilities include programs to develop, test, and acquire manned and unmanned vehicle systems, simulators, reconnaissance and electronic warfare systems and other aeronautical equipment. The major acquisition programs at ASD are F-16, C-17, B1-B, B-2, SRAM II, ATF, and LANTIRN.

  The ASD/EN organization (Directorate of Engineering) provides extensive engineering support to the major acquisition SPOs (e.g., C-17, ATF, etc.) and equipment SPOs (e g , ASD/YZ-Propulsion and ASD/AX-Avionics). The ASD/SC organization (Directorate of Communication and Computer Systems) is responsible for the engineering support and acquisition of CAD/CAM/CAE for ASD.

- **Electronic Systems Division (ESD)** - ESD develops, acquires, and delivers electronic systems and equipment for the command, control, communications and intelligence (C3I) functions of aerospace forces. The major programs at ESD include Joint STARS, AWACS, JTIDS, MILSTAR, TRI-TAC, and C3CM systems.
- **Space Division (SD)** - SD manages the research, development, and acquisition of launch and on-orbit command and control systems for the majority of the nation's military space systems. SD's responsibilities include providing and maintaining space-based communications, meteorological navigation, and surveillance systems in support of combat forces on the ground, at sea, and in the atmosphere.
- **Armament Division (AD)** - AD acquires, plans, researches, and develops conventional air armament. The major mission areas assigned to AD are non-nuclear systems AD is responsible for testing and evaluating armament and electronic combat systems and related equipment.
- **Ballistic Missile Office (BMO)** - BMO is responsible for planning, implementing, and managing Air Force programs to acquire land-based intercontinental ballistic missile systems and sub-systems. The division performs the majority of system integration tasks on each of its projects and their systems are usually Program Management Responsibility Transferred to SAC. Current programs at BMO include the Peacekeeper, Minuteman Modernization Program, Small ICBM Program, and Peacekeeper Rail Garrison.

A.3.3 Major Using Commands

The major Using Commands (Tactical Air Command, Military Airlift Command, Strategic Air Command, Pacific Air Forces, and Alaskan Air Command) require the use of engineering drawings and parts lists to support base maintenance (repairs and local manufacturing) The Using Commands maintain base level EDSCs in support of base maintenance activities A summary chart summarizing the Using Commands and weapon systems is shown in Table A-2. The following are the Using Commands that use and manage engineering data:

A.3.3.1 Tactical Air Command (TAC)

TAC's forces perform reconnaissance, tactical fighter, command and control, and electronic combat operations TAC has approximately twenty-seven base level EDSCs for support of base repairs and local manufacture.

A.3.3.2 Military Airlift Command (MAC)

Major missions of MAC include deployment, employment, resupply, and redeployment of combat forces and the support equipment. The command serves as the single manager for DoD airlift. MAC has approximately eleven base level EDSCs for support of base repair and local manufacture.

TABLE A-2. USING COMMAND/WEAPON SYSTEMS MATRIX

USING COMMANDS	WEAPON SYSTEMS		
MILITARY AIRLIFT COMMAND (MAC)	C-130 C-9	C-5 C-141	
TACTICAL AIR COMMAND (TAC)	F-15 F-16	F-111 F/RF-4	F-106 A-10
STRATEGIC AIR COMMAND (SAC)	B-52 B-1B	FB-111 KC-135	KC-10
PACIFIC AIR FORCES (PACAF)	C-130 C-5 C-141 HH-3 B-52	KC-135 E-3 F-15 F/RF-4	F-16 A-10 F-5 OV-10
ALASKAN AIR COMMAND (AAC)	A-10 OV-10 F-15		

A.3.3.3 Strategic Air Command (SAC)

SAC provides and operates the forces necessary to ensure an effective and credible deterrent to nuclear war and is responsible for the airborne command and control worldwide air refueling support, and strategic reconnaissance. SAC has approximately five base level EDSCs for support of base repair and local manufacture.

A.3.3.4 Pacific Air Forces (PACAF)

PACAF is the principal air arm of the US Pacific Command. The primary mission of PACAF is to plan, conduct, and coordinate offensive and defensive air operations. The command operates 300 PACAF fighter and attack aircraft.

A.3.3.5 Alaskan Air Command (AAC)

The Alaskan Air Command is responsible with providing training and equipping tactical Air Forces to preserve the national sovereignty of United States lands, waters, and airspace.

A.3.4 Major Commands (MAJCOMs)

The MAJCOMs maintain base level EDSCs in support of base maintenance. These commands are: Electronic Security Command (ESC), Air Force Communications Command (AFCC), Air Training Command (ATC), and Space Command (SPACECOM). The following is a general description of other MAJCOMs use and management of engineering data in support of their missions:

A.3.4.1 Electronic Security Command (ESC)

ESC develops ways to exploit, analyze, jam, confuse, or destroy opposing command, control, and communications systems while ensuring that US Air Force Communications are protected from enemy exploitation.

A.3.4.2 Air Force Communications Command (AFCC)

AFCC complements the roles AFSC and AFLC play in the procurement of large-scale developmental systems by purchasing communications systems that are commercially available off-the-shelf. AFCC is responsible for the integration of base level communications-computer systems. AFCC is responsible for planning, budgeting, engineering, installing, operating, and maintaining C-E, automated data processing (ADP), and air traffic control (ATC) support and services for the Air Force.

A.3.4.3 Space Command (SPACECOM)

SPACECOM manages and operates assigned space assets, develops requirements, and advocates needs for space activities and provides an interface between research and development activities and users. SPACECOM provides warnings of a space or missile attack, ground control support for DoD satellites in peacetime and wartime, and has the ability to negate enemy space systems during conflict.

A.3.4.4 Air Training Command (ATC)

ATC is responsible for recruiting and officer commissioning programs as well as basic military, technical, and flying training.

A.3.5 Test Organizations and Laboratories

During acquisition and post-production support phases, the test organizations/laboratories are responsible for performing operational flight testing, design/manufacturing, and installation in support of new weapon systems and modification programs.

A.3.5.1 Test Wings

- 4950th Test Wing - The 4950th Test Wing/AM (Directorate or Aircraft Modifications) conducts flight-test programs on military systems, subsystems, and components and operates and maintains assigned test aircraft and equipment. The Test

Wing performs Class II (research and development) modification engineering analysis, design, fabrication, manufacturing and installation. It also furnishes flight-test engineering support and engineering data acquisition services for specialized missions on a worldwide basis. The Test Wing has an extensive manufacturing capability in support of Class II modifications which includes CAD/CAM/CAE equipment and CNC machines.

- **3246th Test Wing** – The 3246th Test Wing operates and maintains the ranges and facilities for the test and evaluation of non-nuclear armaments and electronic combat systems. Support for testing and other range activities is provided to the Department of Defense, other governmental agencies, and commercial enterprises.

A.3.5.2 Test Centers

- **Air Force Flight Test Center (AFFTC)** – AFFTC conducts and supports flight testing and evaluation of manned and unmanned aircraft, aerospace research vehicles, related propulsion, flight-control avionics, and weapon systems in or entering the Air Force inventory. Similar tests and evaluation can also be carried out by AFFTC on aircraft belonging to other US military services and government agencies and aircraft and related systems of certain foreign governments. AFFTC has a base level EDSC in support of the testing activities.
- **Air Force Operational Test and Evaluation Center (AFOTEC)** – AFOTEC is the Air Force's independent test agency responsible for operational testing of new or modified weapon systems and/or components being developed for Air Force and multiservice use. The primary purpose of conducting operational test and evaluation (OT&E) is to reduce risk in the acquisition process by determining how well systems perform when operated and maintained by Air Force personnel in a realistic operational environment. AFOTEC is also responsible for reviewing appropriate PMDs, SONs, and determining OT&E requirements. AFOTEC, when directed by HQ USAF, budgets and conducts OT&E modification programs.

A.3.5.3 Additional Test Organizations

There are several other development and test organizations, including the Air Force Engineering and Services laboratory (AFESC/RD); Arnold Engineering Development Center (AEDC), Space and Missile Test Organization (SAMTO); Western Space and Missile Center (WSMC), Eastern Space and Missile Center (ESMC), and the Consolidated Space Test Center (CSTC).

A.3.5.4 Laboratories

- **Wright Research and Development Center (WRDC)** – WRDC was established to enhance the integration of technologies in the areas of materials, aero propulsion, avionics, and flight dynamics. WRDC conducts and supports research, exploratory development, and advanced technology development in many fields and is responsible for selected engineering development efforts as well as the Air Force's Manufacturing Technology (MANTECH) program and the Repair Technology (REPTECH) program. WRDC has four major laboratories:

- **Materials Laboratory (ML)** - Conducts the total Air Force program in testing and development of materials application, exploratory development, metals, ceramics, and non-metallic materials. Some major areas of emphasis include Computer-Integrated Manufacturing (CIM), thermal protection materials, composites and metals for high-temperature applications. The following two major ML programs are performing R&D, test and evaluation of emerging PDD technologies:

  Manufacturing Technology (MANTECH) Program - The objective of MANTECH is to reduce material acquisition costs by demonstrating first-case, factory-floor implementation of new or improved manufacturing methods, processes, and equipment at the contractor's plant that are applicable to DoD weapon systems.

  Repair Technology (REPTECH) Program - REPTECH involves the implementation of new technology in the ALCs. In general, a REPTECH project is applicable when the technology for the solution to a depot repair operation problem exists, but a shop floor solution is not commercially available. The objectives of the REPTECH program are to develop/implement appropriate technology to establish, upgrade or modernize the manufacture, repair, maintenance, and quality assurance operations at the ALCs and to integrate advanced technology into depot repair operations for achieving maximum productivity growth and cost efficiency.

- **Avionics Laboratory (AA)** - Conducts research and development in the areas of navigation, surveillance, reconnaissance, electronic warfare, fire control, weapon delivery, electronic technology, and avionics systems to provide a broad technology base for future systems and ensure application to Air Force aerospace needs. The term "avionics" is defined as all of the electronics aboard aviation and aerospace systems.

- **Flight Dynamics Laboratory (FI)** - Focuses primarily on developing flight-vehicle technologies, including structural design and durability, vehicle dynamics, subsystems and equipment, crew escape and recovery, flight simulation, aerodynamics, and performance.

- **Aero Propulsion Laboratory (PO)** - Conducts research and development in the areas of aerospace power, air-breathing propulsion, and fuels and lubrication.

- **Rome Air Development Center (RADC)** - RADC is the principle organization responsible for the Air Force R&D programs related to command, control, and communications (C3). RADC is responsible for advancing technology and assisting in demonstrating and acquiring selected systems and subsystems within the areas of intelligence, reconnaissance, and mapping and charting.

A.3.6 Air National Guard (ANG)

The ANG's federal mission is to provide trained personnel for prompt mobilization as the primary source of augmentation for the Air Force in the event of emergency. ANG units are assigned to 10 gaining MAJCOMs of the Air Force in support of this mission. ANG provides air-to-air refueling for strategic and tactical missions Support units within ANG include tactical control units, combat information system units, engineering installation squadrons, base information systems flights, weather flights, a range control squadron, and aircraft control and warning squadrons. The ANG units have base level EDSCs in support of repairs and local manufacturing.

A.3.7 Separate Operating Agency - Air Force Reserve Forces (AFRES)

AFRES provides trained units and qualified personnel for active duty in times of emergency and supports Air Force mission requirements as a by-product of training for peacetime missions AFRES also flies MAC missions, performs aerial refueling sorties for SAC, performs search and rescue missions, and provides rescue support for launches and recovery of space shuttle missions.

A.3.8 Direct Reporting Unit - Air Force Technical Applications Center (AFTAC)

AFTAC is responsible for system manager responsibilities for all mission equipment which is designated Atmospheric Research Equipment (ARE) and Special Electronic Equipment (SEE) The AFTAC Technical Operations Division maintains an EDSC for atomic energy detection system data.

A.4 FUNCTIONAL RESPONSIBILITIES

Table A-3 depicts the Air Force MAJCOM organizations that acquire, use, and manage PDD throughout the life cycle of the weapon system. The matrix shows the organizations that have primary and supporting responsibility in relation to the functions defined in the $IDEF_0$ model (Section 3)

TABLE A-3. PDD ORGANIZATION/FUNCTIONS MATRIX

MAJCOM	ORGANIZATION		ACQUIRE ENG DATA			PROVIDE POST-PROD. SUPPORT					MANAGE ENG. DATA		
						USE							
			PLAN	CREATE	REVIEW	Mods	Spares Repro-curement	Local Mfg	Repairs	REVISE	CONTROL	DISTRIB.	RETIRE
AFLC	MMA	ACQUISITION DIVISION	●		○	○		○	○	○			
	MME	ENGINEERING DIVISION	○	○	●	○	●	○	○	●	●	●	
	MMI	ITEM MANAGEMENT DIVISION	●		○	○	●	○	○				
	MMS	SYSTEM PROGRAM MGT (SPM) DIV	●		●	●	○	○	○	○	○		
	MAW	MAINTENANCE WORK LOADING						○	●				
	MAQ	QUALITY ASSUF DIVISION						●	●				
	MAN(T)	INDUSTRIAL PROD AND COMMODITIES						●	○	○			
	MAA	MANAGEMENT SUPPORT DIVISION			●						○		
	MAB	AIRCRAFT DIVISION				○			○	○			
	MA_	PRODUCT DIVISION				○		○	○				○
	CRE	ENGINEERING DATA MANAGEMENT DIV	●	○	●	○	●	○		○			
	PM	DIR OF CONTRACT & MANUFACTURING		●	○								
	DS	DIRECTORATE OF DISTRIBUTION					○						
	AGMC	AEROSPACE GUID & METROLOGY CEN						○	○	○			
	AMARC	AEROSPACE MAINT & REGEN CENTER				○							●
	CASC	CATALOGING & STANDARD CENTER									●		
	AFALC	AF ACQUISITION LOGISTICS CENTER	○		○	○	○						
	2750TH ABW	DAD-DATA ADMIN DIVISION										○	
AFSC	ASD/EN	DIRECTORATE OF ENGINEERING	○	○	●	●	○	○	○				
	TEST WINGS	4950TH 3246TH				●			○	○			
	EST	F FLIGHT		○		○							○
	CRE	ENGINEERING DATA MANAGEMENT	●	○	●	○	●	○		○			

	CRE	ENGINEERING DATA MANAGEMENT DIV	●	○	●	○	●	○		○			
	PM	DIR OF CONTRACT & MANUFACTURING		●	○								
	DS	DIRECTORATE OF DISTRIBUTION					○						
	AGMC	AEROSPACE GUID & METROLOGY CEN						○	○	○			
	AMARC	AEROSPACE MAINT & REGEN CENTER				○							●
	CASC	CATALOGING & STANDARD CENTER									●		
	AFALC	AF ACQUISITION LOGISTICS CENTER	○		○	○	○						
	2750TH ABW	DAD-DATA ADMIN DIVISION										○	
AFSC	ASD/EN	DIRECTORATE OF ENGINEERING	○	○	●	●	○	○	○				
	TEST WINGS	4950TH 3246TH				●			○	○			
	TEST CENTER	AF FLIGHT TEST CENTER		○		○							
	LABS	WRIGHT RESEARCH & DEVEL CENTER		○									
	RADC	ROME AIR DEVELOPMENT CEN	○	○									
* MAJOR USING COMMS	MA	DIRECTORATE OF MAINTENANCE	○					○	●		○	○	
ESC	LG	LOGISTICS									○		
SOA	AFOTEC	AF OPERATIONAL TEST & EVAL CEN	○	○		○							
ANG	MA	DIRECTORATE OF MAINTENANCE						○	○		○		

LEGEND

● Primary Responsibility for Function ○ Supports Function

* Includes MAC, SAC, TAC, PACAF, and AAC

APPENDIX B

IDEF$_0$ DIAGRAMS

APPENDIX B: IDEF$_0$ DIAGRAMS

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LIST OF FIGURES

B.1 INTRODUCTION

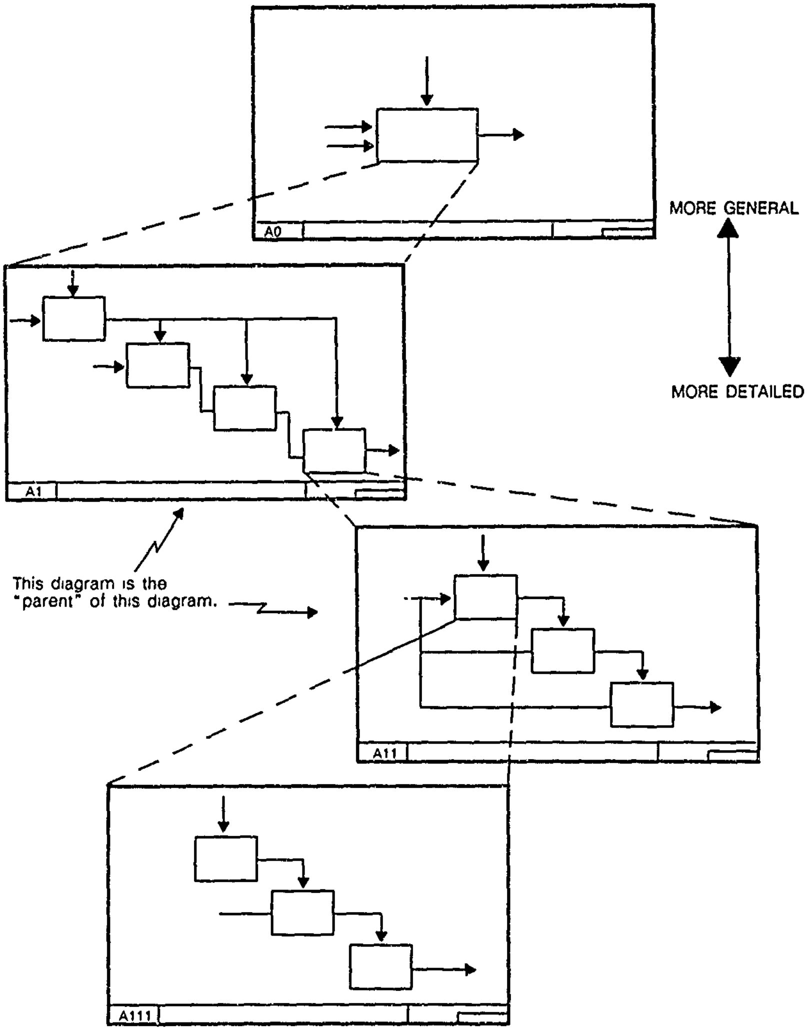
The $IDEF_0$ model analyzes each activity in terms of Inputs, Controls, Outputs, and Mechanisms (ICOMs) and interrelationships among activities. Definitions of ICOMs are given in Figure B-1. The ICOMs indicate the constraints on an activity and the information and materials that are used in or produced by the activity. The process name appears in each box. Information flow between activities is represented by arrows that interconnect the activity boxes. Information flows are identified by using a noun or noun phrase linked to the appropriate arrow by a graphic indicator. The structure of an $IDEF_0$ model is shown in Figure B-2 A series of four diagrams is shown along with each diagram's relation to the others.

INPUTS:	An input is information or material that is used to produce the outputs of an activity. Input is consumed or transformed by the activity. Input flows always enter the left side of an activity box. It is not necessary for each activity to have identified Input flows on a diagram.
CONTROLS:	A control is information or material which constrains an activity. It regulates the transformation of input into output. Controls, however, are not changed by the activity as Inputs are. These flows always enter the top of an activity box. If a control gove'ns all the subtasks for an activity, the entry for the lower level activity is left blank.
OUTPUTS:	Output is information or materials that are produced by the activity or result from the activity Output flows always leave the right side of an activity box. Output must be present for evey activity and must show the transformation of the input.
MECHANISMS:	Mechanisms are usually machines, resources, or existing systems (hardware /software) that perform the activity or provide energy to the activity Mechanisms always enter the bottom of an activity box. All activities must have mechanisms. However, they may be intentionally omitted from a diagram.

FIGURE B-1. ICOM DEFINITIONS

An $IDEF_0$ model starts by representing the whole system as a simple unit - a box with arrow interfaces with functions outside the system. Since the single box represents the system as a whole, the descriptive name written in the box is general. The same is true of the interface arrows, since they also represent the complete set of external interfaces to the system as a whole.

The box that represents the system as a single module is then detailed on another diagram with boxes connected by interface arrows. These boxes represent major subfunctions (submodules), each represented as a box whose boundaries are defined by the interface arrows. Each of these submodule boxes may be similarly decomposed to expose even more detail.



Every component may be decomposed in another diagram
Every diagram shows the "inside" of a box on a parent diagram

FIGURE B-2. IDEF$_0$ MODEL STRUCTURE

B.2 ENGINEERING DATA PROCESS - NODE A0

The node tree provides a high level overview of the entire Engineering Data process. The context diagram A0 decomposes the Engineering Data process into the following major sub-functions Acquire Engineering Data, Use Engineering Data and Manage Engineering Data In general, this node depicts the engineering data acquisition activities performed by AFSC with support from the ALCs (Node A1): receipt of the data by the ALCs in the form of aperture cards to support post-production activities, spares reprocurement, local manufacturing, repairs, and modifications (Node A2), and the management, control, and distribution of the data by the ALCs and MAJCOMs (Node A3). (See Figure B-3, the node tree, and Figure B-4, the $IDEF_0$ process.) AFR 800-34 (Engineering Data Acquisition) sets the policy and guidance for engineering data acquisition and use DoD-D-1000B (Engineering Drawings and Associated Lists) and DoD-STD-100C (Engineering Drawing Practices) prescribes the engineering data format and practices Management and control of the engineering data is performed per AFR 67-28 (Engineering Data Distribution and Control).

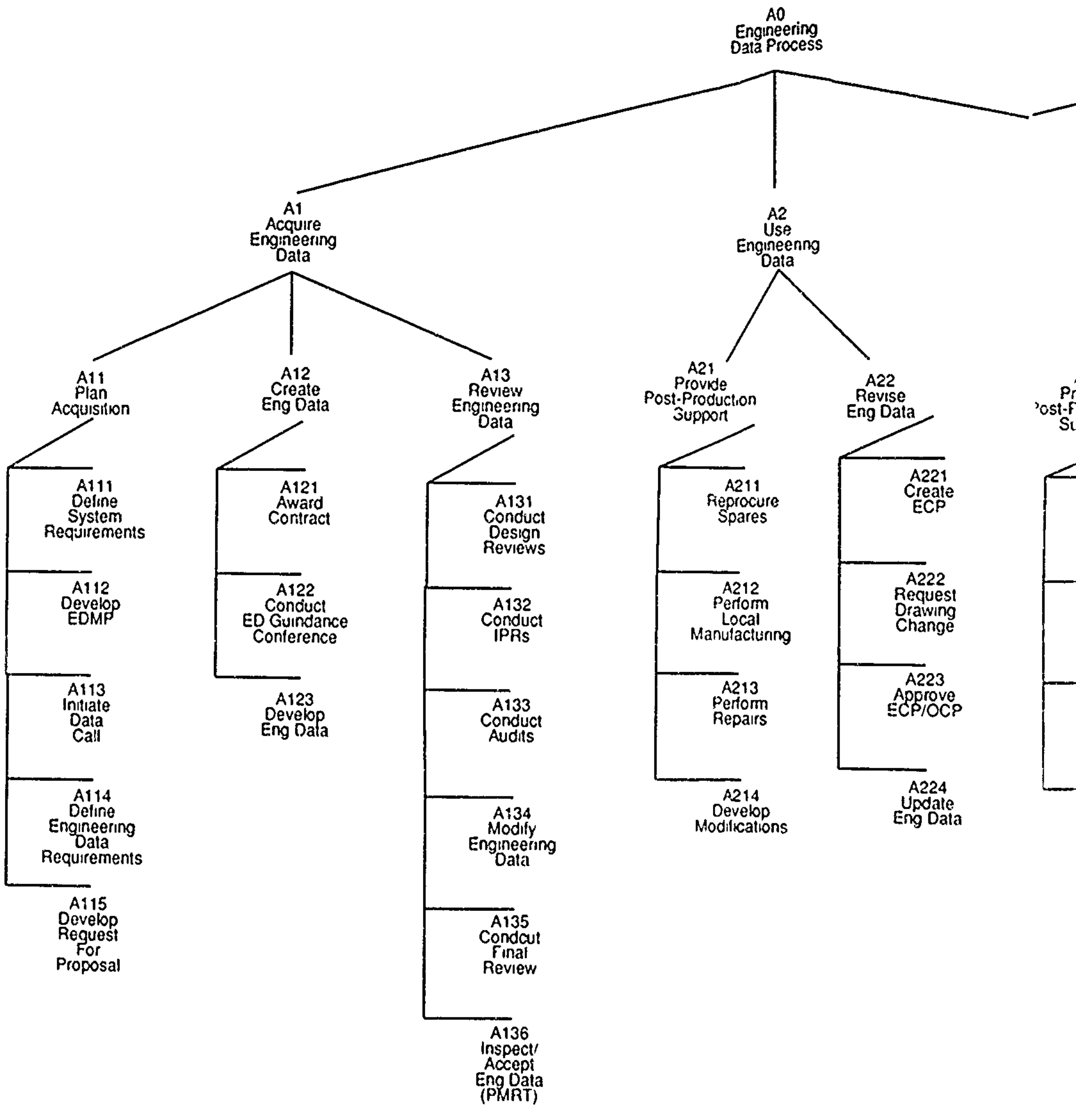
The node tree diagram presented in Figure B-3 gives a hierarchical overview of the engineering data activities In contrast with the $IDEF_0$ model, the node tree does not direct information flows related to the activities. The node tree provides a reference point for understanding the activities and decomposition relationships represented in the $IDEF_0$ diagrams See Figure B-4 for an overview of the $IDEF_0$ model.

B.3 ACQUIRE ENGINEERING DATA - NODE A1

Upon approval of the Statement of Operational Need (SON) by HQ USAF, the acquisition of engineering data is planned in support of the weapon system through the development of the Engineering Data Management Plan (EDMP). A data call is initiated by the SPO allowing the ALCs to define the engineering data requirements. Then, a contract is awarded and the engineering data is developed by contractors. The SPO conducts several reviews and audits throughout the acquisition life cycle. Finally, the engineering data is inspected/accepted by the ALCs. (See Figure B-5, the node tree, and Figure B-6, the $IDEF_0$ process.)

The engineering data to be acquired is developed during each major weapon system phase·

- Level 1 Engineering Data documents the concept and fabrication of the developmental hardware This data is required during the conceptual exploration phase of acquisition and normally is not delivered except as required to support technical reviews.



A0 Engineering Data Process
A1 Acquire Engineering Data
A11 Plan Acquisition
A111 Define System Requirements
A112 Develop EDMP
A113 Initiate Data Call
A114 Define Engineering Data Requirements
A115 Develop Request For Proposal
A12 Create Eng Data
A121 Award Contract
A122 Conduct ED Guindance Conference
A123 Develop Eng Data
A13 Review Engineering Data
A131 Conduct Design Reviews
A132 Conduct IPRs
A133 Conduct Audits
A134 Modify Engineering Data
A135 Condcut Final Review
A136 Inspect/ Accept Eng Data (PMRT)
A2 Use Engineering Data
A21 Provide Post-Production Support
A211 Reprocure Spares
A212 Perform Local Manufacturing
A213 Perform Repairs
A214 Develop Modifications
A22 Revise Eng Data
A221 Create ECP
A222 Request Drawing Change
A223 Approve ECP/OCP
A224 Update Eng Data

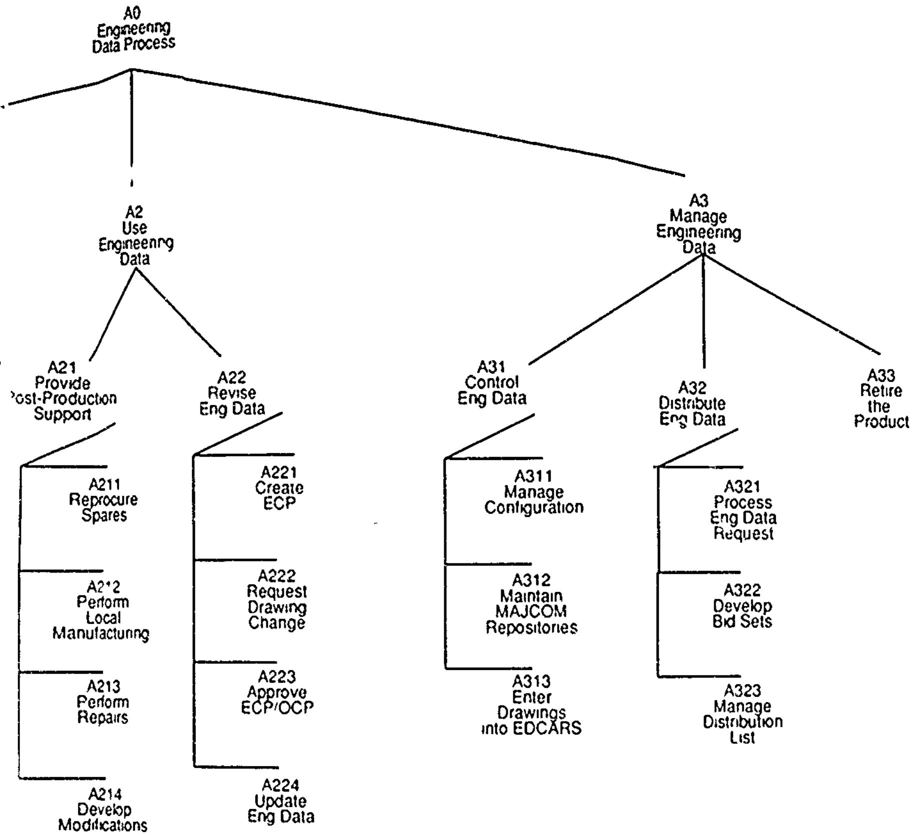


FIGURE B-3 IDEF$_0$ NODE TREE

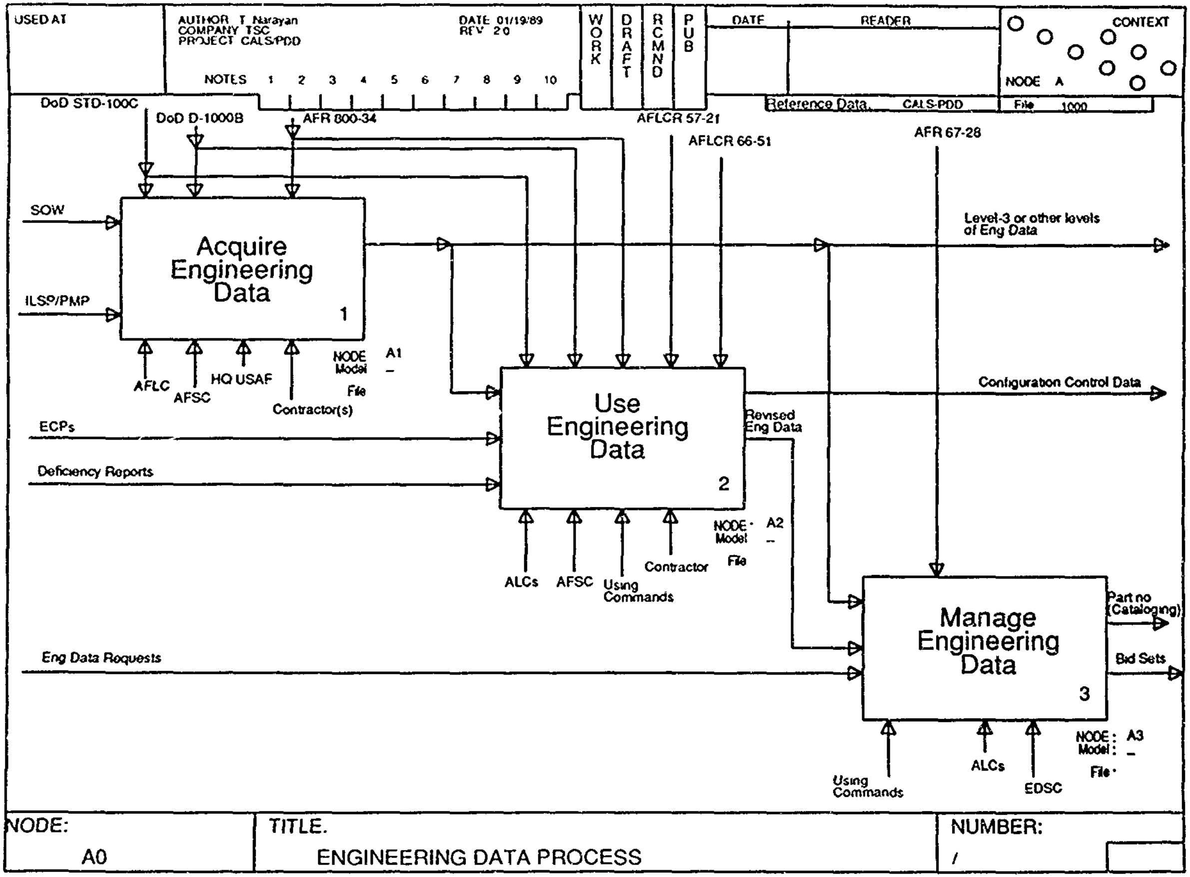


FIGURE B-4. ENGINEERING DATA PROCESS IDEF$_0$ MODEL

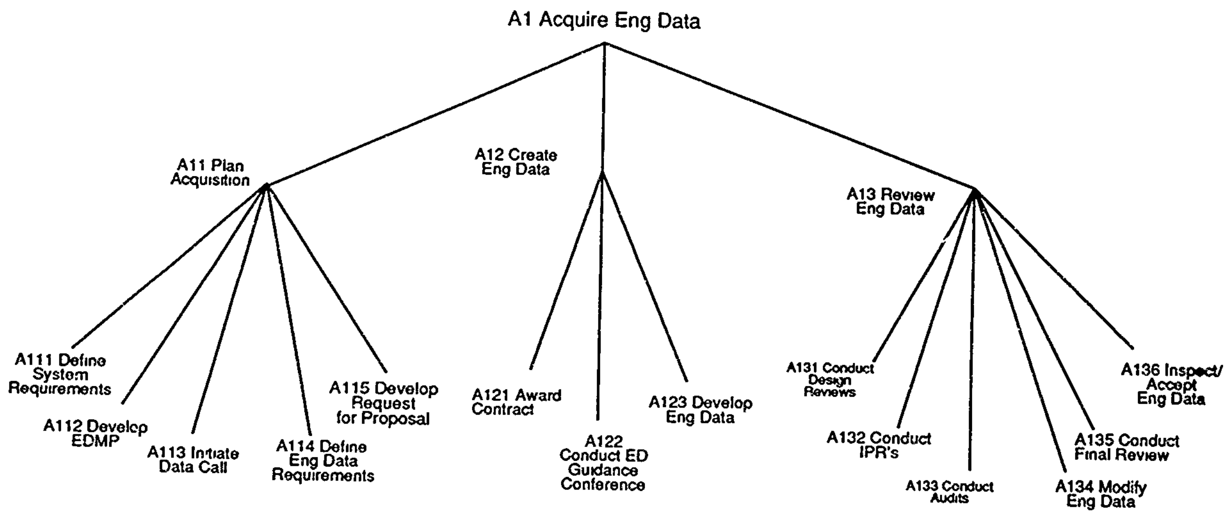


FIGURE B-5. ACQUIRE ENGINEERING DATA NODE TREE

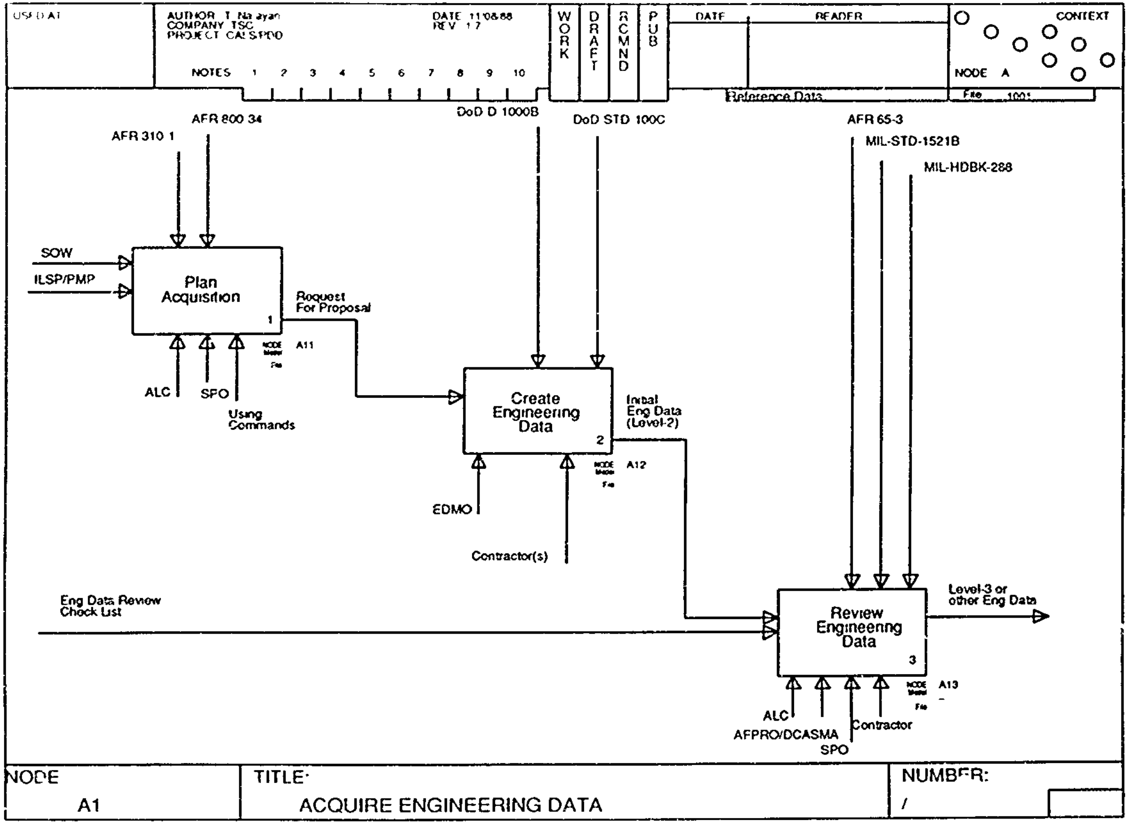


FIGURE B-6. ACQUIRE ENGINEERING DATA IDEF$_0$ MODEL

- Level 2 Engineering Data documents the design approach and is used to develop a prototype. This data is required during the demonstration, validation, and full scale development phases.

- Level 3 Engineering Data is essential for maintenance, modification, logistics, and engineering support of the production item. Level 3 Engineering Data is also essential for the competitive reprocurement of the contract end items and their spare parts.

B.3.1 Plan Acquisition - Box A11

The first major activity in the acquisition of engineering data is developing an EDMP which defines the engineering data requirements. AFSC has primary responsibility for the planning with support from the ALC Engineering Data Management Officer (EDMO). In response to the data call, the EDMOs tailor DoD-D-1000B and DoD-STD-100C based on the requirements (AFSCP/AFLCP 800-34 and AFSCP 800-18 are used as guides in the planning process.)

Inputs:	SOW, ILSP/PMP.
Controls:	AFR 310-1, AFR 800-34.
Outputs:	Request For Proposal (RFP).
Mechanisms:	ALC(s), System Program Office (SPO), Using Commands.

B.3.2 Create Engineering Data - Box A12

The contractor develops the engineering data based on an understanding of the contract requirements in DoD-D-1000B and DoD-STD-100C standards.

Inputs:	Request for Proposal (RFP).
Controls:	DoD-D-1000B, DoD-STD-100C
Outputs:	Initial Engineering Data (Level-2).
Mechanisms:	EDMO, Contractor(s).

B.3.3 Review Engineering Data - Box A13

The initial engineering data developed by the contractor is reviewed and audited by the Air Force at the contractor's site prior to its acceptance. The review process is performed by the SPO with support from the ALCs, Air Force Plant Representative Officer (AFPRO), and/or Defense Contract Administrative Service Management Area (DCASMA) representative.

Inputs.	Initial Engineering Data, Engineering Data Review Check List.
Controls.	AFR 65-3, MIL-STD-1521B, MIL-HNBK-288
Outputs	Level-3 Engineering Data or other Engineering Data
Mechanisms:	Prime ALC, AFPRO/DCASMA, SPO, Contractor

B.4 PLAN ACQUISITION - NODE A11

Planning the acquisition of engineering data is completed primarily by AFSC with support from the ALCs, and includes the following activities. defining the weapon system requirements, developing the EDMP, initiating the data call, defining the data requirements, and preparing the Request For Proposal (RFP). (See Figure B-7)

B.4.1 Define System Requirements - Box A111

The system requirements are determined from the SON and feasibility study contract(s), after which a SOW outlining these requirements is prepared by the SPO. The Program Management Directive (PMD) is the output of this system requirements definition Once the PMD is established, the EDMP can be developed.

Inputs:	SOW, SON, Feasibility Study Contracts.
Controls:	AFR 800-34.
Output:	PMD (AFSC Form 56).
Mechanisms:	SPO, ALCs, Using Commands.

B.4.2 Develop EDMP - Box A112

The Engineering Data Management Plan (EDMP) sets the strategy for the acquisition and management of engineering data. The purpose of an EDMP is two-fold. to document essential planning information and the status of engineering data development The EDMP defines the contractor's proposal evaluation strategy and the criteria for making engineering changes (time period and/or number of changes) The Configuration Management Plan (CMP), which defines the engineering release system, configuration audits, and the contractor change control process, evolves from the EDMP. The EDMP may be part of the Program Management Plan/Integrated Logistics Support Plan (PMP/ILSP) or separately established. The EDMP also initiates the Engineering Data Activity Record File (EDARF), which tracks the acquisition of engineering data as well as other activities (AFR 800-34 describes the requirements for the development of the EDMP.)

Inputs:	PMD, PMP/ILSP
Controls.	AFR 800-34
Outputs	EDARF, EDMP, Configuration Management Plan (CMP)
Mechanisms	Prime ALC/EDMO, SPO/EDMO.

B.4.3 Initiate Data Call - Box A113

The Systems Program Office (SPO), contacts the prime ALC to define the type and content of engineering data to be acquired by the Air Force. The Deputy Program Manager for Logistics (DPML) ensures that the data call from the Data Management Officer (DMO) is initiated properly and responses from ALCs are received. AFLC Form 365 (Contractor Data Call) is used to initiate the data call from DMO. The responses are

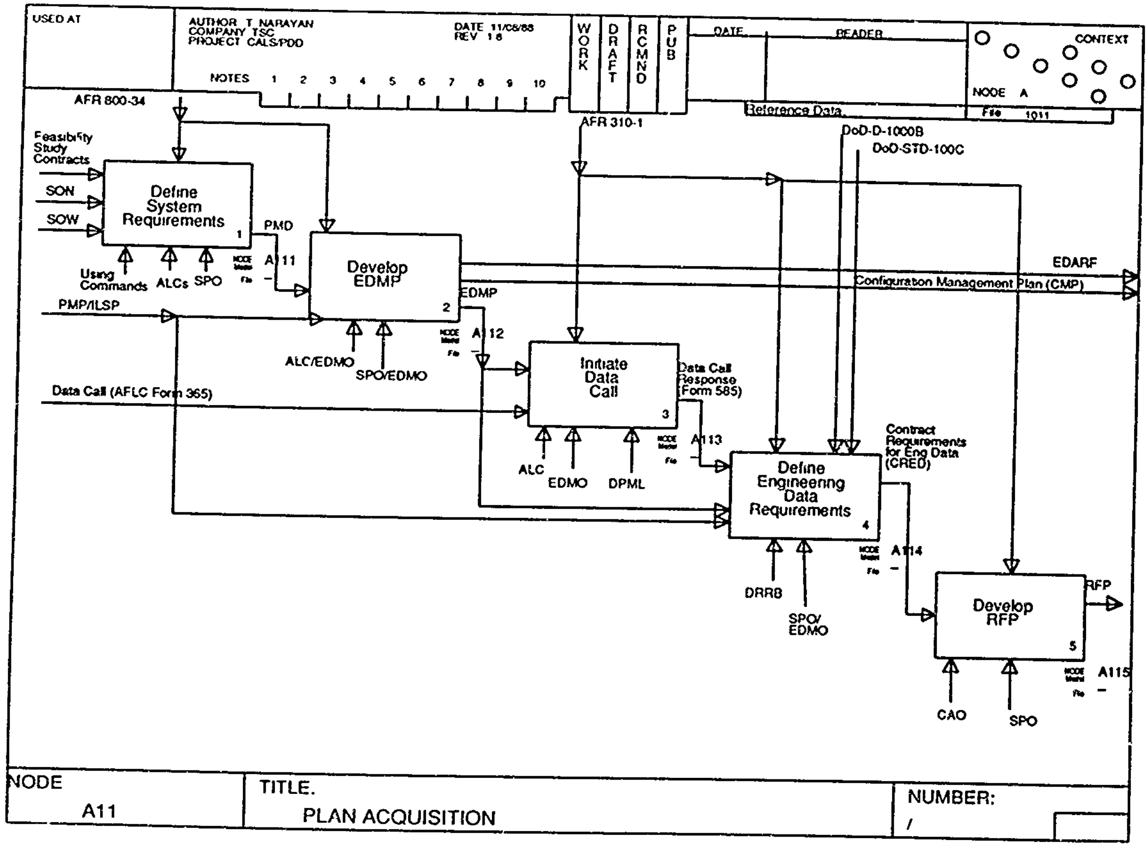


FIGURE B-7. PLAN ACQUISITION $IDEF_0$ MODEL received in AFLC Form 585 (Contractor Data Requirement Substantiation) by the ALC/EDMO. (AFR 310-1 describes the procedures for managing the engineering data.)

Inputs:	Contractor Data Call (AFLC Form 365), EDMP.
Controls:	AFR 310-1.
Outputs	Data Call Response (AFLC Form 585).
Mechanisms:	EDMO, DPML, ALC.

B.4.4 Define Engineering Data Requirements - Box A114

The Data Requirements Review Board (DRRB) and SPO refine the engineering data requirements based on EDMP, PMP/ILSP, and responses to the data call. These requirements not only define contents of data, but also contract requirements (DoD-STD-100C describes the engineering drawing practices and format, and DoD-D-1000B describes the content of engineering data.)

Inputs.	Data Call Response (AFLC Form 585), EDMP, PMP/ILSP.
Controls·	AFR 310-1, DoD-D-1000B, DoD-STD-100C.
Outputs.	Contract Requirements for Engineering Data (CRED)
Mechanisms·	DRRB, SPO/EDMO.

B.4.5 Develop Request for Proposal - Box A115

The SPO and Contract Administration Officer (CAO) prepare the Contract Data Requirements List (CDRL) and a Request for Proposal (RFP) for distribution to appropriate contractor(s) The SOW defines the contract deliverables and the requirements for contractor services (not the actual items or data to be delivered) The CDRL, on the other hand, defines the delivery and content of the engineering data.

Inputs:	Contract Requirement of Engineering Data (CRED)
Controls:	AFR 310-1.
Outputs.	RFP
Mechanisms	CAO, SPO

B.5 CREATE ENGINEERING DATA - NODE A12

The engineering data is developed by the contractor, but the Air Force ensures that the engineering data supports the ALCs and other MAJCOMs during the post-production phase During this process, the contract, which describes the engineering data requirements, is awarded by the Program Contracting Office (PCO). An Engineering Data Guidance Conference is held after the contract is awarded, which allows the contractor and the Air Force to discuss any discrepancies and ambiguous requirements. The contractor then creates the engineering data as agreed upon in the contract. (See Figure B-8)

B.5.1 Award Contract - Box A121

After issuance of the RFP, proposals from various contractors are reviewed and the contract is awarded to the contractor whose proposal best meets the Air Force cost and

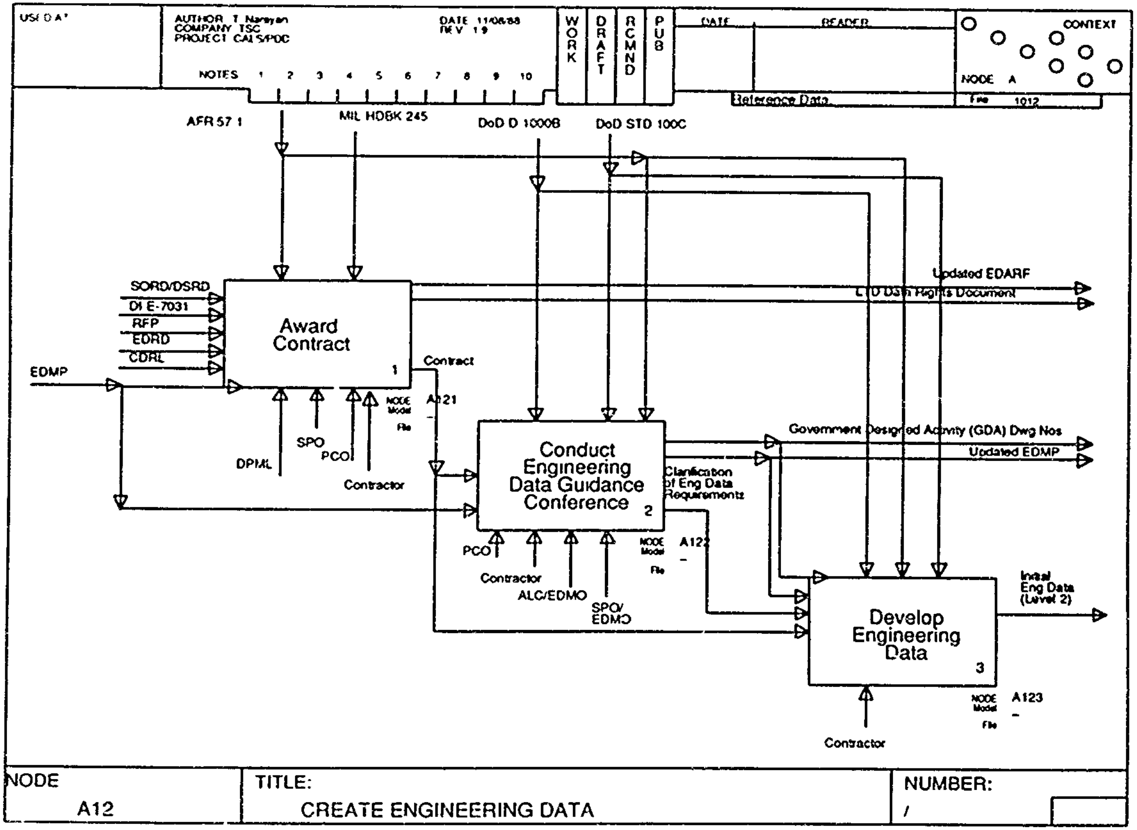


FIGURE B-8. CREATE ENGINEERING DATA $IDEF_0$ MODEL technical requirements. The contract itself consists of the following. SOW, Federal Acquisition Regulation (FAR) clauses, DI-E-7031, and CDRL DD Form 1423. DI-E-7031 (Indentured Engineering Data List) details the requirements for parts list, drawings, process information, specifications, etc., to meet government requirements as per DoD-D-1000B. The DPML is responsible for ensuring that all the above documents are part of the contract

The award of contract also receives input from the System Operational Requirement Document (SORD), Depot Support Requirements Document (DSRD), EDMP and Engineering Data Requirements Document (EDRD). MIL-HNBK-245 describes the preparation of the SOW.

Inputs:	SORD, DSRD, EDRD, EDMP, RFP, DI-E-7031, CDRL.
Controls:	AFR 57-1, MIL-HNBK-245.
Outputs.	Contract, Update EDARF, Limited Data Rights.
Mechanisms:	DPML, SPO, PCO, Contractor.

B.5.2 Conduct Engineering Data Guidance Conference - Box A122

The contractor conducts an Engineering Data Guidance Conference as required in the contract and the EDMP. As the first order of business, the SPO and ALC Engineering Data Management Officers (EDMOs) ensure that the contractor understands the format and the content of the engineering data to be furnished (as per DoD-D-1000B, DoD-STD-100C, and AFR 800-34). The topics addressed by the conference are: 1) CDRL requirements, applicable DIDs, specifications and standards, 2) engineering data review, and delivery requirements and schedules, 3) contractor drafting practices, numbering system, quality assurance procedure, data rights markings, and configuration management system, and 4) the role of subcontractors The Air Force assigns a set of Government Designed Activity (GDA) drawing numbers for the contractor-developed drawings and associated lists As a result of the conference the engineering data requirements are clarified so that the contractor can finalize the preparation of engineering data.

Inputs:	Engineering Data Management Plan (EDMP), Contract.
Controls:	DoD-D-1000B, DoD-STD-100C, AFR 57-1.
Outputs.	Updated EDMP, Clarification of Engineering Data Requirements, GDA Drawing Numbers.
Mechanisms	Program Contracting Officer (PCO), Contractor, SPO/EDMO, ALC/EDMO.

B.5.3 Develop Engineering Data - Box A123

The contractor prepares the engineering data, while the EDMO is responsible for monitoring progress and updating the EDMP throughout the acquisition program. (Data Flow Diagrams that detail a description of the contractor's development of PDD, i.e., engineering design and manufacturing data, are included in Sections 4 3, 4 4, and Appendix C.)

Inputs:	Clarification of Engineering Data Requirements, Updated EDMP, GDA Drawing Numbers, Contract Documents.
Controls:	AFR 57-1, DoD-D-1000B, DoD-STD-100C.
Outputs:	Initial Engineering Data (Level 2).
Mechanisms:	Contractor.

B.6 REVIEW ENGINEERING DATA - NODE A13

This node provides a high level overview of the audits and reviews conducted and the changes that occur before the contractor's engineering data is accepted. AFSCP 800-34, AFLCP 800-18, and AFSCR 800-16 provide guidance for the reviews. The EDARF tracks the status of the reviews and audits. (See Figure B-9)

B.6.1 Conduct Design Reviews - Box A131

During this activity, the ALC/SPM, with support from the division SPO/EDMD and DPML, conducts several reviews typically held at the contractor's facility. These reviews continue throughout the weapon system program and include the System Requirements Review (SRR), System Design Review (SDR), Preliminary Design Review (PDR) and Critical Design Review (CDR). These design reviews allow the Air Force to inspect the complete system design and evaluate its capability to satisfy total mission requirements. The EDMP defines the necessary guidelines and schedules for these reviews.

Inputs:	Initial Engineering Data, EDMP, CMP.
Controls:	MIL-STD-1521B, MIL-HNBK-288, AFR 800-34.
Outputs:	Approved Initial Engineering Data.
Mechanisms.	Contractor, SPO/EDMO, ALC/SPM, DPML.

B.6.2 Conduct IPRs - Box A132

IPRs are conducted periodically by the SPO/EDMO, with support provided by ALC/EDMO, throughout the acquisition phase. The purpose of the IPRs are to ensure that the drawings are prepared per Air Force requirements and to verify that the engineering drawings are in compliance with contractual requirements The IPR checks the engineering drawings for accuracy, legibility, completeness, correctness, contingencies (warranty, etc.), conformance to standard, and ability to completely reprocure. The discrepancies and recommended corrective actions are presented to the contractor by the EDMO. An Engineering Data Review Check List is used as a guide for the reviews.

Inputs.	EDARF, Approved Engineering Data, Engineering Data Review Check List, EDMP, Modified Engineering Data.
Controls:	MIL-STD-1521B, AFSCR 800-16, AFR 800-34.
Outputs	EDARF Update, Revised Engineering Data.
Mechanisms:	PCO, Contractor, SPO/EDMO, ALC/EDMO, AFPRO/DCAS.

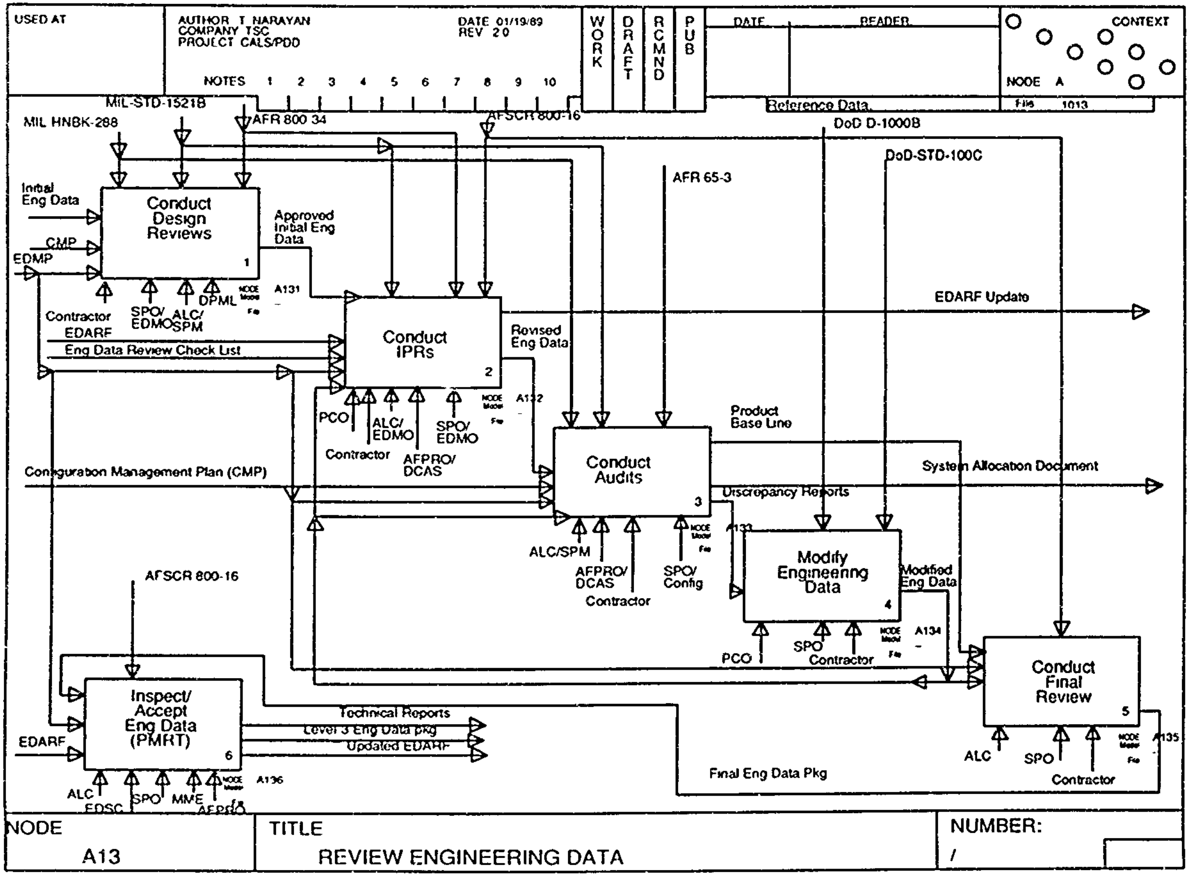


FIGURE B-9. REVIEW ENGINEERING DATA IDEF$_0$ MODEL

B.6.3 Conduct Audits - Box A133

The purpose of the Physical Configuration Audit (PCA), the Functional Configuration Audit (FCA), and the Formal Qualification Review (FQR) are to establish a product baseline reflected by configuration items (CIs). The PCA verify each part against the physical dimensions on the drawings. The PCA is conducted by AFPRO, SPO (Configuration Division), and the ALC System Program Manager (SPM).

The result of the audit is the Product Baseline, System Allocation Document, and Discrepancy Reports. While the Product Baseline describes the basic mission requirements, the System Allocation Document identifies and tracks each item in a weapon system by serial number. The Discrepancy Reports document issues to be resolved.

Inputs:	Revised Engineering Data, Configuration Management Plan (CMP), Modified Engineering Data, EDMP.
Controls.	MIL-STD-1521B, AFR 65-3, MIL-HNBK-288.
Outputs:	Product Baseline, System Allocation Document, Discrepancy Reports.
Mechanisms:	AFPRO/DCAS, Contractor, SPO (Configuration Div), ALC/SPM

B.6.4 Modify Engineering Data - Box A134

Upon receipt of the Discrepancy Report, the contractor modifies the engineering data, incorporating corrections per the deficiencies identified during reviews/audits The modified engineering data is validated at the subsequent IPRs, design reviews, and audits

Inputs:	Discrepancy Reports
Controls:	DoD-D-1000B, DoD-STD-100C
Outputs·	Modified Engineering Data
Mechanisms.	PCO, SPO, Contractor.

B.6.5 Conduct Final Review - Box A135

A final review of the engineering data is conducted as per AFSCR 800-16 prior to the acceptance of the engineering data AFSCP 800-34, AFLCP 800-18, and AFSCP 800-16 guide the final review The contractor makes the final delivery of the engineering data according to the requirements of the CDRL

Inputs	EDMP, Modified Engineering Data, Product Baseline
Controls	AFSCR 800-16
Outputs	Final Engineering Data Package
Mechanisms.	ALC, SPO, Contractor

B.6.6 Inspect/Accept Engineering Data - Box A136

The purpose of Program Management Responsibility Transfer (PMRT) is to ensure orderly, timely, and efficient transfer of program management responsibility from the implementing command (e g., AFSC) to the supporting command (e g , AFLC). The final engineering data package is delivered by the contractor to the prime ALC/MMED (EDSC) organization for inspection and acceptance. The engineering data is manually checked against the packing slip (data list) using DD Form 250. The contractor also prepares and delivers a Technical Report (as required in DI-Misc-80048) describing the weapon system.

When a firm, continuing need exists only then is engineering data stored (and distributed) in active files in the Deferred Requisitioning of Engineering Data (DRED) program.

Inputs:	Final Engineering Data package, EDMP, EDARF.
Controls.	AFSCR 800-16
Outputs	Level-3 Engineering Data Package, Updated EDARF, Technical Report.
Mechanisms:	Prime ALC, MME, EDSC, AFPRO, SPO

B.7 USE ENGINEERING DATA - NODE A2

Engineering data is delivered to the Prime ALC in the form of aperture cards and hard copy drawings The data is used to support the reprocurement of spares, local manufacturing, repairs, modifications, and other activities Engineering Change Proposals (ECPs) are used for updating the engineering data during weapon system support functions (See Figure B-10, the node tree, and Figure B-11, the IDEF$_0$ process.)

B.7.1 Provide Post-Production Support - Box A21

The ALCs require engineering data for the entire life cycle of the weapon system in order to reprocure spares, perform repairs, manufacture parts, and perform modifications. The MAJCOMs use engineering drawings to perform repairs and local manufacturing in support of base maintenance (AFR 57-4 and AFLCR 57-21 describe the procedures and policies for modifications AFLCR 66-50 defines the management of Numerical Control Industrial Plant Equipment [NCIPE])

This process is defined in detail using post-production support data flow diagrams in Section 4 5 and Appendix C

Inputs	Deficiency Reports, Level 3 Engineering Data.
Controls	AFR 57-4, AFLCR 57-21, AFLCR 66-50.
Outputs	Proposed Revisions/Changes
Mechanisms	MME, CRE, Contractor

B.7.2 Revise Engineering Data - Box A22

The changes proposed either by the MM division or contractors are reviewed by the System Program Management (SPM) office and then, if approved, are incorporated into the drawings Occasionally, ECPs are initiated by Using Commands (TAC, MAC and SAC). Integrated Logistics Support (ILS) activities such as provisioning, repairs, spares, etc ,

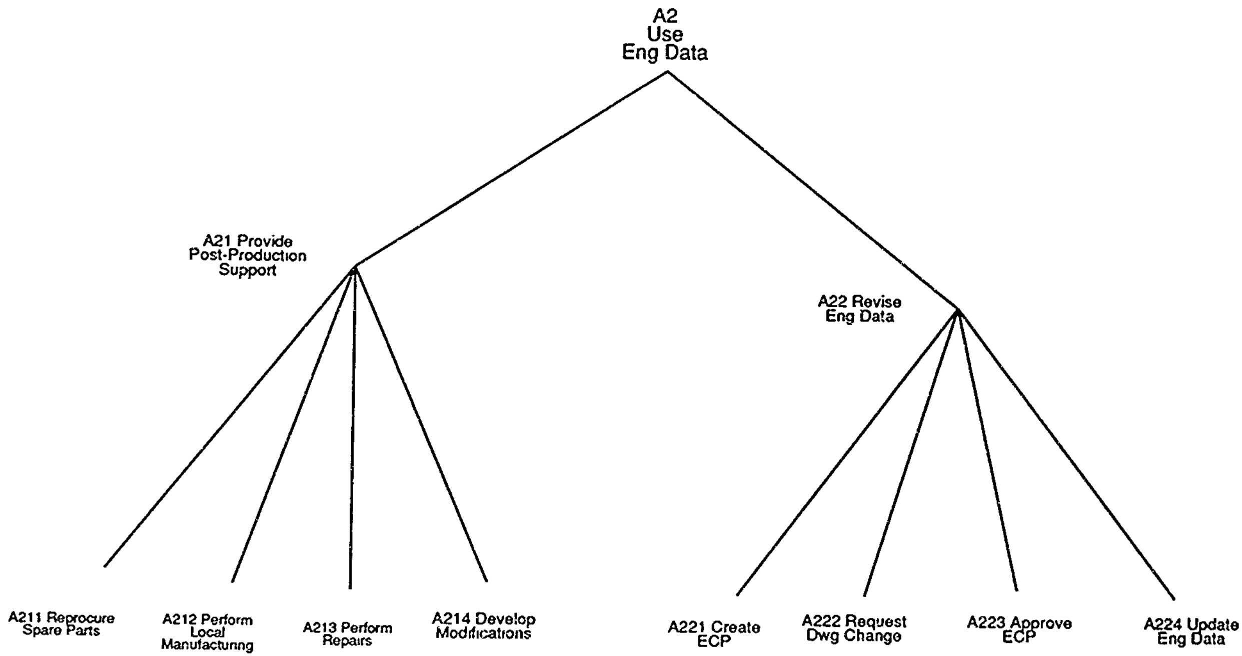


FIGURE B-10. USE ENGINEERING DATA NODE TREE

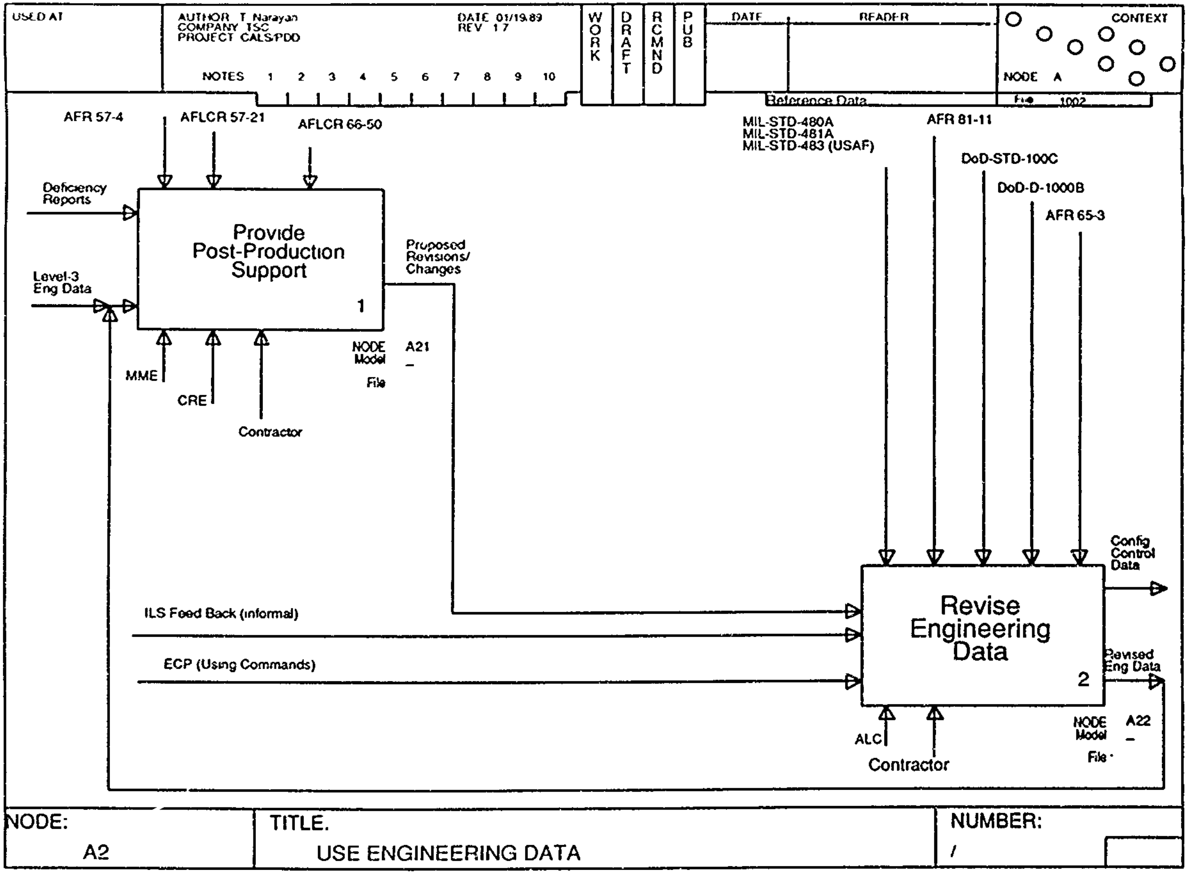


FIGURE B-11. USE ENGINEERING DATA $IDEF_0$ MODEL supply feedback for drawing revisions. Depending on the status of PMRT, the prime ALC or the contractor updates the drawings and keeps track of the configuration. (MIL-STD-480A, MIL-STD-481A and MIL-STD-483 [USAF] specify the requirements for managing the configuration of the drawings. AFR 65-3 describes the policies and procedures for configuration management. AFR 81-11 describes the policy for the engineering data change process.)

Inputs:	ILS Feed Back, ECP (Using Commands), Proposed Revisions/Changes.
Controls:	MIL-STD-480A, MIL-STD-481A, MIL-STD-483 (USAF), AFR 81-11, DoD-STD-100C, DoD-D-1000B, AFR 65-3.
Outputs:	Configuration Control Data, Revised Engineering Data.
Mechanisms:	ALC, Contractor.

B.8 PROVIDE POST-PRODUCTION SUPPORT - NODE A21

After PMRT, engineering data is used to provide support for the entire life cycle of a weapon system in the following four major activities. reprocure spares, local manufacture within the ALC, perform repairs, and develop modifications. The primary users of engineering data for these activities are the ALCs. (See Figure B-12)

B.8.1 Reprocure Spares - Box A211

The spares requirement is initiated by the MMI division depending on the spares required, at which time the requirement computation is performed on automated systems In the case of first time reprocurement, the CRE division performs manual or automatic screening analysis to ensure that the Air Force has adequate engineering data for competitive reprocurement CRE also creates a hierarchy of the drawing "trees" in order to develop the master bid set production. Using Data List Form 1659 to prepare a data list, MMED prepares the master bid set When the master bid set is completed, the Item Manager (IM) initiates procurement activities using a Procurement Request (AFLC Form 306). Items, when delivered, are stored in the DS division inventory.

Inputs:	Screening Analysis, Data List (Form 1659), Purchase Request (AFLC Form 306), Level 3 Engineering Data, Spares Requirement
Controls:	DoD-D-1000B, DoD-STD-100C, AFLCR 57-6.
Outputs:	Screening Analysis for Procurement Method, Spares Status Update, Spares, Spares to be Remanufactured.
Mechanisms:	MMI, CRE, DS, MA.

B.8.2 Perform Local Manufacturing - Box A212

The ALCs remanufacture spares that cannot be reprocured based on the cost and urgency of the requirement The request for manufacturing is initiated by a Temporary Work Request (AFLC Form 206) A Work Control Document (AFLC Form 958/959) is used

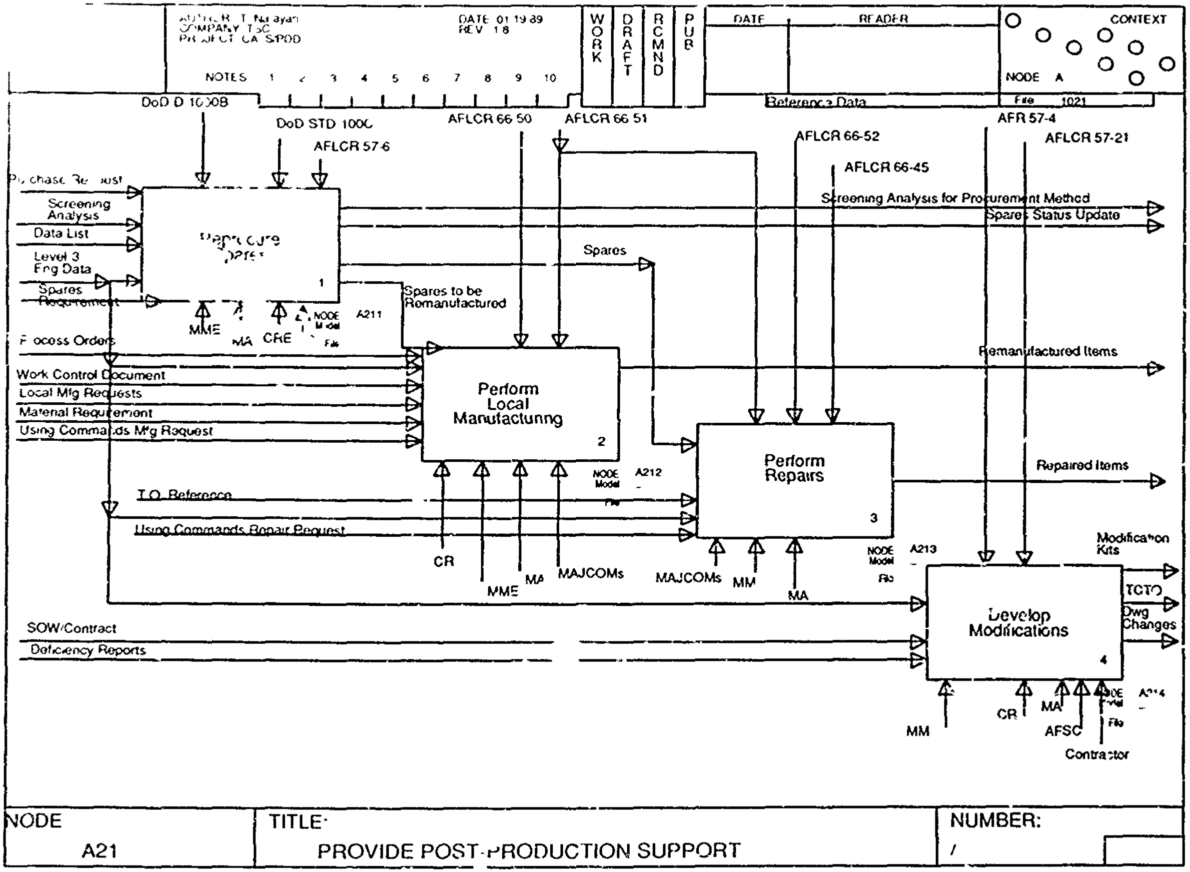


FIGURE B-12. PROVIDE POST-PRODUCTION SUPPORT IDEF$_0$ MODEL for work description, control, and identification of job status. This process is also automated with the G028 system (Maintenance Engineering Data Support System for the Automation of Work Control Data). When the engineering data is not available, MMED creates drawings to enable the MA division to locally remanufacture the parts Remanufactured items are either distributed to MA for installation, sent to the appropriate Using Command, or sent to DS for storage and subsequent use. Using commands also remanufacture items as authorized. Additionally, Using Commands may request ALCs to remanufacture items depending on the authorizations, complexity, and urgency of need

Inputs	Process Orders (AFLC Form 561), Work Control Document (AFLC Form 959)/G028, Local Manufacturing Requests (AFLC 206), Material Requirement (AFLC Form 237), Using Command Manufacturing Request, Level 3 Engineering Data, Spares to be remanufactured
Controls	AFLCR 66-50, AFLCR 66-51.
Outputs	Remanufactured Items.
Mechanisms.	MME, MA, MAJCOMs, CR

B.8.3 Perform Repairs - Box A213

Repairs are performed by ALCs and Using Commands in support of depot and base-level maintenance The ALCs and Using Commands refer to engineering drawings parts lists, specifications, and analysis data when the TO does not provide sufficient information to support the repair functions.

Inputs	Technical Order (TO) Reference, Level 3 Engineering Data, Using Command Repair Request, Spares
Controls	AFLCR 66-51, AFLCR 66-52, AFLCR 66-45
Outputs.	Repaired Items
Mechanisms	MM, MA, MAJCOMs.

B.8.4 Develop Modifications - Box A214

Modifications are required to improve safety or improve reliability and maintainability of the weapon system These requirements are derived from the analysis of the Using Commands' Deficiency Reports (Quality Deficiency Report [QDR], Tear Down Deficiency Report [TDR,] and Maintenance Deficiency Report [MDR]). In addition, a requirement can be generated by HQ USAF for increasing mission capability After the MM division prepares the System Specification (Type A) and SOW, the design/manufacture of the modification is contracted out In some instances, depending on the cost, complexity, and urgency of the requirements, MM will perform the design and MA will manufacture/install the modification kits The necessary drawing changes are incorporated, a kit is prepared for installation, and a Time Compliance Technical Order (TCTO) is developed The modification kit is then installed in the weapon system and tested

Inputs:	Level 3 Engineering Data, SOW/Contract, Deficiency Reports.
Controls.	AFR 57-4, AFLCR 57-21.
Outputs:	Modification Kits, TCTO, Drawing Changes.
Mechanisms:	MM, CR, MA, AFSC, Contractor.

B.9 REVISE ENGINEERING DATA - NODE A22

The engineering data is revised during the weapon system life cycle as a result of local manufacturing, repairs, and modifications. Revisions involve updating the engineering data to reflect changes in the weapon system. The steps involved in the revision cycle are create an ECP, request drawing changes, approve engineering changes, and update engineering data (See Figure B-13)

B.9.1 Create ECP - Box A221

The ECPs are created as a result of deficiency reports (e.g., MDR, QDR) or a problem being identified by the SPO, ALC, or contractor. MIL-STD-481A and 480A describes policies and procedures for initiating and approving ECPs. There are two types of ECPs. Class 1, which are due to changes in drawing due to form, fit, and functions, and Class 2, which are due to changes in documentation.

The contractor sends Advance Change Study Notices (ACSNs) (AFSC Form 223) and preliminary ECPs to the Air Force. The CCB either requests Issue Change Approval or prepares a formal ECP (DD Form 1693). The contractor then prepares the formal ECP, Specification Change Notices (SCNs) (DD Form 1696) which identify specification changes, and change pages for all controlled documents.

Inputs	Deficiency Reports, Advance Change Study Notice (AFSC Form 223)
Controls	MIL-STD-481A, MIL-STD-480A, MIL-STD-483 (USAF)
Outputs	ECP Preparation (DD Form 1693), Specification Change Notice (DD Form 1696)
Mechanisms	Contractor, MM, SPO

B.9.2 Request Drawing Change - Box 222

Apart from the ECPs created by the contractor, Organic Change Proposals (OCP) are generated within the ALCs In addition, drawing changes due to modifications result in drawing change requests Depending on the complexity of the change, the engineering data to be revised is sent to the respective ALC System Program Manager (SPM) or Configuration Control Board (CCB) organizations for review (AFR 65-3 describes policies and procedures for the Configuration Management.)

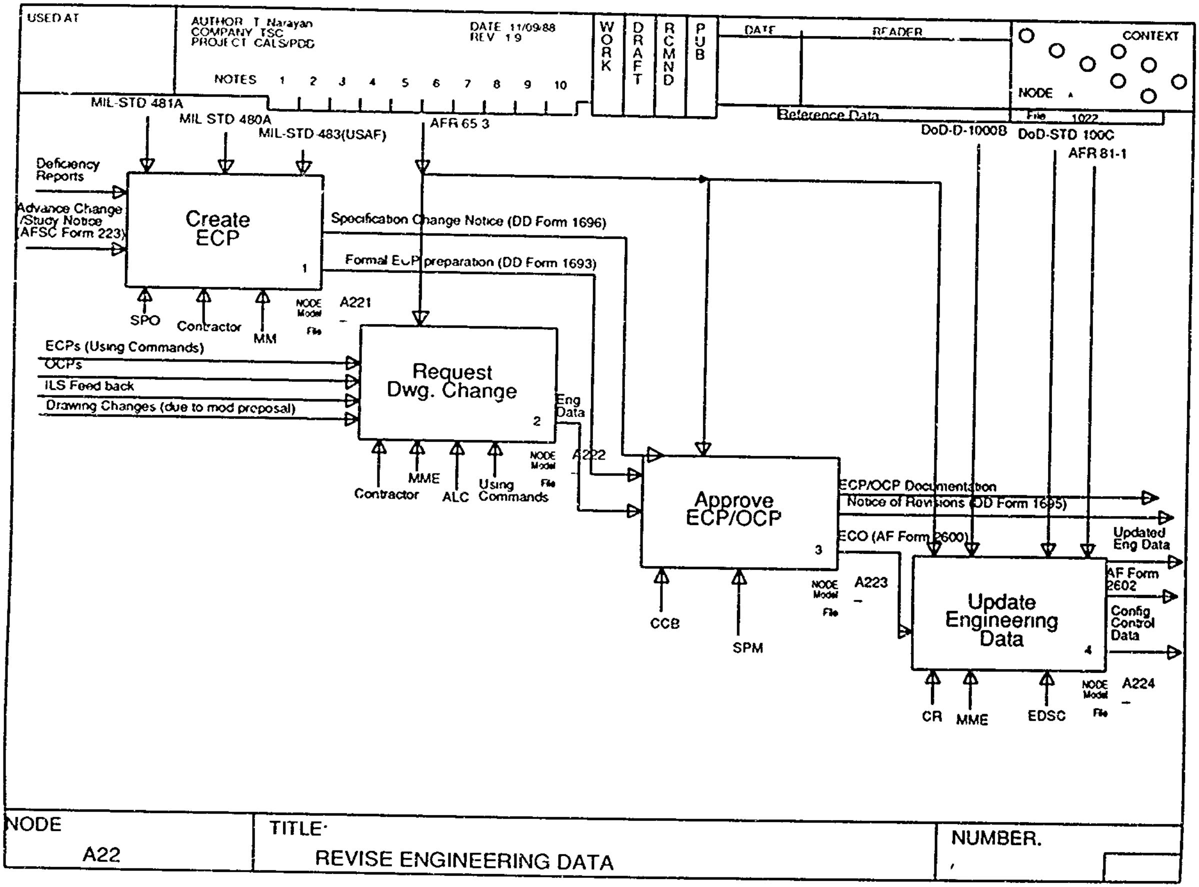


FIGURE B-13. REVISE ENGINEERING DATA IDEF$_0$ MODEL

Inputs:	OCPs, Drawing Changes (due to modification Proposal), ECPs (Using Commands), ILS Feedback.
Controls:	AFR 65-3.
Outputs:	Engineering Data.
Mechanisms:	ALC, MME, Using Commands, Contractor.

B.9.3 Approve ECP/OCP - Box 223

The CCB receives and reviews formal ECPs and OCPs which, when approved, results in drawing revisions. An ECO is prepared reflecting the approved ECP/OCP. The contractor receives the ECO and incorporates the required changes. For changes incorporated by the Air Force, the contractor receives Notices of Revisions (NORs) using DD Form 1695.

Inputs:	Specification Change Notice (DD Form 1696), Engineering Data, ECP Preparation (DD Form 1693).
Controls:	AFR 65-3
Outputs:	ECP/OCP Documentation, ECO (AF Form 2600), Notice of Revisions (DD Form 1695)
Mechanisms:	SPM, CCB.

B.9.4 Update Engineering Data - Box 224

The SPM approved changes are incorporated into the drawings by the MMED division and updated engineering data is stored at the Engineering Data Support Center (EDSC). Also, MMED may perform design/drafting for the required changes for local manufacturing, repair, and modifications. The configuration control data (e.g., drawing trees, revision status, release, and change control) are tracked and updated as a result of this process The revised drawings, associated lists, and specifications changed per ECOs are loaded into Engineering Data Computer Assisted Retrieval Systems (EDCARS)

Inputs:	ECO (AF Form 2600).
Controls:	AFR 65-3, AFR 81-1, DoD-D-1000B, DoD-STD-100C.
Outputs:	Updated Engineering Data, Configuration Control Data, AF Form 2602
Mechanisms:	MME, EDSC, CR

B.10 MANAGE ENGINEERING DATA - NODE A3

Management of engineering data is performed to ensure timely retrieval of the current versions of engineering data. This process consists of the following sub-processes. control engineering data, distribute engineering data, and retire the product. These activities are primarily performed by MM and the Aerospace Maintenance and Regeneration Center (AMARC) (See Figure B-14, the node tree, and Figure B-15, the IDEF$_0$ process)

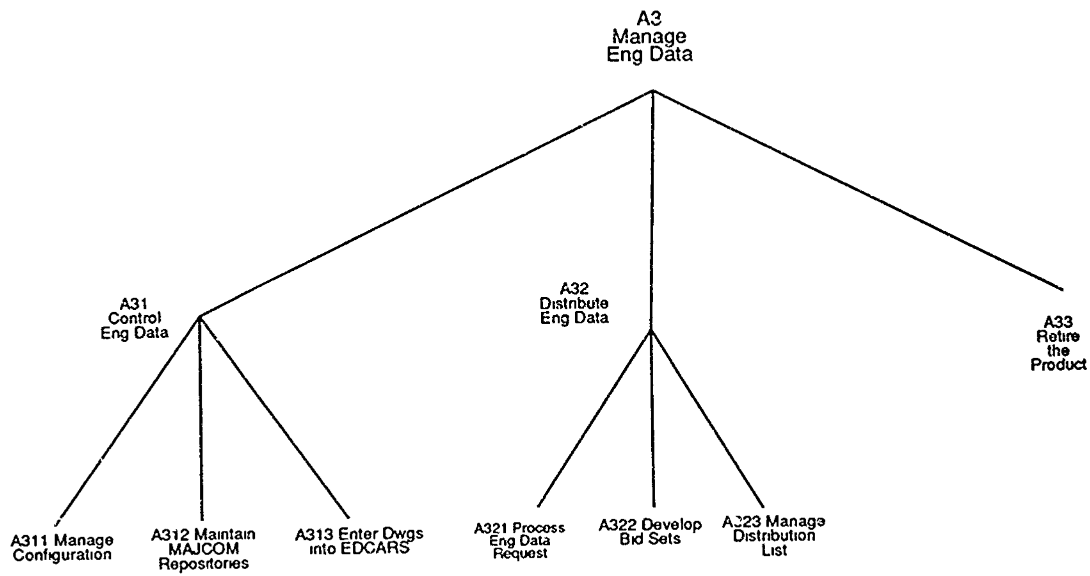


FIGURE B-14. MANAGE ENGINEERING DATA NODE TREE

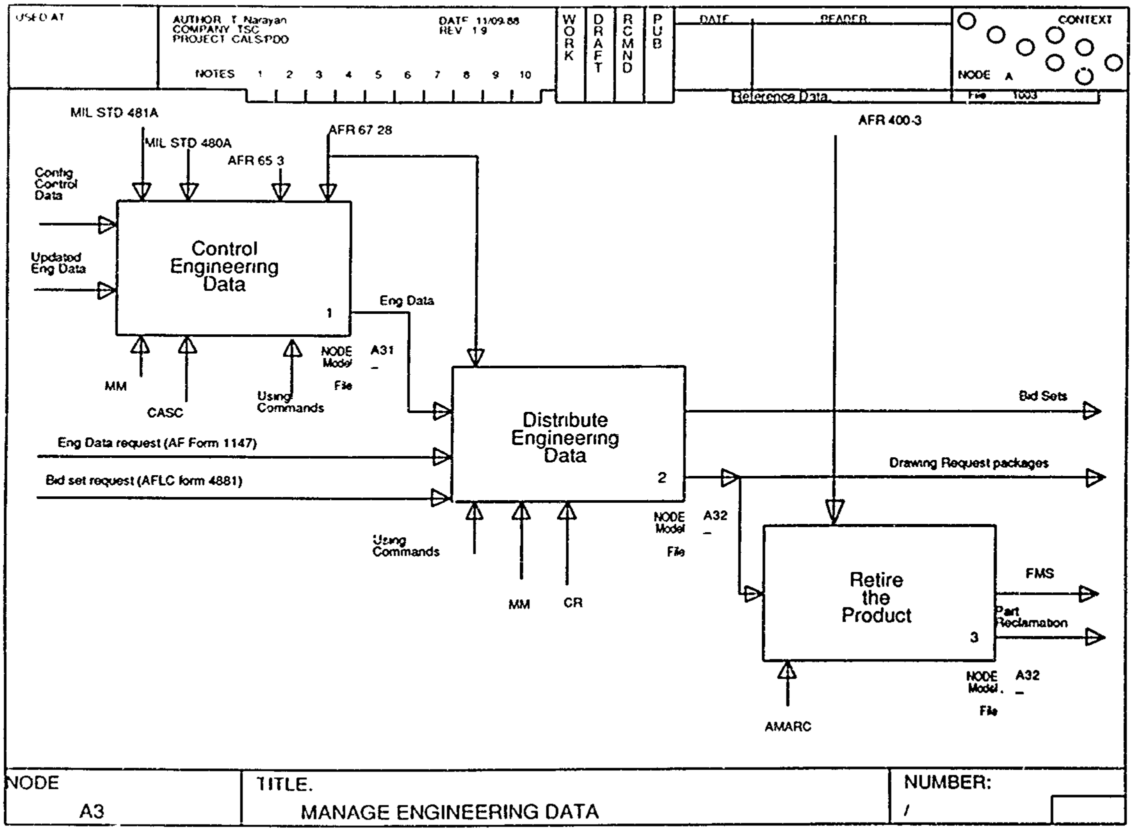


FIGURE B-15. MANAGE ENGINEERING DATA IDEF$_0$ MODEL

B.10.1 Control Engineering Data - Box A31

Engineering data configuration is controlled and managed so that the latest configuration of the weapon system can be made available. Configuration control data and revised Level 3 Engineering Data are used to manage the versions of engineering data. The updated engineering data is sent by MM for distribution to authorized users. (MIL-STD-481, MIL-STD-480A, AFR 65-3 and AFR 67-28 describe policies and procedures for controlling and managing the data.)

Inputs:	Configuration Control Data, Updated Engineering Data.
Controls:	MIL-STD-481, MIL-STD-480A, AFR 65-3, AFR 67-28.
Outputs:	Engineering Data.
Mechanisms:	MM, Using Commands, CASC.

B.10.2 Distribute Engineering Data - Box A32

Using an automated distribution list, engineering data is distributed to the various MAJCOMs for the system supported The EDSC ensures that classified and limited rights data are protected in the distribution process.

Inputs.	Engineering Data, Engineering Data Request (AF Form 1147), Bid Set Request (AFLC Form 4881)
Controls:	AFR 67-28
Outputs.	Drawing Request Package, Bid Sets.
Mechanisms	MM, CR, Using Commands

B.10.3 Retire the Product - Box A33

In this activity, preserving the equipment in extended storage, cannibalizing the damaged planes for parts, and supporting Foreign Military Sales (FMS) are performed by Aerospace Maintenance and Regeneration Center (AMARC) The MA division of AMARC is responsible for receipt, preservation, storage and maintenance in storage of excess aircraft to the military services, some of which return to the US military service and some of which are sold to foreign governments (AFR 400-3 describes the policies and procedures for foreign military sales.)

Inputs.	Drawing Request Package
Controls	AFR 400-3.
Outputs:	Part Reclamation, FMS
Mechanisms.	AMARC.

B.11 CONTROL ENGINEERING DATA - NODE A31

Engineering Data is constantly updated to reflect the changes in the weapon system The activities include manage configuration, maintain MAJCOM repositories, and enter engineering data in digital form into EDCARS (See Figure B-16)

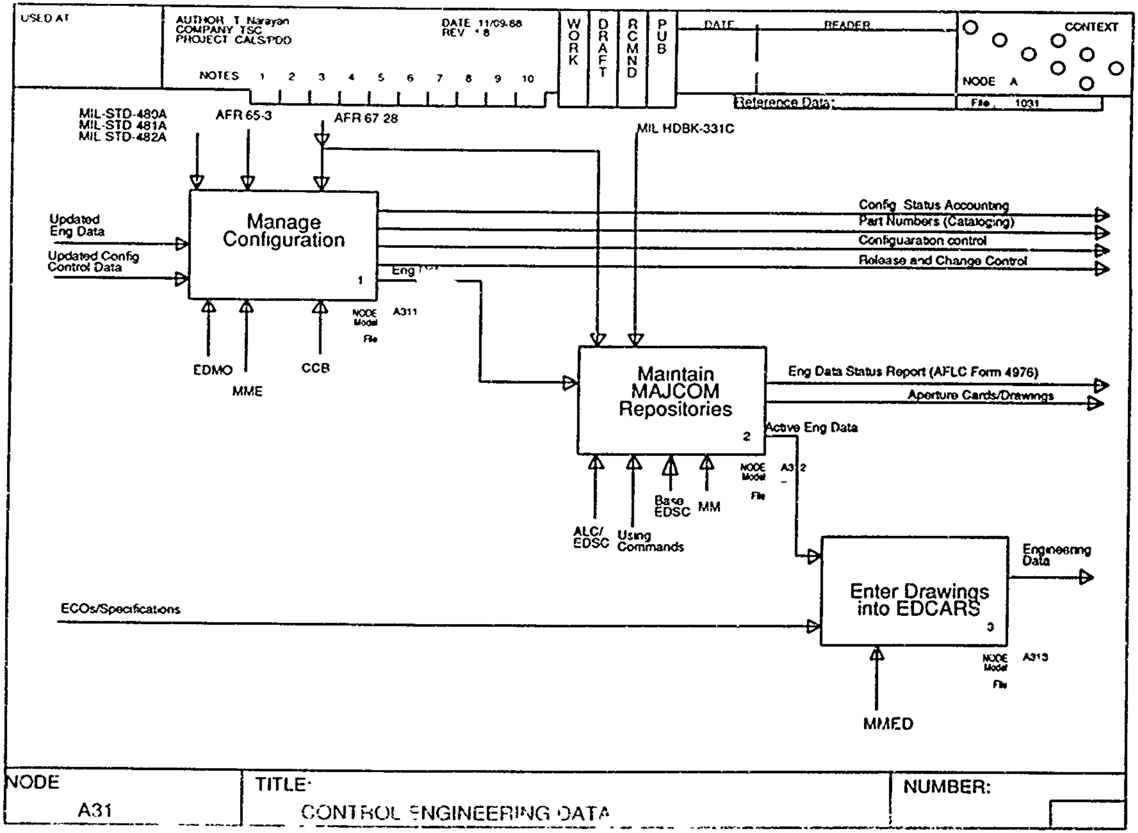


FIGURE B-16. CONTROL ENGINEERING DATA IDEF$_0$ MODEL

B.11.1 Manage Configuration - Box A311

MMED periodically receives ECOs/OCPs from the contractor and Air Force respectively and is responsible for maintaining the updates to the drawings to reflect latest configuration of the weapon system. The configuration of the weapon system is also tracked and maintained by tail number As a result of the changes, configuration status accounting, configuration control (drawing change criteria and change classifications, class 1 and 2), cataloging, and release and change control are updated. (AFR 65-3 describes the details of configuration management.)

Inputs:	Updated Engineering Data, Updated Configuration Control Data.
Controls:	MIL-STD-480A, MIL-STD-482, MIL-STD-481A, AFR 67-28, AFR 65-3.
Outputs	Configuration Status Accounting, Part number (Cataloging), Configuration Control Data, Release and Change Control Data, Engineering Data
Mechanisms.	MME, CCB, EDMO.

B.11.2 Maintain MAJCOM Repositories - Box A312

The Engineering Data Support Center (EDSC) manual files at ALCs are maintained by the MMED division MAJCOMs have base EDSC repositories and receive updates periodically from the ALC The Engineering Data Status/Action Request (AFLC Form 4976) is used to report engineering data status (MIL-HNBK-331C defines the locations of the repositories throughout DoD and AFR 67-28 describes policies, procedures, and guidance for control and distribution of engineering data.)

Inputs.	Engineering Data.
Controls	MIL-HNBK-331C, AFR 67-28.
Outputs	Engineering Data Status Report (AFLC Form 4976), Aperture Cards/ Drawings, Active Engineering Data.
Mechanisms	ALC/EDSC, Using Commands, MM, Base EDSC

B.11.3 Enter Drawings into EDCARS - Box A313

Active engineering data is entered into Engineering Data Computer Assisted Retrieval System (EDCARS) in raster format Active engineering data is defined as engineering data that was used for reprocurement in the past three years EDCARS provides access to and viewing of drawings and assembly of bid sets.

Inputs	Active Engineering Data, ECOs/Specifications.
Controls	Unavailable
Outputs	Engineering Data
Mechanisms	MMED

B.12 DISTRIBUTE ENGINEERING DATA - NODE A32

Engineering Data Support Centers (EDSCs) are located at the five prime ALCs, Using Commands, and other MAJCOMs to store and maintain sets of aperture cards/hard copy in support of the weapon system. Each EDSC maintains the assigned weapon system and/or commodities in support of reprocurement of spares, local manufacturing, repairs, modifications, and engineering support. (See Figure B-17)

The ALC/EDSC distributes the engineering data in hard copy or aperture cards to the requesters at the ALCs for reprocurement and sustaining engineering. Also, the MAJCOMs maintain base-level EDSCs that contain a set of engineering data to support the level of their mission. In some cases, the bases request the engineering data from the prime ALC/EDSC. (For more details on EDSC refer to Appendix A.)

B.12.1 Process Engineering Data Request - Box A321

The engineering data is requested (AF Form 1147) to support repairs, local manufacturing, modifications, and other engineering activities. CRE requests engineering data for the assembly of reprocurement bid sets (AFLC Form 4881). In addition, the EDSC maintains statistics on the number of requests and bid sets on a quarterly basis (AFLC Form 24). (AFR 67-28 describes policy and procedure for distribution and control of engineering data.)

Inputs	Engineering Data Request (AFLC Form 4881), Engineering Data Request (AF Form 1147), Engineering Data
Controls	AFR 67-28
Outputs	Drawing Request Package.
Mechanisms	EDSC, AGMC, MMED, MA

B.12.2 Develop Bid Sets - Box A322

Bid sets are prepared to support competitive spares reprocurement. A set of drawings, associated lists, specifications, and other related documentation forms a bid set. The CRE division submits a request for the reproduction of engineering data (AFLC Form 4753) [illegible] drawing set. The MME division is responsible for preparing the drawing tree [illegible] part of the bid set preparation. (Data item DI-E-5349 is used to identify the structure and [illegible] relationships of engineering drawings, associated lists, and specifications.

Inputs	Request of Reproduction of Engineering Data (AFLC Form 4753), Drawing Request Packages, Drawing Tree(s)
Controls	MIL-M-9868D, MIL-D-5480F
Outputs	Bid set
Mechanisms	CRE, MME

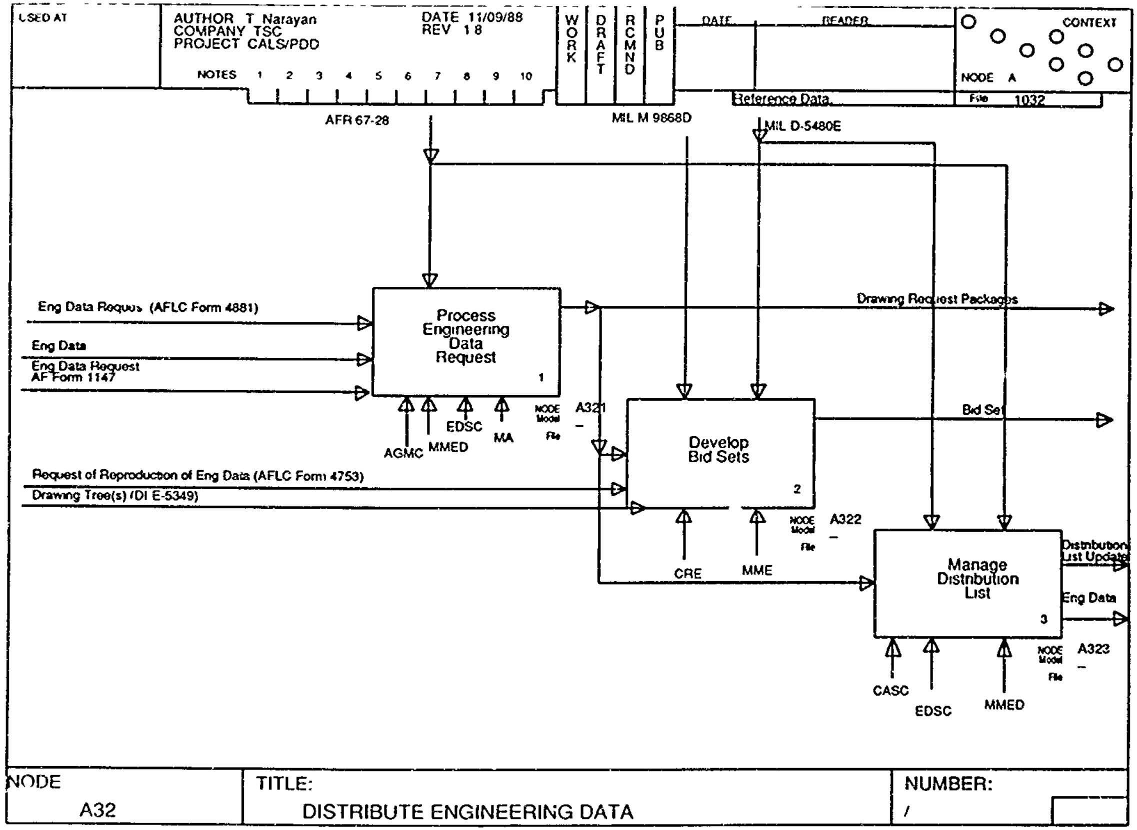


FIGURE B-17. DISTRIBUTE ENGINEERING DATA $IDEF_0$ MODEL

B.12.3 Manage Distribution List - Box A323

An automated distribution list is generated and maintained by the EDSC in order to distribute the new and updated engineering data to MAJCOMs and FMS. MIL-STD-5480E describes the procedure for the distribution list. The Cataloging and Standardization Center (CASC) performs cataloging which involves assigning part number, available procurement sources, alternate materials, etc.

Inputs:	Drawing Request Packages.
Controls:	MIL-STD-5480E, AFR 67-28.
Outputs:	Distribution List Update, Engineering Data.
Mechanisms:	EDSC, MMED, CASC

APPENDIX C

DATA FLOW DIAGRAMS (DFDs)

APPENDIX C: DATA FLOW DIAGRAMS (DFDs)

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C.1 INTRODUCTION

This section presents a data flow representation of the Design/Engineering, Manufacturing, and Post-Production Support phases of a weapon system's life cycle (See Figure C-1, DFD Overview, and Figure C-2, Node Tree) using the Gane and Sarson method of data flow diagrams. The major objectives of the DFDs are: 1) to describe the flow of data between contractor and Air Force organizations and functions, 2) to provide an identification of data sources and destinations in each functional area, and 3) to allow the Air Force to identify PDD that can be accessed and used.

The activities themselves have been identified in two ways. First, at a gross level, major activities have been identified using a node tree. Second, each activity is broken down into a series of processes needed to accomplish the activity, and are described in detail.

In certain instances the Gane and Sarson rules and procedures have been altered to allow for clearer presentation of additional information. Whereas the Gane and Sarson methodology does not consider automation status, media/physical storage types, and data conditions, the DFDs have been tailored to depict the creation, storage, format, and level of PDD automation. Also, the DFDs present an additional level of detail not found in the $IDEF_0$ models by representing the contractor's creation and the Air Force's use of PDD during the Post-Production phase.

C.2 GANE AND SARSON SYMBOL CONVENTIONS

The Gane and Sarson symbol conventions are described here to acquaint the reader briefly with this method of data flow methodology. The Gane and Sarson data flow diagrams are constructed using four different symbols. These symbols are used to describe a system as a network of processes connected by data paths. The symbol convention in Gane and Sarson data flow diagrams are as follows:

External Entities

External entities (See Figure C-3) are logical groupings of organizations or processes that represent a source or destination of data. By designating an organization or process as an external entity, it is implicitly stated that it is outside the boundary of the system being considered. An external entity is symbolized by a "double" square, with the upper and left sides in double thickness to make the symbol stand out from the rest of the diagram. A double square with a diagonal line crossing the lower right corner of the symbol is used when the same external entity is repeated in a diagram. The entity can be identified by a lower case letter in the upper left-hand corner for reference.

Process

Each process represents an activity that transforms data in some way. Processes are symbolized by an upright rectangle, with the corners rounded. Each process symbol

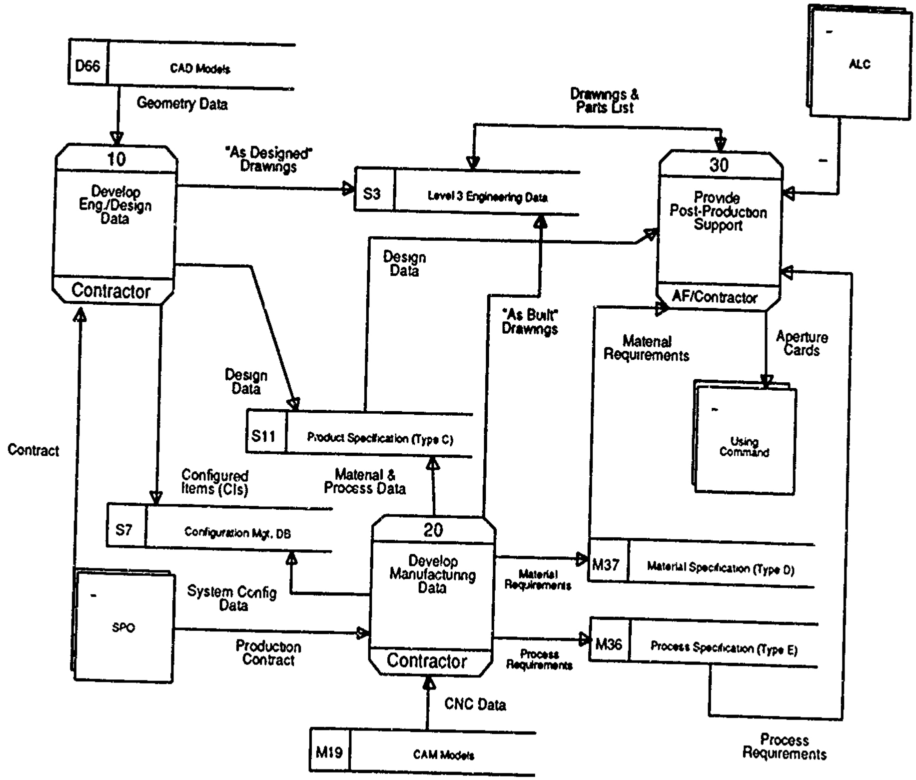
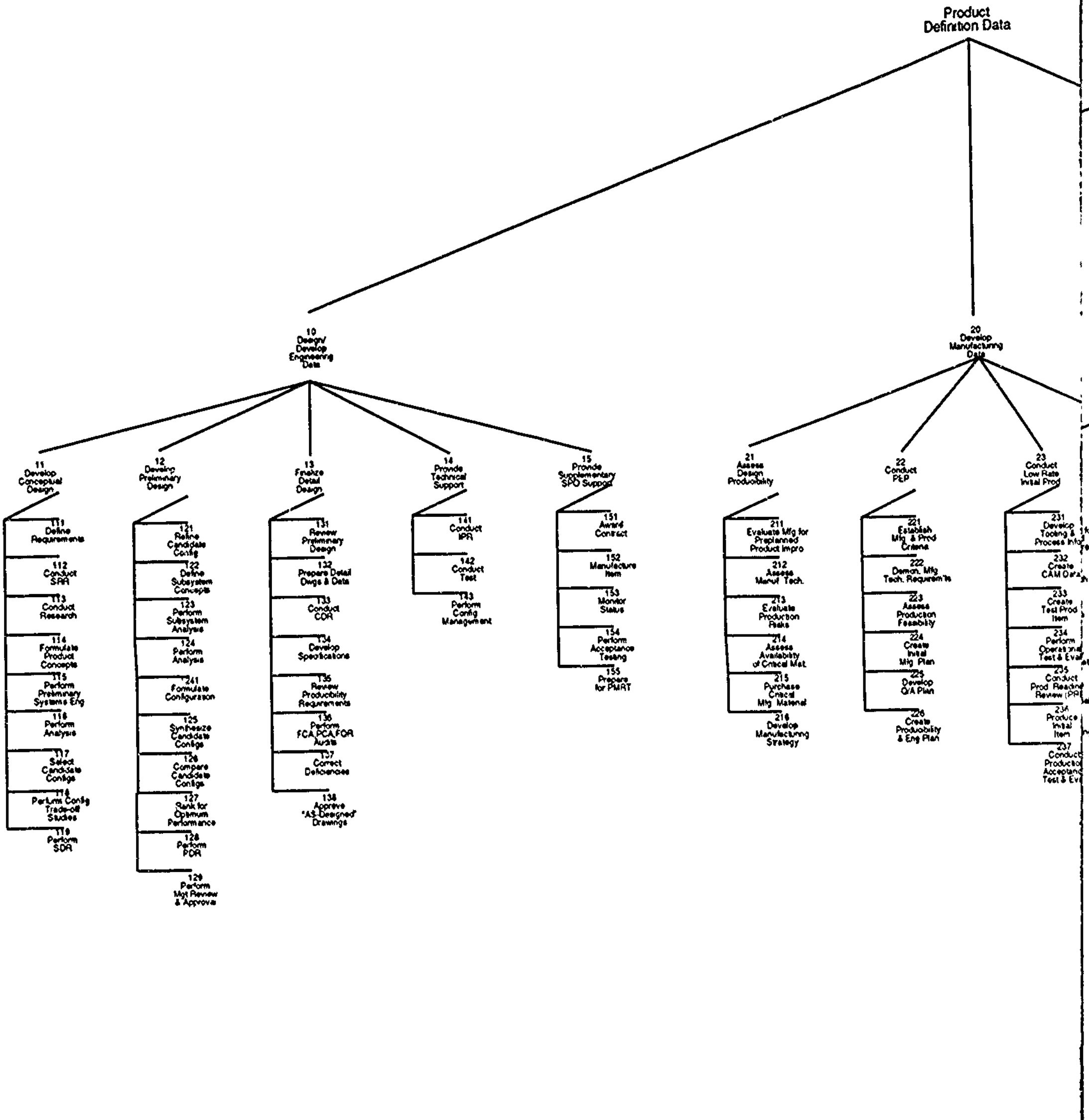


FIGURE C-1. PDD DFD OVERVIEW



Product Definition Data
10 Design/ Develop Engineering Data
20 Develop Manufacturing Data
11 Develop Conceptual Design
111 Define Requirements
112 Conduct SRR
113 Conduct Research
114 Formulate Product Concepts
115 Perform Preliminary Systems Eng
116 Perform Analysis
117 Select Candidate Configs
118 Perform Config Trade-off Studies
119 Perform SDR
12 Develop Preliminary Design
121 Refine Candidate Config
122 Define Subsystem Concepts
123 Perform Subsystem Analysis
124 Perform Analysis
1241 Formulate Configuration
125 Synthesize Candidate Configs
126 Compare Candidate Configs
127 Rank for Optimum Performance
128 Perform PDR
129 Perform Mgt Review & Approval
13 Finalize Detail Design
131 Review Preliminary Design
132 Prepare Detail Dwgs & Data
133 Conduct CDR
134 Develop Specifications
135 Review Producibility Requirements
136 Perform FCA,PCA,FQR Audits
137 Correct Deficiencies
138 Approve "AS-Designed" Drawings
14 Provide Technical Support
141 Conduct IPR
142 Conduct Test
143 Perform Config Management
15 Provide Supplementary SPO Support
151 Award Contract
152 Manufacture Item
153 Monitor Status
154 Perform Acceptance Testing
155 Prepare for PMRT
21 Assess Design Producibility
211 Evaluate Mfg for Preplanned Product Impro
212 Assess Manuf Tech.
213 Evaluate Production Risks
214 Assess Availability of Critical Mat.
215 Purchase Critical Mfg Material
216 Develop Manufacturing Strategy
22 Conduct PEP
221 Establish Mfg & Prod Criteria
222 Demon. Mfg Tech. Requirem'ts
223 Assess Production Feasibility
224 Create Initial Mfg Plan
225 Develop Q/A Plan
226 Create Producibility & Eng Plan
23 Conduct Low Rate Initial Prod
231 Develop Tooling & Process Info
232 Create CAM Data
233 Create Test Prod Item
234 Perform Operational Test & Eval
235 Conduct Prod Readiness Review (PR
236 Produce Initial Item
237 Conduct Production Acceptance Test & Ev

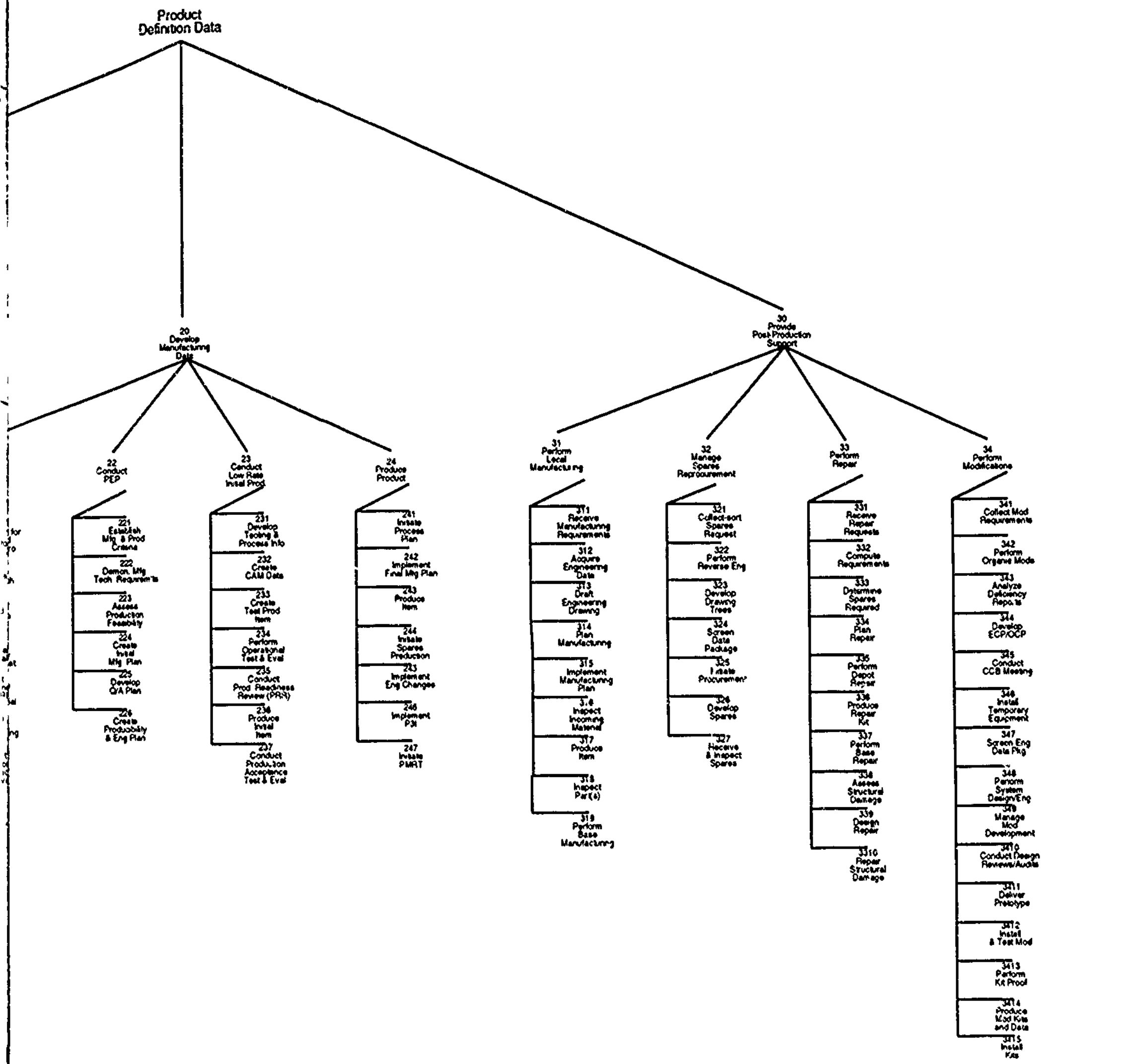


FIGURE C-2. PDD NODE TREE

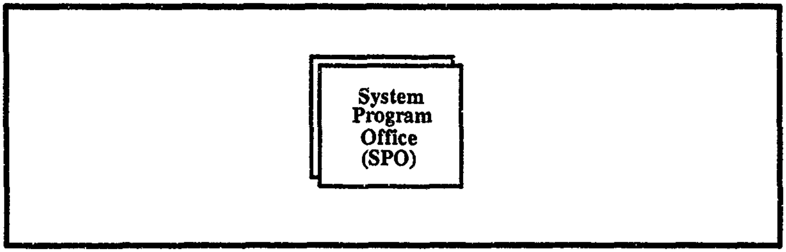


FIGURE C-3. GANE AND SARSON EXTERNAL ENTITY REPRESENTATION

contains three descriptive areas: identification number, description of process, and organization performing the process. These three reference areas provides basic identifying information. The identification number is useful for cross-referencing between the DFDs. The description of process names the process and represents its decomposition. The organization performing the process identifies organization(s). Figure C-4 below shows the location of each area:

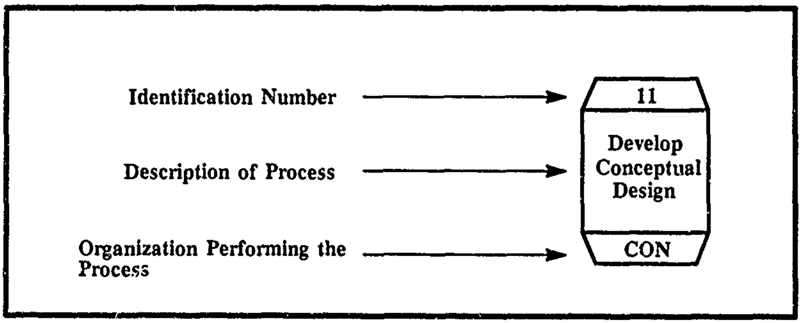


FIGURE C-4. GANE AND SARSON PROCESS SYMBOL REPRESENTATION

Data Flow

The data flows are symbolized by lines with arrowheads showing the directions of the flows. Descriptions of each data flow include identification of the data source(s) and destination(s) (See Figure C-5).

Data Store

During analysis, it is often necessary to define places where data is stored between processes This is particularly helpful when data does not proceed directly from one process

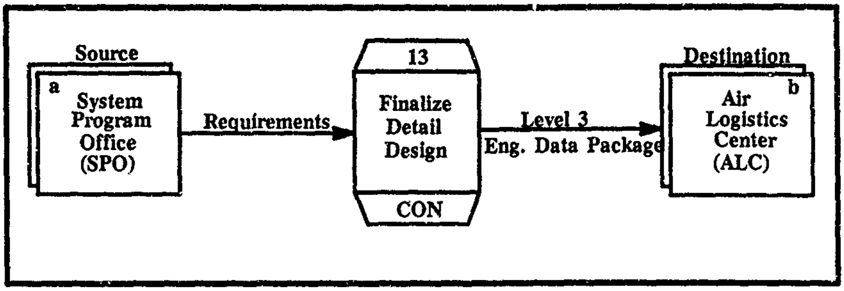


FIGURE C-5. GANE AND SARSON DATA FLOW SYMBOLOGY

to the next or the next process uses the data in a different order. Data stores are symbolized by a pair of horizontal lines closed at the left-hand side. Each store is identified by a letter code and number at the left-hand end for reference. In addition each data store has an alpha-numeric code which describes the automation status, data format, and physical storage format used (See Figure C-6). In addition, Table C-1 defines the codes and definitions for both data formats and storage types.

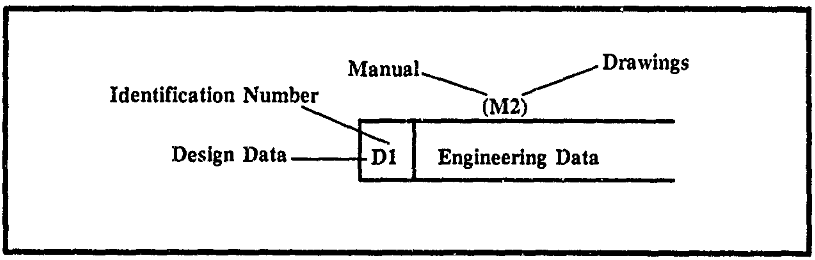


FIGURE C-6. GANE AND SARSON DATA STORE SYMBOL

C.3 DESIGN/ENGINEEERING DATA FLOWS

The data flow diagrams in this section provide a general overview of the processes, data stores, and data flows for the design and engineering of a weapon system. These diagrams are not intended to define a specific contractor or acquisition program, but provide a generic description of the design/engineering process and data used by both Air Force and contractor.

The node tree (Figure C-7) provides an overview of the design/engineering process and the use of PDD. The node decomposes design/engineering into five major sub-processes:

TABLE C-1. DATA STORE LEGEND

CODE	DEFINITION	CATEGORY
A	Automated	Automation Status
M	Manual	
E	Either Manual or Automated	
B	Both Manual and Automated	
1	Aperture Cards	Data Formats
2	Drawings	
3	Hard Copy Reports	
4	2D Vector Image	
5	3D Vector Image	
6	Database	
7	Analytical Models (e.g., FEM, Simulation)	
8	Air Force Form	
9	Raster Image	
10	Microfiche	Physical Storage Types
11	Magnetic Media	
12	N/C Tape	
13	Optical Disc	
D	Design/Engineering Data	Data Stores
M	Manufacturing Data	
P	Post-Production Support Data	
S	Shared Data	

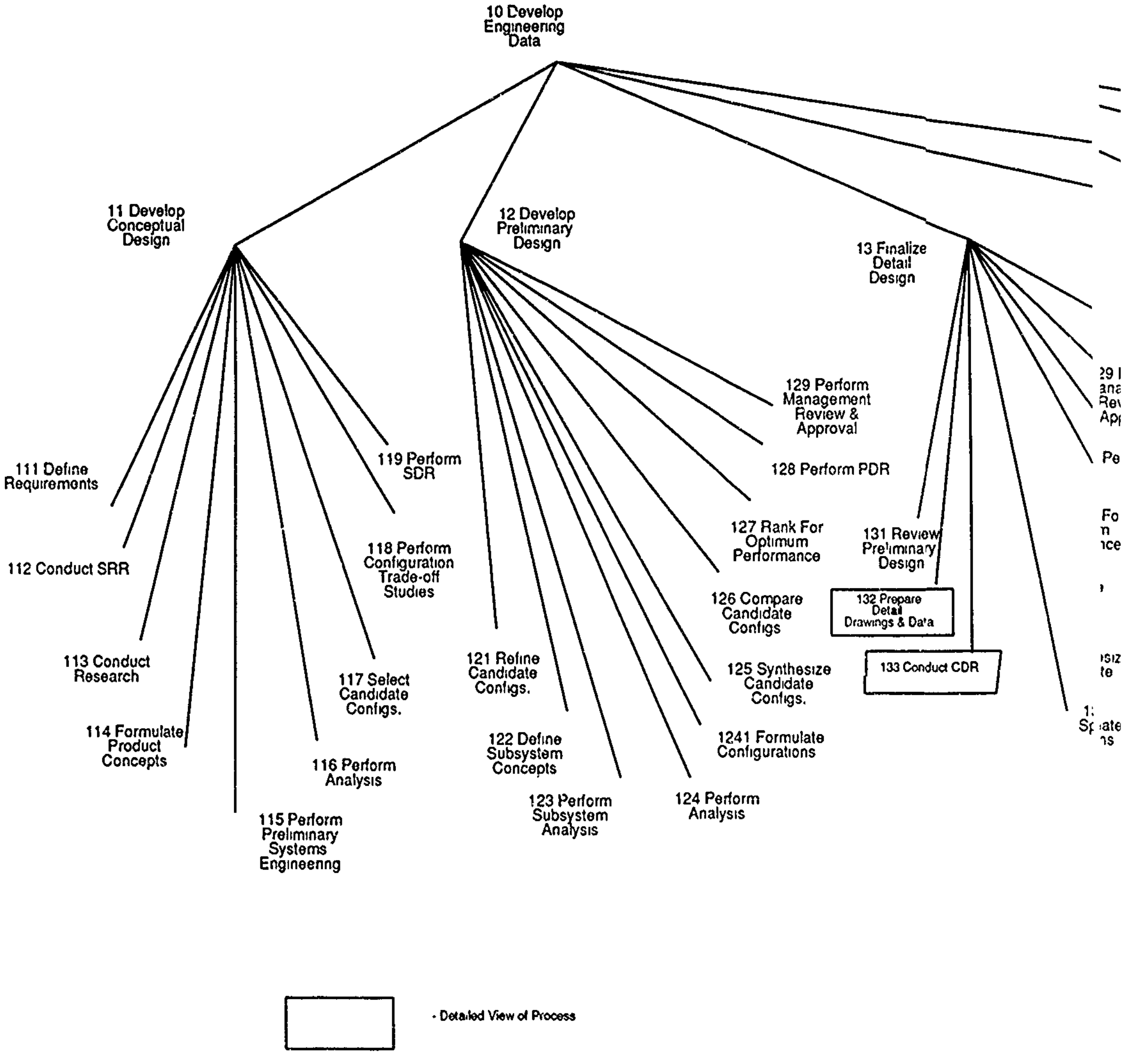
Develop Conceptual Design, Develop Preliminary Design, Finalize Detail Design, Provide Supplementary SPO Support, and Provide Technical Support.

C.3.1 Level 11 - Develop Conceptual Design

The Engineering/Design data flows (Figure C-8) describe the data processes, stores, dataflows, and external entities used during the engineering/design effort during the acquisition process. The following are summary descriptions of the processes depicted in the node tree diagram. (See Figure C-9)

C.3.1.1 Process 111 - Define Requirements

The first major task in the acquisition of a new weapon system is for the Air Force to define the requirements. These requirements are based on a previously developed need (i.e., PMD, SON). As these are the initial requirements, they are typically quite broad in scope. The requirements are defined through a series of design reviews and audits throughout the acquisition cycle. As the requirements are formulated, they are assembled into a requirements document.


10 Develop Engineering Data
11 Develop Conceptual Design
12 Develop Preliminary Design
13 Finalize Detail Design
111 Define Requirements
112 Conduct SRR
113 Conduct Research
114 Formulate Product Concepts
115 Perform Preliminary Systems Engineering
116 Perform Analysis
117 Select Candidate Configs.
118 Perform Configuration Trade-off Studies
119 Perform SDR
121 Refine Candidate Configs.
122 Define Subsystem Concepts
123 Perform Subsystem Analysis
124 Perform Analysis
1241 Formulate Configurations
125 Synthesize Candidate Configs.
126 Compare Candidate Configs
127 Rank For Optimum Performance
128 Perform PDR
129 Perform Management Review & Approval
131 Review Preliminary Design
132 Prepare Detail Drawings & Data
133 Conduct CDR
- Detailed View of Process

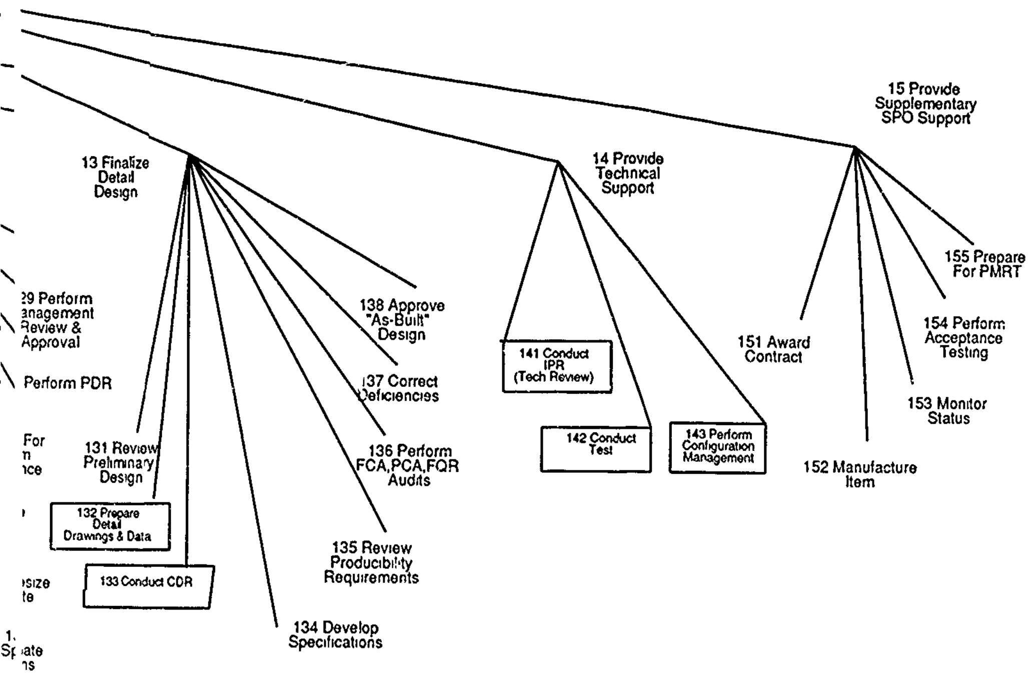


FIGURE C-7.

DEVELOP DESIGN/ENGINEERING DATA NODE TREE

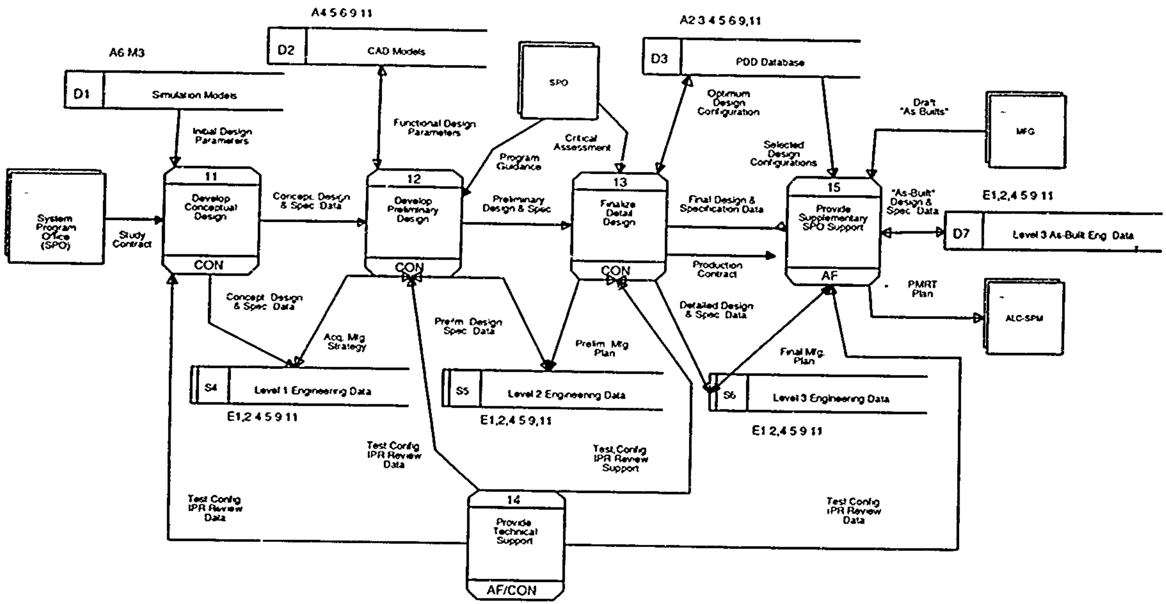


FIGURE C-8. DEVELOP DESIGN/ENGINEERING DATA DFD

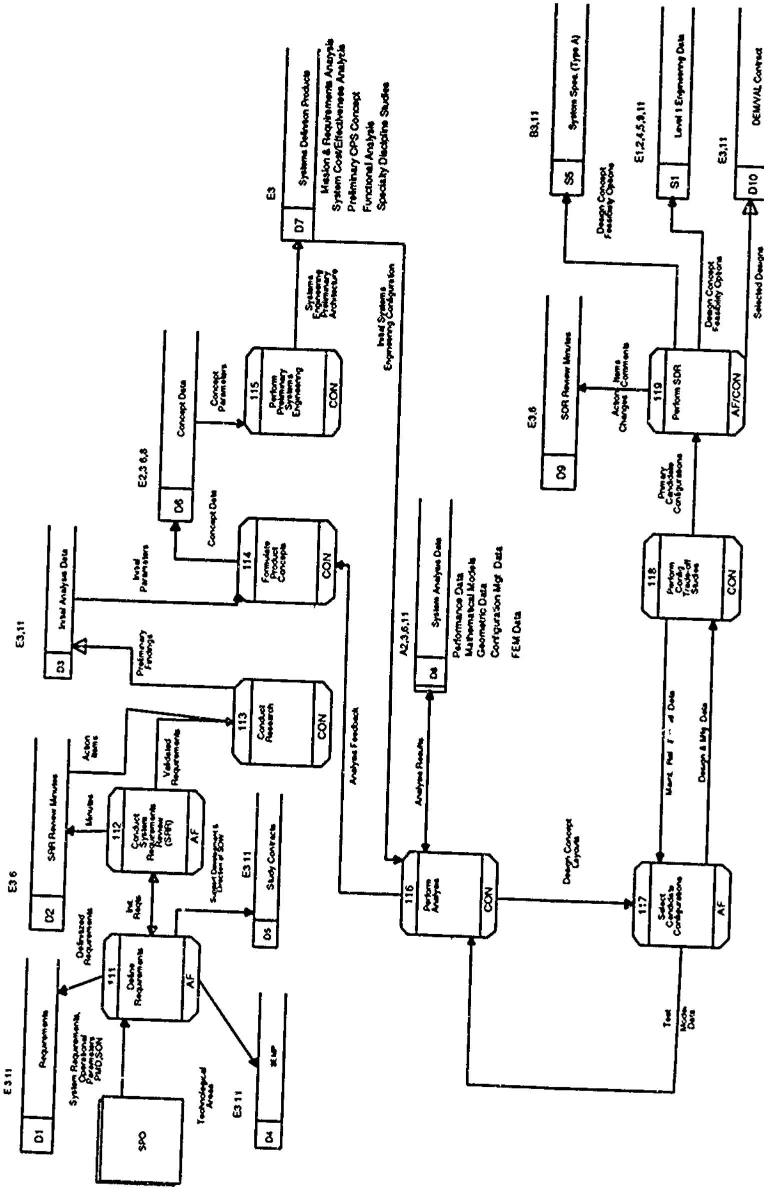


FIGURE C-9. DEVELOP CONCEPTUAL DESIGN DFD

C.3.1.2 Process 112 – Conduct System Requirements Review (SRR)

The SRR is a technical review of the initial system engineering efforts. Through this review, discussion and/or clarification takes place to refine the requirements. The purpose of this review is to identify any anticipated problems early on in the acquisition life cycle and provide the opportunity for resolution.

Some of the more major issues discussed at this meeting include: Mission & Requirements Analysis, Functional Flow Analysis, System Interface Studies, Configuration Management, Producibility, and Reliability and Maintainability.

C.3.1.3 Process 113 – Conduct Research

This activity initiates the Concept Exploration phase. Initial research into broad areas such as propulsion, structures, airframe, etc., is performed, and many reasonable alternatives are defined to formulate product concepts.

C.3.1.4 Process 114 – Formulate Product Concepts

Using information developed from the initial research, product concepts are generated. The goal of each concept is to meet the broad mission requirements.

C.3.1.5 Process 115 – Perform Preliminary Systems Engineering

The systems engineering process is a systematic approach that breaks down each of the product concepts into functional areas. Each of the functional areas are then analyzed further to determine how effectively each functional area measures up against the requirement, and how well it interfaces with each of the subsystems.

C.3.1.6 Process 116 – Perform Analysis

Each product concept is analyzed from a functional standpoint. The analysis is summarized into FFBDs (Functional Flow Block Diagrams). These diagrams describe succinctly the steps necessary to accomplish the functional requirements of the system (in conjunction with the concept definition). A number of engineering documents are produced within this effort including the FFBD, the Interface Control Document (ICD), and the RAS (Requirements Allocation Sheet).

C.3.1.7 Process 117 – Select Candidate Configurations

Candidate configurations which meet the functional requirements, but are not attainable through conventional means, are screened out. Upon completion of the screening process, a collection of candidate configurations are assembled for trade-off analysis.

C.3.1.8 Process 118 – Perform Configuration Trade-off Studies

The trade-off studies provide analytical support for comparing candidate configurations. They review facets of the system which include technical parameters, schedule requirements, reliability, maintainability, producibility, and performance requirements. The studies address areas which may be optimized as a result of modifying technical aspects of the system.

C.3.1.9 Process 119 – Perform System Design Review (SDR)

The SDR allows a review of the preliminary systems engineering activities. These activities include the system specification (Type A), mission/ requirements analysis, any functional analysis, and the results of trade-off studies. The SDR is an opportunity to determine the contractor's understanding of the system requirements.

C.3.2 Level 12 – Develop Preliminary Design

The Preliminary Design phase (which equates to the Demonstration/Validation phase in the acquisition cycle) allows concepts developed in the previous phase to be defined in more detail. The concepts are then reviewed and refined for the functional decomposition. Each system is comprised of several sub-systems, which may then be comprised of several components. The process of decomposition helps identify the logical and physical inter-relationships among the functional components. Once this definitization is complete, quantitative analysis in the form of performance models, Finite Element Modeling (FEM), and mathematical models is applied to establish a baseline of projected performance characteristics. (See Figure C-10)

C.3.2.1 Process 121 – Refine Candidate Configurations

The candidate configurations identified in the previous phase are reviewed and refined. This refinement process entails the development of detailed information which will help establish concepts to support the definition of subsystem concepts.

C.3.2.2 Process 122 – Define Subsystem Concepts

As each candidate configuration is further refined, the definition of subsystem concepts are initiated. Each system is developed towards achieving a major functional goal. Identification of subsystem concepts, i.e., Configuration Items (CIs), will help further define the elements required to meet the Development Specification (Type B).

C.3.2.3 Process 123 – Perform Subsystem Analysis

Using modeling tools, each subsystem within each candidate configuration is analyzed. The tools used to perform the analysis include FEM models, performance models, optimized geometric models, etc. As this analysis is performed, a number of products are developed such as Schematic Block Diagrams (SBD), Interface Control Documents (ICD), and general preliminary design data. This information is presented through design sheets.

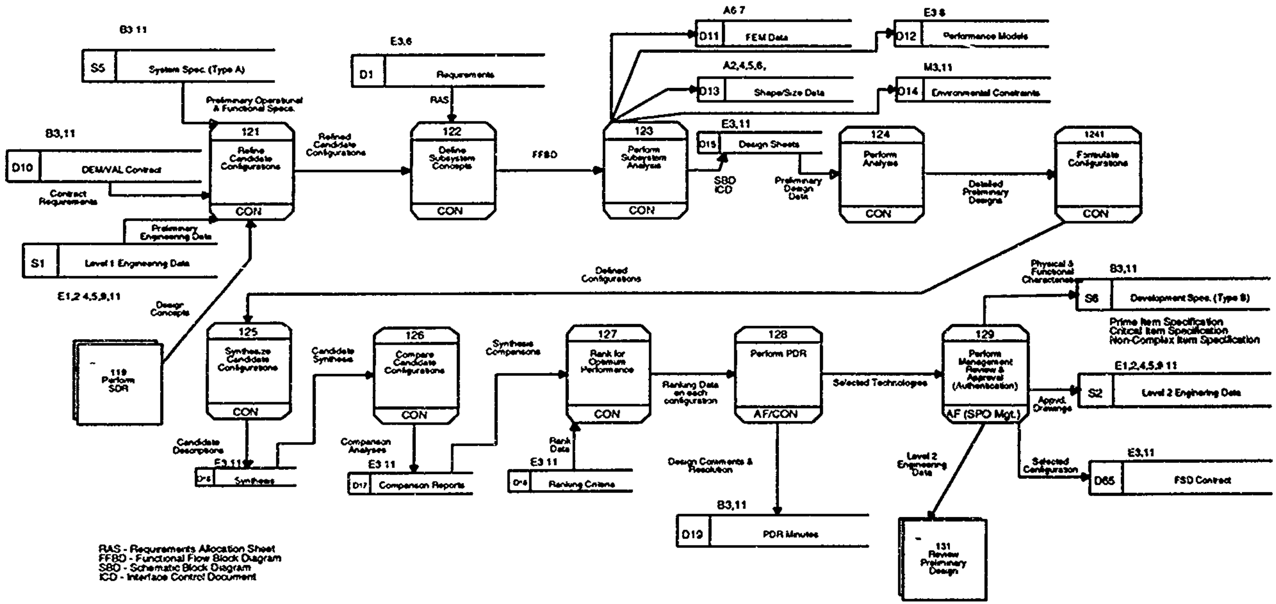


FIGURE C-10. DEVELOP PRELIMINARY DESIGN DFD

C.3.2.4 Process 124 – Perform Analysis

With the SBDs, FFBDs, and ICDs, the candidate configuration has sufficient design information to formulate a detailed preliminary design. This analysis focuses on the interface between the subsystems and the overall performance of the system.

C.3.2.5 Process 125 – Synthesize Candidate Configurations

In order to adequately evaluate each configuration, a synthesis is formulated identifying the configuration's salient points and its ability and degree to which it meets functional requirements.

C.3.2.6 Process 126 – Compare Candidate Configurations

The comparison of the synthesized configurations assists in identifying the unique approaches to fulfilling the functional requirements. This analysis provides an insight to the technical merits of each system configuration in relation to the Requirement Allocation Sheets (RAS).

C.3.2.7 Process 127 – Rank for Optimum Performance

The ranking process identifies the configuration which best meets the functional requirements. It is important that the ranking reflects the relationship between the configurations and the ranking criteria. The process of developing criteria and assigning weights is critical in the evaluation of candidate configurations. Once the criteria are identified, each configuration is analyzed to provide ranking results.

C.3.2.8 Process 128 – Perform Preliminary Design Review (PDR)

The Preliminary Design Review (PDR) is a technical review of Hardware Configuration Items (HWCIs), Computer Software Configuration Items (CSCIs), and Support Equipment (SE). At this point in the acquisition cycle, broad design parameters have been developed through the Functional Flow Block Diagram (FFBD), System Allocation Document (SAD) and a preliminary design synthesis. The review is held to develop a technical understanding of how the preliminary design and proposed CIs will meet the Development Specification (Type B).

The configuration items are also reviewed against specific criteria. The criteria include Evaluation of Electrical, Mechanical and Logical Design, Design Reliability; Design Maintainability; Human Factors; System Safety; Natural Environment; Equipment and Parts Standardization; Value Engineering; Transportability; Test; Maintenance Concept; Packaging; and Technical Manuals.

C.3.2.9 Process 129 – Perform Management Review and Approval (Authentication)

This process includes a review of all change actions summarized in the PDR minutes. The contractor generates the appropriate changes according to a particular approach or methodology, as discussed during the PDR. Once the change has been implemented and authenticated, the Air Force then signs-off for authentication and approval.

C.3.3 Level 13 - Finalize Detail Design

The Finalize Detail Design processes (Level 13) typically occur in the FSD (Full Scale Development) phase. During this phase, a particular design or technology has been developed to a point where a complete, detailed design can be produced. The detailed design is then used as input to the production contract to support production at the manufacturing contractor's plant. The major output of this phase is the Level 3 Engineering Data "As-Designed" and the Product Specification (Type C). (See Figure C-11)

C.3.3.1 Process 131 - Review Preliminary Design

This process allows the selected contractor to review the engineering data developed in the previous phase. This data consists primarily of the Level 2 Engineering Data and the applicable Specifications (Type B). At this point, the Air Force has selected the technology with which to produce the system.

C.3.3.2 Process 132 - Prepare Detail Drawings and Data (Detailed View)

The contractor is responsible for the generation and production of a variety of drawings depicting the design aspects of the weapons system. There are approximately seventy identified drawing types (as defined in DOD-D-1000B and DOD-STD-100C). The drawings are critical in the configuration management (CM) of an aircraft, as they provide the physical and logical data to track through the CM process. (See Figure C-12)

This section was identified as a critical step in the acquisition process, and is broken out to depict a more detailed process:

- **Process 1321 - Verify Engineering Data.** Prior to actually generating a drawing, the data contained in the sketches or rough drafts will be verified. This provides the opportunity for the Engineer to request any special requirements on the drawing, such as applying a particular standard or specification.

- **Process 1322 - Review and Interpret Data for Drawing.** The drafting group receives the engineering request for production of the drawings. The review ensures that all pertinent drawing information is available to the draftsman. The package is then assigned to a draftsman for production.

- **Process 1323 - Draft Drawings.** This activity denotes the actual production of the drawing. The draftsman is responsible for initial compliance with the contractor's drawing standards and formatting directions. The draftsman will produce the drawing either manually or via CAD.

- **Process 1324 - Check Drawings.** The drawing is checked for quality, adherence to standards, and correct tolerances and dimensions. If corrections are necessary, the

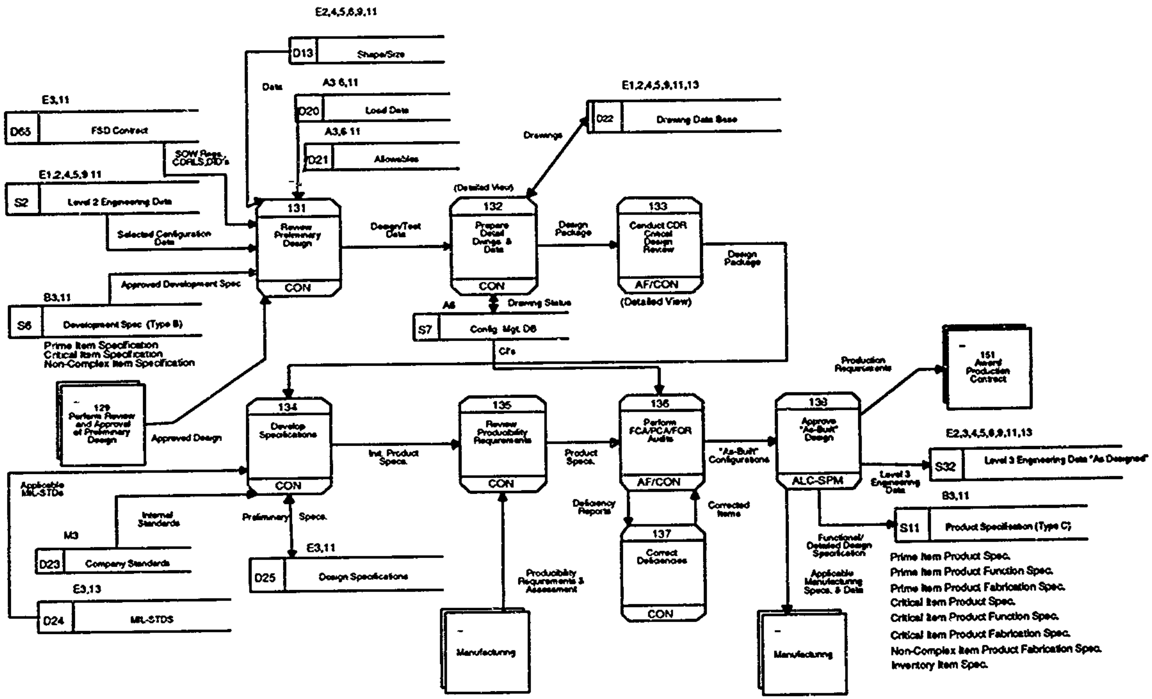


FIGURE C-11. FINALIZE DETAIL DESIGN DFD

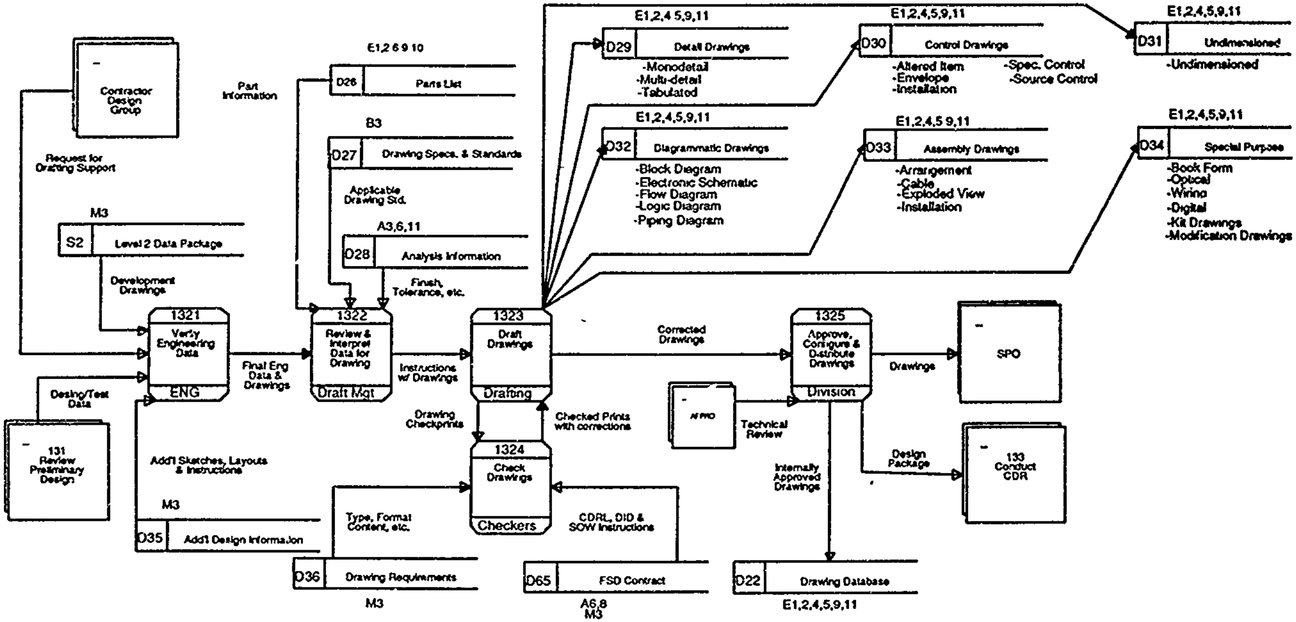


FIGURE C-12. PREPARE DETAIL DRAWINGS AND DATA DFD

Checker will return the drawing to the draftsman for correction. Once the corrections have been made, the sign-off process may begin.

The sign-off block is a critical component in the review process as it shows not only the management levels, but the technical levels involved in the checking and review of a document. The approval and sign-off involves the drafting management and engineering group. As they each complete their review, their signatures are added to the drawing and the drawing is completed for submission to the Air Force as a package for review.

- **Process 1325 - Approve, Configure and Distribute Drawings.** As each drawing is completed and approved, the drawing is tracked via configuration management for changes. Other items such as drawing trees or lists are updated to reflect the current status of drawings available for review.

C.3.3.3 Process 133 - Conduct Critical Design Review (CDR) (Detailed View)

The Critical Design Review (CDR) provides an opportunity for a detailed review of the identified CIs within the system. The CDR process is critical in the formulation and design of a weapon system and is therefore broken out into a more detailed set of processes. (See Figure C-13)

- **Process 1331 - Schedule CDR (Critical Design Review).** The Critical Design Review is scheduled to review the design specification prior to fabrication or production. This activity identifies the coordination between the SPO and the Contractor regarding the identification of the subjects and other pertinent data to be covered on the agenda.

- **Process 1332 - Assemble and Distribute Detail Design Package.** In order that the appropriate technical review is performed on the various draft segment specifications, the draft package (drawings and other pertinent design information) must be assembled and distributed to the Air Force prior to the actual CDR.

- **Process 1333 - Review Detail Design Package.** The SPO reviews the design package to ensure that the design meets the functional requirements. Each engineer or groups tasked with review responsibility compiles and synthesizes each area which requires clarification by the contractor.

- **Process 1334 - Conduct CDR.** The CDR is a formal review held specifically to determine the adequacy of a selected design against the requirements documented in the Development Specification (Type B). The design is presented in terms of HWCI's and CSCI's (Hardware Configuration Items and Computer Software Configuration Items respectively). A review of Electrical, Mechanical and Logical Design to ensure system compatibility is also conducted. This activity focuses on the design of the system (as opposed to the system requirements). Several other major

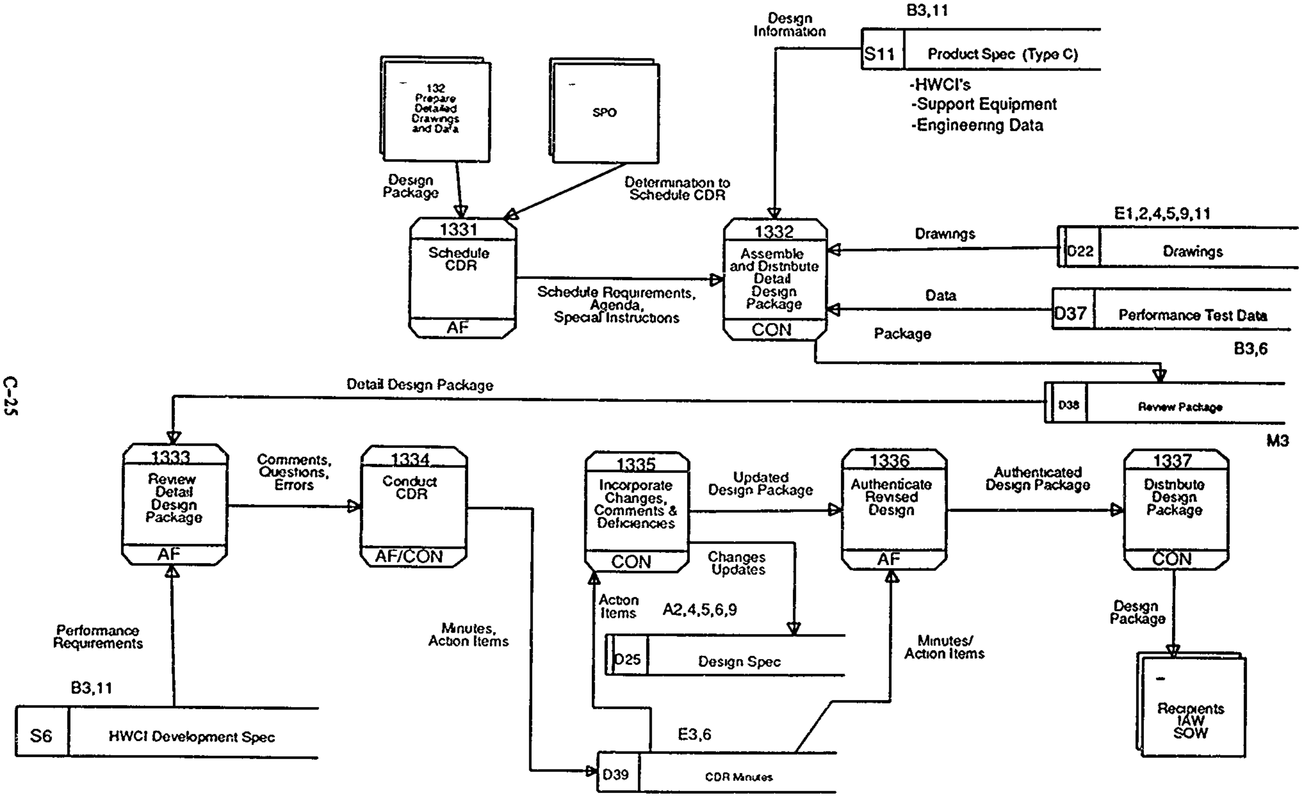


FIGURE C–13. CONDUCT CDR DFD

areas are covered during the CDR including: Design Techniques, Built-In Test Capability, Electromagnetic Compatibility, Design Reliability, Design Maintainability, Human Factors, System Safety, Natural Environment considerations, Equipment Standardization, Value Engineering, Transportability, Test, Maintenance Data, Spares, Packaging/SDPE, System Allocation Document, Design Producibility and Manufacturing, and any Post-Review Action which may be required.

- **Process 1335 – Incorporate Changes, Comments and Correct Deficiencies.** The appointed Secretariat compiles the minutes of the meeting noting technical changes, agreements, and action items resulting from discussions. Should these items affect the present design package, the contractor will effect the changes for resubmittal to the SPO.

- **Process 1336 – Authenticate Revised Design.** The SPO will make a final review of the design package specifically in those areas which were cited in the list of changes. The design can be authenticated once the agreed upon changes have been verified.

- **Process 1337 – Distribute Design Package.** The contractor, upon receiving an authenticated package from the SPO, may now distribute the design package for any further analysis or preparation as instructed in the contract.

C.3.3.4 Process 134 – Develop Specifications

Using applicable MIL-STDs, corporate standards and practices, and preliminary design specifications, the Contractor generates the Product Specification (Type C). As listed below, the Product Specification (Type C) may include the following:

- Prime Item Product Specification
- Prime Item Product Function Specification
- Prime Item Product Fabrication Specification
- Critical Item Product Specification
- Critical Item Product Function Specification
- Critical Item Product Fabrication Specification
- Non-Computer Item Product Fabrication Specification
- Inventory Item Specification

C.3.3.5 Process 135 – Review Producibility Requirements

Using the initial product specification, the contractor reviews the specification relative to the item's producibility. This consists of tooling requirements, manufacturing processes, facbrication requirements, assembly requirements, and any special requirements for production.

C.3.3.6 Process 136 - Perform FCA/PCA/FQR

The Functional Configuration Audit (FCA), the Physical Configuration Audit (PCA) and Formal Qualifications Review (FQR) serve to qualify and measure the contractor products delivered to the Air Force. The following briefly describes the audits and illustrates the differences between them:

- The Functional Configuration Audit (FCA) establishes compliance for a configuration item with the functional and performance requirements. The compliance can be verified through either test or inspection, although a prototype can be used for verification purposes (normally the First Article is used).
- The Physical Configuration Audit (PCA) examines the First Article against the design documentation.
- The Formal Qualifications Review (FQR) verifies that the performance results determined at test meet the hardware, software, and interface requirements. This review is usually concurrent with the FCA, but can be held independently. At FQR, test information and documents showing functional traceability against a system or subsystem requirement are verified. At that point, certification for configuration management will be performed.

C.3.3.7 Process 137 - Correct Deficiencies

Within each of the reviews and/or audits, the function of the Secretariat is to compile a record of agreements, points of discussion, action items, and deficiencies. The reviews and audits reveal deficiencies which must be corrected in order for the design to meet approval.

C.3.3.8 Process 138 - Approve "As-Designed" Design

The "As-Designed" design, consisting of Level 3 Engineering Data and Type C Product Specifications must then be approved by the Air Force in order to initiate the production process. This package is sometimes referred to as "Level 2 1/2" data (because the data will ultimately be changed to accommodate design changes and enhancements). The "As-Builts" engineering data which is delivered to the Air Force reflects the changes subsequent to the initiation of the production run.

C.3.4 Level 14 - Provide Technical Support

Provide Technical Support (Level 14) groups those processes which occur independently or concurrently with the major acquisition phases. These processes include the In-Process Reviews (IPR's), testing, and the configuration management activities. Although the node tree identifies the processes as a separate node, these processes support, in part or whole, the design/engineering processes.

C.3.4.1 Process 141 - Conduct In-Process Review (IPR)

The IPR plays a critical role in ensuring that the delivery and quality of engineering drawings will be met successfully. The IPR provides the SPO/EDMO and ALC an opportunity to review the engineering drawings in several technical areas. For the purposes of clarification, the IPR process has been defined in detail. The steps that follow detail the process of initiating, conducting, and the following up an IPR. Figure C-14 provides a dataflow of the IPR process.

- **Process 1411 - Request an IPR.** An IPR, typically defined as a contract requirement, allows the Air Force to review the progress of drawings prior to delivery. The IPR provides an opportunity to determine the quality of production, configuration accounting, and overall detail to the development of the prime (and subcontractor) engineering drawings.

  The government will usually request the IPR after a certain percentage of drawings have been produced (e.g., 30%, 60%, 90% complete). If the contractor experiences problems, additional IPRs may be scheduled.

- **Process 1412 - Prepare For IPR.** The contractor will prepare for the IPR by updating the drawing tree (i.e., indentured data list) and assembling the current drawing set. The contractor is responsible for providing staff who are responsible for the content of the drawings.

- **Process 1413 - Retrieve Sample Showing Change from Previous IPR.** This process identifies which drawings have been updated as a result of the previous IPR. These drawings are then retrieved prior to the IPR for presentation to the Air Force.

- **Process 1414 - Confirm Previous Discrepancies.** One of the first tasks in a typical IPR is to retrieve and review any drawings which were cited in a previous IPR. This ensures that the contractor has taken the necessary steps to correct any deficient drawings or drawing practices.

- **Process 1415 - Retrieve Current Sample.** The retrieval of drawings from those available may be made on a random basis, or focus specifically on a particular system segment. Once selected, this set of drawings forms the basis of the review comments.

- **Process 1416 - Review Drawings.** The review of the drawings usually occurs at the contractor's plant. A list of the drawings completed (at the time of the IPR) are presented via a drawing tree to the Air Force. From the drawing tree the Air Force selects a random sample for review. The IPR includes a review of:

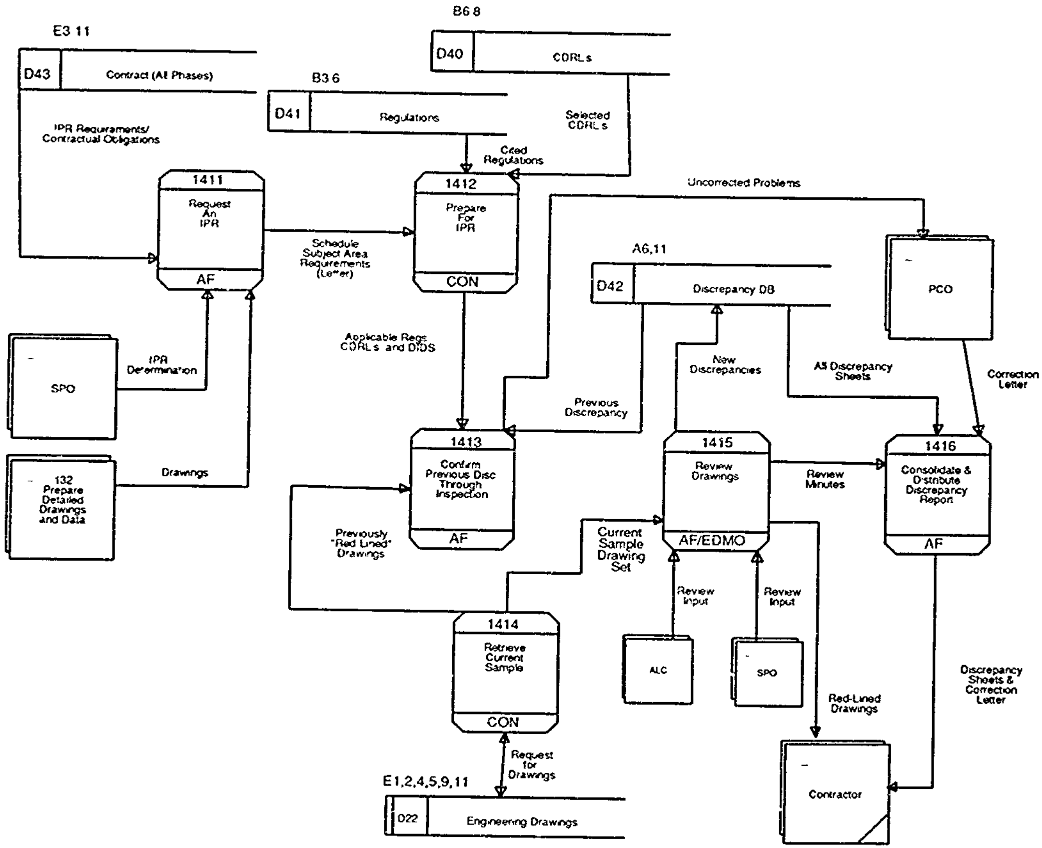


FIGURE C-14. CONDUCT IN-PROCESS REVIEW DFD

Degree of completeness of the drawing
Adherence to standard
Whether the drawing has been checked
Whether the drawing has been reviewed internally according to Company standards
General quality
Conformance to drawing standards

Discrepancy Reports are developed that identify the scope of the problem, as well as any comments or notes which were made at the review. These reports are collected, analyzed, and collated for a summary format.

- **Process 1417 – Consolidate and Distribute Discrepancy List.** As each drawing is reviewed, annotations are made identifying the drawing(s), the discrepancy, and any information pertinent to the drawing. At the end of the IPR, minutes are generated noting general statements concerning the drawings, their quality, and resolution of any problems. Should action be necessary on the part of the contractor, the minutes, along with action items, will be transmitted via the PCO to the contractor.

C 3.4.2 Process 142 – Provide Test Support

The Test phase allows a design to demonstrate its compliance with the requirements specification. The following details the processes equired to conduct a test effort (See Figure C-15)

- **Process 1421 – Generate Test Requirements.** The test requirements are specific criteria which demonstrate compliance with a design requirement. From the test, performance characteristics can be derived and analyzed in relation to the test requirements document. An example of a test requirement would be to measure the system's operational capability versus the functional specification.

- **Process 1422 – Generate Test Plan.** The Test Plan outlines the entire test effort from an organizational, functional, and analytical viewpoint. The plan identifies the test schedule, test milestones, and organizational lines of responsibility in conducting the test. The plan also identifies unique test requirements such as independent test support from the Test Wings or the Flight Test Centers (e.g., AFFTC or AFOTEC).

- **Process 1423 – Generate Test Procedures.** The Test Procedures outline specific steps in the performance and operation of the test. The procedures outline the test preparation requirements, any environmental considerations and how data will be recorded, reduced, and interpreted. For example, the requirement for any pre-existing test conditions are documented in the test procedures.

- **Process 1424 – Generate Test Data Sets.** CSCI's and HWCI's with built-in tests (i.e., firmware) require the use of established and verifiable test data sets. These

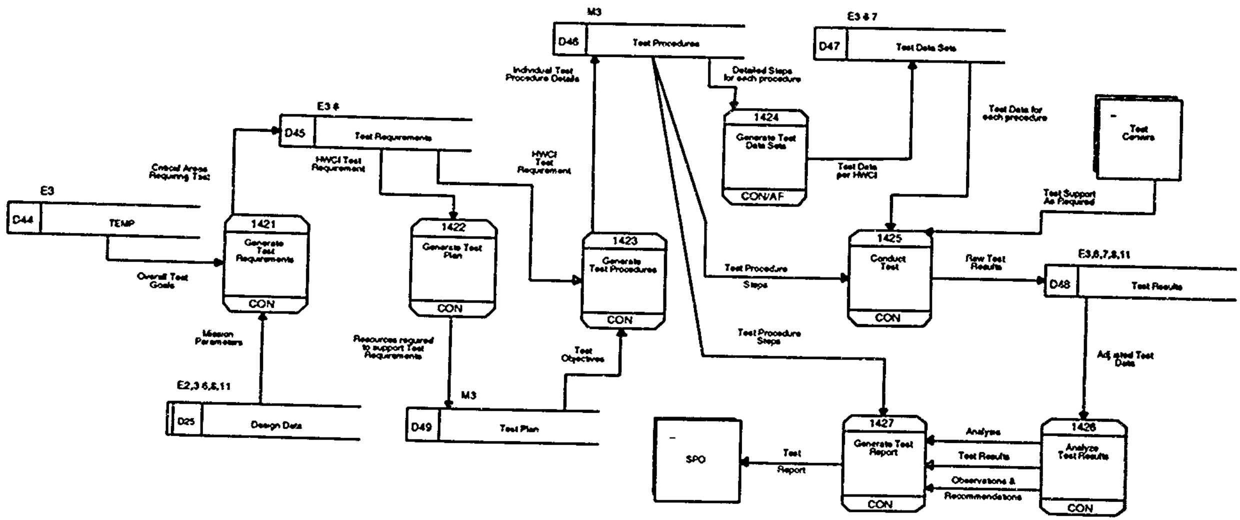


FIGURE C-15. PROVIDE TEST SUPPORT DFD

test data sets verify error conditions, establish internal parameters, and exercise permutations based on the parameters of the software. An analysis of the design is performed to ensure that the test data sets encompass the functions to be tested.

- **Process 1425 – Conduct Test.** The test is then conducted according to the test plan, test requirements, and test procedures. Each operation is documented to provide as much qualitative and quantitative data as possible.

- **Process 1426 – Analyze Test Results.** The test data is then analyzed in relation to the test and design requirements. This analysis forms the basis for documenting the results of the test.

- **Process 1427 – Generate Test Report.** The Test Report identifies test observations, test results, analyses, conclusions, etc. In addition, each design requirement is traced through the System Segment Specification (Type A), and test requirements. This report is used to support the FQR by establishing compliance with the specification via the test results.

C.3.4.3 Process 143 – Provide Configuration Management

Configuration Management is the process of identifying functional and physical characteristics of an item during the weapon system life cycle, controlling changes to the item, and tracking configuration items. As with other general technical support processes, Configuration Management has been broken down into several identifiable activities. (See Figure C-16)

- **Process 1431 – Develop Configuration Management Plan.** This plan identifies how the contractor will meet the configuration management requirements within the life-cycle of the item (CI). In addition, this plan defines the criteria for controlling engineering changes (i.e., ECP, SCNs, ACSNs, etc.)

- **Process 1432 – Configure HWCI Item.** As outlined in the system allocation document, each item to be identified for configuration is performed at the product baseline. Earlier baselines (functional baselines and allocated baselines) have applicability over an entire segment of configuration items. The product specification identifies the detailed design information to be included as configuration items.

- **Process 1433 – Review Proposed Changes.** An engineering change to a CI are documented in an ECP, OCP, ACSN, or waiver. Modifications are divided into five classes: temporary, R&D, retrofit, Safety of Flight, or new operational capabilities. Each proposed modification is reviewed for technical sufficiency, cost, and schedule and must be approved by the Configuration Control Board (CCB).

- **Process 1434 – Generate Configuration Status Report.** The configuration status report is used to perform and manage configuration status accounting. This report

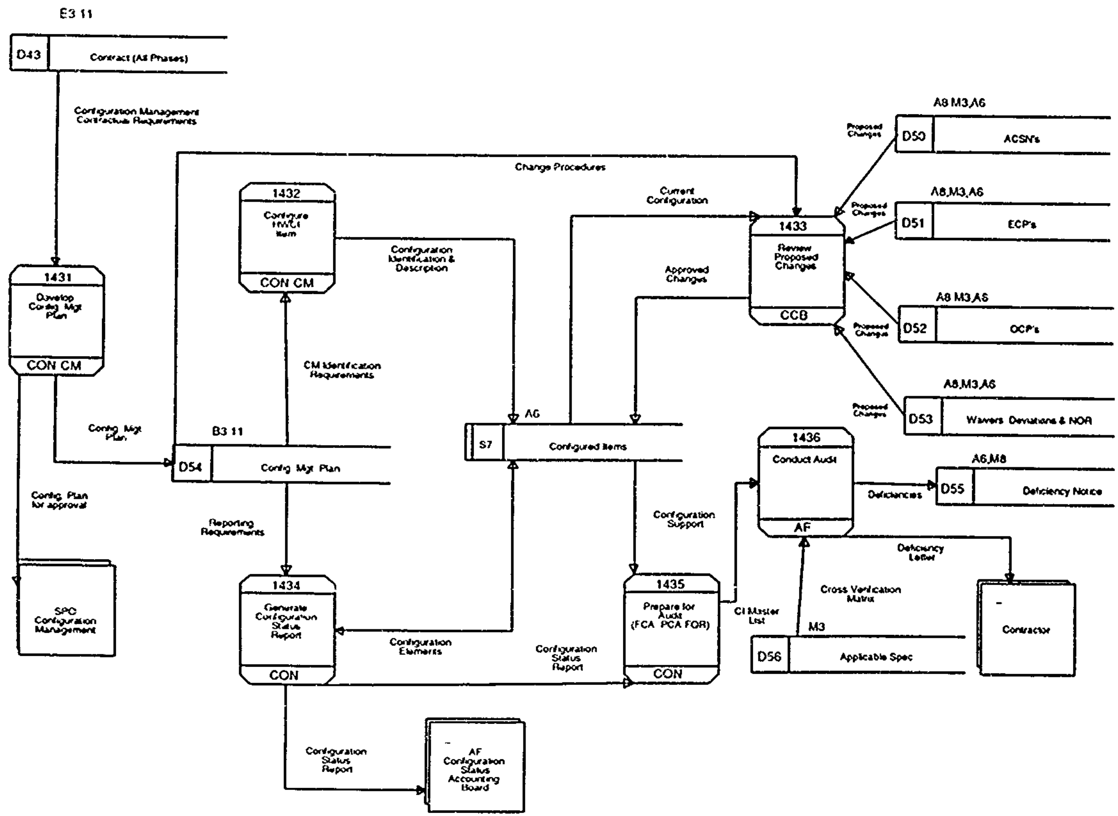


FIGURE C-16. PERFORM CONFIGURATION MANAGEMENT DFD maintains traceability of the configuration baseline and facilitates the effective control of changes. The information to be recorded regarding the system, i.e., tail number, serial number, version number, is specified IAW MIL-STD-482A.

- **Process 1435 - Prepare for Audit (FCA, PCA, FQR).** This process supports each of the audits and reviews which occur subsequent to the finalization of the design during FSD. The audits, both physical and functional, use the CM systems to help identify traceability towards the initial requirements. A configuration status report will identify current status in terms of CI development, changes, and implementation.

- **Process 1436 - Conduct Audit.** This activity refers to the SPO's auditing of either the Physical Configuration Items or the system's functional configuration. The physical configuration audit ensures delivery of all items cited in the contract and identified in the CM system. The functional configuration audit refers to the weapon systems demonstrated ability to meet the functional specification.

C.3.5 Level 15 - Provide Supplementary SPO Support

The Post-Award support characterizes the activities of the SPO prior to and during PMRT. The processes at this level depict those activities performed by the SPO subsequent to the award of the production contract. This activity is comprised primarily of a coordination activity by the SPO in terms of financing, resources, and changes of a corrective nature. In terms of the system, the PMRT Working Group is initiated which provides additional coordination between the SPO and the SPM. (See Figure C-17)

C.4 DEVELOP MANUFACTURING DATA DFDs

The Develop Manufacturing Data data flow diagrams provide a general overview of the processes, data stores, and data flows for the manufacture of a weapon system. These diagrams are not intended to define a specific contractor or acquisition program, but are intended to give a generic view of the manufacturing process and data available for both Air Force and contractor use.

The node tree (Figure C-18) and the DFD Overview (Figure C-19) provides an overview of the manufacturing process and the use of PDD. The node decomposes manufacturing into four major sub-processes. Assess Design Producibility, Conduct Producibility and Engineering Planning (PEP), Conduct Low Rate Initial Production (LRIP), and Produce Product.

During the manufacturing process AFSC is responsible for acquiring and managing PDD for system acquisitions until Program Management Responsibility Transfer (PMRT), at which time the prime Air Logistics Center (ALC) assumes control of the PDD. Air Force Regulation 800-34 (Acquisition of Engineering Data) sets the current policy and guide-

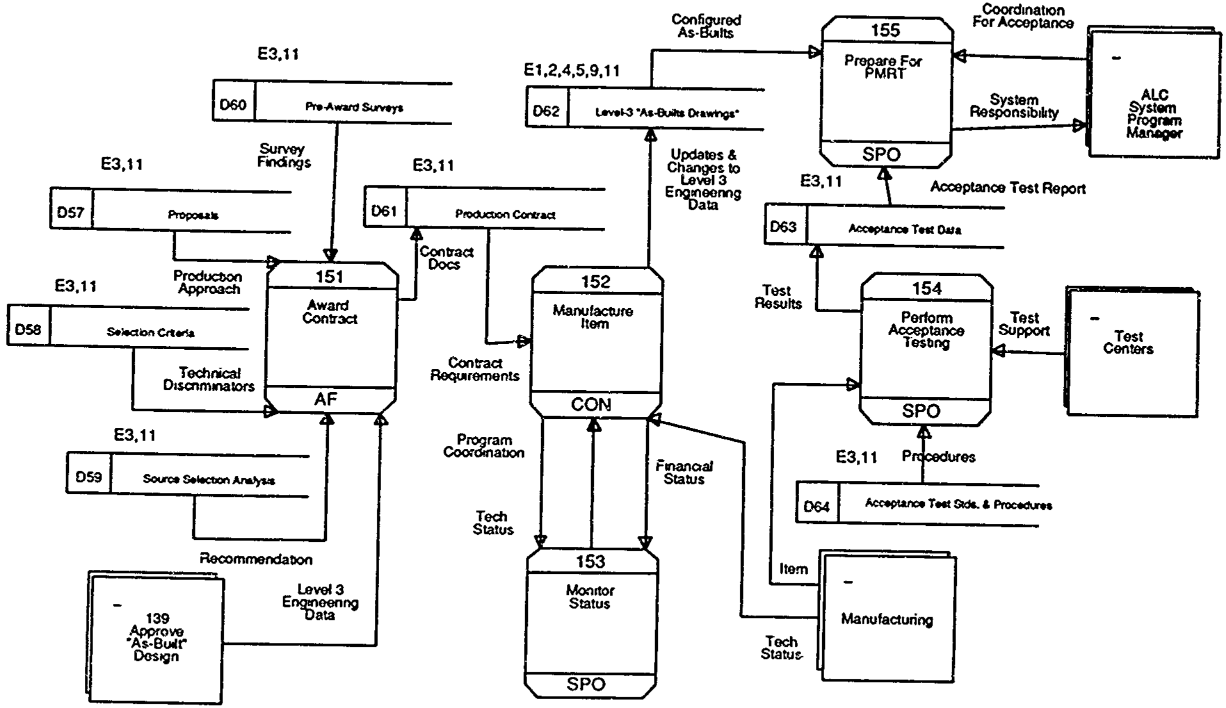


FIGURE C-17. PROVIDE SUPPLEMENTARY SPO SUPPORT DFD

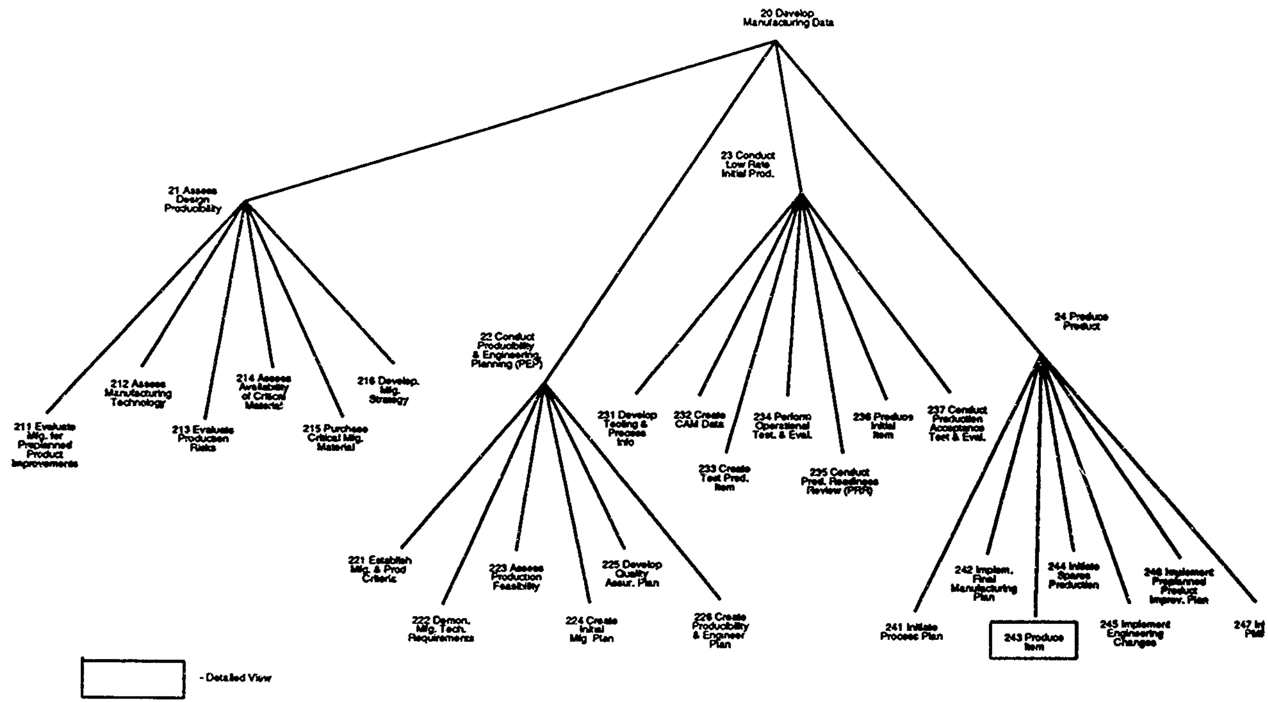


FIGURE C-18. DEVELOP MANUFACTURING DATA NODE TREE

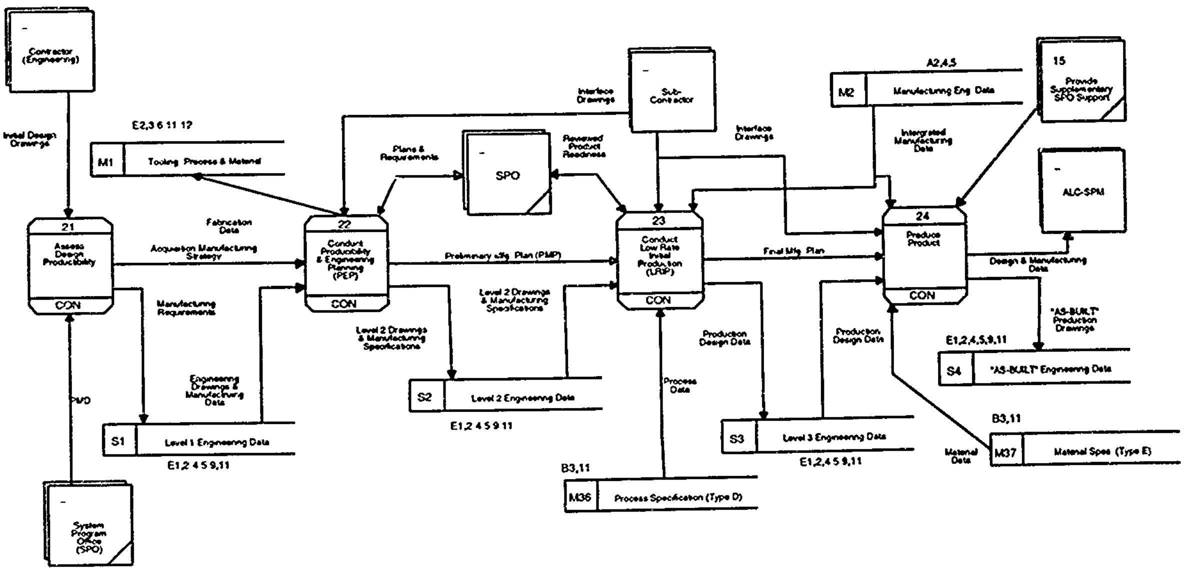


FIGURE C-19. DEVELOP MANUFACTURING DATA DFD lines for the acquisition of engineering drawings and associated data. This regulation is further augmented by DoD-D-1000B and DoD-STD-100C which set the requirements for the development and delivery of engineering drawings and associated data.

C.4.1 Level 21 - Assess Design Producibility

During the Concept Exploration phase of weapon system development, the preliminary designs are examined for manufacturability. (See Figure C-20)

C.4.1.1 Process 211 - Evaluate Manufacturing for Preplanned Product Improvements (P3I)

This is an acquisition strategy which plans for technologies to accomplish an orderly and cost-effective phased development of a system. The plan accounts for enhancements in system capability, utility, and operational readiness. The P3I program objectives are: 1) shorten acquisition and deployment time for a system or incremental improvement; 2) reduce acquisition and operational support costs; 3) extend the life of a system; 4) reduce technical, cost, and schedule risks; 5) accomplish the orderly enhancement of a system; and 6) reduce logistics and support problems.

C.4.1.2 Process 212 - Assess Manufacturing Technology

During the "Assess Manufacturing Technology" process, an evaluation of current capabilities and requirements to existing manufacturing technology is conducted. The identification of manufacturing needs and the consideration of optional technologies for risk areas or the demonstration of capabilities within the laboratory are determined.

C.4.1.3 Process 213 - Evaluate Production Risks

An evaluation of the manufacturing risk is conducted early within the development of a system. The production risk evaluation is used to quantify the feasibility of manufacturing a proposed system. This assessment is a support tool used by the contractor and the System Program Office (SPO) in making decisions on the manufacturability of a product.

C.4.1.4 Process 214 - Assess Availability of Critical Material

System performance may be dependent upon the use of one or more materials classified as strategic. Because the availability of some material is beyond the control of the Air Force or the contractor, the evaluation of alternative system concepts is necessary. The potential need for these materials is identified and the nonavailability of these materials is considered.

C.4.1.5 Process 215 - Purchase Critical Manufacturing Material

If material is identified as critical to a system, forward planning determines the availability of this material in the current market. Once long lead time material has been identified, it is possible to place advance purchase orders for this material or obtain it from government stockpiles.

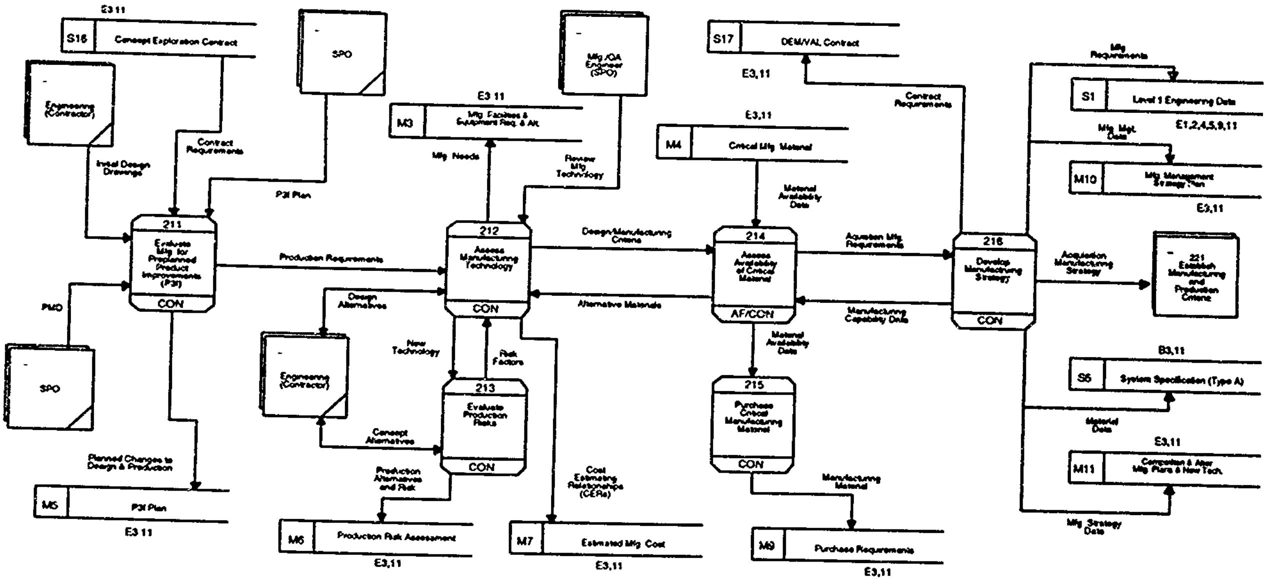


FIGURE C-20. ASSESS DESIGN PRODUCIBILITY DFD

C.4.1.6 Process 216 - Develop Manufacturing Strategy

The development of a manufacturing strategy is a subset of the overall acquisition strategy. All new manufacturing technologies, if required, will have specific plans for the development, proof, and transition of the technology to the producer.

C.4.2 Level 22 - Conduct Producibility and Engineering Planning (PEP)

Once the Concept Exploration phase of system development has been completed, the technologies and candidate designs are examined for producibility. During PEP the manufacturing criteria, MANTECH requirements, production feasibility, and initial manufacturing package are created. (See Figure C-21)

C.4.2.1 Process 221 - Establish Manufacturing and Production Criteria

The producibility and engineering plan requires the contractor to develop producibility criteria to guide the design effort. The criteria reflect the mixture of general and specific criteria applicable to the system being developed.

C.4.2.2 Process 222 - Demonstrate Manufacturing Technology Requirements (MANTECH)

For those technologies requiring development, laboratory demonstrations are necessary. The development of new manufacturing technology represents a phased approach to the definition and demonstration of these new capabilities.

C.4.2.3 Process 223 - Assess Production Feasibility

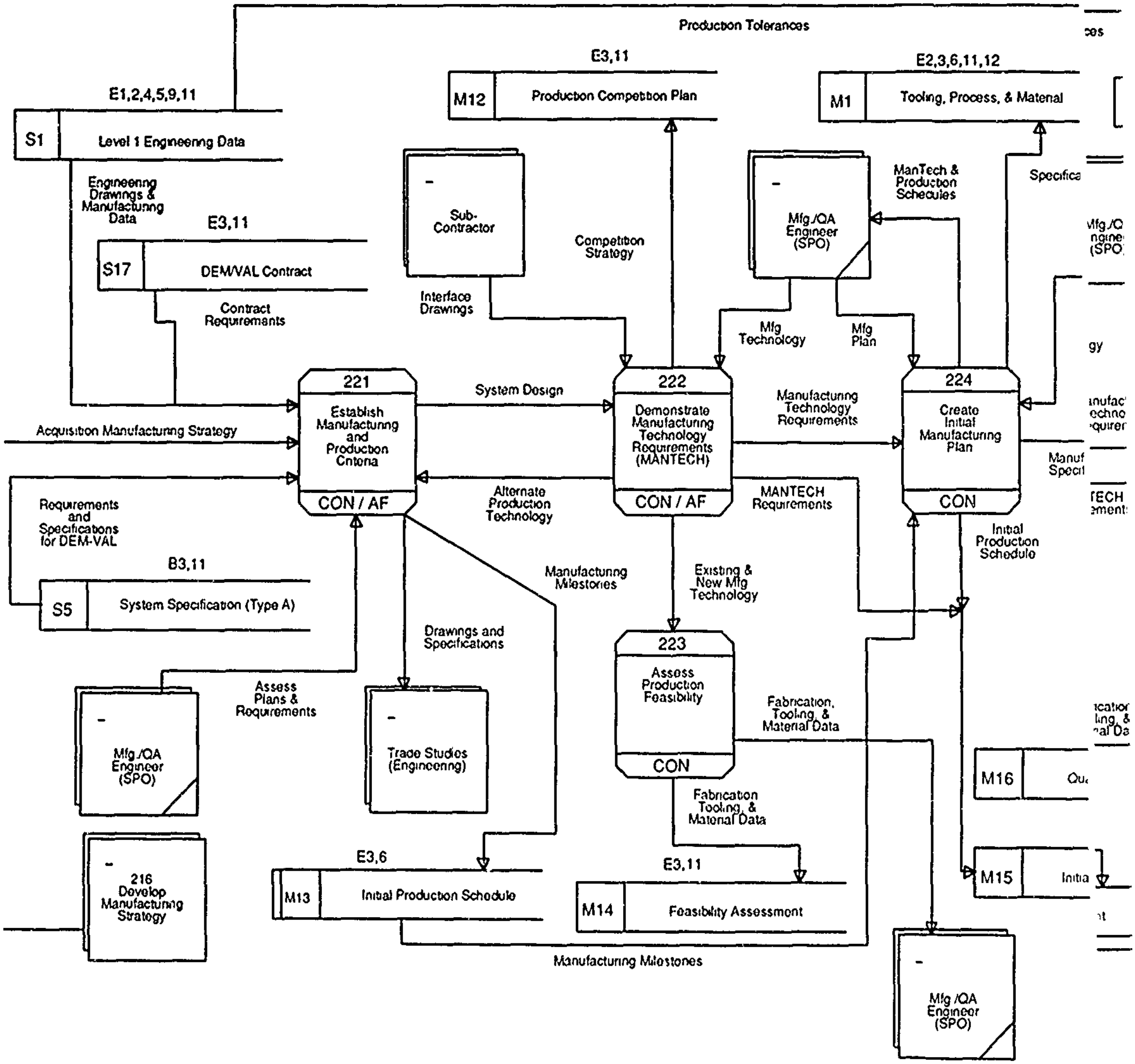
This is the likelihood that a design can be produced using existing production technology, while meeting the quality, production rate, and cost requirements of the program.

C.4.2.4 Process 224 - Create Initial Manufacturing Plan

The initial manufacturing plan is designed to describe the expected facilities, tooling, and personnel resources necessary to produce the design. The plan reflects the phased activities required to produce, test, and deliver an acceptable system on schedule and at a minimum cost. Such a plan may identify the fabrication methods planned, facilities, and estimated personnel requirements for the production of the system. The initial plan is carefully evaluated by the SPO for reasonableness and attainability within the planned program budget.

C.4.2.5 Process 225 - Develop Quality Assurance Plan

A preliminary quality assurance plan is developed to assure the product will meet the performance requirements set in the system specification, yet also meet production schedules. The quality assurance plan details the testing and evaluation of the system and its components.



Production Tolerances
E3,11
M12
Production Competition Plan
E2,3,6,11,12
M1
Tooling, Process, & Material
E1,2,4,5,9,11
S1
Level 1 Engineering Data
Sub-Contractor
Mfg./QA Engineer (SPO)
ManTech & Production Schedules
Specifica
Engineering Drawings & Manufacturing Data
E3,11
S17
DEM/VAL Contract
Competition Strategy
Interface Drawings
Contract Requirements
Mfg Technology
Mfg Plan
221
Establish Manufacturing and Production Criteria
CON / AF
System Design
222
Demonstrate Manufacturing Technology Requirements (MANTECH)
CON / AF
Manufacturing Technology Requirements
224
Create Initial Manufacturing Plan
CON
Acquisition Manufacturing Strategy
Requirements and Specifications for DEM-VAL
Alternate Production Technology
MANTECH Requirements
Initial Production Schedule
B3,11
S5
System Specification (Type A)
Manufacturing Milestones
Existing & New Mfg Technology
Drawings and Specifications
223
Assess Production Feasibility
CON
Assess Plans & Requirements
Mfg./QA Engineer (SPO)
Trade Studies (Engineering)
Fabrication, Tooling, & Material Data
M16
Fabrication Tooling, & Material Data
216 Develop Manufacturing Strategy
E3,6
M13
Initial Production Schedule
E3,11
M14
Feasibility Assessment
M15
Manufacturing Milestones
Mfg./QA Engineer (SPO)

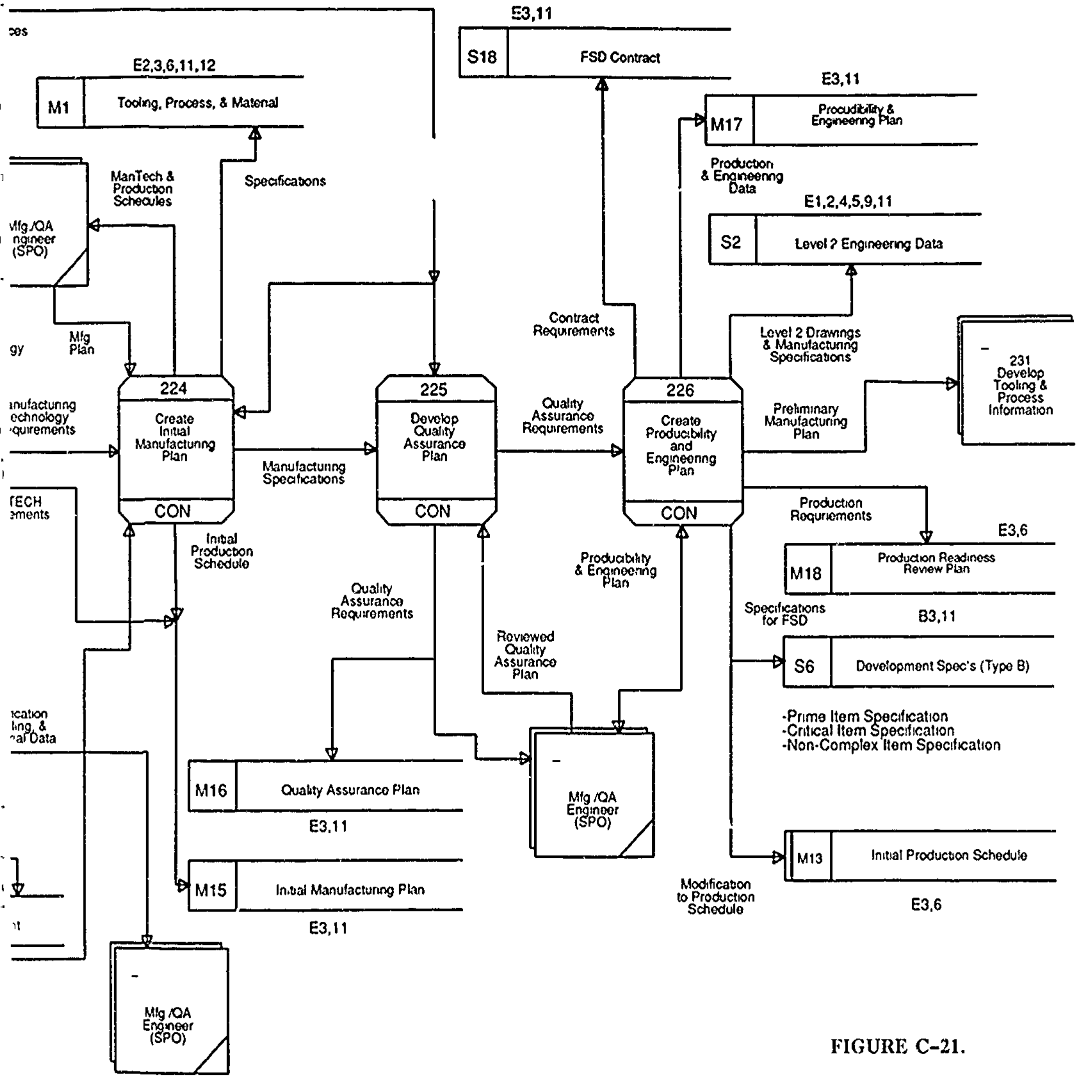


FIGURE C-21.

CONDUCT PRODUCIBILITY AND ENGINEERING PLANNING DFD

C.4.2.6 Process 226 - Create Producibility and Engineering Plan

The design of a system must take into consideration the producibility of an item. In the creation of the Producibility and Engineering Plan measures are used to develop the technical data, designs, special purpose manufacturing equipment, tooling and computer models used to assess the producibility of an item. A plan is developed from this assessment which details the technical findings and the producibility of the system.

C.4.3 Level 23 - Conduct Low Rate Initial Production (LRIP)

Once the Demonstration and Validation phase of system development is complete, the selected design is manufactured for testing and evaluation during the Full Scale Development phase of weapon system acquisition. (See Figure C-22)

C.4.3.1 Process 231 - Develop Tooling and Process Information

The during this phase the contractor develops the production methods that are representative of the final production system. These methods may be temporary, low-cost alternatives to the final method used, but provide a product which is representative of the final production line item During this period, the development and fabrication of production tooling and processes can occur.

C.4.3.2 Process 232 - Create CAM Data

The creation of CAM data from CAD data occurs during this process. The CAM data can then be used for the development of manufacturing models, CNC data, and manufacturing engineering data for system production.

C.4.3.3 Process 233 - Create Test Production Item

A pre-production prototype is created for development testing and evaluation (DT&E) as well as initial operational testing and evaluation (IOT&E). If such a prototype is used for IOT&E, the test item should reflect the production item's operational effectiveness and suitability.

C.4.3.4 Process 234 - Perform Operational Testing and Evaluation

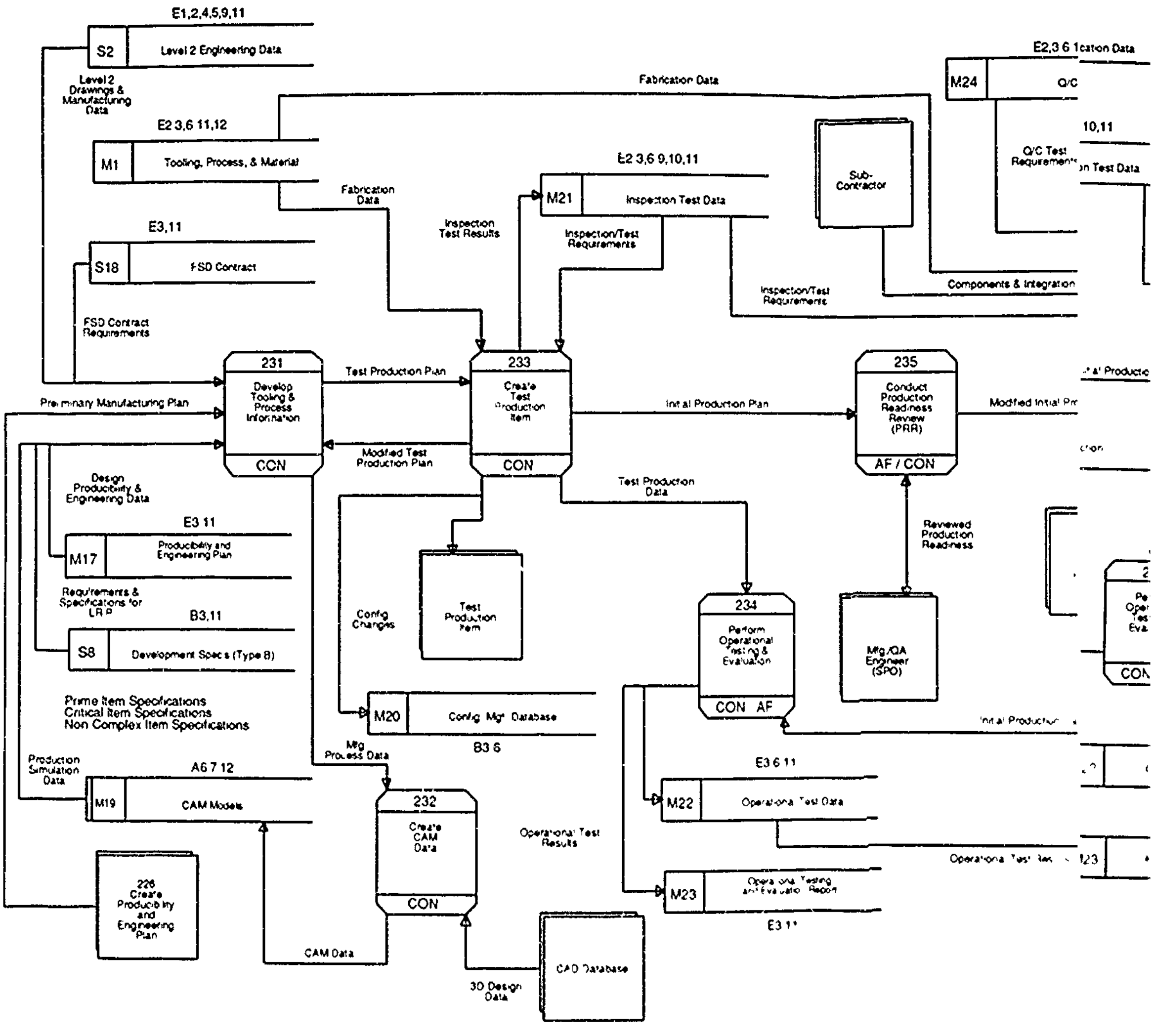
During operational testing and evaluation the item's operational effectiveness and suitability are determined.

C.4.3.5 Process 235 - Conduct Production Readiness Review (PRR)

The production readiness review verifies that the production design planning and production preparations are at a point where production can occur without incurring unacceptable risk. The results from the PRR support the Program Manager's decision whether or not to continue with production

C.4.3.6 Process 236 - Produce Initial Item

During initial item production a limited number of special pilot items are produced. Pilot items produced under this phase must satisfy DT&E and OT&E requirements During


E1,2,4,5,9,11
S2
Level 2 Engineering Data
Level 2 Drawings & Manufacturing Data
E2 3,6 11,12
M1
Tooling, Process, & Material
Fabrication Data
E3,11
S18
FSD Contract
FSD Contract Requirements
E2 3,6 9,10,11
M21
Inspection Test Data
Inspection Test Results
Inspection/Test Requirements
Sub-Contractor
Components & Integration
E2,3 6
M24
Q/C
10,11
Q/C Test Requirements
231
Develop Tooling & Process Information
CON
Test Production Plan
233
Create Test Production Item
CON
Initial Production Plan
235
Conduct Production Readiness Review (PRR)
AF / CON
Modified Initial
Preliminary Manufacturing Plan
Modified Test Production Plan
Design Producibility & Engineering Data
E3 11
M17
Producibility and Engineering Plan
Requirements & Specifications for LRIP
B3,11
S8
Development Specs (Type B)
Prime Item Specifications
Critical Item Specifications
Non Complex Item Specifications
Test Production Data
Test Production Item
Config Changes
234
Perform Operational Testing & Evaluation
CON AF
Reviewed Production Readiness
Mfg/QA Engineer (SPO)
M20
Config Mgt Database
B3 6
Mfg Process Data
Production Simulation Data
A6 7 12
M19
CAM Models
232
Create CAM Data
CON
Operational Test Results
E3 6 11
M22
Operational Test Data
Operational Test Res
M23
Operational Testing and Evaluation Report
E3 11
226
Create Producibility and Engineering Plan
CAM Data
3D Design Data
CAD Database

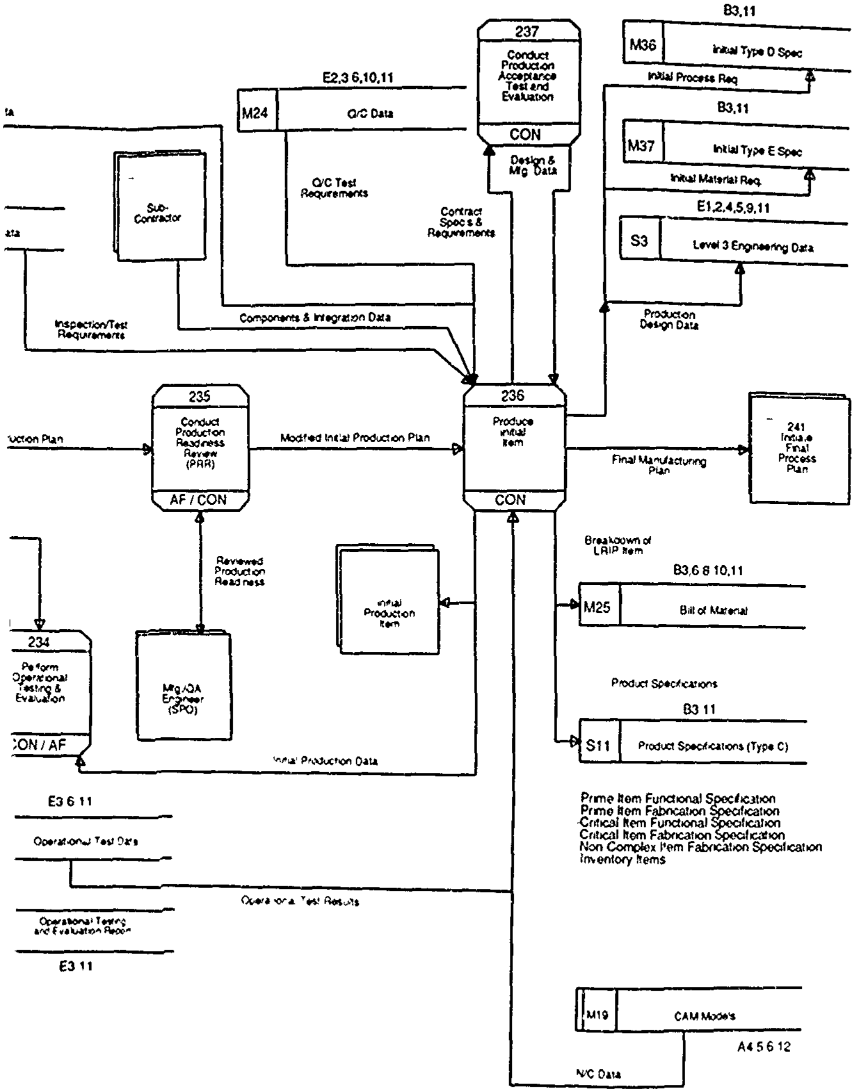


FIGURE C-22.

CONDUCT LOW RATE INITIAL PRODUCTION DFD

this period, final production line capability and preparations for full scale production are completed.

C.4.3.7 Process 237 - Conduct Production Acceptance Test and Evaluation

The prototype items are tested and a final evaluation is made to determine if they meet operational effectiveness and suitability standards.

C.4.4 Level 24 - Produce Product

Once testing and evaluation of initial production items have been completed, full scale production of the configured item can be initiated. (See Figure C-23)

C.4.4.1 Process 241 - Initiate Final Process Plan

The initiation of a final process plan begins with the modification of production facilities, tooling, test equipment, and manufacturing processes necessary to produce the item.

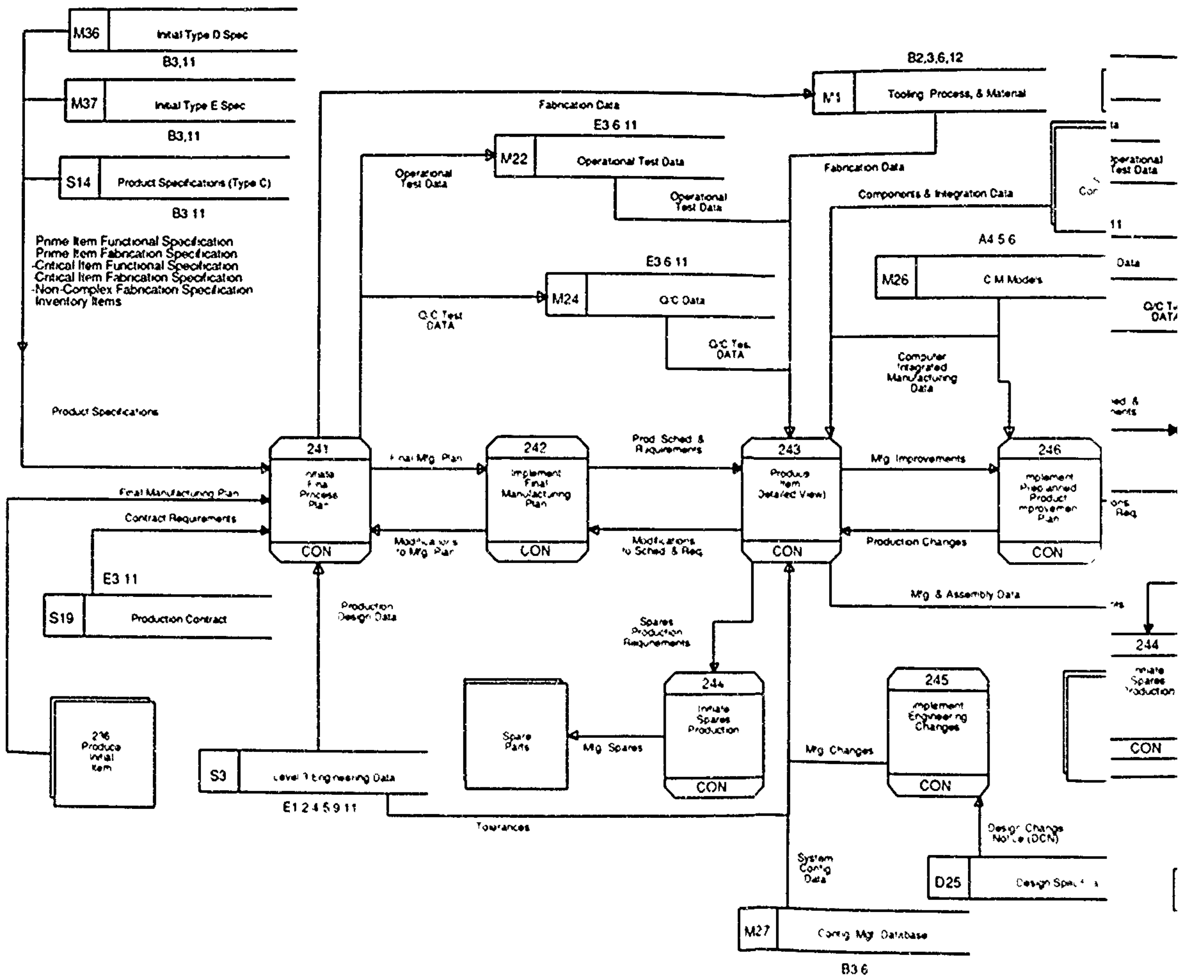
C.4.4.2 Process 242 - Implement Final Manufacturing Plan

The implementation of the final manufacturing plan begins with the initiation of production according to previously developed schedules. This phase focuses on the schedules and deliverable items necessary to meet the production contract.

C.4.4.3 Process 243 - Produce Item (Detailed View)

The item is now produced on a production (quantity) basis. The manufacturing processes, tooling, test equipment, and schedules are used to create the contracted item. This level of information provides an overview of the processes which occur during the manufacture of a "generic" product. (See Figure C-24)

- **Process 2431 - Implement Manufacturing Management Plan.** The manufacturing management plan, which details schedules, facility layout, personnel requirements, and delivery dates, is implemented during this phase of system manufacture. Implementation causes initiation of material requests, subcontractor manufacturing, construction of jigs and fixtures, and the modification of facilities for production.
- **Process 2432 - Conduct Shipping and Receiving Operations.** During this process, material, sub-components, and government furnished equipment are ordered, received, and stored for use by the manufacturing facilities. The material identified in Process 214 (Assess Availability of Critical Material) and purchased in Process 215 (Purchase Critical Manufacturing Material) are received along with non-strategic material for the manufacture of the system. The material and sub-components are provided by the government, subcontractor, and vendors and prepared for processing and assembly.
- **Process 2433 - Perform Tool and Die Production.** The tooling, dies, jigs, and special fixtures are fabricated during this process according to manufacturing re-



M36 Initial Type D Spec
B3,11
M37 Initial Type E Spec
B3,11
S14 Product Specifications (Type C)
B3 11
Prime Item Functional Specification
Prime Item Fabrication Specification
-Critical Item Functional Specification
-Critical Item Fabrication Specification
-Non-Complex Fabrication Specification
Inventory Items
Product Specifications
Final Manufacturing Plan
Contract Requirements
E3 11
S19 Production Contract
B2,3,6,12
M1 Tooling Process, & Material
Fabrication Data
E3 6 11
M22 Operational Test Data
Operational Test Data
Fabrication Data
Components & Integration Data
E3 6 11
M24 Q/C Data
Q/C Test DATA
A4 5 6
M26 C M Models
Computer Integrated Manufacturing Data
241
CON
Final Mfg Plan
242
Implement Final Manufacturing Plan
CON
Prod Sched & Requirements
243
Produce Item (Detailed View)
CON
Mfg Improvements
246
Implement Preplanned Product Improvement Plan
CON
Modifications to Mfg Plan
Modifications to Sched & Req
Production Changes
Mfg & Assembly Data
Production Design Data
Spares Production Requirements
244
Initiate Spares Production
CON
245
Implement Engineering Changes
CON
Spare Parts
Mfg Spares
Mfg Changes
S3 Level 3 Engineering Data
E1 2 4 5 9 11
Tolerances
System Config Data
Design Change Notice (DCN)
D25 Design Spec
M27 Config Mgt Database
B3 6
244
Initiate Spares Production
CON

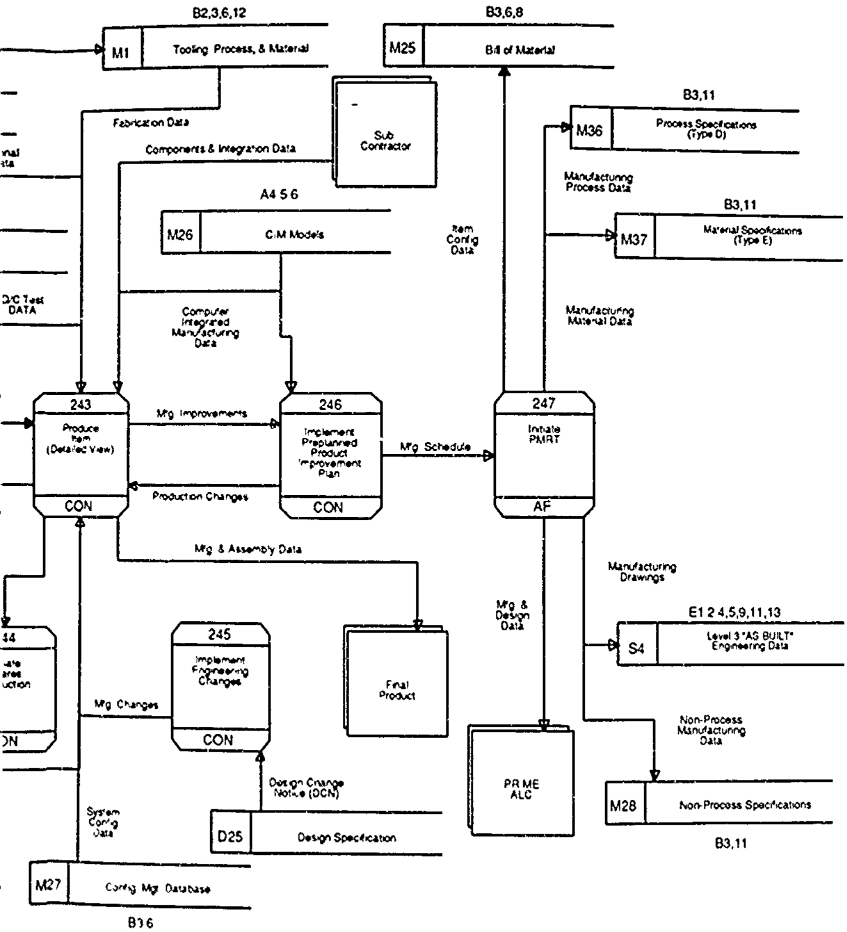
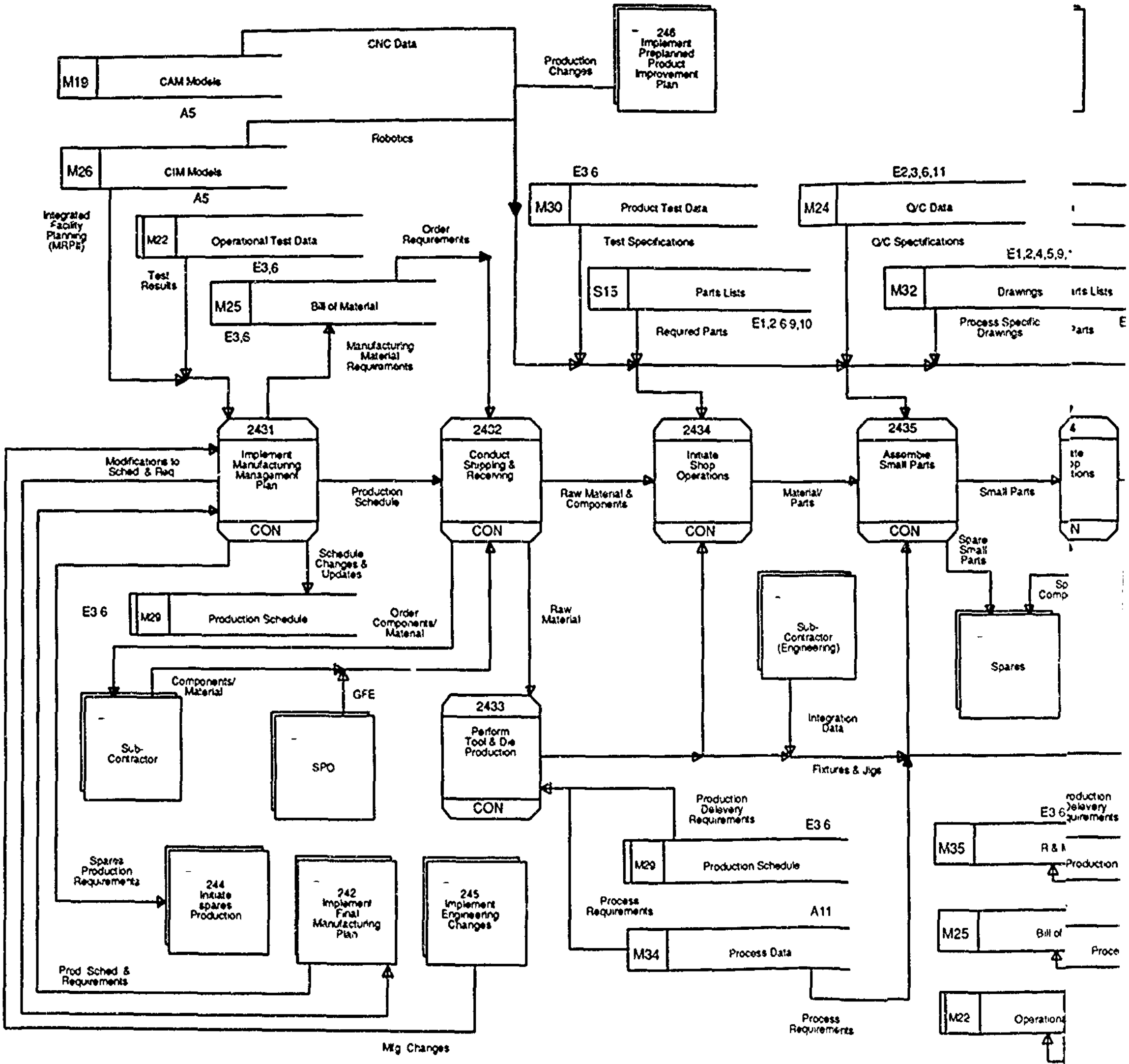


FIGURE C-23. PRODUCE PRODUCT DFD


CNC Data
M19 CAM Models
A5
Production Changes
246 Implement Preplanned Product Improvement Plan
Robotics
M26 CIM Models
A5
E3 6
M30 Product Test Data
E2,3,6,11
M24 Q/C Data
Integrated Facility Planning (MRPII)
M22 Operational Test Data
Order Requirements
Test Specifications
Q/C Specifications
E1,2,4,5,9,
E3,6
Test Results
M25 Bill of Material
S15 Parts Lists
M32 Drawings
E3,6
Manufacturing Material Requirements
Required Parts
E1,2 6 9,10
Process Specific Drawings
2431 Implement Manufacturing Management Plan CON
2432 Conduct Shipping & Receiving CON
2434 Initiate Shop Operations CON
2435 Assemble Small Parts CON
Modifications to Sched & Req
Production Schedule
Raw Material & Components
Material/ Parts
Small Parts
Schedule Changes & Updates
Spare Small Parts
E3 6
M29 Production Schedule
Order Components/ Material
Raw Material
Sub-Contractor (Engineering)
Spares
Components/ Material
GFE
Sub-Contractor
SPO
2433 Perform Tool & Die Production CON
Integration Data
Fixtures & Jigs
Production Delivery Requirements
E3 6
M29 Production Schedule
M35
Spares Production Requirements
244 Initiate spares Production
242 Implement Final Manufacturing Plan
245 Implement Engineering Changes
Process Requirements
A11
M34 Process Data
M25
Prod Sched & Requirements
M22
Process Requirements
Mfg Changes

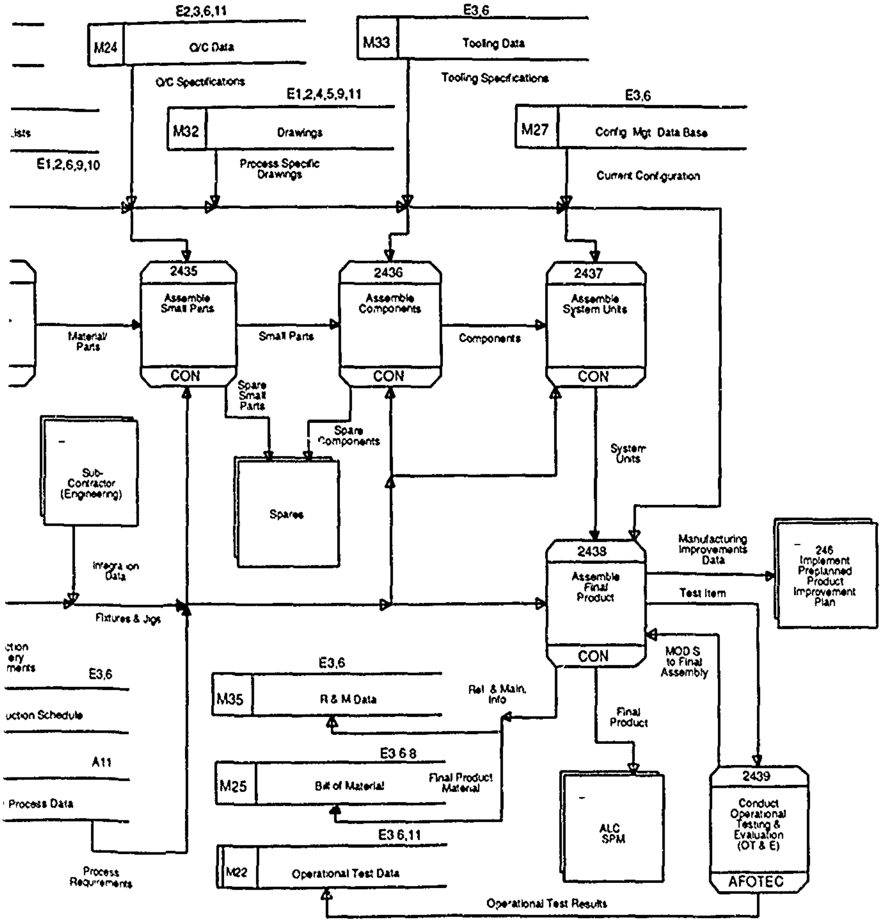


FIGURE C-24. PRODUCE ITEM DFD

quirements and specifications. These tools, dies, jigs, and fixtures are used to process, treat, machine, and assemble the system.

- **Process 2434 – Initiate Shop Operations.** During this process raw material is machined, treated, and processed to create parts and components used during other phases of production. Also, the tooling, jigs, and fixtures are applied to the machining, treatment, and assembly of certain parts.

- **Process 2435 – Assemble Small Parts.** The parts created during the previous processes or purchased from vendors are assembled into small part assemblies which are used during other phases of manufacturing.

- **Process 2436 – Assemble Components.** The small part assemblies are combined to form larger components which are used later in the production process. These components may be specific subsystem units such as avionics, navigation, communications, power plant, etc., that will be integrated into the system.

- **Process 2437 – Assemble System Units.** The components assembled in the previous process are integrated into system units. These systems units are assemblies of related components that are combined to create the final product.

- **Process 2438 – Assemble Final Product.** The previously created system units are assembled into the final product.

- **Process 2439 – Conduct Operational Testing and Evaluation (OT&E).** As with the test and initial production items, operational testing and evaluation is conducted to determine if the product produced meets the operational effectiveness and suitability criteria detailed in the system specifications.

C.4.4.4 Process 244 – Initiate Spares Production

The manufacture of spare parts is integrated with the production of the item. This takes advantage of the lower costs associated with large fabrication lots.

C.4.4.5 Process 245 – Implement Engineering Changes

During follow-on operational testing and evaluations, feedback on the system can identify areas for improvement These improvements frequently result in design changes that modify the manufacture of the product.

C.4.4.6 Process 246 – Implement Preplanned Product Improvement Plan

During this phase, the preplanned product improvements identified earlier are implemented. This allows for a phased growth in the systems capabilities, utility and operational readiness.

C.4.4.7 Process 247 - Initiate PMRT

PMRTis the delivery of system management responsibility to the AFLC by the acquisition SPO. During this period, engineering, financial, and logistical support information are delivered to the ALC SPO.

C.5 DATA DICTIONARY

C.5.1 Data Stores

The following dictionary defines the contents of the data stores identified in the data flow diagrams. In the diagrams these data stores are symbolized by a pair of horizontal lines closed at the left-hand side. Each store has an identification number at the left-hand end, and has an alpha-numeric code on the top which describes the automation status, media and physical storage format used (refer to Table C-1 for details of the DFD codes.)

Acceptance Test Data

Identifies the conditions and parameters under which the First Article will be tested.

Acceptance Test Standards and Procedures

In performing acceptance testing, standards and procedures are formulated to ensure that the First Article meets the Type C Specification and will reflect accurately the information contained in the approved Level 2 drawings.

ACSN (Advanced Change Study Notice)

Used to present essential information regarding a change proposal. This information includes a statement of the problem, the proposed solution, and estimated cost.

Additional Design Information

Identifies any information not currently available in the Level 2 Engineering Data package Generated by the engineers, this information supplements the package of information supplied to the drafting organization. This information also includes any additional sketches, layouts or instructions prior to production of the drawing.

AFLC Form 206 - Temporary Work Request Form

Local Manufacturing is initiated by MM using AFLC Form 206. This request sent to the planner who has an option to accept/reject the request. This form is being automated as Maintenance Work Load System (G336).

AFLC Form 237 - Temporary Labor And Material Plan

Used to plan the labor and material requirements. From this form is extracted the L-3A funding report for input into G004L automated system. This form is prepared by the maintenance/engineering planner. It includes RCC code, the operator number, time required to perform task, operation description, material code, part number, quantity, cost center, etc.

AFLC Form 256 - Job Control

Assigns job control number to the work.

AFLC Form 761 - Screening Analysis Work Sheet

Competition Advocacy (CR) uses AFLC Form 761-Screening Analysis Work Sheet to screen engineering data to ensure that the data is adequate to support competitive reprocurement.

AFLC Form 958/959 - Work Control Document

The maintenance/engineering planner in the MA_E organization must prepare work control document that sequences all the necessary steps to repair or local manufacture the item with the essential engineering data defined for each step. MA uses this form for parts routing, operation description, and work verification by assigning a work control job order number.

Allowables

Allowable stresses (shear, fracture, bond, etc.) are the calculated permissible physical characteristics so that the structure/part will not fail.

Analysis Information

Identifies process data for the production of the item. It is included on the drawing required for manufacturing in areas such as machining, tolerance, finish, hardness, etc.

Applicable Specification

Identifies the specifications which identify functional requirements. They are used to establish the means of verification for the FQR and both functional and physical audits (FCA/PCA).

Assembly Drawings

Comprised of arrangement, cable, exploded view and installation drawings.

Bill of Material (BOM)

Describes the raw materials and purchased parts used in the manufacture and assembly of a product or those materials or purchased parts required as a result of a change in a product.

CAD (Computer Aided Design) Database

This is the design data (geometry, typology, dimensions, etc.) developed by the designers of the item and issued to develop Computer Aided Manufacturing (CAM) data.

CAD Models

Represents at this level the conglomeration of quantitative design models used to provide the design definition. In more detailed drawings, CAD models are defined within the various processes such as fuel-use vs. mission analysis, propulsion vs. weight, flight-envelope vs. mission, etc. All of these models serve to provide a quantitative approach in optimizing the design given a particular mission.

CAM (Computer Aided Manufacturing) Data

The MA_P, organization creates CAM Models when CNC (Computer Numerical Control) methods are employed. A 2D/3D vector model is developed and then CAM data (cutter tool path) is created. The CAM data is entered into models and used when the manufacturing is performed.

CAM Models

Refer to the quantitative approach in defining how an item will be manufactured. This work defines, for example, methods and parameters for achieving a particular hardness, establishing tooling paths, and generating optimum resource scheduling for the manufacturing floor.

CDR (Critical Design Review) Minutes

Generated at the CDR and includes any notes, comments, action items or problems identified at the CDR. The minutes are also used to authenticate an updated or appended design.

CDRLs (Contract Data Requirement Lists)

Generated on DD Form 1423. This item which is cited in the SOW (Statement of Work) and supported or supplemented by various DIDs. It is an integral component of the contract, and includes schedule, delivery, and identification information.

CIM (Computer Integrated Manufacturing) Models

Allow for an integrated method of scheduling jobs, shop floor control, robotics, and the management of the production operation.

Company Standards and Specifications

Identify internal corporate practices used to describe how the contractor will develop drawings, specifications, and produce an item.

Comparison Reports

Identify the results of analyses detailing the trade-off process between the various technologies of each CI.

Competitor and Alternate Manufacturing Plans and New Technologies

Contains the plans used to create a competitive environment for the manufacture of a design. It also contains alternative manufacturing plans and new technologies needed to produce an item.

Concept Data

Identifies a particular configuration of technologies which, when deployed, comprise a system. As this information resides in the Develop Conceptual Design process, the concept data is broad.

Concept Exploration Contract

Represents the contracts utilized during the Concept Exploration phase of a weapon system acquisition.

Configuration Items (CIs)

Represent the active list of identified HWCIs and CSCIs which comprise an item or system CIs are the identified major assemblies/components (e.g., landing gear, avionics, wing) of the weapon system.

Configuration Management Database

Used in the context of applying configuration management control to the engineering drawings. Each of the drawings are numbered IAW instructions contained in the CDRL.

Configuration Management (CM) Plan

Identifies the approach, method, and organizational requirements for instituting the CM process. It identifies identification schemas, tree diagrams, and reporting requirements and methods for CM status reporting.

Contract (All Phases)

Represents the contractual vehicle which provides the technical authority to initiate various tasks within the development and acquisition of a weapon system.

Control Drawings

Comprised of altered item drawings, envelope, installation, source control, and specification control drawings.

Critical Manufacturing Material

Contains information on materials critical to the manufacture of a system and its availability.

D032-Item Management Stock Control And Distribution (IMSC&D)

Performs the wholesale stock control and distribution functions for worldwide users. It maintains visibility of all assets within the wholesale complex controlled by the inventory manager and tracks the issuance of material within levels and priority.

D033-AFLC Retail Stock Control

This system is the Central Materiel Locator Management System for AFLC Retail Stock Control and Distribution and provides inventory accounting for all stock items in support of repair activities, tenants, and other local organizations including the accounting for materials issued to the Directorate of Maintenance Inventory Control Center at ALCs.

D039-Equipment Item Requirements Computation System

Using reported organizational authorizations and assets as projected against the organization program file, this system computes USAF requirements for equipment items. This information is used for the preparation of procurement plans and budget estimates.

D041-Recoverable Consumption Item Requirements System

Computes peacetime and war readiness requirements for Air Force Recoverable Items. Provides indication of items subject to buy, repair, termination, and disposal. This system provides products in accordance with DoD formats and on-line file maintenance and interrogation capability to system users.

D049-Master Material Support Record (Recoverable)

Maintains current identification of all parts and materials which are part of recoverable items subject to depot level repair. AFLCR 65-3 establishes the requirements to maintain currency of data developed during the Provisioning function. The resulting data is used to establish the records and data in D049.

D057G-Advanced Configuration Management System

Provides: 1) automated data system support for weapon system configuration status accounting, 2) status of modification actions by Air Force activities, 3) status of serialized items related to the parent system. 4) Technical Order notification and compliance status information.

D062-EOQ Buy/Budget Computation System

Computes current wholesale stock levels, buy requirements, projected requirements, and the asset position for budget purposes. The system operates for stock fund and centrally procured ERRC coded items The buy computation is run weekly; the budget computation is run quarterly.

D066-Commodity Configuration Management System

Provides TCTO/modification status for selected commodity type accessories not covered by other established configuration status systems. Provides AFLC Item Managers with a monthly status in terms of units and man-hours. Outputs control accumulated TCTO backlogs, resolves kit/material shortages preventing accomplishment, and ensures desired configuration improvement.

D073-Repair Requirement Computation

Provides an automated method for determining short and long range repair needs. The system computes a Weighted Daily Demand Rate (WDDR) for all recoverable items (expendability-repairability-recoverability-cost (ERRC) codes

Data List Form 1659

Used to prepare a data list which forms part of the bid set. This also acts as a check list for the bidder to verify if all the drawings are present in the reprocurement package.

Demonstration/Validation (DEM/VAL) Contract

Represents the information contained in the contract used to implement the Demonstration/Validation phase of the acquisition.

Deficiency Notice

Identifies a functional or physical deficiency revealed during the audits. The notice points out shortcomings or failure to comply with a given specification or design requirement.

Design Data

Consists of the design information contained in the design specification. This information is updated, changed, or enhanced as a result of the technical review at CDR.

Design Sheets

Used to describe performance, design, and test requirements for equipment end items, critical components, and computer programs. The Design Sheet provides the basis of configuration management identification

Design Specifications

Represents the preliminary design information. This information is used to generate the initial Product Specifications (Type C).

Detail Drawings

Represents the mono-detail, multi-detail, and tabulated drawings that are developed during detailed design.

Development Specification (Type B)

Contains additional details beyond the System Specification (Type A) The B specification consists of five components. 1) B1-Prime Item, 2) B2-Critical Item, 3) B3-Non-Complex Item, 4) B4-Facility or Ship, and 5) B5-Software. The content of the B Specifications are defined in MIL-STD-490A, Specification Practices.

Diagrammatic Drawings

Include block diagrams, electronic schematics, flow diagrams, logic diagrams, and piping diagrams

Discrepancy Database

Identifies the list of discrepancies which are identified at the IPR. This form adheres to a check list of factors which helps the reviewer generate a quantitative assessment of each drawing.

Drawing Database

Identifies the entire spectrum of drawing types identified in DoD-STD-100C These drawing types form six drawing groups. 1) detail drawings, 2) control drawings, 3) undimensioned drawings, 4) diagrammatic drawings, 5) assembly drawings, and 6) special purpose drawings.

Drawing Requirements

Identifies the type, format, quantity, content, and production requirements for the drawings. The requirements are derived from the internal standards and practices, DoD-STD-100C, DoD-D-1000B, or explicit direction in the contract.

Drawing Specifications and Standards

Refers to the specific regulations and standards imposed upon drawings This includes MIL-STD-100C and MIL-STD-1000B.

Drawings

Illustrates the collection of drawings which are managed under configuration control after acceptance.

DTA (Damage Tolerance Assessment) Models

Used to find the critical locations of cracks. Crack growth analysis uses the load spectra data base and material data base. Then, testing is performed to verify the analytical DTA models

ECPs (Engineering Change Proposals)

Used to apply changes to a given configuration. The ECP is reviewed for priority and financial impact, as well as related ECPs which may encompass similar efforts. If the review is approved, the ECP will be designed, installed, and tested on the weapon system.

EDCARS Data

Engineering drawings and associated lists ranging from A to E size in aperture card or paper form are scanned and stored in EDCARS in raster format EDCARS drawings are consolidated to form a master bid set for spares reprocurement

Engineering (Contractor)

Represents the engineering group within a contractor that develops the design of a weapon system

Engineering Drawings

Represents the engineering drawings which are made available to the government at the IPR During the IPR, the government selects sample drawings for review and to serve as a representative sample from which assessments of quality, adherence to standards, and completeness are made

Environmental Constraints

Represents that body of data which encompasses the limiting factors of the environment on the system This information includes temperature, humidity, electrical grounding considerations, operating altitude, pressure, cooling requirements, etc.

Estimated Manufacturing Cost

Contains the estimated cost to manufacture the preliminary design.

Fabrication Data

Contained in the Fabrication Specification, and consists of joining or assembly information pertaining to welding, soldering, or riveting processes.

Fasteners Specification

Addresses the specific requirements for riveting and bolting of aircraft structures.

Feasibility Assessment

Using design and manufacturing data along with available prototypes, an assessment of the items producibility is formulated. This analysis determines the extent of the effort required to produce the item.

FEM (Finite Element Model) Data

Represents the 2-D/3-D wire frame data used to analyze stress on isolated components.

FSD Contract

Represents the contract awarded at the onset of the Full Scale Development phase. It is shown at the end of the Demonstration/Validation phase where critical information for the next phase is assembled. The contract is comprised of the SOW (Statement of Work), CDRLs (Contract Data Requirement List), a list of applicable regulations, and signature sheets.

G004L-Job Order Production Master System

Establishes a production number for each work authorization document authorizing work in MA. Provides mechanized output products reflecting status of end items in work. Serves as a Control Number Cross Reference file for validating maintenance shop production count and actual material costs.

G019C-MISTR Requirements, Scheduling and Analysis System

Schedules items to be repaired organically and produces management and problem reports. Master files are maintained at each ALC on all items repaired. From this data, Source of Repair (SOR) reports are produced for MA and IM reports are produced for MM.

G028-Maintenance Engineering Data Support System for Automation of Work Control Data

Maintenance Engineering Data Support System for the automation of work control data is designated by G028. This automates AFLC Form 959 used by MA for parts routing, operation description and work verification. Work Control Document data are entered into the system by MA personnel.

G063-Maintenance and Operational Data Access System (MODAS)

This system provides an on-line (weapon system oriented) data system for maintenance (AFR 66-267) and operational (AFR 65-110) data collected from base, ALC, and contractor levels. A data base stores data to support Reliability and Maintainability, Product Improvement and Product Performance programs directed by HQ USAF for a period of two years.

HWCI (Hardware Configuration Item) Development Specification

Required to evaluate the design package prior to CDR. HWCIs provide a baseline of design requirements for the engineer to measure and review the particular design.

Initial Analysis Data

Represents the preliminary design of the weapon system. The general approach of the entire acquisition cycle is to identify very broad requirements (i.e., stating the system must be capable of delivering a minimal payload, to a more defined position of flight characteristics during the delivery of the payload). This data will be used as a benchmark for the demonstration/validation phase of the acquisition.

Initial Manufacturing Plan

Identifies the processes, material, and equipment needed to initiate the manufacturing process

Initial Material Specification (Type E)

Represents the initial material requirements for the manufacture of a product.

Initial Process Specification (Type D)

Represents an initial version of the Process Specification. In the initial version the pre-production process requirements are specified. Once production begins, the process specifications for a product are finalized and documented in the final Type D specification

Initial Production Schedule

Represents the production schedule based on information available during the demonstration and validation phase of system acquisition.

Inspection Test Data

Contains the results from the inspection of the product.

J008 - Screening Analysis For Procurement Method Code

Tracks screening analysis worksheet (Form 761) and supplies statistical data on the current workload of procurement method code assignment for high dollar spare parts breakdown program.

Level 1 Engineering Data

Documents the concept and fabrication of the developmental hardware. This data is required during the conceptual exploration phase of acquisition and normally is not delivered except as required to support technical reviews. This information consists of primary candidate configurations which have been selected for further analysis.

Level 2 Engineering Data Package

Identifies the completed design information which is generated to develop a prototype during the demonstration/validation phase. This information provides the baseline for the engineering effort during the Finalize Detail Design phase.

Level 3 "As-Built" Engineering Data

Developed to accurately reflect the manufactured item. The drawings are used to manufacture the First Article and are often referred to as "Level 2 1/2", due to the fact that the drawings are now detailed Level 2 drawings, but not to the level of "As-Built" (Level 3). The "As-Built" are developed during development of the first article, and are reviewed during the acceptance test. Once the First Article is accepted, changes to the CI as well as the drawing occur through the production process.

Level 3 "As-Designed" Engineering Data

Contains all drawings, specifications, requirements, test, and other information required to manufacture and assemble the product.

Level 3 Engineering Data

Represents Level 3 Engineering Data ~~is~~ essential for the maintenance, modification, logistics, and engineering support of the production item. Level 3 Engineering Data is also essential for the competitive reprocurement of the contract end items and their spare parts. This data is obtained from contractors either in aperture cards or hard copy are stored in the EDSC. The MA and MM division request drawings using AFLC Form 1147 to support sustaining engineering activities. Level 3 ED consists of drawings and associated lists such as the parts list, index list, and data list. Level 3 ED is stored in the EDSC (or locally within the MA or MM directorate).

Level 3 Engineering Data is further defined as the data required to document and engineering design or product configuration identification. They include, but are not limited to, engineering drawings and associated lists, tooling data, flat patterns, master printed circuit patterns, numerical control data, test methods and procedures, acceptance test criteria, electrical schematic and logic diagrams, configuration item specifications, computer products (such as CAD/CAM), and all processes and documents referenced therein that define the physical geometry, performance characteristics, manufacture, assembly, and operation of parts, assemblies, or systems.

Load Data

As a select configuration is chosen for finalization, the load characteristics are developed for structural and mechanical soundness. This information is gained from structural analysis and mechanical loading models which identify possible points of stress, fracture, or tear.

Manufacturing Facilities and Equipment Requirements and Alternatives

Contains preliminary information on manufacturing facilities, equipment, and alternatives necessary to manufacture a design.

Manufacturing Management Strategy Plan

Outlines the long term management of the manufacture of a product

Material Specification (Type E)

Provides extensive information regarding the material to be used in the fabrication of a weapon system. This information includes but is not limited to material name, material characteristics; the electrical, mechanical, and chemical properties of the material; the stability or shelf-life; and processes to be used in the preparation or installation of the material.

Military Specifications/Standards

Consists of the applicable standards which will be applied to the acquisition effort. This datastore includes MIL-STDS, FAR regulations, Air Force regulations, and any division specific regulations which are normally applied to a contract. The purpose of these regulations is to apply standardization and control through the contractual vehicle.

Non-Process Specifications

Identify the final System Specifications and requirements for the "As-Built" item.

OCPs (Organic Change Proposals)

Represent change proposals which originate within the Air Force. OCPs are similar to ECPs.

Operational Test and Evaluation Report

Prepared from the OT&E results, and presents the test data on the operational effectiveness and suitability of the product.

Operational Test Data

Represents the results of the OT&E of the product to determine if it meets the specified operational effectiveness and suitability.

Parts List

Details the nomenclature, part name, part number, and drawing reference for each item.

PDD (Product Definition Data) Database

Represents that set of product data which defines the design of a system. In this context, it consists of an optimum design based upon selection criteria. It includes the design, analytical, and engineering data that is required to develop the part.

PDR (Preliminary Design Review) Minutes

Represents minutes which reflect technical comments made at the Preliminary Design Review.

Performance Test Data

Represents the qualification parameters which must be attained during the test period.

Pre-Award Surveys

Conducted to ensure that the contractor is capable of performing the contract tasks. The survey includes a review of the corporate drawing standards, procedures, manufacturing capabilities, etc.

Pre-Planned Product Improvements (P3I) Plan

Contains the proposed improvements in a system based on information on new technologies, materials, or processes that will be available in the future.

Prime ALC

Represents the Air Logistics Center (ALC) which has the principle responsibility for the management and maintenance of the engineering data on a weapon system

Process Data

Represents the processes, such as heat-treat, welding, hardness, etc., which are used to manufacture a product.

Process Specification (Type D)

Details the processes required to fabricate or manufacture and process information.

Producibility and Engineering Plan (PEP)

Represents the producibility and engineering criteria that will be used in the design effort. This plan contains both general and specific quantitative and qualitative criteria, and defines the types of production technology.

Product Specification (Type C)

Details five major specifications. The specifications describe the functional and fabrication specifications for the 1) prime item, 2) critical item, and 3) non-complex item. In-addition, an inventory item and a software product specification are created under the Type C specification.

Production Competition Plan

Outlines the competitive production of an item.

Production Contract

Represents one of several contract types identified during the acquisition cycle. The Production Contract is the vehicle whereby the Air Force contracts with a firm to produce, manufacture, and fabricate the designed configuration based on the approved detail design.

Production Risk Assessment

Contains an assessment of the risk involved with the production of a specific design.

Production Schedule

Describes the facilities, processes, and routing used to produce an item.

Production Test Data

Is acquired during production on the static testing of selected item to meet the performance and quality requirements.

Proposals

Are the vehicles whereby the contractor documents the technical approach to meet the requirements and tasking, as outlined in the Request For Proposal (RFP) or Invitation For Bid (IFP).

Purchase Requirements

Represents the requirements for the purchase of material which may require a long lead time

Quality Assurance (QA) Data

Distribution Division (DS) uses contractor supplied or Air Force developed QA data to inspect and verify the quality of the incoming raw material/parts prior to being accepted.

Quality Control (QC) Data

Either supplied by the contractor or internally developed, QC data is used by MAQ to ensure that the quality of manufactured parts are same as the original parts in the weapon system. QC data checks for form, fit and function of the manufactured parts. QC inspection involves both destructive and non-destructive testing methods.

Quality Assurance Plan

Outlines the procedures and measures that will be taken to ensure the quality of the product produced.

Ranking Criteria

Represents the criteria used in evaluation of the defined configurations. The criteria used must be broad enough to differentiate between configurations. Sources of the criteria include the SEMP, TEMP, and System Concept papers. The configurations are then scored on the basis of the criteria. The criteria may also be weighted for emphasis in particular areas.

Requirements

Represents the initial system requirements. These requirements are continually refined in parallel with the design of the weapon system.

Review Package

Represents the design and technical information presented to engineers prior to the CDR. This package affords the reviewers time in which to critically evaluate the design, and to formulate comments or issues which occur at the CDR.

SDR (System Design Review) Review Minutes

Identify any inconsistencies or problems prior to any preliminary development. The review is an opportunity to gain an understanding of the system specifications, design, cost, preliminary operational concept, and any interface requirements.

Selection Criteria

Identifies those factors which may be considered indicators in analyzing and projecting the relative merit of a proposal. Examples of selection criteria include the soundness of the technical approach, an examination of risk, or experience in relative areas.

SEMP (System Engineering Management Plan)

Identifies the process, methodology, and controls to be used during the system engineering process. This document consists of three sections: Technical Program Planning and

Control, Engineering Process, and Engineering Specialty Integration. The SEMP requirements are defined in MIL-STD-499A.

Shape/Size Data

Identifies the shape and size characteristics, such as geometry, topology, dimensions, etc. for the product.

Simulation Models

Represent the simulation models used to determine performance characteristics in a simulated environment.

Source Selection Analysis

Represents the qualitative and quantitative analysis of the submitted proposals. Using weighted criteria, the Air Force employs quantitative analysis as well, reviewing the technical, financial, and managerial capability of the firm.

Special Purpose Drawings

Represents drawings which are not easily incorporated into the other five categories., for example: book form, optical, wiring, digital, kit drawings, and modification drawings.

Specifications

There are five types of specifications: System Specification (Type A), Development Specification (Type B), Product Specification (Type C), Process Specification (Type D) and Material Specification (Type E). All these specifications are used in the post-production support of the weapon system.

SRR Review Minutes (System Requirements Review)

Are generated to record the first review of the system requirements as they are interpreted to meet the various "need" statements (SON, MENS). The minutes include actions items, points of clarification, and a step-by-step account of each major requirement area.

Study Contracts (Concept Exploration)

Establish a baseline of technology used to determine available technologies for a system. An example of a study contract in this context would include a review of metal alloys, available tooling methods, or a review of current propulsion systems available for the aircraft.

Synthesis

Within each candidate configuration, a synthesis is formulated detailing the essence of its functional characteristics. This synthesis is used for trade-off analysis on the candidates effectiveness, affordability, and design.

System Analysis Data

Represents analyses of each of the concepts. The functional areas covered include performance predictions, and mathematical, geometric, and FEM (Finite Element Modeling) data. This data will be used for preliminary evaluation of each of the concepts.

System Definition Products

As more systems engineering is performed on each of the initial concepts, system definition products are formulated. Examples of these products include Mission Requirements Analysis, System Cost/Effectiveness Analysis, Preliminary Operational Concept, Functional Analysis, and Specialty Discipline Studies.

System/Segment Specification (Type A)

Contains the data item descriptions that will apply to the development of a system.

TO 00-35D-54-USAF Materiel Deficiency Reporting and Investigating System

Defines USAF materiel deficiency reporting and investigating system.

TCTO (T.O. 00-5-15)

Describes policies and procedure for preparing Time Compliance Technical Orders (TCTOs) for the modification kits.

Technical Order (TO)

Are manuals describing the process, tools, and equipment required to perform repair.

Technical Reports

Are prepared by contractors and delivered to Air Force at PMRT. They contain information on the technical description of the weapon system on areas such as stress analysis, assumptions and input for analysis, results of the analysis, test results and system description, etc.

TEMP (Test and Evaluation Master Plan)

Identifies the objectives of the test program which is detailed in the test plan or test procedure The TEMP is used to identify the thrust of the test program initiatives early enough for a review prior to development of the detailed test plans.

Test Data

Operational and flight test data is tracked, verified, and recorded for the installation/test of the modification kit.

Test Data Sets

For some weapon systems, it may be necessary to simulate an operational environment to conduct and achieve a valid test. In order to simulate an operational environment, manually generated test data sets can be substituted. Further, test data sets can be tailored to test for error conditions, thereby establishing that functional parameters have been met.

Test Plan

Describes the planning, execution, and testing of the performance and functionality of a configuration item. This document outlines the roles and responsibilities of various organizations throughout the test effort and also identifies the formal test requirements, required interfaces, and the assumptions and constraints.

Test Procedures

In order to outline the steps involved in conducting the test, a Test Procedure document is generated Using the Test Plan, the available specifications, and the requirements document, as a basis for those CIs requiring test, test procedures are developed. Each test procedure details the steps necessary to fulfill the test requirements outlined in the Test Plan.

Test Production Item

Represents the first item of a product produced. This item is used to perform preliminary operational testing and evaluation.

Test Results

Represents the data recorded during each test procedure. The test results are used as the basis of analysis in determining functional compliance, which will then be outlined in the Test Report.

Test Requirements

Identify how functional characteristics can be verified. Each test requirement details the approach in determining how each characteristic requires verification. The document will be used to generate the test procedures.

Tooling Data

Defines the necessary tooling for each process during the manufacture of an item.

Tooling, Process, and Material

Contains the tooling, process, and material requirements necessary to manufacture a design.

Trade Studies (Engineering)

Establish trade-offs in the capabilities and manufacture of a design.

Undimensioned Drawings

Depict to a precise scale items for which dimensioned drawings would prove impractical. These drawings include loft line information, templates, patterns, panels, special scales, or cable assemblies.

Waivers, Deviations, and NORs

The waivers, deviations, and NORs (Notice of Revision) involve changes to the specification or drawings. These differ from ECPs and OCPs in that the change is not to the system, but to the design.

C.6.2 EXTERNAL ENTITIES

External entities are logical groupings of organizations or processes that represent a source or destination of data. By designating an organization or process as an external entity, it is implicitly stated that it is outside the boundary of the process being defined.

AF CSAB (Configuration Status Accounting Board)

Identifies the process of handling the configuration status accounting, the application of CM principles, and generating the requirements of configuration status reports.

AFPRO (Air Force Plant Representative Officer)

Provides coordination, Q/C, and liaison between the contractor and both the implementing and supporting commands. The AFPRO is generally required on longer acquisitions and is usually located at the contractor site.

ALC (Air Logistics Center)

Identifies the ALC's presence at the IPR. The SPM/EDMO will work with the SPO/EDMO in determining not only the quality but the acceptability of the drawings.

ALC Depot (SRU)

Replenishes spares for shop replaceable units (SRU). SRUs are the type of spares replacement performed only at Depot in contrast to Line Replaceable Units. DS stores the SRUs in a warehouse for subsequent distribution and installation.

ALC-SPM (System Program Manager)

Provides a focal point for technical, operational, and logistical support for a weapon system The SPM is the organization within a given ALC responsible for supporting the engineering effort for implementing modifications, managing the system configu :ion and providing logistics support for the system during the weapon system life-cycle.

Contract Award

Upon approval of ECP, a prototype contract is awarded to produce a First Article for testing the proposed modification. A second contract for full scale production of the modification is awarded after verification of the modification test results.

Contractor (CON)

Identifies input to or output from the Contractor. This external is used in several processes, such as the production effort, the In-Process Review, Spares Reprocurement, or the modification effort

Contractor Design Group

Serves as the initiator for development of drawings used to support the design package and provides the specific design information which is required for the drawing to meet standards

CR - Competition Advocacy

The primary mission of the CR organization is to acquire Level 3 Engineering Data packages for the competitive reprocurement of weapon systems, spare parts, and modification programs.

Depot/Base

Repairs and local manufacturing are performed both at depot level and base level. Requests are nitiated in support of the repair/local manufacturing performed When base does not have the capabilities, they request depot to perform manufacturing/repair

DMMIS (Depot Maintenance Management Information System)

This system will replace 33 current data systems. Phase 1 is a prototype effort that will control material; functions, compute material requirements, maintain maintenance inventory records, initiate, edit and control material requirements, and schedule workloads. Phase 2 will incorporate industry accepted Manufacturing Resources Planning (MRP II) concepts in the acquisition and implementation of a prototype system at Ogden Air Logistics Center and the Aerospace Guidance and Metrology Center (1988). Phase 3 will incrementally implement the final design at the Air Logistics Centers' product divisions in the mid 1990's.

DS (Directorate of Distribution)

Responsible for the receipt, storage, packaging and shipment, material quality control, and transportation of all parts and equipment.

EDSC (ALC)

Represents the manual repositories for storing and maintaining engineering data acquired by Air Force weapon systems. The EDSCs maintain engineering data aperture cards/hard copy drawings and produce millions of reproductions annually. Each ALC/EDSC maintains engineering data for the assigned weapon system and commodities in support of reprocurement of spares, local manufacturing/repairs, modifications, and engineering support.

EDSC (Base)

Provides engineering data support to all installation activities which require engineering data support. The EDSCs at the bases only contain Contractor Designed Activity (CDA) or subcontractor drawings.

Final Product

Represents the production line item produced during full scale production

HQ-USAF

Initiates a modification request when the system requires new operational capabilities (Class V modification).

Initial Production Item

Is produced using techniques that represent those that will be used during full scale production of a product.

MA (Directorate of Maintenance)

Responsible for the organic depot-level maintenance production facilities in the modification, local manufacturing, and repair of weapon system. MA initiates a request to MMI to buy occasional or as-needed spares purchase.

Manufacturing

Identified as both a recipient and contributor of manufacturing specifications, as well as the organization responsible for production.

Manufacturing/QA Engineer

Responsible for establishing the produceability and suitability of a design and associated manufacturing processes.

Material Substitution

Involves the engineering analysis to define material requirements and specifications then select the material to meet the requirements.

MM (Directorate of Materiel Management)

Responsible for engineering management, development, and control of the design, performance, and reliability of assigned systems and equipment. MM initiates the local manufacturing request for depot level re-manufacturing.

MMMSU

Defines the tooling data requirements for spares reprocurement packages.

MM_D (Requirements and Distribution Branch)

Initiates the Procurement Request (PR), ensures inclusion of approved engineering data, and provides item management support by acquiring and maintaining material inventory in support of spares reprocurement and modification.

MM_R (Engineering and Reliability Branch)

Performs engineering analysis for modifications, ECPs review, and performs analysis and defines requirements for structural damage repairs. MM_R performs Damage Tolerance Assessment as part of the repair process.

Modification Policy Group Program Review Committee

This group consists of the ALC/SPM, Equipment Specialist, Item Managers and Engineers monitoring and managing the modification.

N/C vs. Conventional Machining Comparison (NCIPE)

The Numerical Control Industrial Plant Equipment (NCIPE) package is used to develop a cost comparison whether to manufacture a part by conventional machining or by NC machining The NCIPE program identifies the cost for both machining and manpower requirement.

PCO (Procurement Contracting Officer)

Represents the individual authorized to make changes to the contract. This office is also used for official lines of communication on subject areas such as acceptance or rejection of deliverables, delays, problems in meeting technical goals, etc. In the context of the the IPR, the PCO formally tasks the contractor to resolve any deficiencies.

PM (Manufacturing and Contracting Division)

Responsible for establishing contractual relations with industries for the acquisition, maintenance, and modification of aircraft and spare parts. PM is responsible for the execution of the PR, acquisition of engineering data, evaluating potential firms for contract award, administering the performance of the contract, and accepting the final products.

Production Readiness Review Plan

Outlines the major issues which impact the readiness of a program to begin full-scale production.

Recipients IAW SOW

Represents those cited on the CDRL as recipients of the design package. The recipients may include the Using Commands, associated agencies, laboratories, other contractors, etc.

Regulations

Identifies, for the context of the IPR dataflow, the regulations cited in the contract which may pertain to the holding of an IPR. It also serves as the body of information which identifies the procedures for corrections to be established or effected subsequent to the IPR.

Spare Parts

Represents the components of a product which have been identified as being replaced during the life of the product. Additional components are produced during the initial manufacture of an item to take advantage of the cost reductions available through mass production.

SPO (System Program Office)

Provides a focal point for the design, development, acquisition, and implementation of a weapon system. The SPO is comprised of several subcomponents: Engineering, Configuration Management, Logistics, Program Control, Program Management, Data, and Manufacturing. The SPO provides funding, program and technical direction, and business support to the Air Force in developing a weapon system.

SPO (Configuration Management)

Provides the technical review of the configuration management (CM) plan which is generated by the contractor. This review will ensure that CM requirements are met, and that the CM approach proposed is sound.

Subcontractor

Represents a company to which the prime contractor issues contracts for the development and manufacture of system components.

Test Centers

Represents those organizations (i.e., AFOTEC, AFFTC, Test Wings, etc.) which are employed during testing due to their unique test capabilities or experience.

Test Wings

Responsible for performing operational flight testing, design/manufacturing, and installation in support of new weapon systems and modification programs. In the modification process, they perform operational flight testing for Class II (R & D) temporary modifications.

Using Commands (SAC, MAC, and TAC)

Identify and document operational deficiencies in the form of reports (QDR, TDR and MDR) These reports are sent to ALCs for analysis. A data base G063 (Maintenance and Operational Data Access System) is used to track the weapon system R&M data.

Warehouse

Represents that part of the Distribution and Supply (DS) Directorate which is responsible for storing the material and distributing to the appropriate requesters.

APPENDIX D

REFERENCES

APPENDIX D: REFERENCES

Regulations

AFLC 0-2	Numerical Index of AFLC Publications
AFLC 23-49	Directorate of Competition Advocacy
AFLC/AFSC 800-34 Supplement 1	Engineering Data Acquisition
AFLCP/AFSCP 800-34	Acquisition Logistics Management
AFLCR 23-1	Air Force Acquisition Logistics Center
AFLCR 23-13	The Aerospace Maintenance and Regeneration Center
AFLCR 23-42	Directorate of Maintenance
AFLCR 23-42 (App 1-5)	Deviations in the Directorate of Maintenance
AFLCR 23-43	Directorate of Materiel Management
AFLCR 23-43 (App 1-5)	Deviations in the Directorate of Materiel Management
AFLCR 23-48	Aerospace Guidance and Metrology Center
AFLCR 23-52	The Cataloging and Standardization Center
AFLCR 57-4	Recoverable Consumption Items Requirements System (D041)
AFLCR 57-21	Operational Requirements
AFLCR 66-45	Manufacturing Information System for Depot Maintenance
AFLCR 66-50	Management of N/C Industrial Operations
AFLCR 66-51	Use of Technical Data within Depot Maintenance
AFLCR 66-52	Depot Maintenance Materiel Support Systems
AFLCR 66-68	Functions and Responsibilities of the Equipment Specialist During Acquisition
AFLCR 70-22	First-Article Management

AFLCR 400-1	Logistics Management Policy
AFLCR 523-1	Mission Assignment Policy
AFLCR 523-3	AFLC Mission Assignments Organizations
AFP 23-21	USAF Command Organization Chart Book
AFR 0-2	Numerical Index of AFR Publications
AFR 23-1	Air Force Reserve
AFR 23-2	Air Force Logistics Command
AFR 23-6	Air Training Command
AFR 23-8	Air Force Systems Command
AFR 23-10	Tactical Air Command
AFR 23-12	Strategic Air Command
AFR 23-17	Military Airlift Command
AFR 23-20	US Air Forces in Europe
AFR 23-27	Pacific Air Forces
AFR 23-28	Alaskan Air Command
AFR 23-32	Air Force Communications Command
AFR 23-36	Air Force Operational Test and Evaluation Center
AFR 23-51	Space Command
AFR 23-53	Air Force Management Engineering Agency
AFR 57-1	Operational Needs
AFR 57-4	Modification Approval and Management
AFR 65-3	Configuration Management
AFR 66-30	Product Improvement Program for Operational Equipment
AFR 67-26	Engineering Data Acquisition and Logistics Management
AFR 67-28	Engineering Data Distribution and Control

AFR 81-10	Engineering Drawing System
AFR 81-11	Engineering Drawing Change System
AFR 310-1	Management of Contractor Data
AFR 310-3	Acquisition and Management of Data for Follow-on Procurement
AFR 800-2	Acquisition Program Management
AFR 800-3	Engineering for Defense Systems
AFR 800-4	Transfer of Program Management Responsibility Transfer
AFR 800-9	Manufacturing Management Policy for Air Force Contractors
AFR 800-18	Air Force Reliability and Maintainability Program
AFR 800-26	Spares Acquisition Integrated with Production (SAIP)
AFR 800-33	Manufacturing Technology Program
AFR 800-34 S1	Engineering Data Acquisition
AFR 800-35	Air Force Competition Advocate Program
AFR 800-36	Provisioning of Spares & Repair Parts
AFSC 0-2	Numerical Index of AFSC Publications
AFSCP 800-7	Configuration Management
AFSCP 800-18	User's Guide for the Management of Technical Data and Computer Software
AFSCR 23-3	ASD Organization
AFSCR 23-10	ESD Organization
AFSCR 23-XX	AFSC Organization
AFSCR/AFLCR 800-5	Support Equipment Acquisition Management
AFSCR/AFLCR 800-16	Acquisition & Management of Technical Data and Computer Software

Standards

DoD-D-1000B	Drawings, Engineering and Associated Lists
DoD-D-4245.7	Transition from Development to Production
DoD-D-5000.1	DoD Weapon System Acquisition Process
DoD-STD-100C	Engineering Drawing Practices
DoD-STD-483	Configuration Management Practices for Systems, Equipment and Computer Programs
MIL-D-5480E	Reproduction Requirement for Engineering and Technical Data
MIL-D-18300	Design Data Requirements for Avionics Equipment
MIL-HDBK-245	Preparation of Statement of Work
MIL-HDBK-288	Review and Acceptance of Engineering Drawing Packages
MIL-HDBK-331C	Directory of DoD Engineering Data Repositories
MIL-M-9868B	Preparation of Roll Microfilm of Engineering Documentation
MIL-STD-143	Specifications and Standards Order of Precedence
MIL-STD-280A	Mil Std Definition of Item Level/Exchangeability, Models and Reliable Terms
MIL-STD-480A	Configuration Control-Engineering Changes, Deviations and Waivers
MIL-STD-481A	Configuration Control-Engineering Changes, Deviations and Waivers
MIL-STD-482A	Configuration Status Accounting, Data Elements and Related Features
MIL-STD-483A (USAF)	Configuration Management Practice for System, Equipment, Munition and Computer Programs
MIL-STD-490A	Specification Practices
MIL-STD-499A	Engineering Management

MIL-STD-1521B	Technical Review & Audits for Systems, Equipment, and Computer Software
MIL-STD-1840A	Automated Interchange of Technical Information
MIL-STD-9868	Quality Program Requirements

Related Documents

"Report of Audit· Management of Engineering Data", Air Force Audit Agency, 1983

"Spare Parts Acquisition Study", Air Force Management Analysis Group (AFMAG), 1983

"DoD Manufacturing Handbook for Program Managers", Defense System Management College, 1984

"Lessons Learned Bulletin· Engineering Data", Air Force Acquisition Logistics Center, 1988

"Report of Audit· Allocation and Funding of Depot Repair Capability Within the Air Force", Air Force Audit Agency, December 1986

"Report of Audit Follow-up Audit-Management of Engineering Data", Air Force Audit Agency, 1986

"The Inspector General's (TIG) Inspection of the Effectiveness and Timeliness of Engineering Data", Air Force Inspection and Safety Center, 1986

"Systems Engineering Management Guide", Defense System Management College, 1986

"Air Force Almanac", Air Force Magazine, May 1988

APPENDIX E

POINTS OF CONTACT

APPENDIX E: POINTS OF CONTACT

AFLC								AFSC					
HQ AFLC	SA/ALC	SM/ALC	WR/ALC	OO/ALC	OC/ALC	AFALC	AGMC	HQ AFSC	AD	BMO	SD	ESD	ASD
MAQF MMTI SCTA	MMEC MMP MMSP MMUR MMED MATE	MMED MMMP MMEP MMKB MMEH MMSR MMKR CR CREE MAWS MAQ MAIT	MMED MMEC MMAG MMMM MMFR MAIE MANE CREF	MMMD MMED MMAR CREE CRED MAQP MANE MAKE	MMET MMB MATE MANE CRED	LSG	MAWF	PLXC	END	AWC	ALM	YWD(AWACS) YWCS PLEC JSL (J-STARS)	ENO SCE ENFS YPCA VFD (F-15) YPEF (F-16) B1E (B1-B) YCC (C-17) 4950th TW AFWAL/FIB AFWAL/AA AFWAL/MLT
USAF	**DoD**	**SAC**	**MAC**	**ANG**	**CONTRACTORS**				**OTHERS**				
LEYM	DDMO	509BMW 321SMW	436thMAW	102 FIW	GRUMMAN McAIR HARRIS PRATT & WHITNEY ROCKWELL AT&T CONTROL DATA GENERAL ELECTRIC PRIME/COMPUTERVISION DIGITAL EQUIPMENT CORP LTV CORPORATION				NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY (NIST) NAVAL SUPPLY SYSTEM COMMAND NAVAL AVIATION DEPOT (CHERRY POINT) ARIZONA STATE UNIVERSITY TACOM (U.S. ARMY TANK AUTOMOTIVE COMMAND)				

The above organizations are the points of contact within the Air Force, DoD, and Industry that supported this effort through site visits, personal, and/or telephone contacts.