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PDES APPLICATION PROTOCOL SUITE FOR COMPOSITES (PAS-C)

Functional Needs Report for the PAS-C Program

South Carolina Research Authority (SCRA)
5300 International Blvd.
N. Charleston, SC 29418

September 1991

Final Report for period July 1991 - August 1991

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12 FEB 92
DATE

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12 Feb 92
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13. ABSTRACT

This document addresses the first portion of an informational needs analysis for composite parts. A sample part set of Aircraft Composite Structural Components is described with the supporting life-cycle functional activities node trees. An attempt was made to standardize a set of terminology and informational constructs so that a Framework/Building-Block (FW/BB) approach could be established which would organize and capture the information into a usable/reusable structure. The sample part set was then mapped to this FW/BB structure identifying what was in and out of scope for the PDES Application Protocol Suite for Composites (PAS-C) project.

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LIST OF ACRONYMS

ACSP	Aircraft Composite Structural Part
ALC	Air Logistics Center
ATLM	Automatic Tape Laying Machine
BOM	Bill of Materials
CBA	Cost Benefit Analysis
DoD	Department of Defense
EAMR	Engineering Advanced Material Requests
ENG	Engineering
FEA	Finite Element Analysis
FW/BB	Framework/Building-Block
ICOM	Input, Control, Output, Mechanism
IPD	Integrated Product Development
IML	Inner Mold Line
M&P	Materials & Processes
MFG	Manufacturing
OML	Outer Mold Line
PD	Product Data
PDD	Product Definition Data
PAS-C	PDES Application Protocol Suite for Composites
PDES	Product Data Exchange using STEP
RFP	Request for Procurement
RPCM	Rapid Ply Cutting Machine
STEP	Standard for the Exchange of Product Model Data

1 INTRODUCTION

There have been many attempts to analyze the needs of composites parts, in particular, the informational needs that support data exchange of composite data between life-cycle applications. The challenge has been to scope the needs gathering process into a structured, achievable task that provides usable/reusable knowledge. Most previous composite needs analysis have been focused on a narrow application view or particular part type which has limited the reusability of the information. What has been lacking is a methodology that allows for the informational needs of all aspects of composite parts to be captured. This methodology requires ar approach that manages and utilizes existing needs gathering methods to capture existing composite needs analysis work. The difficulty in establishing this methodology is the required standardization of terminology and informational constructs throughout industry.

An objective of the PAS-C team is to create and utilize a methodology that addresses these challenges in collecting and organizing composite part needs to the detail required for PDES (Product Data Exchange using STEP) implementation. The first portion of this methodology addresses activities which includes the following:

1) Establishing a Framework/Building-Block (FW/BB) structure, including formalizing a standard set of composite items/components and functional view.
2) Selecting a sample part set of composite parts that are commonly used in the Aircraft industry and show a large payback potential for utilizing them in a PDES/STEP (Standard for the Exchange of Product Model Data) environment.
3) Collecting the functional life-cycle activities associated with Aircraft Composite Structural Components by interviewing composite experts.

This document is an interim document and records only the results of utilizing the first portion of this methodology. A second document will be published at the end of the needs analysis which will include an updated version of these findings, and the second portion of the needs analysis including detailed IDEF0 diagrams for each in-scope Framework/Building-Block. ? graphically represents the methodology of the PAS-C Framework/Building-Block approach.

The scope of the PAS-C needs analysis will be limited to areas within and between the functions of analysis, design, manufacturing, and support. Care was taken to insure that genuine needs of the composite community were addressed and that these needs were prioritized based on a high potential return on investment. Even though the PAS-C scope is limited, care was also taken to insure that the Framework/Building-Block structure was expandable so that additional knowledge of new and/or different composite part types could be incorporated into it smoothly.

Composite terminology is defined in section 2.1.2. This should aid the reader in comprehending the context of terminology used throughout this document.

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2 METHODOLOGY

2.1 Overall Methodology/Terminology

Two of the critical success factors for the PAS-C program are standardization of an Application Protocol development methodology and composites terminology. The following sections establish the baseline in these factors for the PAS-C effort.

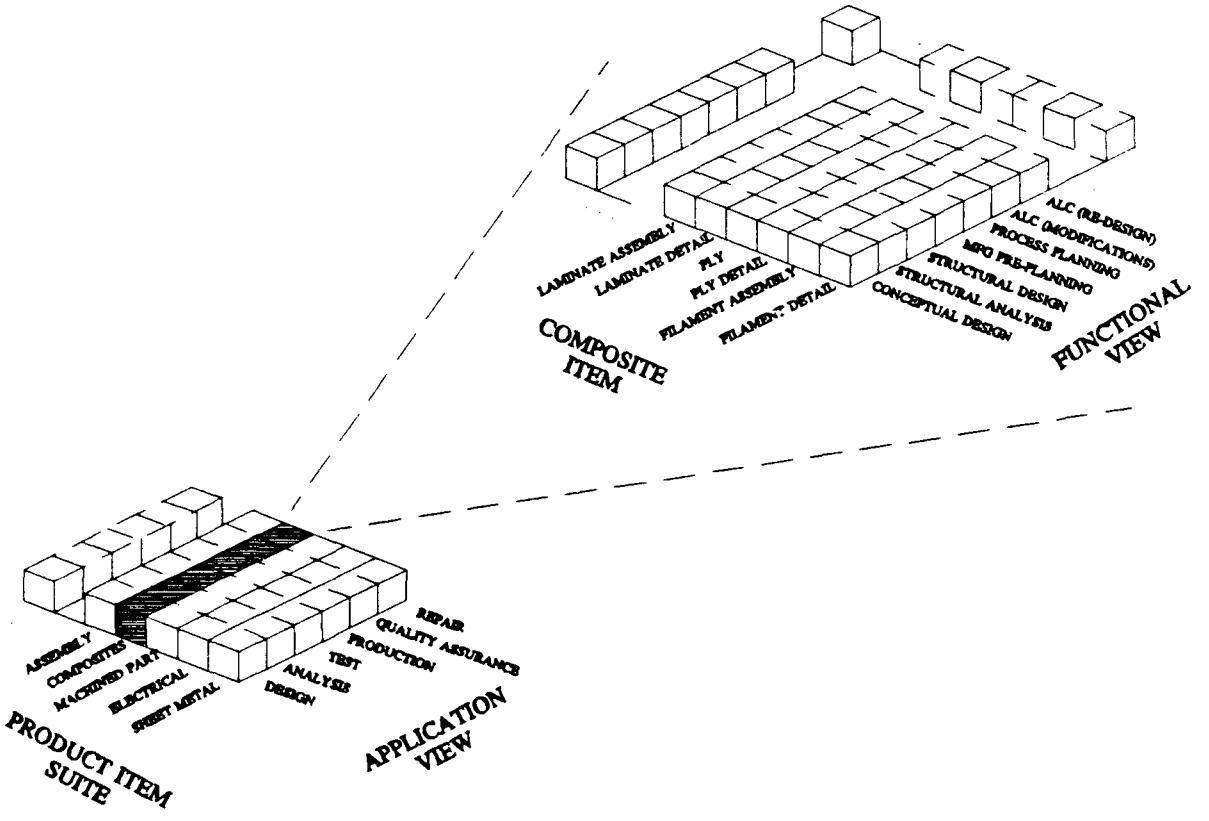


Figure 1 Composite Product Item Suite

2.1.1 Methodology Overview

The methodology used to perform the needs analysis was built around a Framework/Building-Block (FW/BB) structure. The FW/BB methodology's primary goal is to organize the collected knowledge into digestible and integratible pieces. An overview of this methodology is found in Appendix A. The methodology that was used to perform this composite needs analysis can be summarized by the following tasks. The results of the first five tasks listed below are addressed in this document:

(1) Standardize physical components (composite items)
(2) Determine composite part families and priorities
(3) Select example part set
(4) Establish functional views
(5) Determine functional activities within each view
(6) Determine which functional activities correspond to a composite item across its life-cycle
(7) Determine for each Building-Block its corresponding functional activities
(8) Build IDEF0 models for each potential in-scope building block
(9) Determine characteristics and their aspects (from IDEF0 ICOMs)
(10) Determine relationships among characteristics and their aspects
(11) Identify potential "Units of Functionality"
(12) Collect initial percent time and cost data for performing as-is activities

The IDEF0 diagram in Figure 2, FW/BB Need Analysis Process, graphically depicts the major interrelationships of the activities being performed in the itemized tasks shown above.

Some of the unique aspects of this methodology are (1) establishing a standardized set of composite items and terminology, (2) identifying the functional activities to a low enough level so that specific informational elements can be captured directly from the composite experts, and 3) integrating these informational elements across multiple functional views/disciplines.

2.1.2 Terminology

The real back bone of this or any other methodology is to establish a common set of terminology. The goal is not to replace existing terminology, but to develop a standard set (from a consensus of existing terminology where possible) of terminology that can be mapped to and from different industry, company, and functional discipline views. Without establishing this communication tool up-front, the information exchange task will be impossible.

In that light, the PAS-C team has initialized a generic set of terminology. This terminology includes:

(1) general FW/BB terminology
(2) Composite Item terminology
(3) Functional View terminology
(4) general terminology

The relationship of Composite Item, Functional View, and Composite Characteristics are illustrated in 3. The following paragraphs provide a narrative description of the Composite Items in a Laminate Detail.

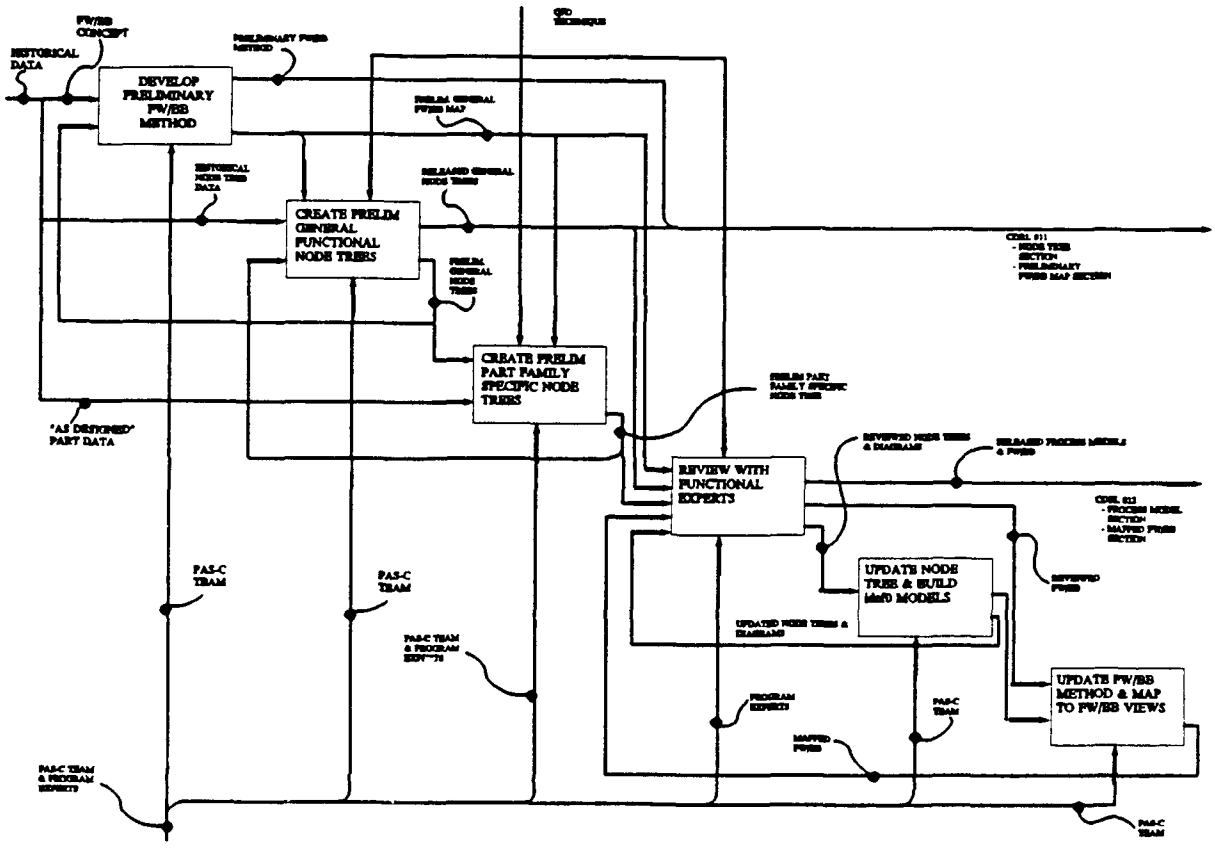


Figure 2 FW/BB Need Analysis Process

2.1.2.1 Narrative Description of Laminate Detail

The scope of this narrative is limited to the composite parts refer to as laminate details. Laminate details are things that are made up of plies . The basic format that will be used to facilitate the creation of a composite item set for laminate details will be based initially on shape. Laminate details are just a subset of all composite part types.

To start off with, a list of composite items that make up a composite part must be defined. The most primitive of these elements are the fibers and homogenous material (that can be formed from a liquid or semi-liquid state in some cases). The fibers are long thin (usually cylindrical) material (e.g., graphite). The homogenous material is usually used to bond a collection of fibers together (e.g., resin). The fibers are the primary load carrying material. Fibers and homogenous material can be combined together in many different shapes to form a variety of higher level elements that make up a composite part.

The next level of elements deal with the combining of fibers and homogenous materials. A tow is a continuous group of fiber which can be impregnated with homogenous material. The shape of the tow has not changed yet except for the possibility of getting a little wider if impregnated. Next the possible shapes that can be created from a collection of tows and homogenous material becomes infinite. Such would be the case for example if one would use a pultrusion method for assembling tows. For the scope of this narrative the assembly of tows and homogenous material into sheet forms will only be addressed.

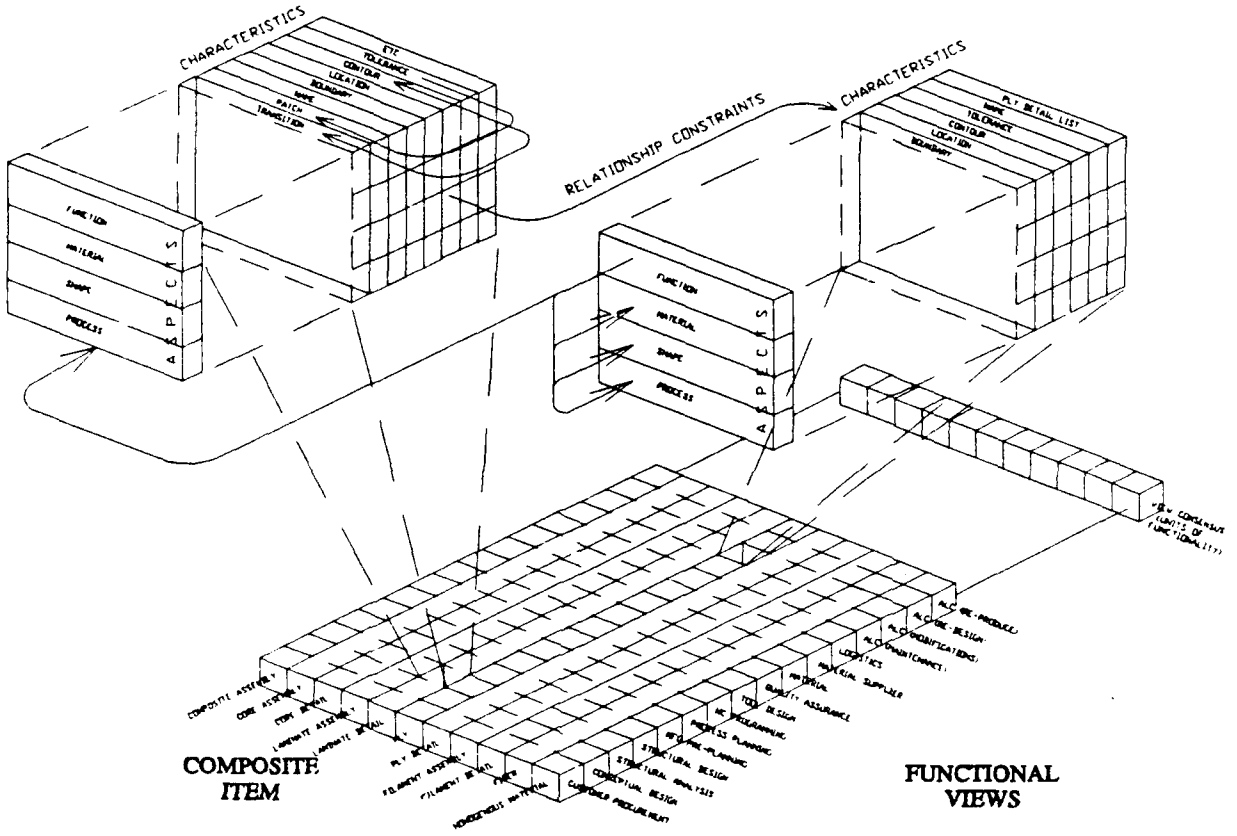


Figure 3 PAS-C Composite Item Terminology

Sheets of material can be made up by in many different ways. Some sheet configurations are:

- Interwoven tows with or without resin.
- Tows aligned in the same direction with resin.
- Random chopped fibers with resin.
- Just homogenous material in sheet form.

Sheets of material usually come from specialty material suppliers. These sheets come in many different lengths, widths, and thicknesses. Sheets of material are used to create features called ply details.

A ply detail basically depicts a sheet of material when it is used as a portion of a ply. A ply is a single layer of material in a laminate detail. A ply can consist of more than one ply detail. A ply detail has a constant thickness with a unique shape boundary depending on specific requirements of a ply. Plies are a focal point of much information. The information includes such things as material type, positional information (warp direction, placement, replicates), make-up (single sheet, multiple sheet - tape strips or over-lapping broadgoods), and shape (boundary - flat pattern, plan view, 3D, etc.). Plies, because they are initially flexible, can be formed into many different shapes.

Laminate Details are a collection of plies that form a specific shape. In many cases certain shapes are associated with performing a particular function. The FW/BB structure can be used to establish a set of

laminate detail types based exclusively on shape. Examples of these laminate detail types can be found in section 2.2 Part Families.

2.1.2.2 General Terminology

Laminate Assy

A type of composite assembly consisting of a collection of mating laminate details. Individual plies could be included in a laminate assy when the individual plies' location and mating definition depends on the combination of the mating laminate details. Laminate assemblies can be used as a portion of another composite assy.

Composite material

A material made up of two or more different materials. Typically material such as broadgoods and tape good examples. These examples consist of a set of tows impregnated within a matrix such as resin.

Composite part family

A group of similar parts. For this exercise similar shape and set of composite items will be the primary grouping criteria.

Assembly

The fitting together of manufactured parts and/or components of a manufactured part into a finished or partially finished part.

Laminate

A laminate is a laminate detail, or any composite assy that contains two or more plies. Some filament assembly detail that are considered composite parts, such as a filament wound part, are called laminates.

Tape

Unidirectional Prepreg material. A type of filament assembly detail.

Broadgoods

Uncured preimpregnated materials wider that 12 inches. These include woven cloths of fabrics of various constructions, and pre-collimated tapes made either in one operation or by combining several narrow widths.

Roving

Material with tows in one direction formed into various cross sections.

Skin

The relatively dense material that may form the surface of a cellular composite or of a sandwich. The outside layer of a composite assembly.

Honeycomb

A manufactured product consisting of metal or resin impregnated sheet material formed into hexagonal shaped cells. It is used as the core for bonded honeycomb panels and generally referred to as core.

2.1.2.3 FW/BB Terminology

This section covers terms that are utilized throughout the FW/BB methodology. In general these terms have broad meanings or can be interpreted in many ways. Appendix A contains a description with diagrams as to how this terminology interrelates. For this document they will be scoped to take on the following meanings:

Composite Part

A physical part or conceived part that is made of multiple materials which are bonded (versus mechanical fastened) together. A composite part can be mechanically fastened together with other parts which means it must have a rigid shape at completion. To achieve this rigid shape a chemical interaction usually takes place in the presents of heat and pressure.

Composite Item

Composite Items are a set of fundamental physical components that make up a composite part. A composite item can be as basic as a fiber or as complex as a composite assembly. The key is that composite items can be combined to form all the possible combinations of composite parts. Figure 4 shows how composite items combine together to make other composite items.

Functional Views

Represent the life cycle set of application groups required to define, build, and support a composite part. The groups' bounds are established based on traditional company organizations.

Composite Item Characteristic

A unique arrangement of informational aspects that characterize a particular composite item within a particular functional view. A Composite Item Characteristic can be valid for more than one functional view.

Informational Aspect

A piece of information about function, material, shape or process. Aspects are combined and constrained to make up unique characteristics describing such things as plies, laminate details, composite assemblies, core, etc.

Function

Defines the role a composite item characteristic performs (e.g., load carrying, connector, separator). It is a type of informational aspect.

Material

Defines the physical properties of the composite item characteristic as it relates to its chemical makeup. It is a type of informational aspect.

Shape

Defines the form of the composite item characteristic. This also includes all the different ways a shape can be represented. It is a type of informational aspect.

Process

This defines the mechanism for which a material is converted from its initial shape to form the desired composite item characteristic shape that performs a particular function. This includes processes such as assembly, material removal, material deformation, and state changes. It is a type of informational aspect.

2.1.2.4 Composite Item Terminology

Composite Items are a set of fundamental physical components that make up a composite part. A composite item can be as basic as a fiber or as complex as a composite assembly. The key is that composite items can be combined to form all the possible combinations of composite parts. Figure 4 shows how composite items combine together to make other composite items.

Composite Assembly

A physical or conceived assembly which is made of multiple materials that are bonded (versus mechanically fastened) together. A composite assembly (assy) does not have to stand as a rigid shape without support (tooling) at completion. The composite assy can be made up of any combination of material and/or other composite assemblies that are potentially going to be combined or bonded with other composite assemblies and material. Some composite assemblies could be used as a composite part but do not have to be. A composite assy can be any combination of the following:

> composite assembly, laminate detail, ply, core detail, core assembly, filament assembly detail, and homogeneous material (eg. adhesive)

Core Detail

A honeycomb or solid block of material that is used within a composite assy primarily for stiffness and/or shear transfer. A core detail can be used directly within a composite assy or a core assy. Core can be machined and formed into the needed shape. Core can have a potting compound or adhesive added to it making its shape rigid.

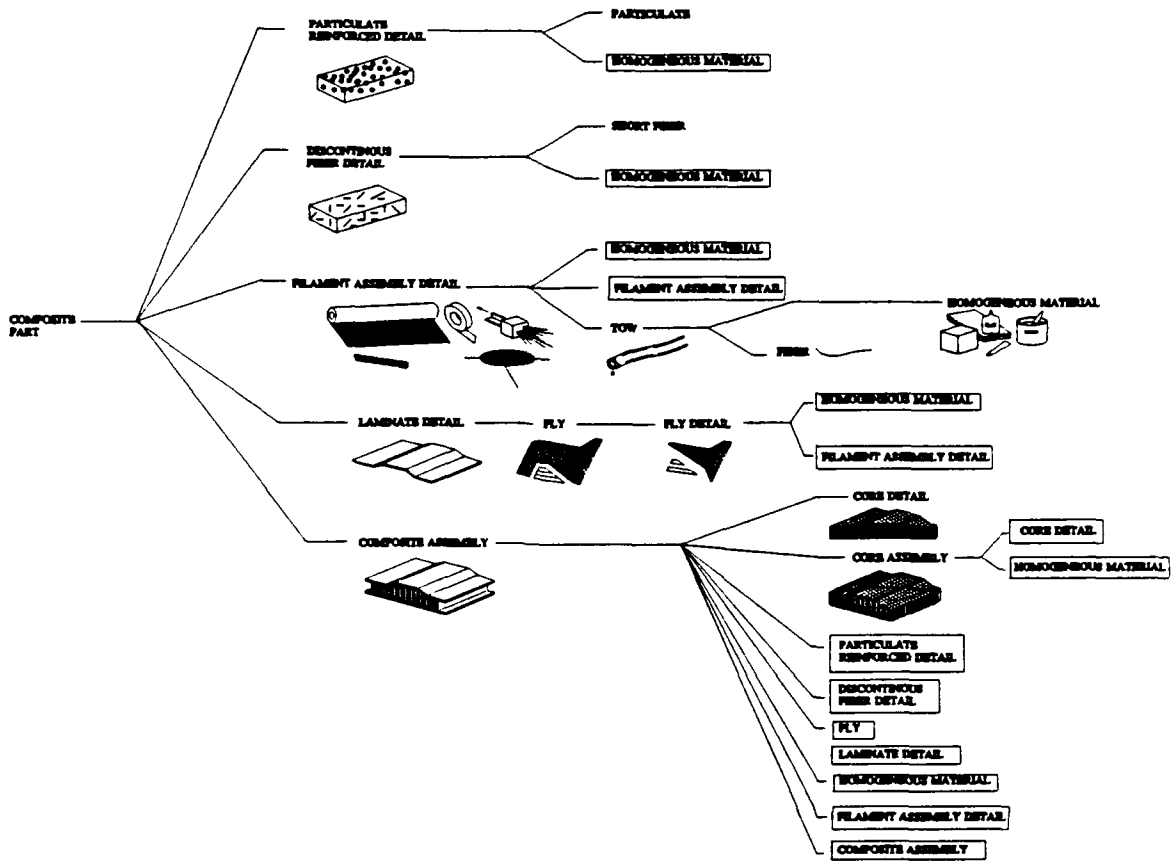


Figure 4 Composite Item Relationships

Core Assembly

A combination of single pieces of core material that are bonded together. The single pieces of core might be machined before or after assembly. The core assemblies are always used as a portion of a composite assy. A core assy is composed of core, adhesive and sometimes stabilizer.

Tow

A continuous group of fibers which are sometimes impregnated with a resin type of homogenous material.

Filament Assembly Detail

A collection of tows combined together in some manner and frequently accompanied by a joining homogenous material (matrix). The filament assy detail can be viewed as a unique composite part as in the case of an "I" shape pultrusion. A filament assembly detail can be used within a composite assy when used for example as a "v" filler between two adjacent radiuses. A filament assy detail can be viewed as roving or weaving for example in filament winding. Certain sheet material used to make plies can be viewed as a filament assy detail.

Laminate Detail

A collection of plies that mate with one another. The plies have unique orientation and shape within the laminate detail.

Ply

A single layer of material in a laminate. One thickness of tape or fabric with a special orientation (warp), material, thickness, and shape. One or more ply details make up a ply.

Ply Detail

A single piece of material in a laminate. One or more ply details make up a ply.

Fiber

A single homogeneous strand of material (essentially one dimensional in the macro-behavior sense) used as a principal constituent in advanced composites because of its high axial strength and modulus.

Homogenous Material

This material can be viewed in many ways. A partial list follows:

resin - used for bonding fibers together
stabilizer - a filler or coating put on core to make it rigid
adhesive - material capable of joining one surface to another.
solid blocks - used as core. (e.g. phenolic block and foam.)
sheets of material - used as a ply or honeycomb walls

The one thing that it does not depict is fiber or particulate.

Particulate Reinforced Detail

A collection of particulates suspended in a homogenous material (matrix).

Discontinuous Fiber Detail

A collection of short fibers suspended in a homogenous material (matrix). Usually the length of the fibers are relatively the same within a detail. The orientation of the fibers are usually random.

Short Fiber

Noncontinuous fibers relative to the total size of the homogenous material (matrix) they are suspended in.

Particulate

Small pieces of material which are basically symmetric in shape. The size of a particulate is relative to the size of the homogenous material (matrix) it is suspended in.

2.1.2.5 Functional View Terminology

This section defines an initial set of life-cycle application views. These views were established by determining the product life-cycle applications and dividing them into groups. These views can be as general or specific as necessary in order to communicate with various composite experts. Most experts come from particular disciplines such as analysis, design, manufacturing, engineering, etc. Thus, this initial set of views was established based on traditional company organizations that the experts will recognize. Within each organizational view, smaller detailed views can be created to facilitate the knowledge gathering process. Building activity node trees and IDEF0 models will facilitate the documentation of the informational needs within these views.

Manufacturing Organizational
Functions Relative to a Composite Part

Organization	Function

MFG Pre-Planning

Determine overall MFG build or buy scenario. *Determine* MFG ENG's and QA's PD (Product Data) generation tasks. Identify all required ENG PDD (Product Definition Data) to perform MFG PD generation tasks.

Process Planning

Determine Process steps for fabrication of part. Identify what tools are required per fabrication step. Coordinate and Incorporate PD generated by other groups into planning package.

NC Programming

Generate PD required to support automated shop floor processes - ATLM, RPCM, Part Trimming, Ultrasonic. Machining bond mold surfaces, material handling devises.

Tool Design

Design tools based on fabrication process Lay-up, handling, curing, assembly. Design tools that build production tools.

Quality Assurance (QA)

Identify and determine all inspection steps and QA processes required to produce and maintain composite parts and support tooling. Develop Inspection Plans for Incoming Material, Fabrication Methods, Curing, Post Cure.

Engineering Organizational
Functions Relative to a Composite Part

Organization	Function

Conceptual Design

Convert performance criteria into functional requirements. Determine which parts will be composites. Determine overall configuration and relationships between parts.

Structural Analysis

Analyze and optimize the conceptual design components so that they meet functional requirements. Analysis consists of static loads, thermal, dynamic, mass properties, static stress, and durability/damage tolerance analyses.

Structural Design

Transform analytical and descriptive information about the part into an unambiguous definition of the part supporting detail physical makeup, part interfaces, and specifications.

Logistics/Support Organizational
Functions Relative to a Composite Part

Organization	Function

Materiel

Buy and insure incoming material quality.

Material Supplier

Produce and test composite material per user's and/or supplier's specifications.

Configuration Management

Maintain configuration control over product definition and product data versions.

Logistics

Develop maintenance and repair manuals.

ALC Maintenance

Perform scheduled upkeep and testing on composite components.

ALC Modifications

Define and perform repair on existing composite components.

ALC Redesign

Conceive, develop, and fabricate a replacement part which could be based on updated requirements.

ALC Reproduce

Build a composite part based on an existing product definition.

Customer Procurement

Define performance criteria of overall deliverable. Verify product met deliverable requirements.

2.2 Part Families

There are many ways one can delineate composite parts into different families. The part families described in this document were determined primarily by the combination of composite items that made them up and basic shapes aspects. It is recognizable that from a manufacturing point of view, process and material aspects are also very important grouping criteria for composite parts. This needs analysis will be sensitive to collecting process and material aspects in addition to capturing relationships between process, shape, material, and function. It is a goal of this needs analysis to acquire the knowledge of composite parts in a modular form so that different composite part family trees can map and utilize the information easily.

The reason for establishing these part families is to create an aid for organizing and gathering information. These part families will be used for determining the types of composite parts which benefit most from being implemented in PDES. This scoping process is described in section 2.2.2.

2.2.1 Part Family Descriptions

The part families are listed below with example picture(s) and the composite items that make up each part family. This is not a complete list of composite part families. It only covers typical aircraft composite parts that are either laminate details or composite assemblies.

Channels - Laminate Detail

Channels have two up standing legs from a base. Channel legs do not have to be flat and/or parallel. The channel base does not have to be flat. Legs are /separated from the base by a quick change in the radius of curvature on the surface along a surface curve.

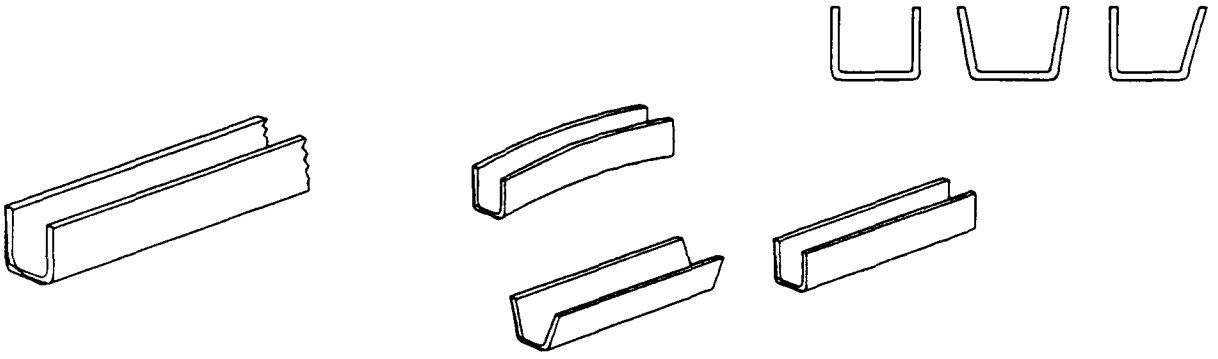


Figure 5 Channels - Laminate Detail

Contains the following composite items

Plies
Ply Details
Filament Assemblies
(broadgoods)
(tape)

Angles - Laminate Detail

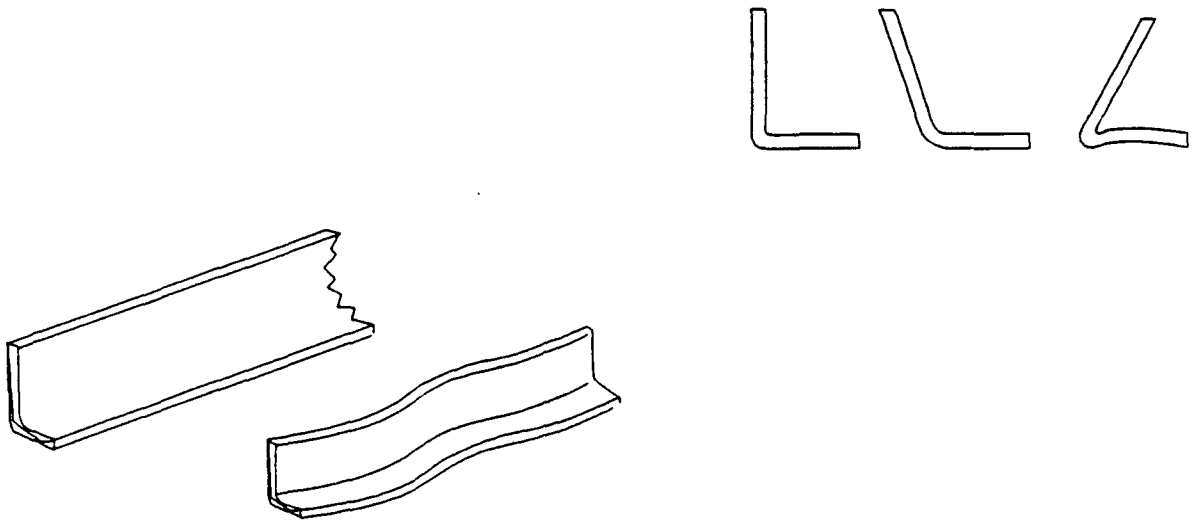


Figure 6 Angles - Laminate Detail

Angles have two legs. Angle legs do not have to be flat and/or parallel. Legs are separated by a quick change in the radius of curvature on the surface along a surface curve.

Contains the following composite items

Plies
Ply Details
Filament Assemblies
    (broadgoods)
    (tape)

"Z" - Laminate Detail

"Z's" have two legs from a base, one up standing, the other down standing. Channel legs do not have to be flat and/or parallel. The channel base does not have to be flat. Legs are separated from the base by a quick change in the radius of curvature on the surface along a surface curve.

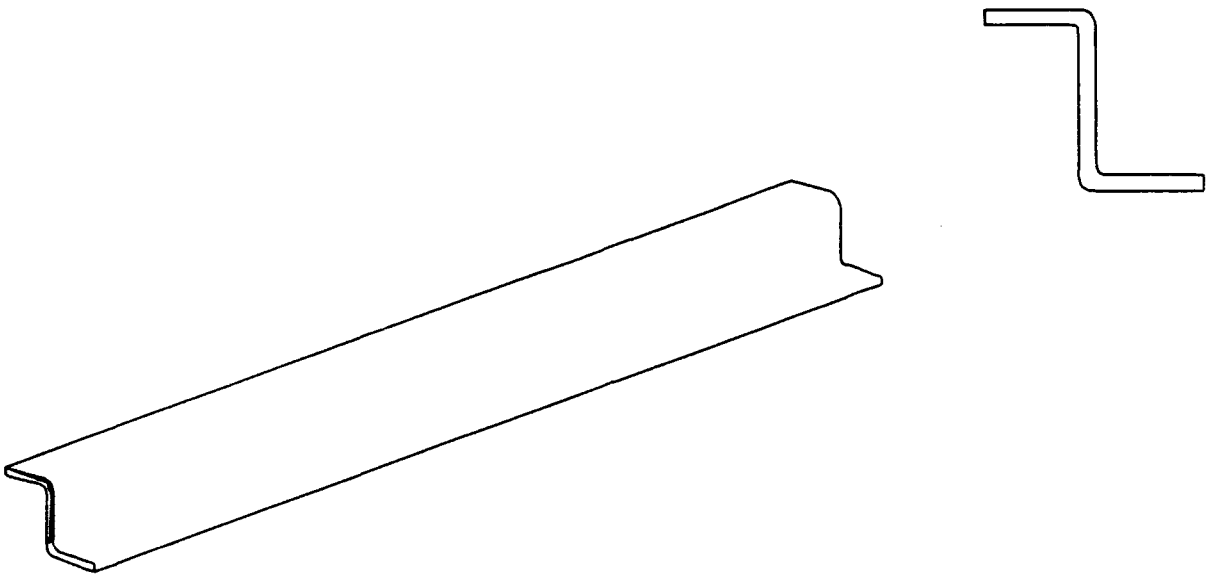


Figure 7 "Z" - Laminate Detail

Contains the following composite items

Plies
Ply Details
Filament Assemblies
(broadgoods)
(tape)

Caps - Laminate Detail

A cap is a special type of general - laminate detail. It has no legs. A cap's contour follows the contour of two butted legs within an assembly.

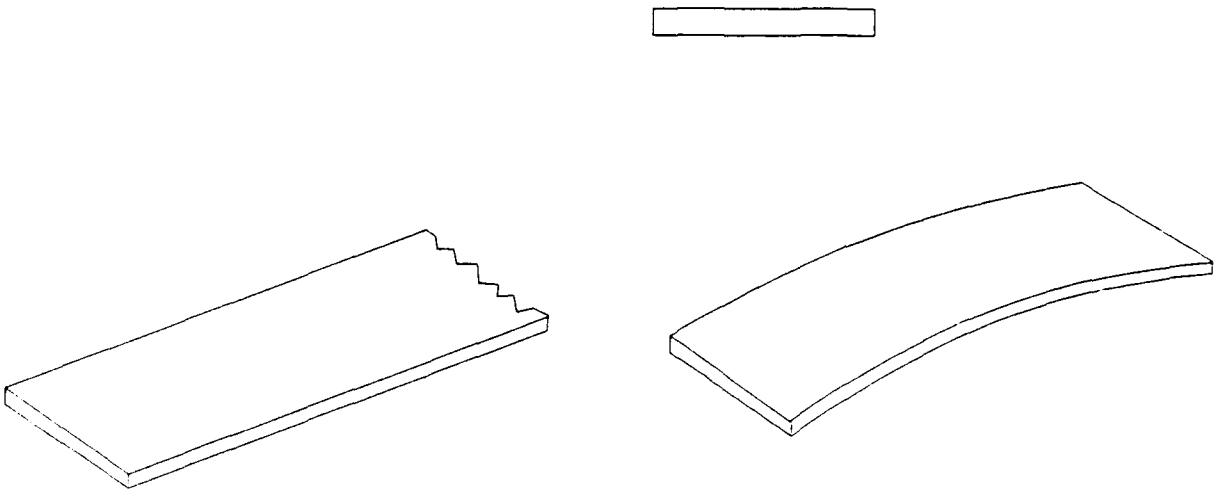


Figure 8 Caps - Laminate Detail

Contains the following composite items

Plies
Ply Details
Filament Assemblies
    (broadgoods)
    (tape)

Hats - Laminate Detail

Hats have five distinct surface areas separated by a quick change in the radius of curvature on the surface along a surface curve. The two outer surface areas have contours that match that of a mating part. The other three surface areas do not have to be flat or parallel.

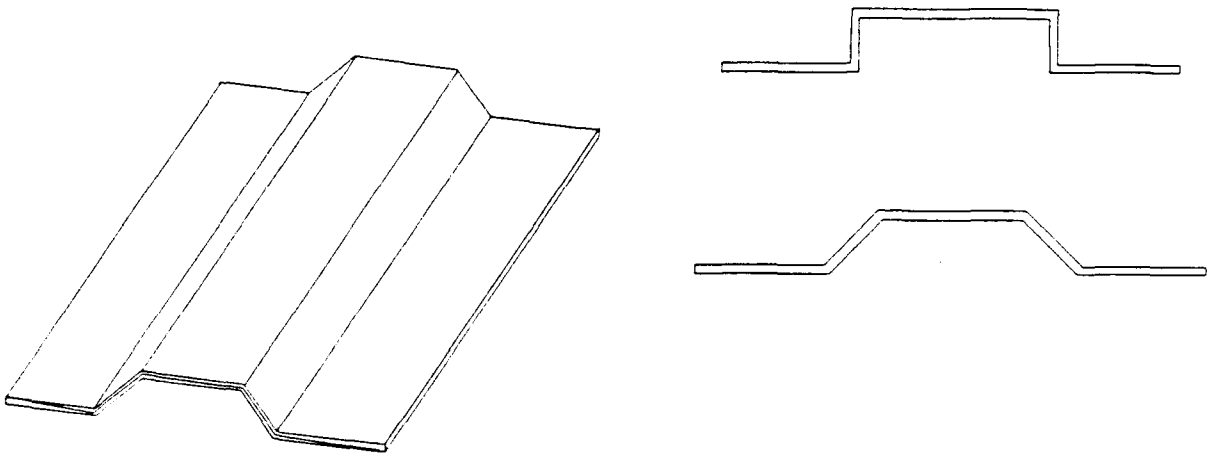


Figure 9 Hats - Laminate Detail

Contains the following composite items

Plies
Ply Details
Filament Assemblies
(broadgoods)
(tape)

Ducts/Tubing - Laminate Detail

Ducts/Tubing have a topological genus of one relative to the large surface area of the part.

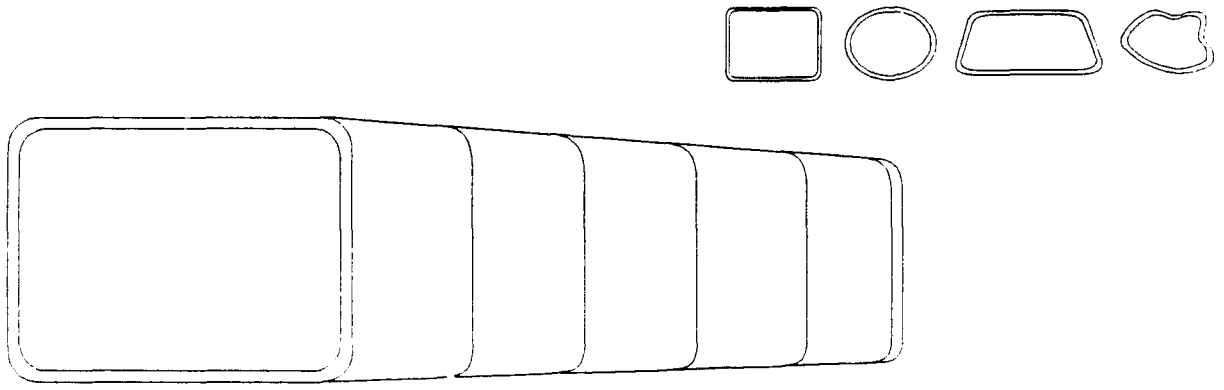


Figure 10 Ducts/Tubing - Laminate Detail

Contains the following composite items

Plies
Ply Details
Filament Assemblies
    (broadgoods)
    (tape)

General (Flat) - Laminate Detail

A general (flat) has to be flat on one side of the lay-up.

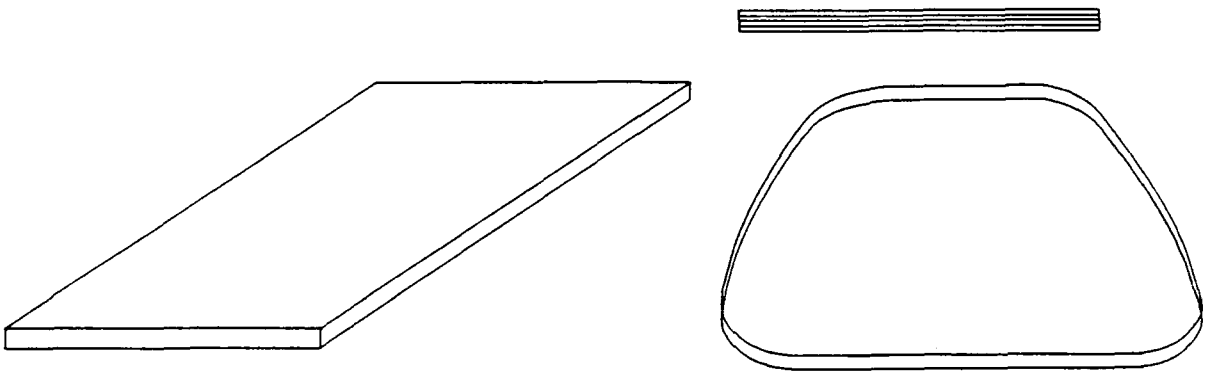


Figure 11 General (Flat) - Laminate Detail

Contains the following composite items

Plies
Ply Details
Filament Assemblies
    (broadgoods)
    (tape)

General (Contour/Wrappable) - Laminate Detail

A general (contour/wrappable) has a surface that can be physical unwrapped to a flat pattern and preserve its surface area. One example of this type of surface is a ruled surface.

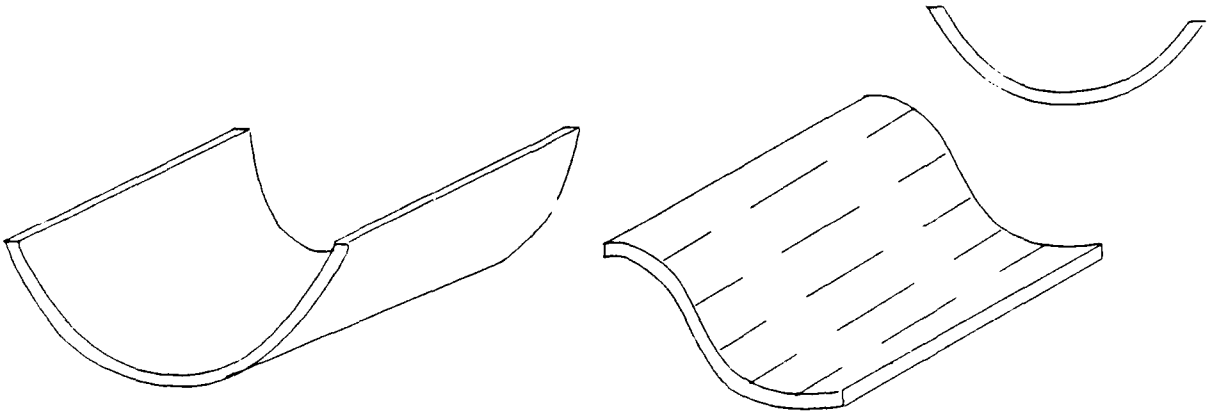


Figure 12 General (Contour/Wrappable) - Laminate Detail

Contains the following composite items

Plies
Ply Details
Filament Assemblies
    (broadgoods)
    (tape)

General (Contour/Unwrappable) - Laminate Detail

A general (contour/unwrappable) has a surface that can not be physical unwrapped to a flat pattern without distorting its surface area or peripheral boundary. One example of this type of surface is a sphere.

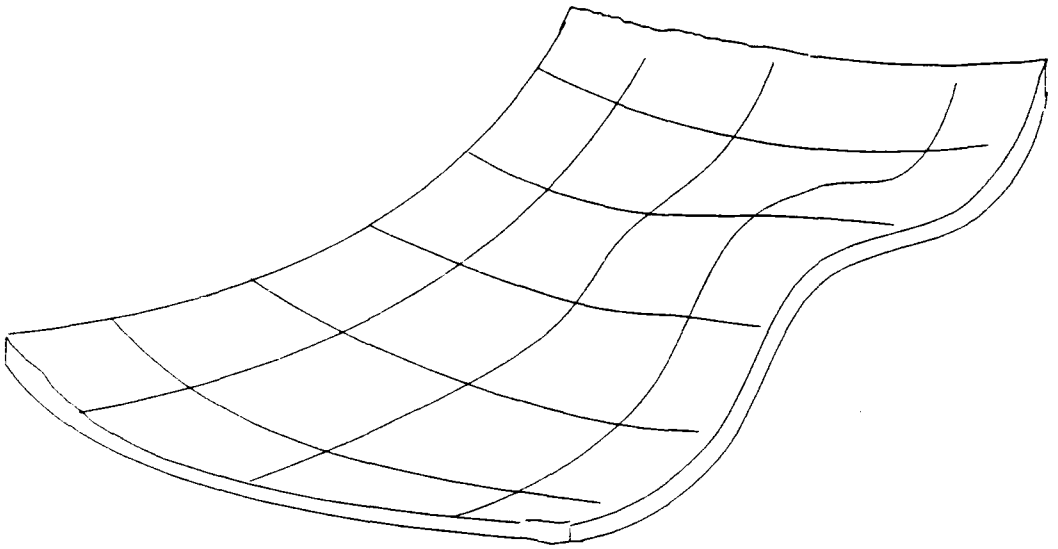


Figure 13 General (Contour/Unwrappable) - Laminate Detail

Contains the following composite items

Plies
Ply Details
Filament Assemblies
    (broadgoods)
    (tape)

General (with Edge Flange) - Laminate Detail

A general with edge flange has a large general area with a small up standing leg on edge. The height of the leg relative to the width of the large general area is over 1 to 5.

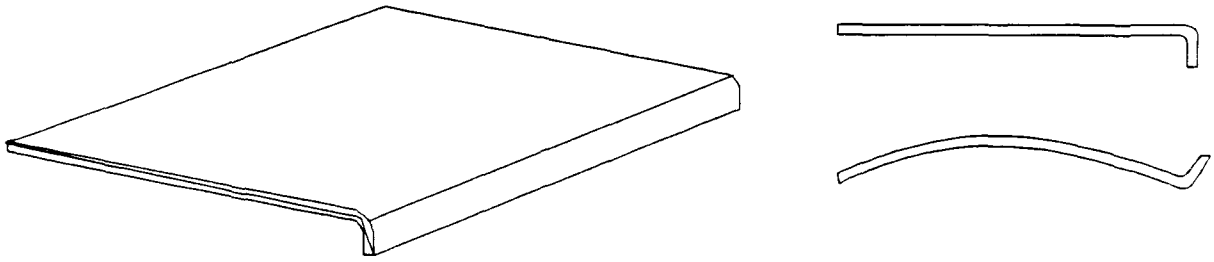


Figure 14 General (with Edge Flange) - Laminate Detail

Contains the following composite items

Plies
Ply Details
Filament Assemblies
(broadgoods)
(tape)

Stiffened Panel (CORE) - Composite Assembly

A panel with one or more pieces of core sandwiched between two general composite laminates.

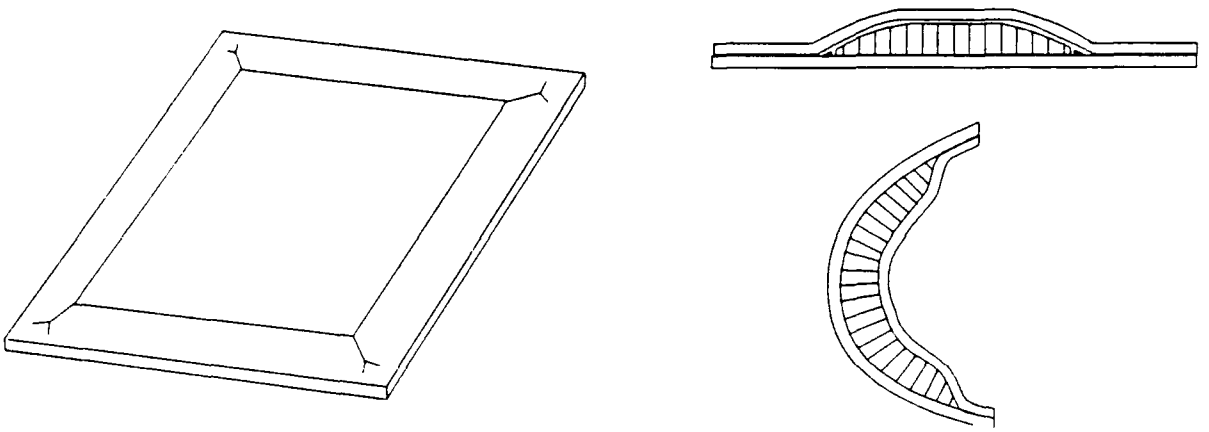


Figure 15 Stiffened Panel (CORE) - Composite Assembly

Contains the following composite items
Core(s) and/or core assemblies
Laminate Detail
    (2) Generals
Plies
Ply Details
Filament Assemblies
    (broadgoods) and/or
    (tape)
    (roving), if required

Stiffened Panel (HAT) - Composite Assembly

A general composite laminate (panel) with one or more hat sections bonded to it on a single side.

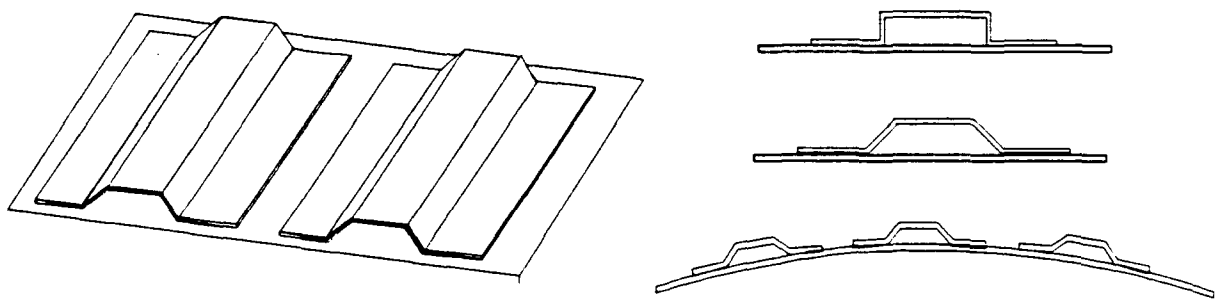


Figure 16 Stiffened Panel Hat - Composite Assembly

Contains the following composite items
Laminate Details
    Hat section(s)
    General
Plies
Ply Details
Filament Assemblies
    (broadgoods) and/or
    (tape)
    (roving), if required

Stiffened Panel (Blade) - Composite Assembly

A general composite laminate (panel) with a set of channels and angles details covering the entire panel, positioned leg to leg forming blades.

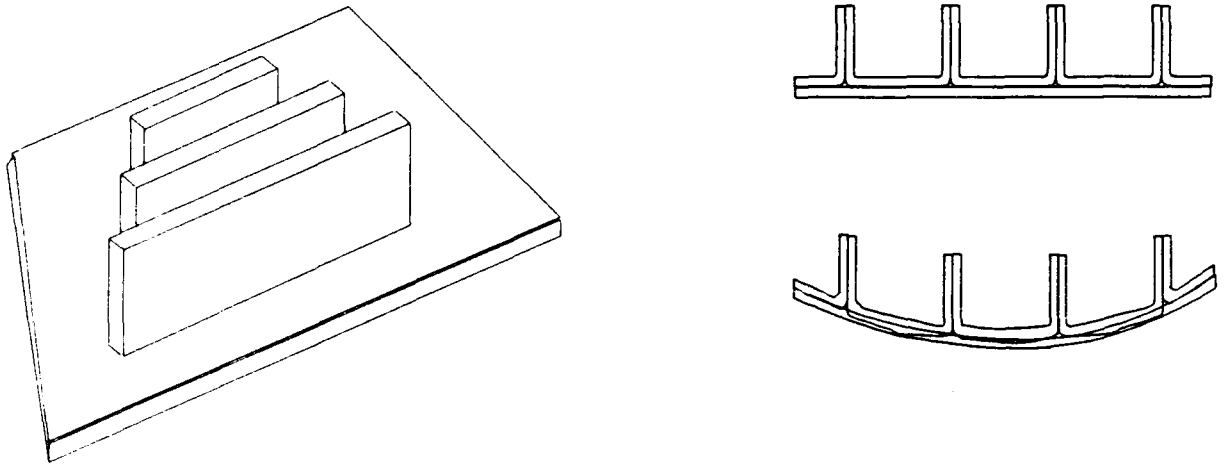


Figure 17 Stiffened Panel (Blade) - Composite Assembly

Contains the following composite items

Laminate Details
- angles
- channel(s)
- General

Plies

Ply Details

Filament Assemblies
- (broadgoods) and/or
- (tape)
- (roving), if required

Stiffened Panel ("J") - Composite Assembly

A general composite laminate (panel) with one or more "J" sections bonded to it on a single side.

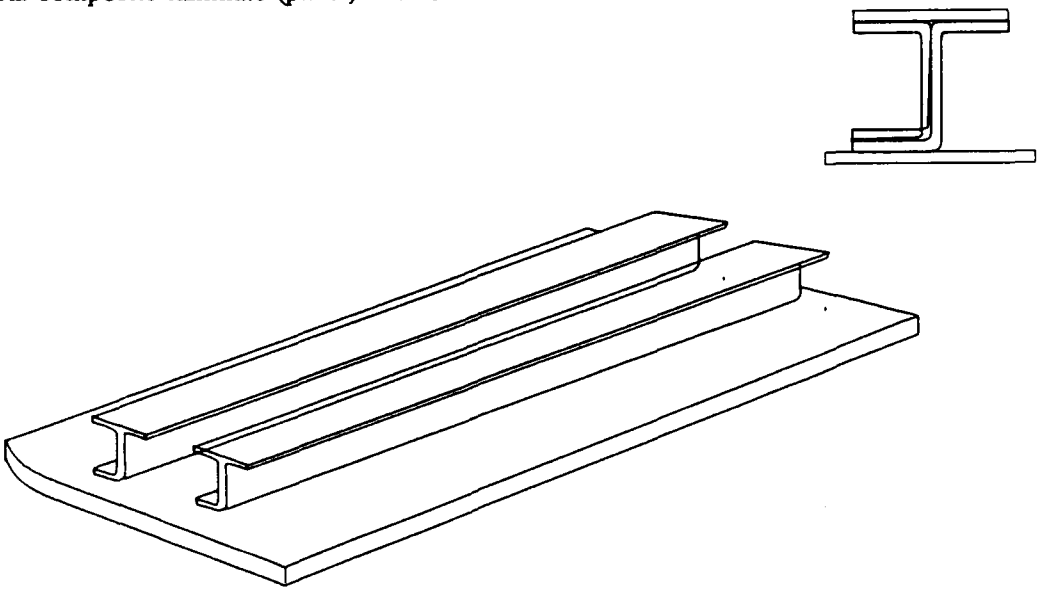


Figure 18 Stiffened Panel ("J") - Composite Assembly

Contains the following composite items

Composite Assembly
    "J'(s)"
Laminate Details
    General
Plies
Ply Details
Filament Assemblies
    (broadgoods) and/or
    (tape)

Stiffened Panel ("I") - Composite Assembly

A general composite laminate (panel) with one or more "I" sections bonded to it on a single side.

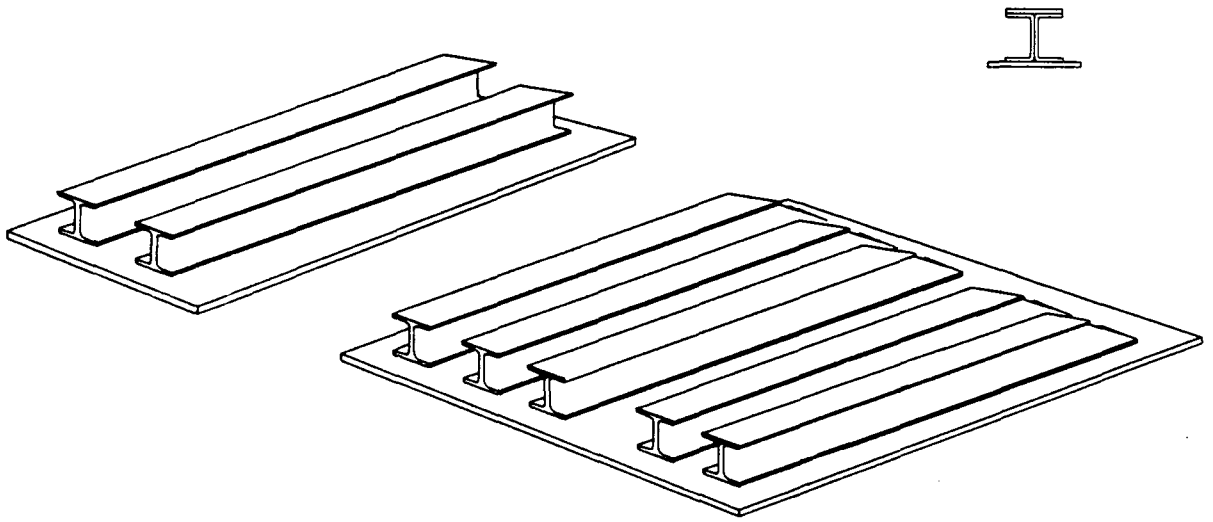


Figure 19 Stiffened Panel ("I") - Composite Assembly

Contains the following composite items

Composite Assembly
    "I'(s)"
Laminate Details
    General
Plies
Ply Details
Filament Assemblies
    (broadgoods) and/or
    (tape)

Stiffened Panel ("T") - Composite Assembly

A general composite laminate (panel) with one or more "T" sections bonded to it on a single side.

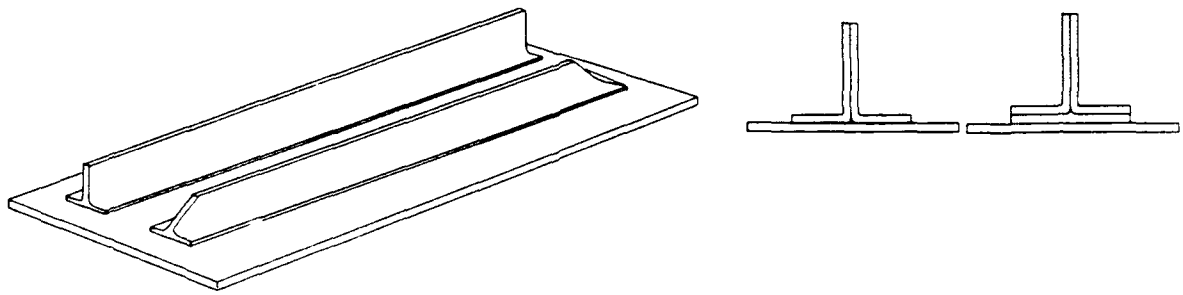


Figure 20 Stiffened Panel ("T") - Composite Assembly

Contains the following composite items
Composite Assembly
    "T'(s)"
Laminate Details
    General
Plies
Ply Details
Filament Assemblies
    (broadgoods) and/or
    (tape)

Stiffened Panel ("Z") - Composite Assembly

A general composite laminate (panel) with one or more "Z" sections bonded to it on a single side.

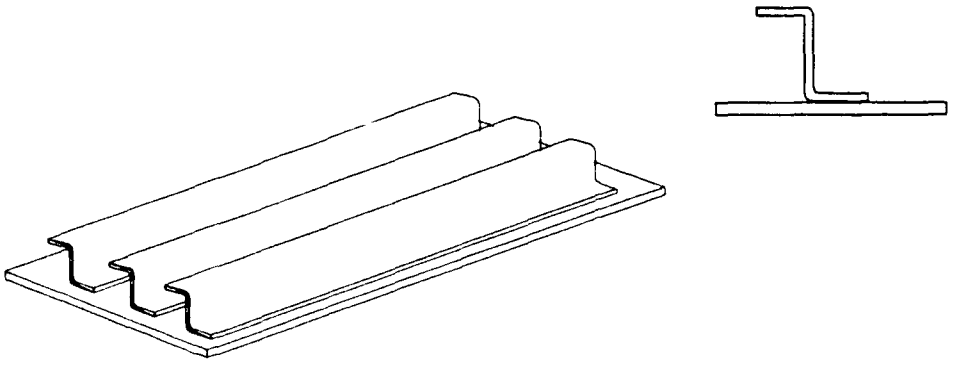


Figure 21 Stiffened Panel ("Z") - Composite Assembly

Contains the following composite items
Composite Assembly
"Z'(s)" or
Laminate Details
or "Z"(s)
General
Plies
Ply Details
Filament Assemblies
(broadgoods) and/or
(tape)

Stiffened Panel (angle) - Composite Assembly

A general composite laminate (panel) with one or more angle sections bonded to it on a single side.

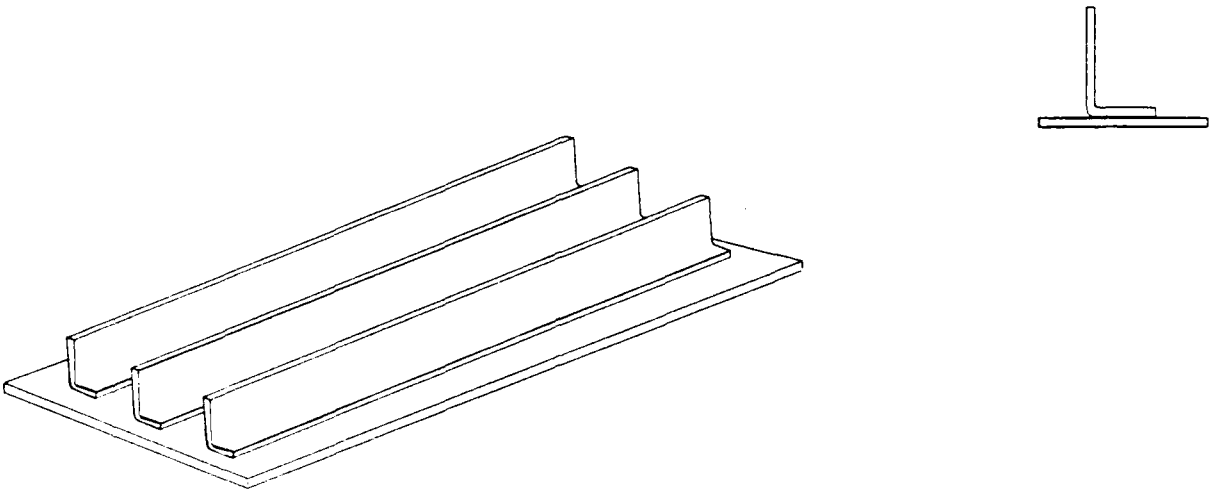


Figure 22 Stiffened Panel (Angle) - Composite Assembly

Contains the following composite items
Laminate Details
    angle(s)
    General
Plies
Ply Details
Filament Assemblies
    (broadgoods) and/or
    (tape)

Stiffened Panel (channel) - Composite Assembly

A general composite laminate (panel) with one or more channel sections bonded to it on a single side.

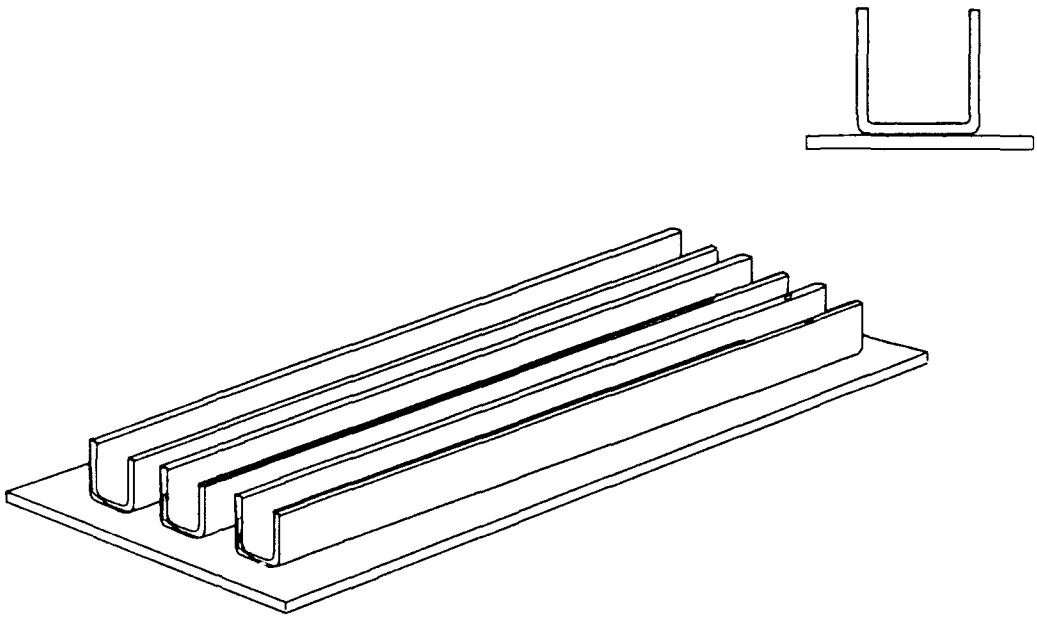


Figure 23 Stiffened Panel (Channel) - Composite Assembly

Contains the following composite items

Laminate Details
- channel(s)
- General

Plies

Ply Details

Filament Assemblies
- (broadgoods) and/or
- (tape)

Stiffened Panel (Core with edge channels) - Composite Assembly

A panel with one or more pieces of core sandwiched between two general composite laminates. The edges of the panel have channel laminates that close out the core.

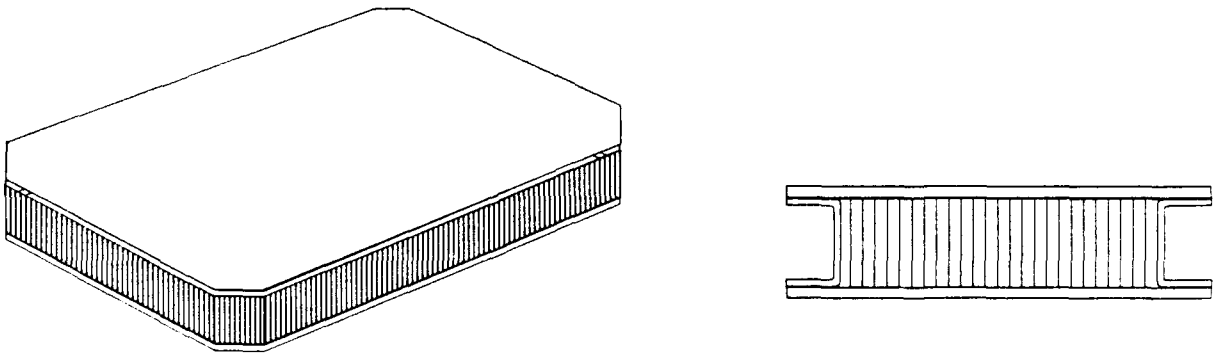


Figure 24 Stiffened Panel (Core with Edge Channels) - Composite Assembly

Contains the following composite items
Core(s) and/or core assemblies
Laminate Detail
    (2) Generals
    channels
Plies
Ply Details
Filament Assemblies
    (broadgoods) and/or
    (tape)
    (roving), if required

"I" - Composite Assembly

A assembly of two channels and two caps. The two channels are placed back to back. Each cap lie on two legs, one from each channel.

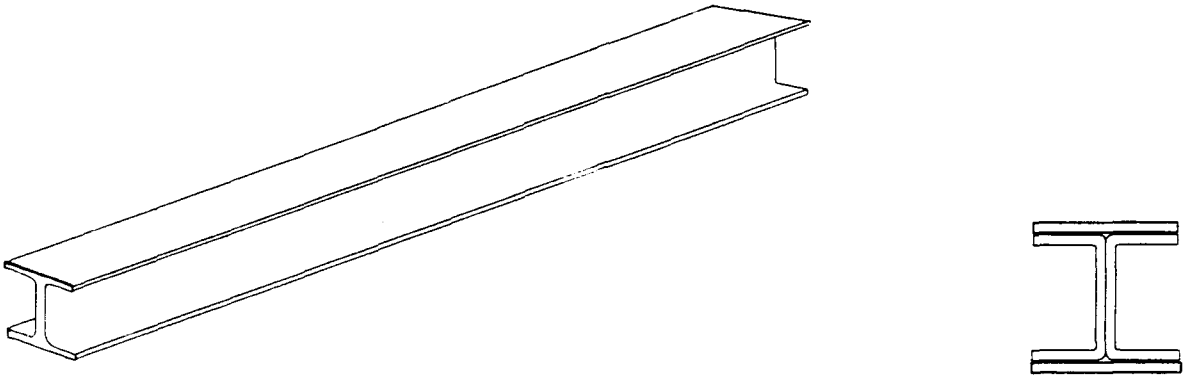


Figure 25 "I" - Composite Assembly

Contains the following composite items
Laminate Detail
(2) channels
(2) caps
Plies
Ply Details
Filament Assemblies
(broadgoods) and/or
(tape)
(roving), if required

"J" - Composite Assembly

An assembly of a channel, a laminate detail "Z" and a cap. Or an assembly of a channel, an angle and a cap.

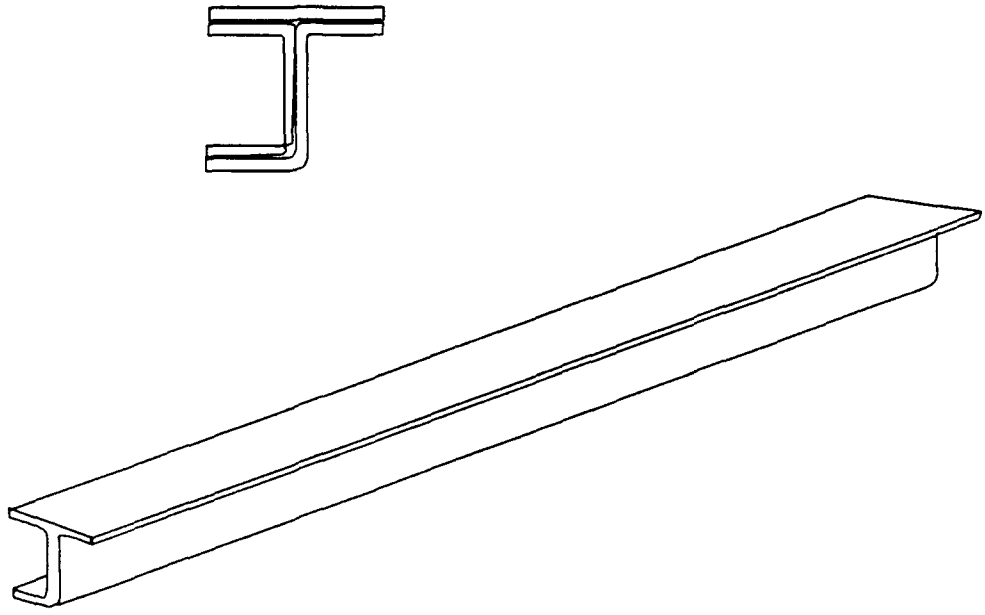


Figure 26 "J" - Composite Assembly

Contains the following composite items

Laminate Detail
- channel
- cap
- angle or a "Z"

Plies

Ply Details

Filament Assemblies
- (broadgoods) and/or
- (tape)
- (roving), if required

"T" - Composite Assembly

A assembly of two angles and one cap. The two angles are placed back to back. The cap lies on two legs, one from each angle.

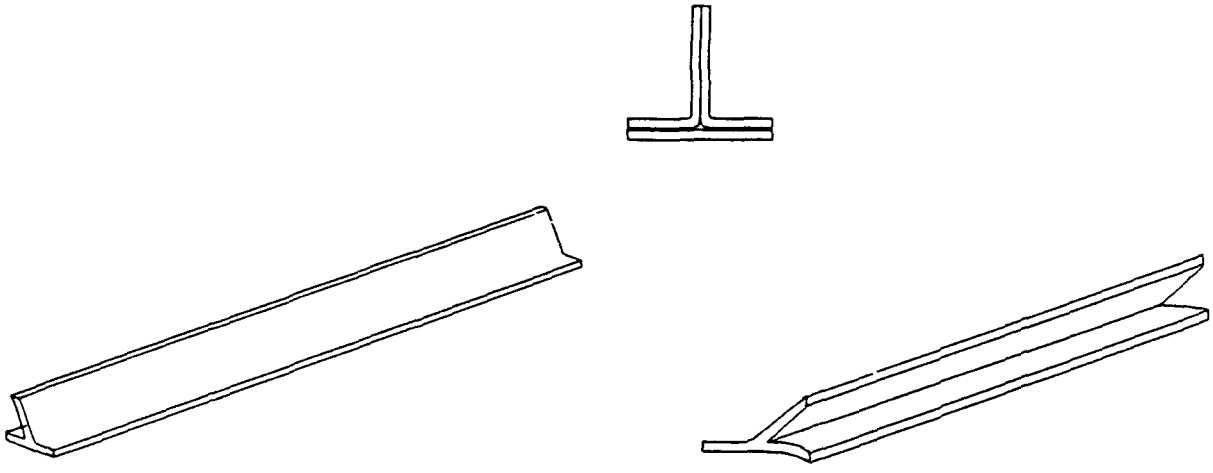


Figure 27 "T" - Composite Assembly

Contains the following composite items
Laminate Detail
(2) angles and cap or (2) angles
Plies
Ply Details
Filament Assemblies
(broadgoods) and/or
(tape)
(roving), if required

"Z" - Composite Assembly

An assembly of a laminate detail "Z" and a cap. Or an assembly of a laminate detail "Z" and an angle. Or an assembly of two angle back to back.

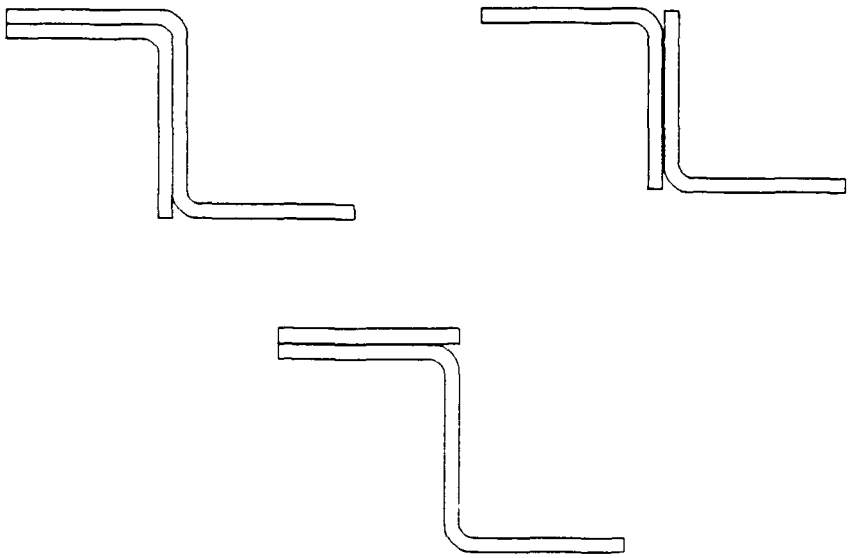


Figure 28 "Z" - Composite Assembly

Contains the following composite items

Laminate Detail
- (2) angles or
- angle and a "Z" or
- cap and a "Z"

Plies

Ply Details

Filament Assemblies
- (broadgoods) and/or
- (tape)
- (roving), if required

General - Composite Assembly

An assembly of any combination of laminate details and/or composite assemblies.

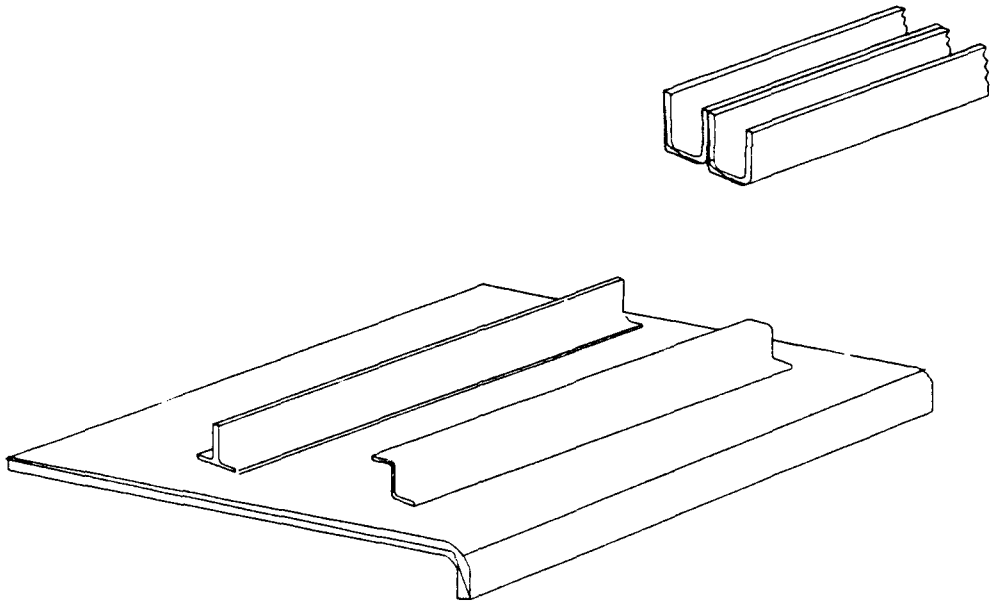


Figure 29 General - Composite Assembly

Contains the following composite items

Composite Assembly(s) (any)
Laminate Detail(s) (any)
Plies
Ply Details
Filament Assemblies
(broadgoods) and/or
(tape)
(roving), if required

2.2.2 Part Selection Criteria

This section contains the criteria for selecting a set of part families and a representative part example within three families. The formulation of the criteria was based on RFP requirements and the composite communities needs.

First, the criteria for prioritizing the set of part families is described:

(1) Significant numbers in all types of Aircraft
(2) Significant numbers in DoD fleet
(3) Air Force has example part within part family
(4) Good for determining scope with well defined bounds

Second, this criteria is applied to the part family list. This is done using the QFD house of Quality matrix (figure 30).

Third, based on evaluating the QFD matrix, figure 30, three composite part families were selected as prime areas for sample part selection. The three part families were

(1) laminate detail - general contour
(2) stiffened panel (core)
(3) "T" composite assembly

Example parts from different airplane programs were collected and compared against a second set of criteria using a QFD house of Quality matrix (figure 31). The list of criteria is as follows:

(1) Is the Example Part a Secondary Structure/ Load carrying member?
(2) Is the Example Part in the DoD Operational fleet?
(3) Is the History of use in the fleet representative of life-cycle views which is readily available for Cost Benefit Analysis (CBA)?
(4) Is the Product Data Releasable data?
(5) Does it cover most of the part family aspects it is to represent?
(6) Is the part recognizable by the experts that will be interviewed?
(7) Is the part simple yet comprehensive enough for an effective demonstration?
(8) Is the part data in a Digital format that will aid in the population of a PDES data base?

The three example parts can be found in PAS-C Document number PASC003.01.00, PAS-C Sample Part Set. The recommended parts include two F-16 parts and one B-2 part being selected from the three part families.

2.3 Functional Node Trees

The preliminary general node trees developed thus far have been created using various existing documentation at the respective PAS-C team members' locations along with conducting preliminary interviews with composite experts and industry available process models.

The preliminary general functional node trees represent the first step in the information collection process. These will be iterated as many times as possible with the functional experts in order to arrive at the

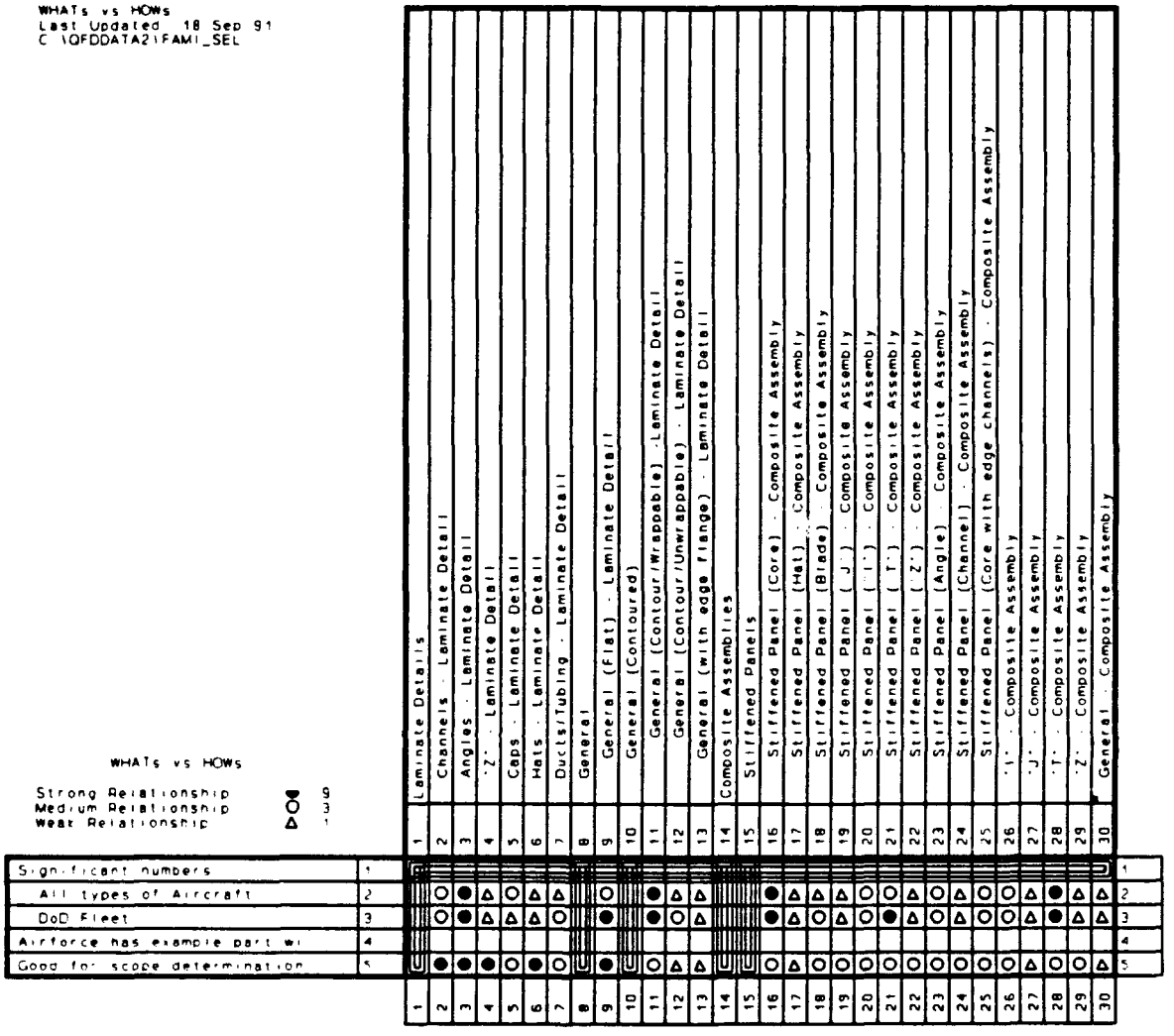


Figure 30 Selection of three Composite Part Families using a QFD Matrix.

desired FW/BB views. The FW/BB method requires mapping these node trees to the functional view axis and the associated Composite Item axis. This mapping can be done by decomposing the IDEF0 diagrams to a low enough level so that an individual decomposition diagram's Inputs, Controls, Outputs and Mechanisms (ICOMs) support a specific Composite Item on the composite item axis. At this point these general node trees, which assume the life cycle of any Aircraft Composite Structural Part (ACSP), can be mapped to a specific type of composite assembly or a specific type of laminate detail on the Composite Item axis.

This particular section of node trees has been set in a style that takes into account the 8 1/2 X 11" page format, Functional View constraints, and some basic IDEF0 rules that required specific segmenting.

The structure of this section (2.3) is set up for quick reference. Section 2.3.1 contains an indentured list

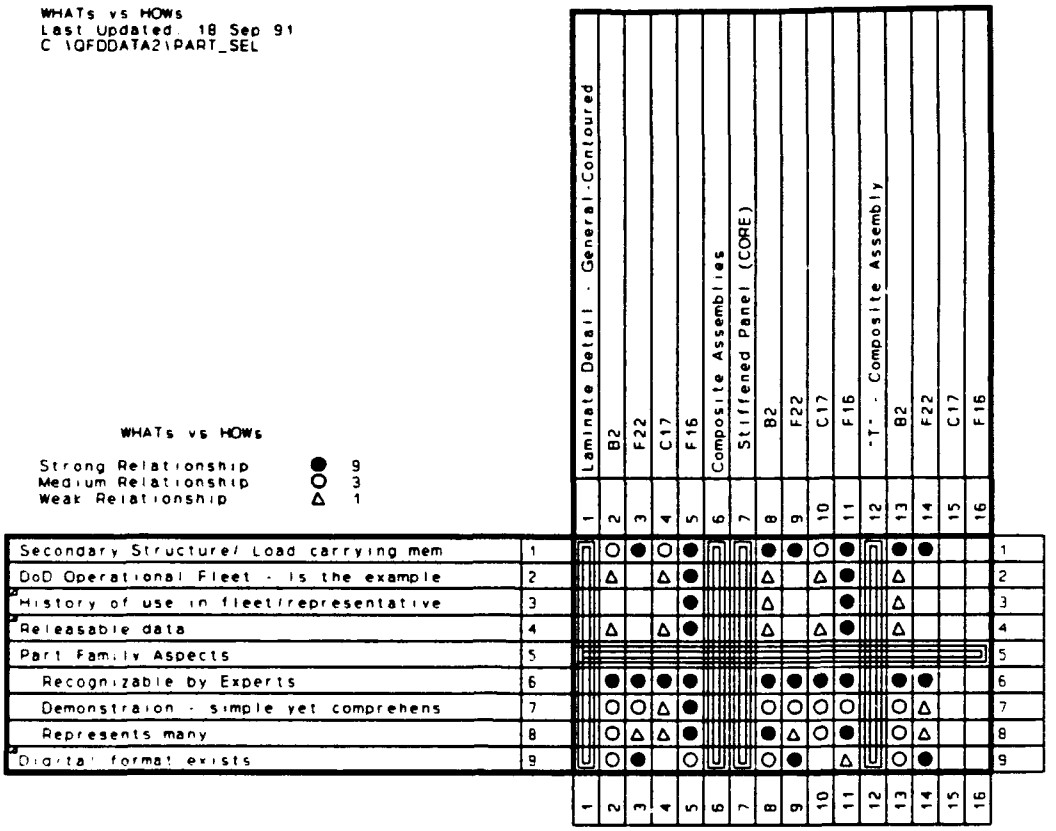
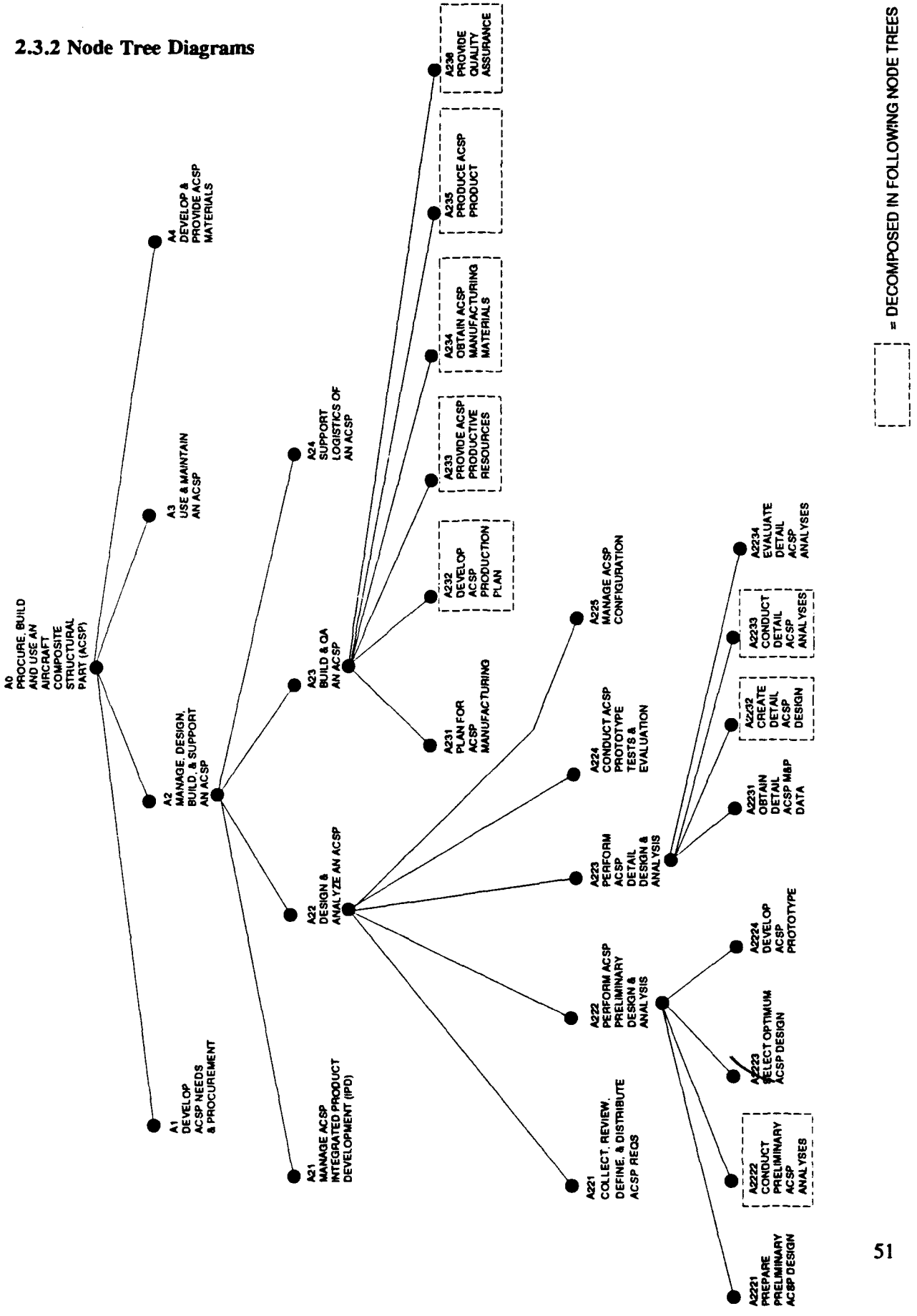


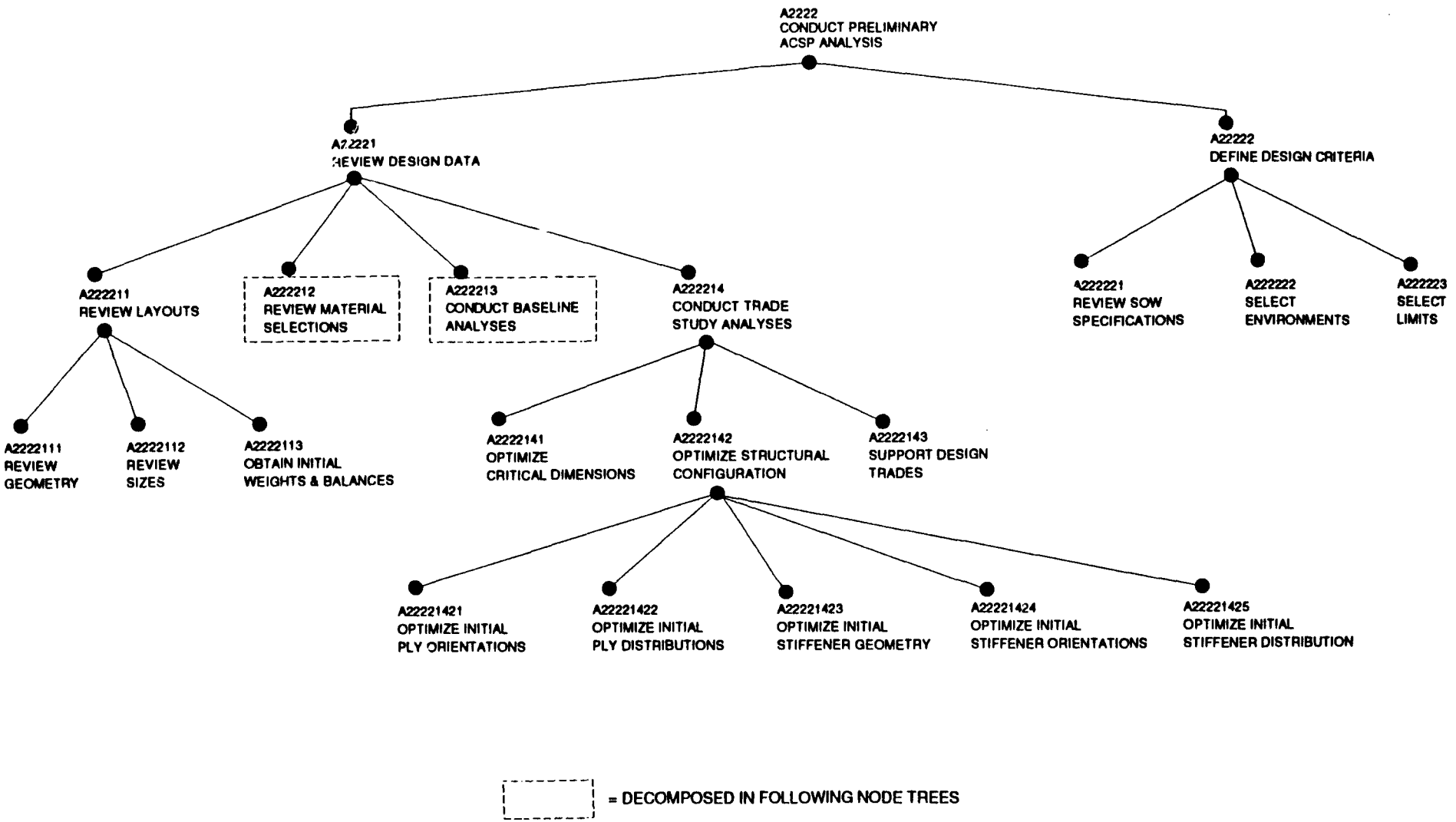
Figure 31 Selection of Example Parts using a QFD Matrix.

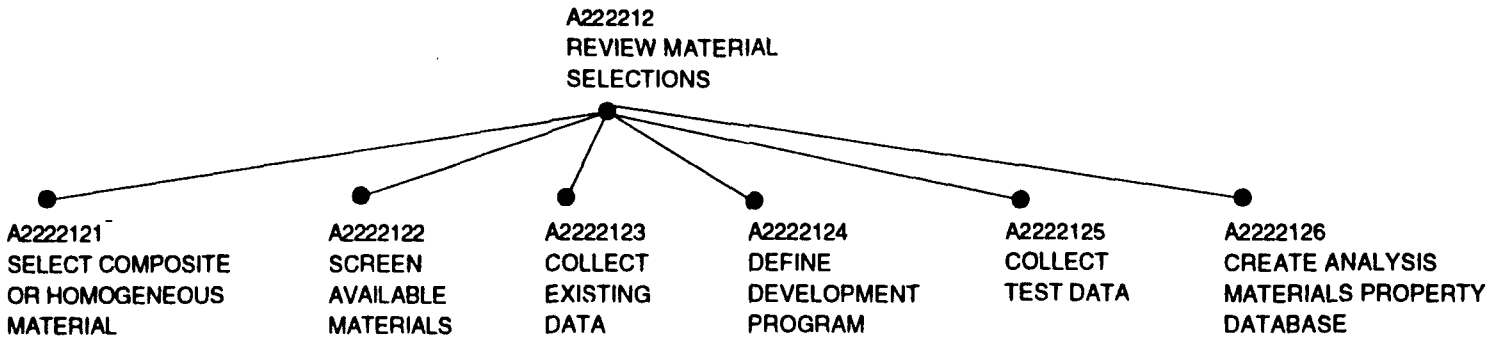
of all the functional nodes. Section 2.3.2 contains all the node tree diagrams, starting off with a general parent node tree. Each of the Node Trees have been broken up based on the size constraints for the node tree diagrams. Section 2.3.3 contains the node tree definitions. The definitions are organized in the same order as the indentured list. The breadth of the definitions are very general at this point, and will be refined in the next iteration with the functional experts.

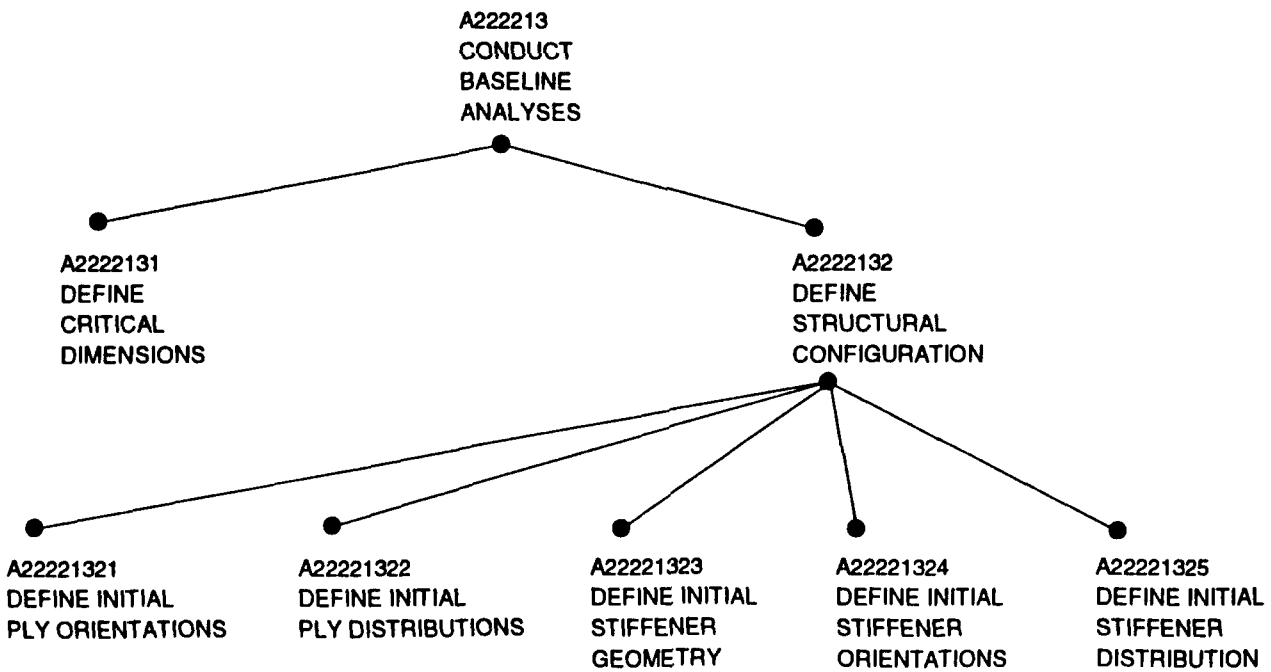
2.3.1 Indentured List

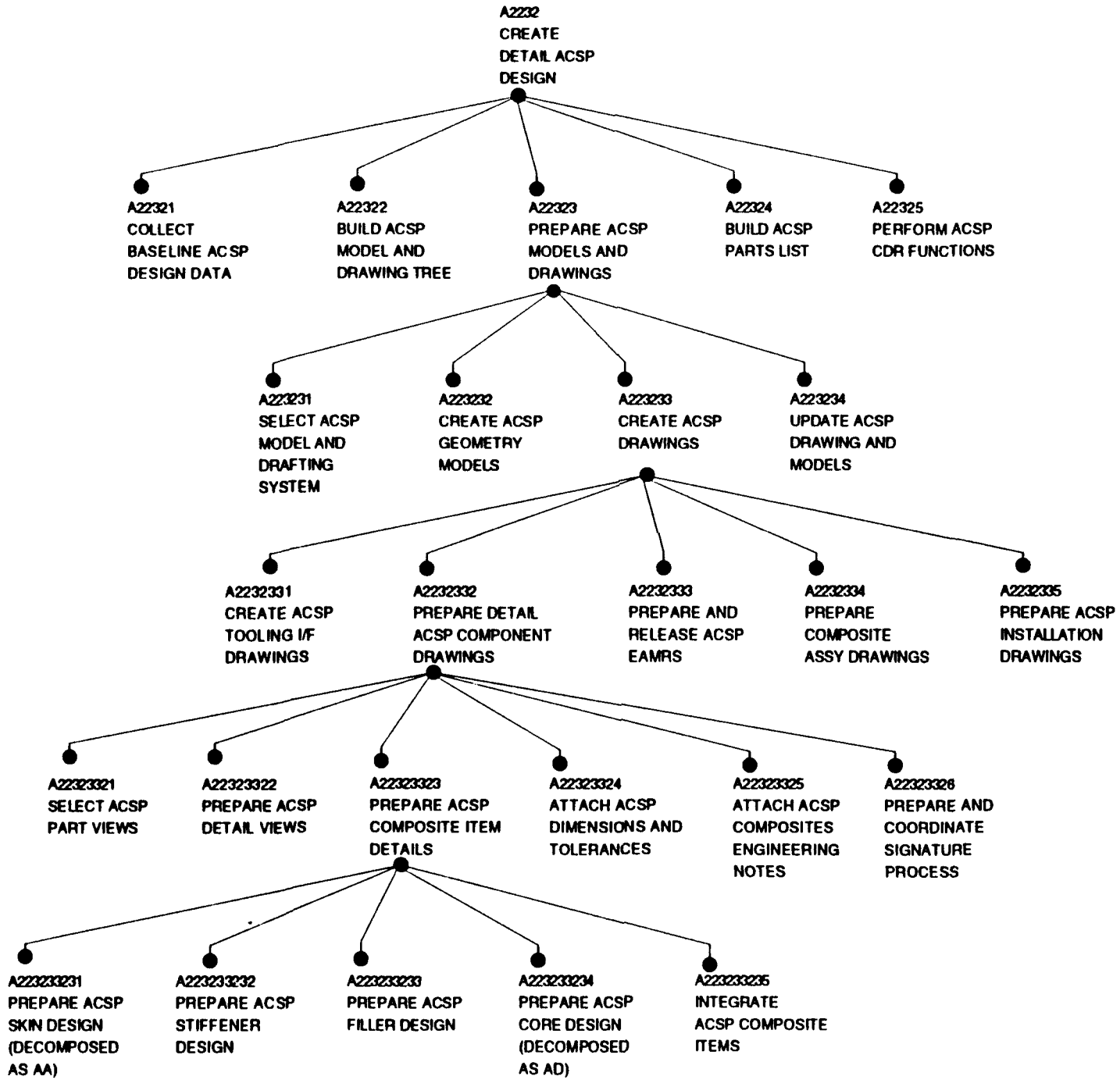
2.3.2 Node Tree Diagrams

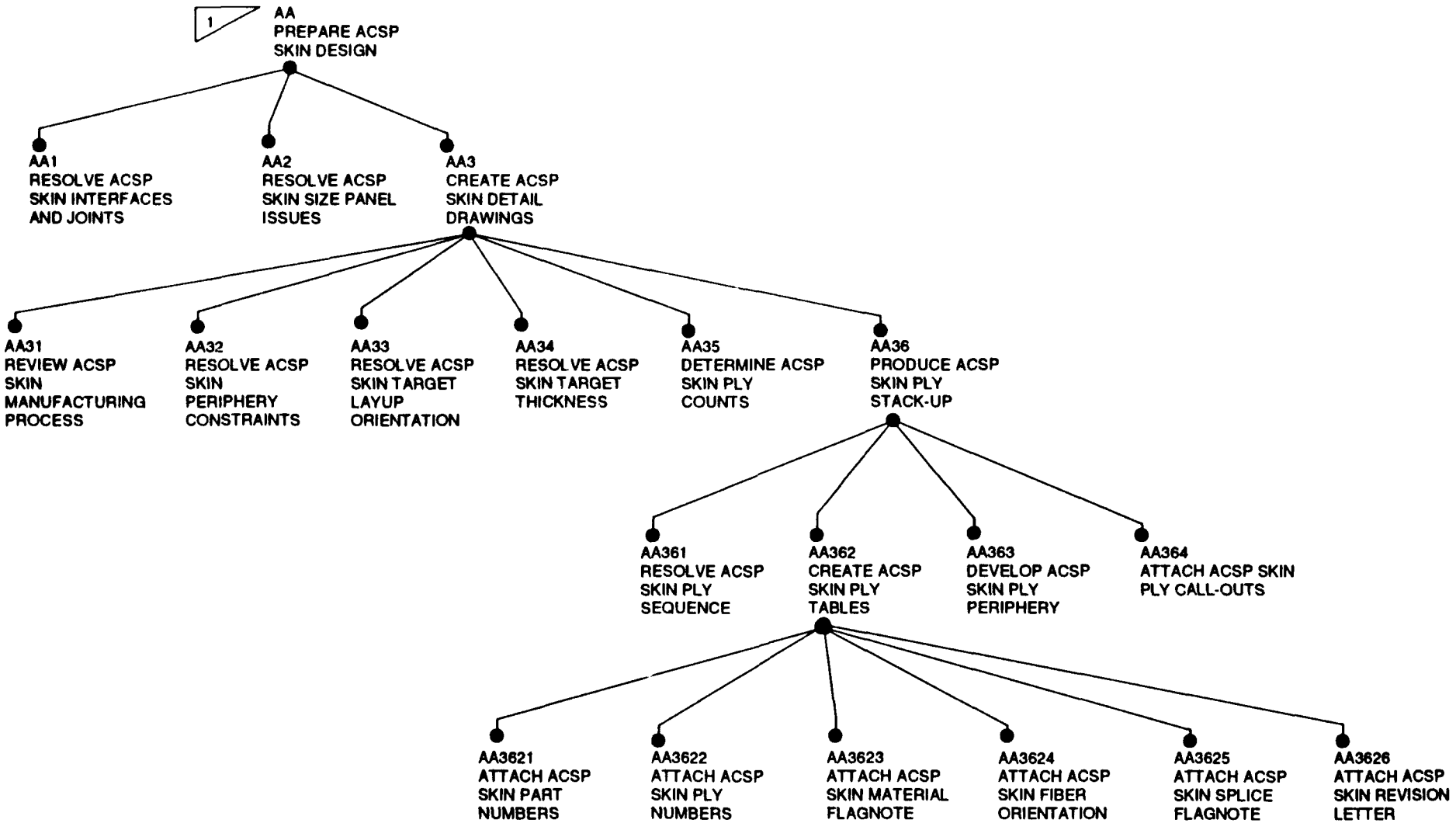



A2222
CONDUCT PRELIMINARY
ACSP ANALYSIS
A2222
DEFINE DESIGN CRITERIA
A222221
REVIEW SOW
SPECIFICATIONS
A222222
SELECT
ENVIRONMENTS
A222223
SELECT
LIMITS
A222211
REVIEW LAYOUTS
A222212
REVIEW MATERIAL
SELECTIONS
A222213
CONDUCT BASELINE
ANALYSES
A222214
CONDUCT TRADE
STUDY ANALYSES
A2222111
REVIEW
GEOMETRY
A2222112
REVIEW
SIZES
A2222113
OBTAIN INITIAL
WEIGHTS & BALANCES
A2222141
OPTIMIZE
CRITICAL DIMENSIONS
A2222142
OPTIMIZE STRUCTURAL
CONFIGURATION
A2222143
SUPPORT DESIGN
TRADES
A22221421
OPTIMIZE INITIAL
PLY ORIENTATIONS
A22221422
OPTIMIZE INITIAL
PLY DISTRIBUTIONS
A22221423
OPTIMIZE INITIAL
STIFFENER GEOMETRY
A22221424
OPTIMIZE INITIAL
STIFFENER ORIENTATIONS
A22221425
OPTIMIZE INITIAL
STIFFENER DISTRIBUTION
= DECOMPOSED IN FOLLOWING NODE TREES

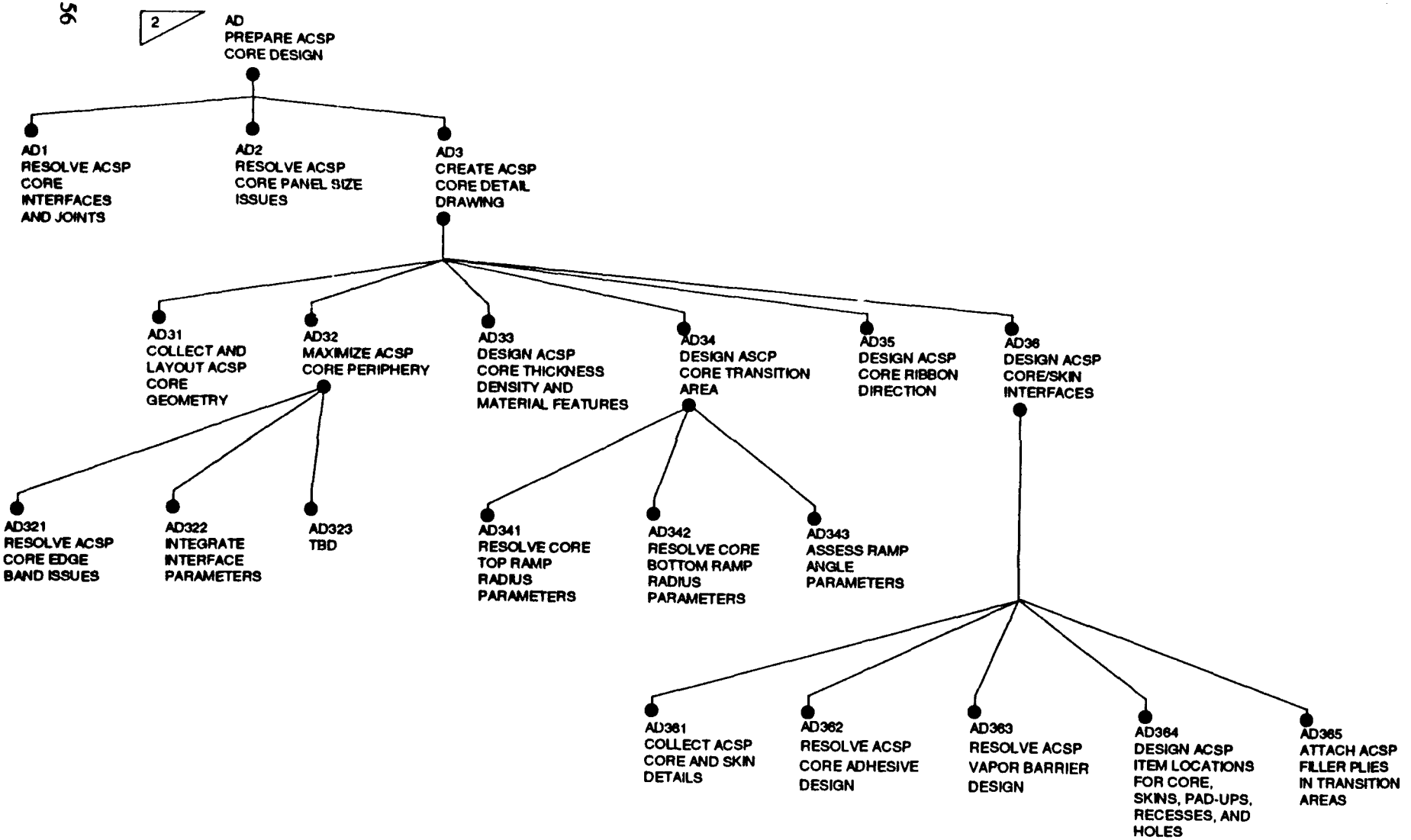

A222212
REVIEW MATERIAL
SELECTIONS
A2222121
SELECT COMPOSITE
OR HOMOGENEOUS
MATERIAL
A2222122
SCREEN
AVAILABLE
MATERIALS
A2222123
COLLECT
EXISTING
DATA
A2222124
DEFINE
DEVELOPMENT
PROGRAM
A2222125
COLLECT
TEST DATA
A2222126
CREATE ANALYSIS
MATERIALS PROPERTY
DATABASE


A222213
CONDUCT
BASELINE
ANALYSES
A2222131
DEFINE
CRITICAL
DIMENSIONS
A2222132
DEFINE
STRUCTURAL
CONFIGURATION
A22221321
DEFINE INITIAL
PLY ORIENTATIONS
A22221322
DEFINE INITIAL
PLY DISTRIBUTIONS
A22221323
DEFINE INITIAL
STIFFENER
GEOMETRY
A22221324
DEFINE INITIAL
STIFFENER
ORIENTATIONS
A22221325
DEFINE INITIAL
STIFFENER
DISTRIBUTION

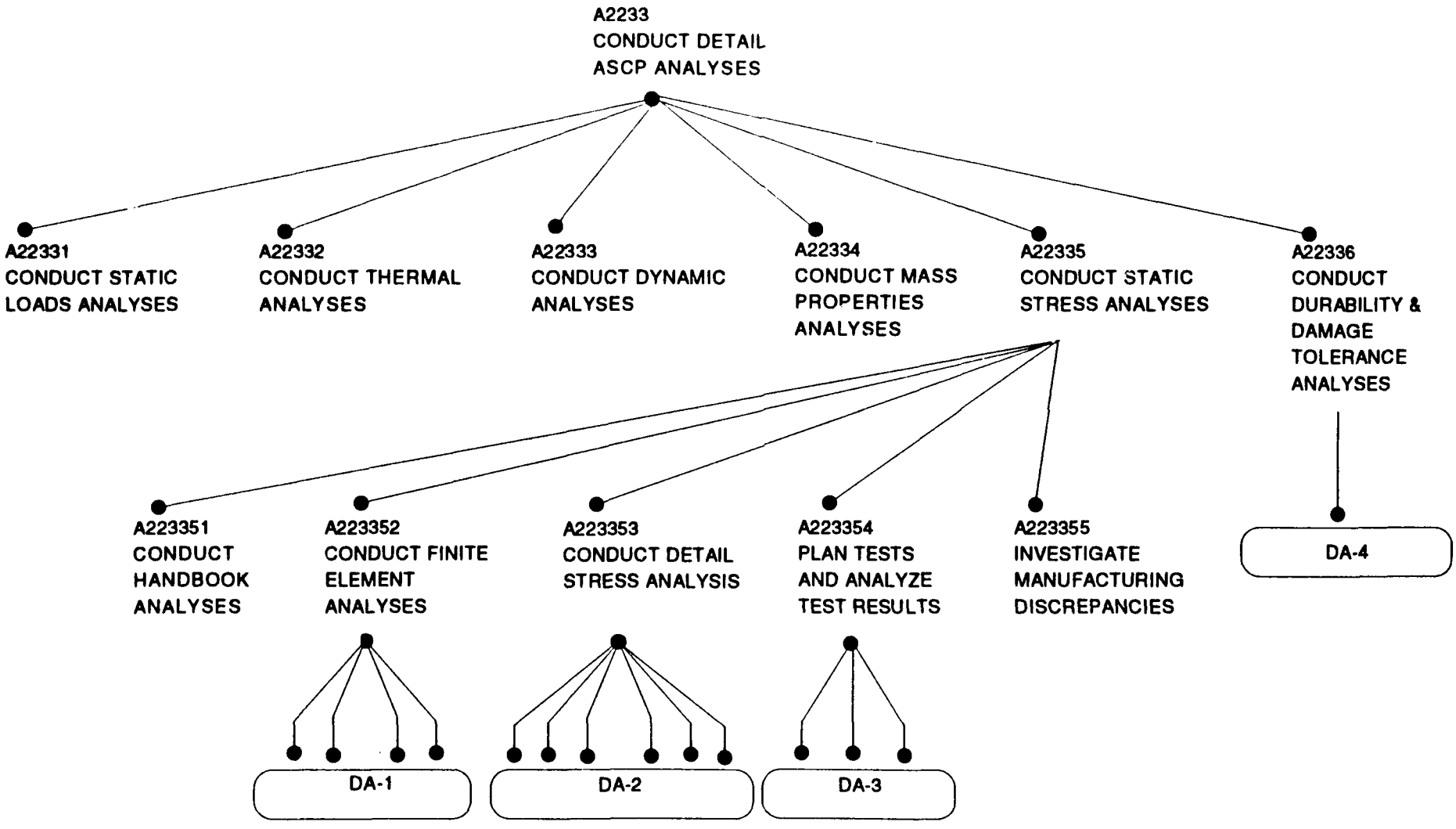

A2232
CREATE
DETAIL ACSP
DESIGN
A22321
COLLECT
BASELINE ACSP
DESIGN DATA
A22322
BUILD ACSP
MODEL AND
DRAWING TREE
A22323
PREPARE ACSP
MODELS AND
DRAWINGS
A22324
BUILD ACSP
PARTS LIST
A22325
PERFORM ACSP
CDR FUNCTIONS
A223231
SELECT ACSP
MODEL AND
DRAFTING
SYSTEM
A223232
CREATE ACSP
GEOMETRY
MODELS
A223233
CREATE ACSP
DRAWINGS
A223234
UPDATE ACSP
DRAWING AND
MODELS
A2232331
CREATE ACSP
TOOLING I/F
DRAWINGS
A2232332
PREPARE DETAIL
ACSP COMPONENT
DRAWINGS
A2232333
PREPARE AND
RELEASE ACSP
EAMRS
A2232334
PREPARE
COMPOSITE
ASSY DRAWINGS
A2232335
PREPARE ACSP
INSTALLATION
DRAWINGS
A22323321
SELECT ACSP
PART VIEWS
A22323322
PREPARE ACSP
DETAIL VIEWS
A22323323
PREPARE ACSP
COMPOSITE ITEM
DETAILS
A22323324
ATTACH ACSP
DIMENSIONS AND
TOLERANCES
A22323325
ATTACH ACSP
COMPOSITES
ENGINEERING
NOTES
A22323326
PREPARE AND
COORDINATE
SIGNATURE
PROCESS
A222323231
PREPARE ACSP
SKIN DESIGN
(DECOMPOSED
AS AA)
A222323232
PREPARE ACSP
STIFFENER
DESIGN
A222323233
PREPARE ACSP
FILLER DESIGN
A222323234
PREPARE ACSP
CORE DESIGN
(DECOMPOSED
AS AD)
A222323235
INTEGRATE
ACSP COMPOSITE
ITEMS

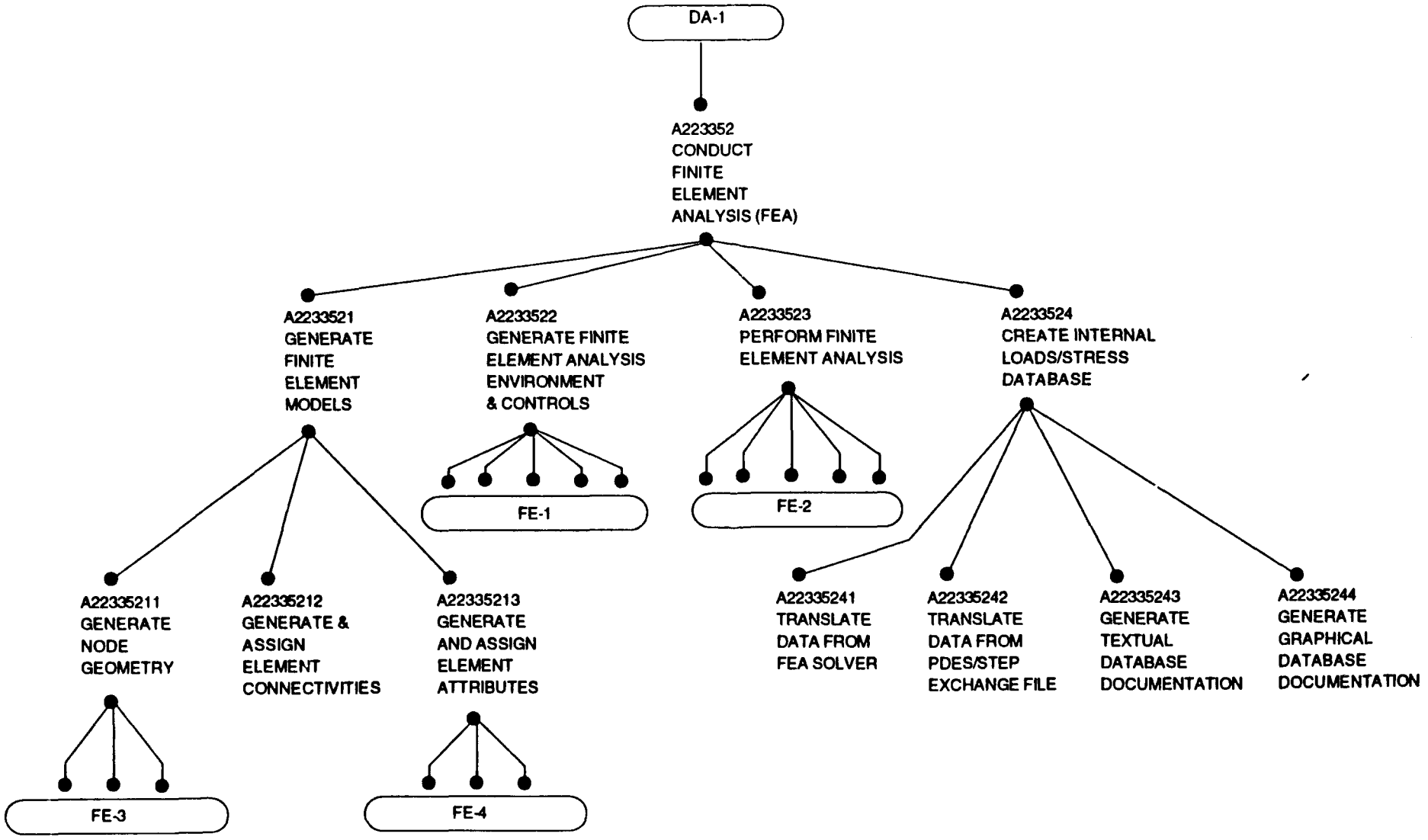


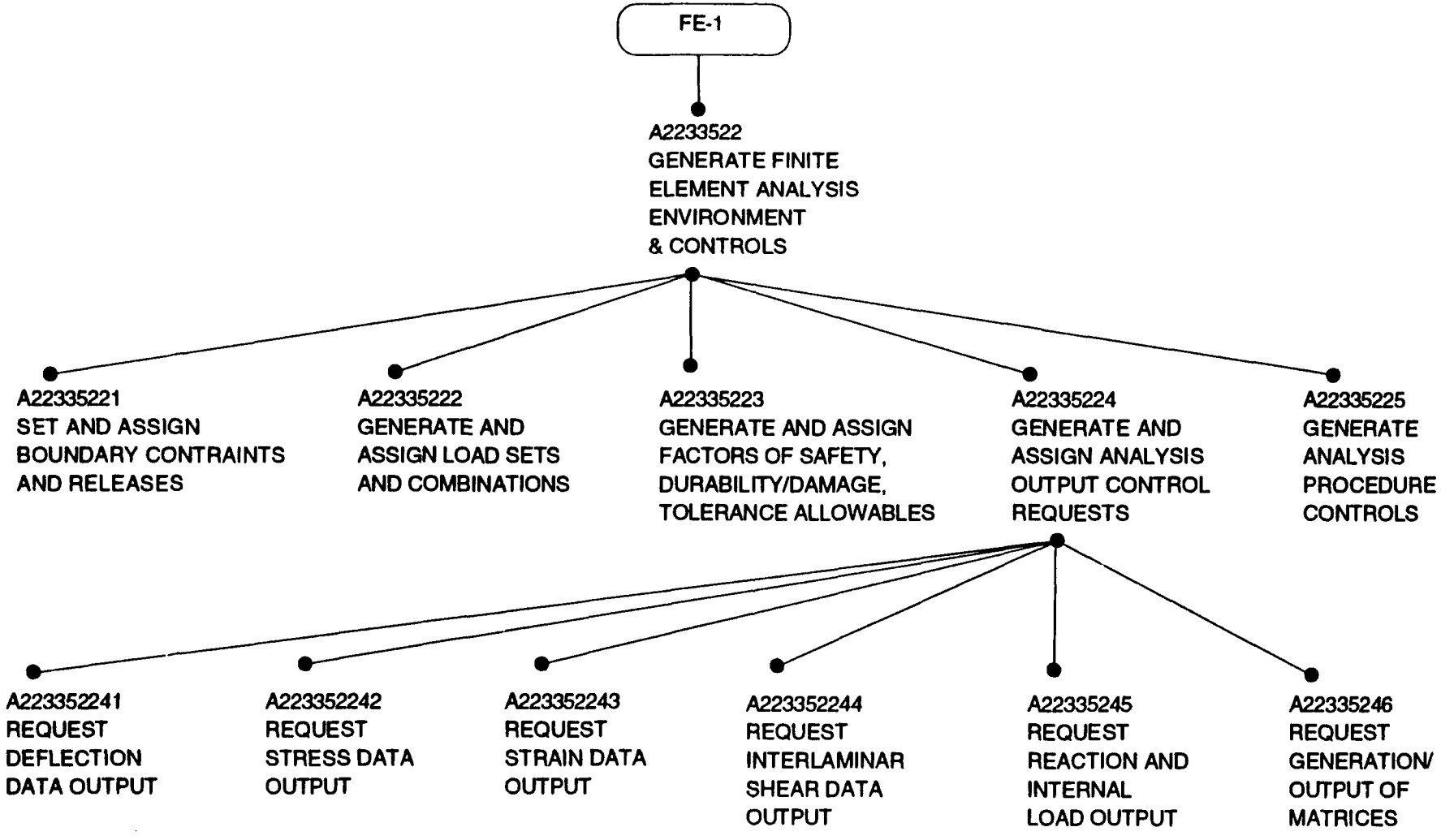
1 DUE TO THE FIELD WIDTH OF THE NODE # A223233231, AS DERIVED FROM THE PARENT GENERAL NODE TREE, THIS CHILD NODE HAS BEEN ASSIGNED THE AA NUMBER.

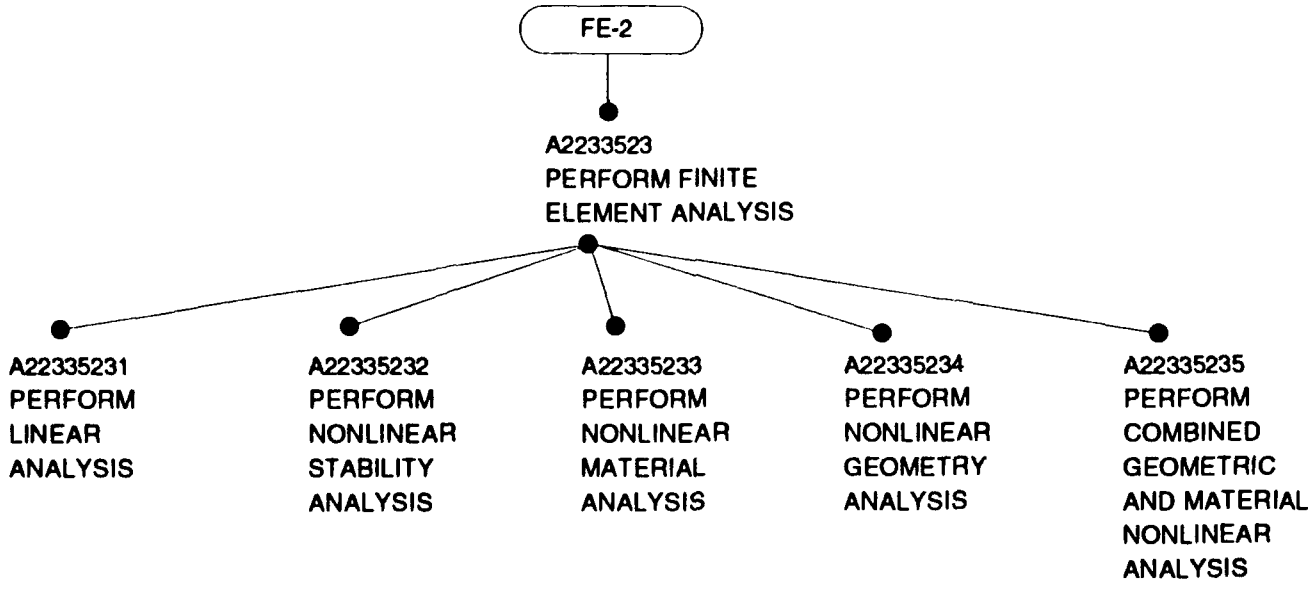


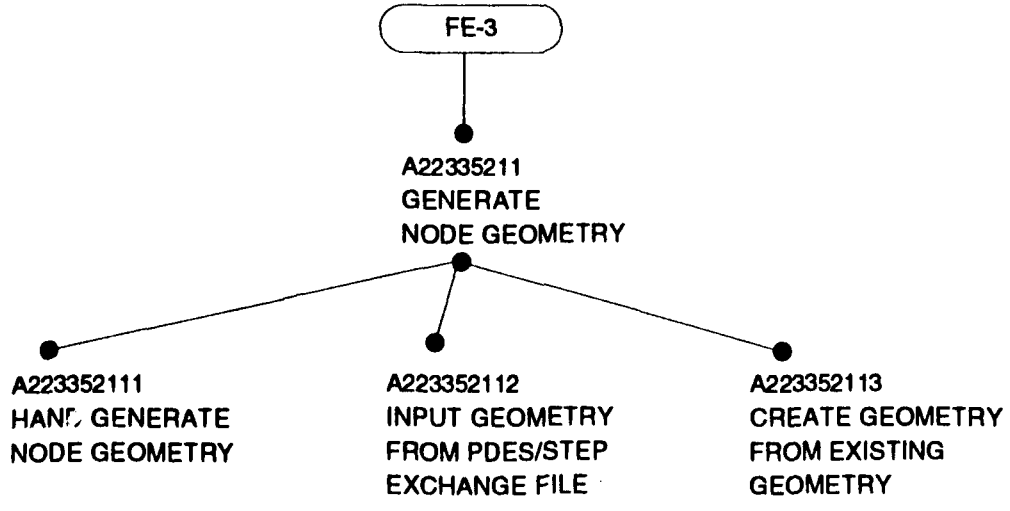
2 DUE TO THE FIELD WIDTH OF THE NODE # A223233234, AS DERIVED FROM THE PARENT GENERAL NODE TREE, THIS CHILD NODE HAS BEEN ASSIGNED THE AD NUMBER.

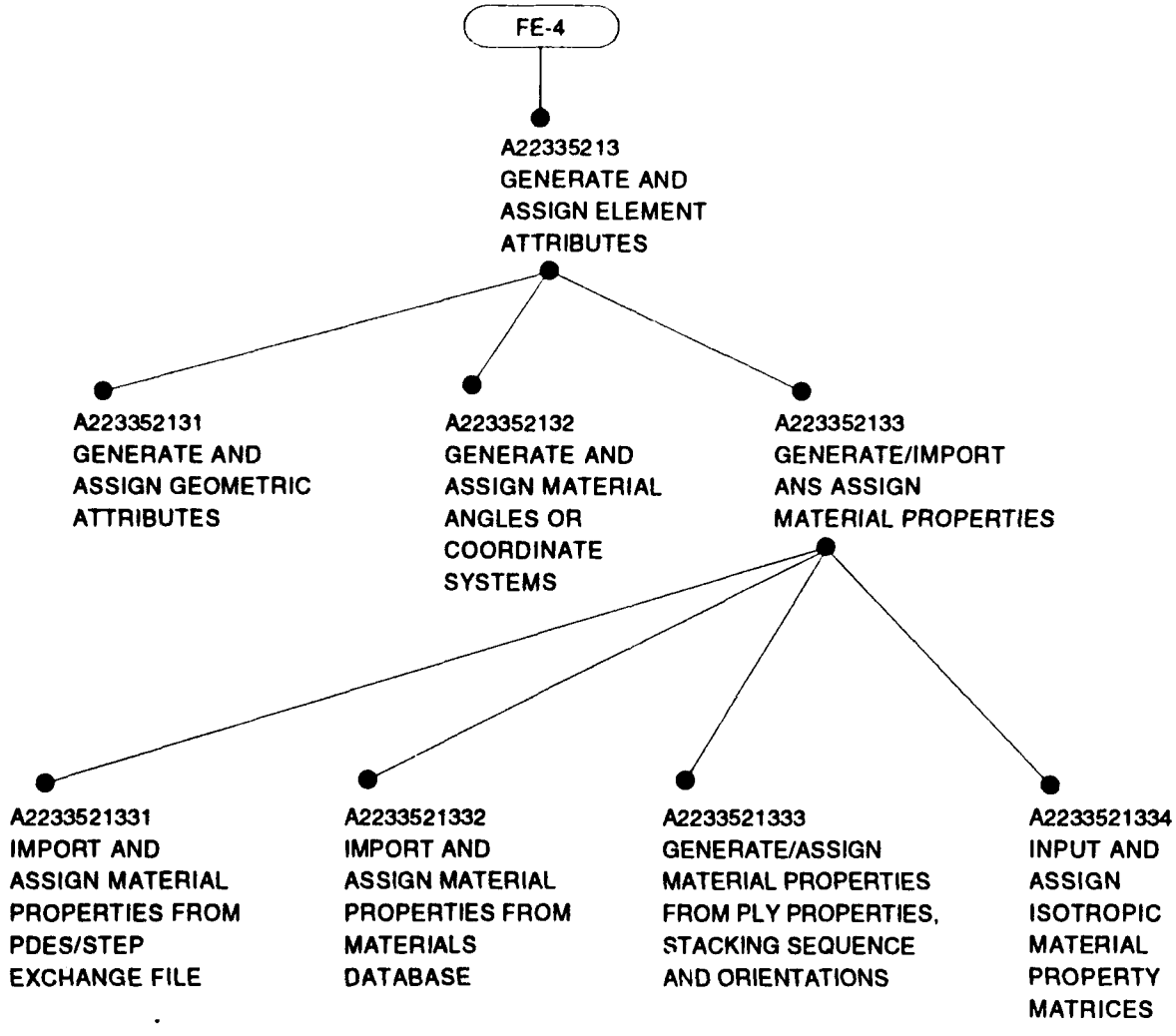

A2233
CONDUCT DETAIL
ASCP ANALYSES
A22331
CONDUCT STATIC
LOADS ANALYSES
A22332
CONDUCT THERMAL
ANALYSES
A22333
CONDUCT DYNAMIC
ANALYSES
A22334
CONDUCT MASS
PROPERTIES
ANALYSES
A22335
CONDUCT STATIC
STRESS ANALYSES
A22336
CONDUCT
DURABILITY &
DAMAGE
TOLERANCE
ANALYSES
A223351
CONDUCT
HANDBOOK
ANALYSES
A223352
CONDUCT FINITE
ELEMENT
ANALYSES
A223353
CONDUCT DETAIL
STRESS ANALYSIS
A223354
PLAN TESTS
AND ANALYZE
TEST RESULTS
A223355
INVESTIGATE
MANUFACTURING
DISCREPANCIES
DA-1
DA-2
DA-3
DA-4

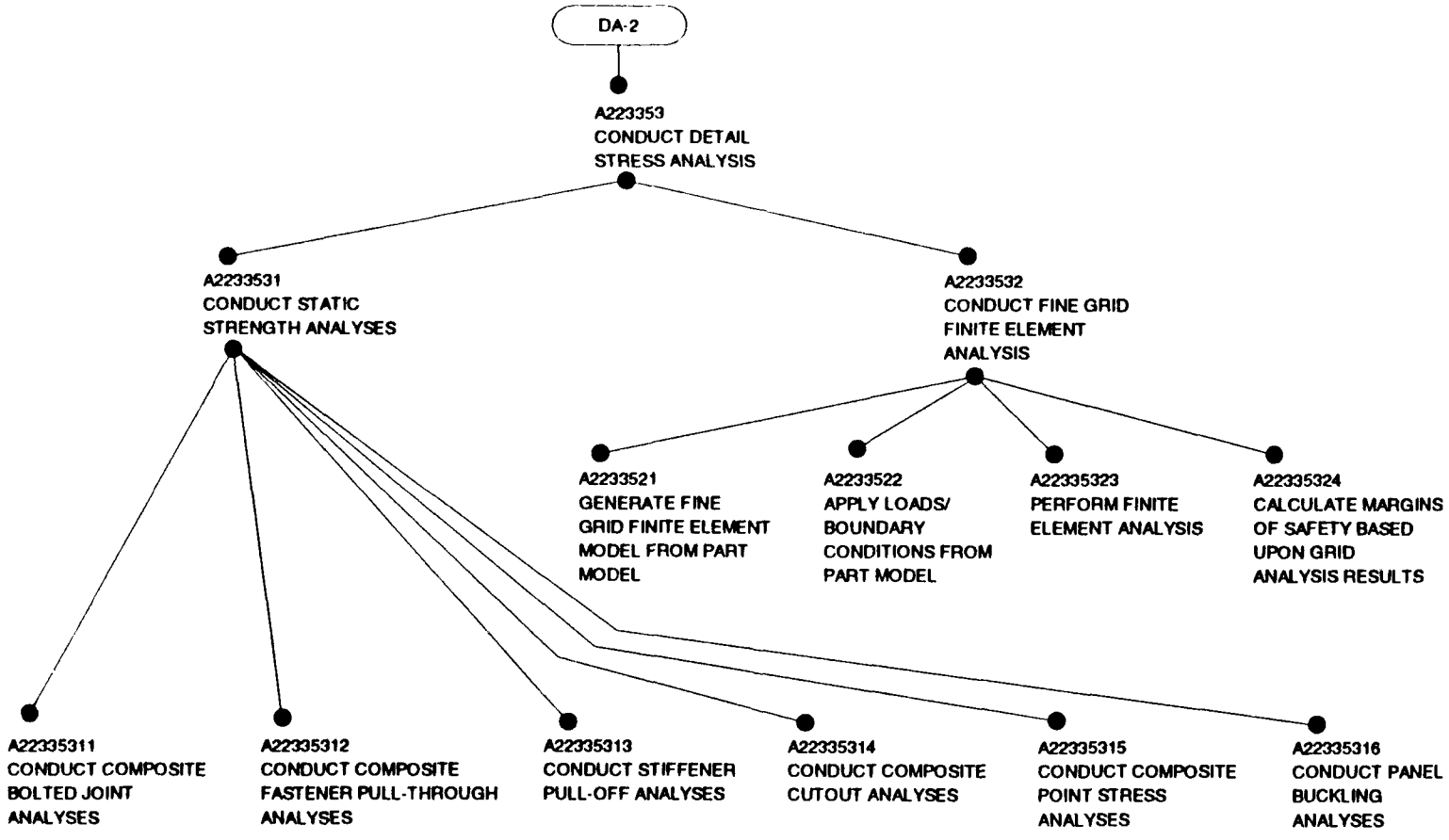

DA-1
A223352
CONDUCT
FINITE
ELEMENT
ANALYSIS (FEA)
A2233521
GENERATE
FINITE
ELEMENT
MODELS
A2233522
GENERATE FINITE
ELEMENT ANALYSIS
ENVIRONMENT
& CONTROLS
A2233523
PERFORM FINITE
ELEMENT ANALYSIS
A2233524
CREATE INTERNAL
LOADS/STRESS
DATABASE
FE-1
FE-2
A22335211
GENERATE
NODE
GEOMETRY
A22335212
GENERATE &
ASSIGN
ELEMENT
CONNECTIVITIES
A22335213
GENERATE
AND ASSIGN
ELEMENT
ATTRIBUTES
A22335241
TRANSLATE
DATA FROM
FEA SOLVER
A22335242
TRANSLATE
DATA FROM
PDES/STEP
EXCHANGE FILE
A22335243
GENERATE
TEXTUAL
DATABASE
DOCUMENTATION
A22335244
GENERATE
GRAPHICAL
DATABASE
DOCUMENTATION
FE-3
FE-4

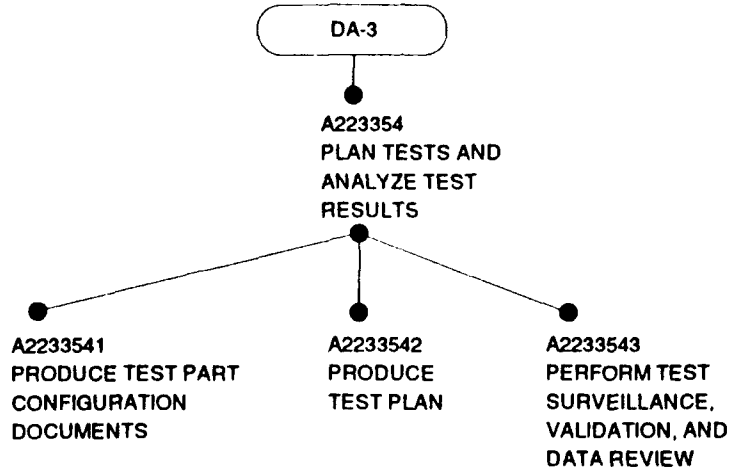

FE-1
A2233522
GENERATE FINITE
ELEMENT ANALYSIS
ENVIRONMENT
& CONTROLS
A22335221
SET AND ASSIGN
BOUNDARY CONTRAINTS
AND RELEASES
A22335222
GENERATE AND
ASSIGN LOAD SETS
AND COMBINATIONS
A22335223
GENERATE AND ASSIGN
FACTORS OF SAFETY,
DURABILITY/DAMAGE,
TOLERANCE ALLOWABLES
A22335224
GENERATE AND
ASSIGN ANALYSIS
OUTPUT CONTROL
REQUESTS
A22335225
GENERATE
ANALYSIS
PROCEDURE
CONTROLS
A223352241
REQUEST
DEFLECTION
DATA OUTPUT
A223352242
REQUEST
STRESS DATA
OUTPUT
A223352243
REQUEST
STRAIN DATA
OUTPUT
A223352244
REQUEST
INTERLAMINAR
SHEAR DATA
OUTPUT
A22335245
REQUEST
REACTION AND
INTERNAL
LOAD OUTPUT
A22335246
REQUEST
GENERATION/
OUTPUT OF
MATRICES

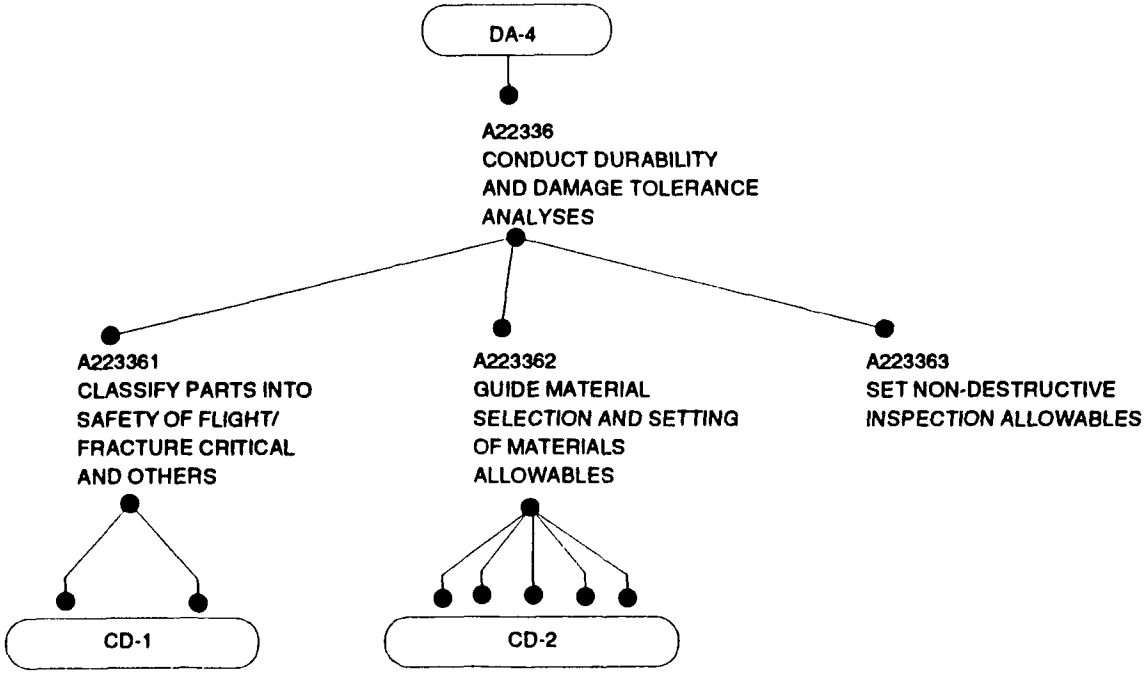

FE-2
A2233523
PERFORM FINITE
ELEMENT ANALYSIS
A22335231
PERFORM
LINEAR
ANALYSIS
A22335232
PERFORM
NONLINEAR
STABILITY
ANALYSIS
A22335233
PERFORM
NONLINEAR
MATERIAL
ANALYSIS
A22335234
PERFORM
NONLINEAR
GEOMETRY
ANALYSIS
A22335235
PERFORM
COMBINED
GEOMETRIC
AND MATERIAL
NONLINEAR
ANALYSIS

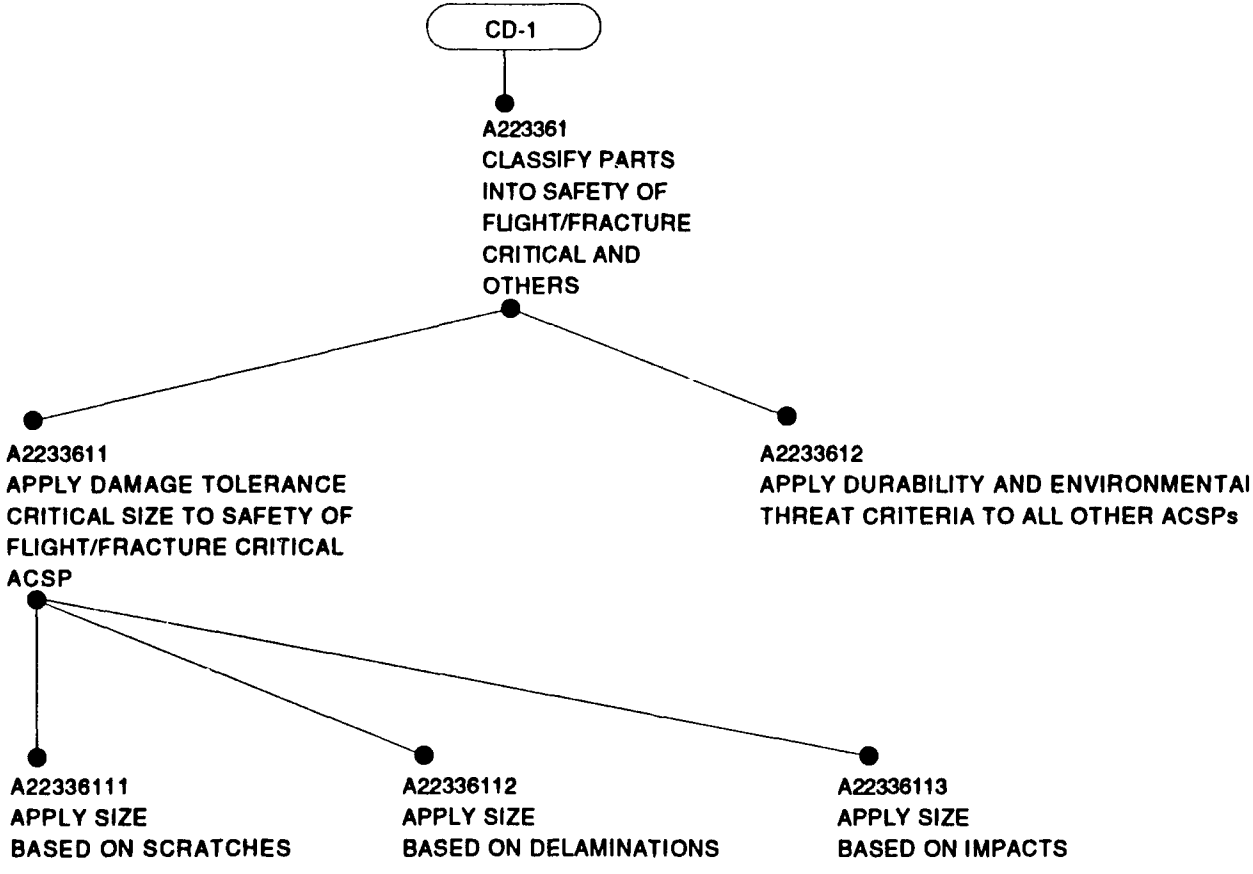

FE-3
A22335211
GENERATE
NODE GEOMETRY
A223352111
HAND GENERATE
NODE GEOMETRY
A223352112
INPUT GEOMETRY
FROM PDES/STEP
EXCHANGE FILE
A223352113
CREATE GEOMETRY
FROM EXISTING
GEOMETRY

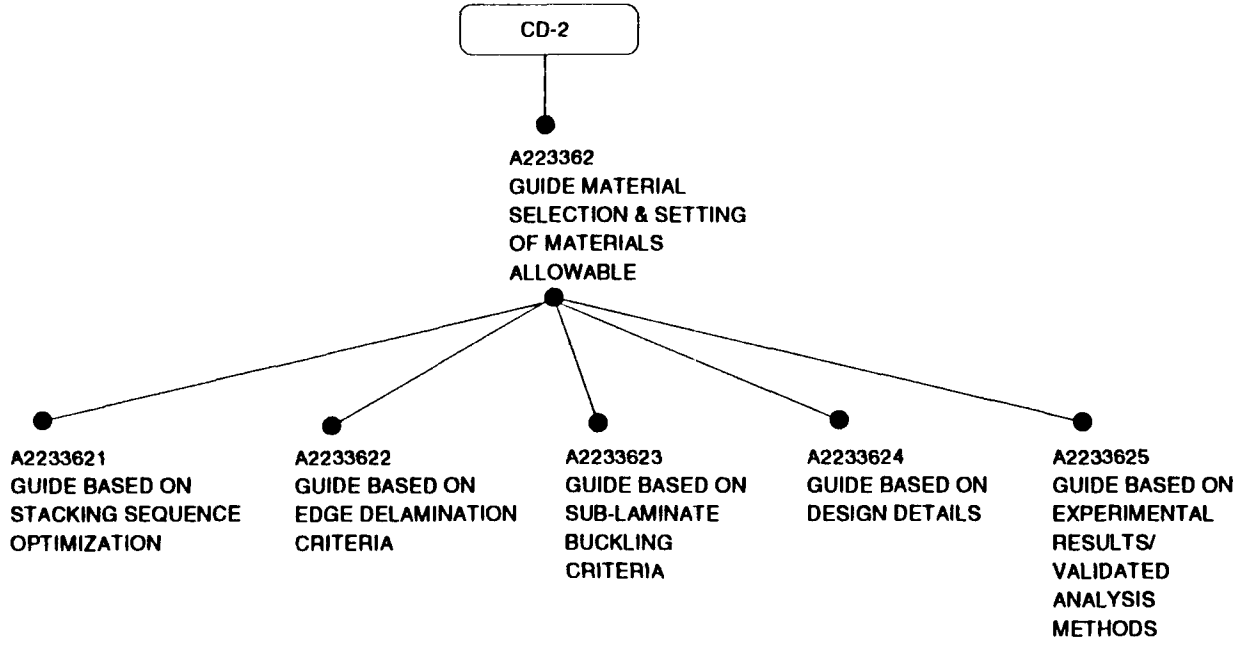

FE-4
A22335213
GENERATE AND
ASSIGN ELEMENT
ATTRIBUTES
A223352131
GENERATE AND
ASSIGN GEOMETRIC
ATTRIBUTES
A223352132
GENERATE AND
ASSIGN MATERIAL
ANGLES OR
COORDINATE
SYSTEMS
A223352133
GENERATE/IMPORT
ANS ASSIGN
MATERIAL PROPERTIES
A2233521331
IMPORT AND
ASSIGN MATERIAL
PROPERTIES FROM
PDES/STEP
EXCHANGE FILE
A2233521332
IMPORT AND
ASSIGN MATERIAL
PROPERTIES FROM
MATERIALS
DATABASE
A2233521333
GENERATE/ASSIGN
MATERIAL PROPERTIES
FROM PLY PROPERTIES,
STACKING SEQUENCE
AND ORIENTATIONS
A2233521334
INPUT AND
ASSIGN
ISOTROPIC
MATERIAL
PROPERTY
MATRICES

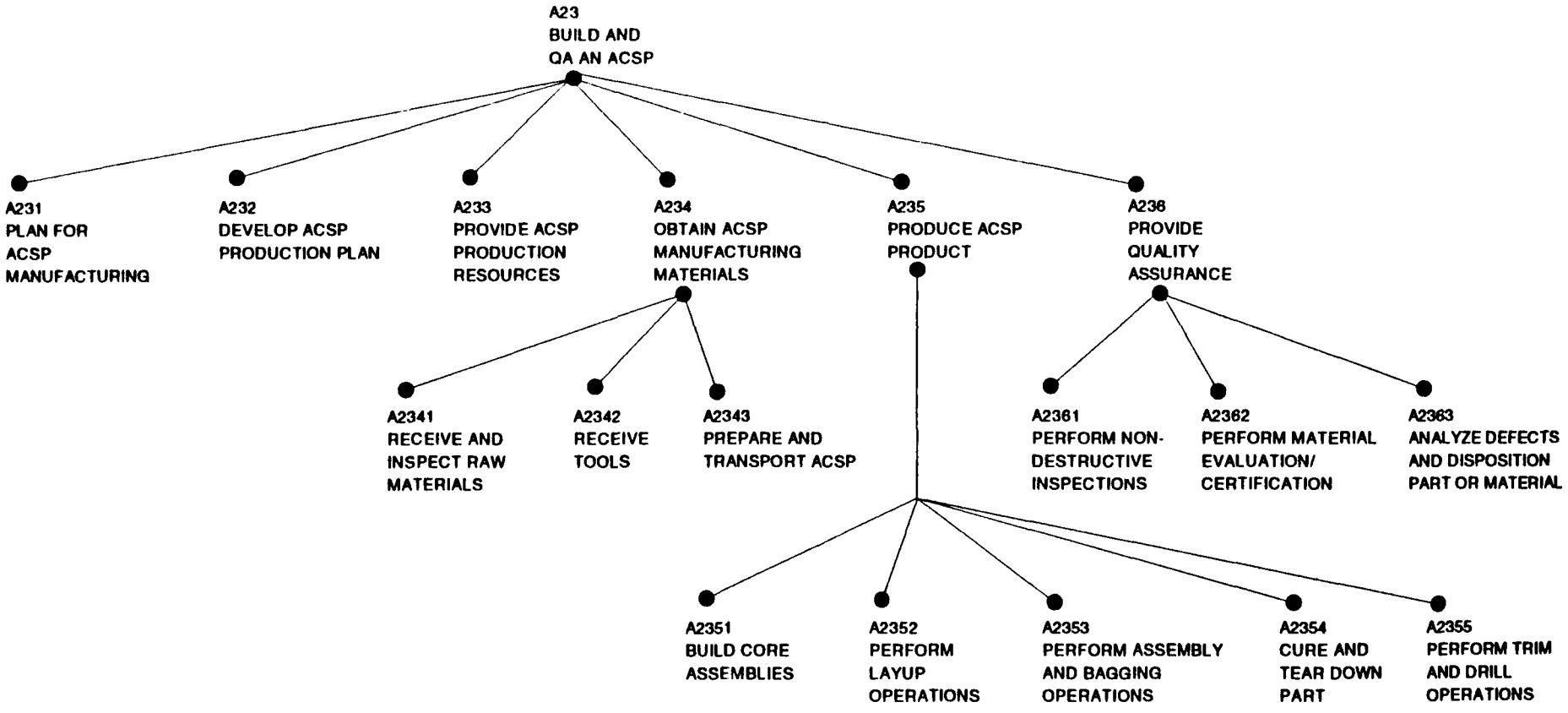

DA-2
A223353
CONDUCT DETAIL
STRESS ANALYSIS
A2233531
CONDUCT STATIC
STRENGTH ANALYSES
A2233532
CONDUCT FINE GRID
FINITE ELEMENT
ANALYSIS
A2233521
GENERATE FINE
GRID FINITE ELEMENT
MODEL FROM PART
MODEL
A2233522
APPLY LOADS/
BOUNDARY
CONDITIONS FROM
PART MODEL
A22335323
PERFORM FINITE
ELEMENT ANALYSIS
A22335324
CALCULATE MARGINS
OF SAFETY BASED
UPON GRID
ANALYSIS RESULTS
A22335311
CONDUCT COMPOSITE
BOLTED JOINT
ANALYSES
A22335312
CONDUCT COMPOSITE
FASTENER PULL-THROUGH
ANALYSES
A22335313
CONDUCT STIFFENER
PULL-OFF ANALYSES
A22335314
CONDUCT COMPOSITE
CUTOUT ANALYSES
A22335315
CONDUCT COMPOSITE
POINT STRESS
ANALYSES
A22335316
CONDUCT PANEL
BUCKLING
ANALYSES

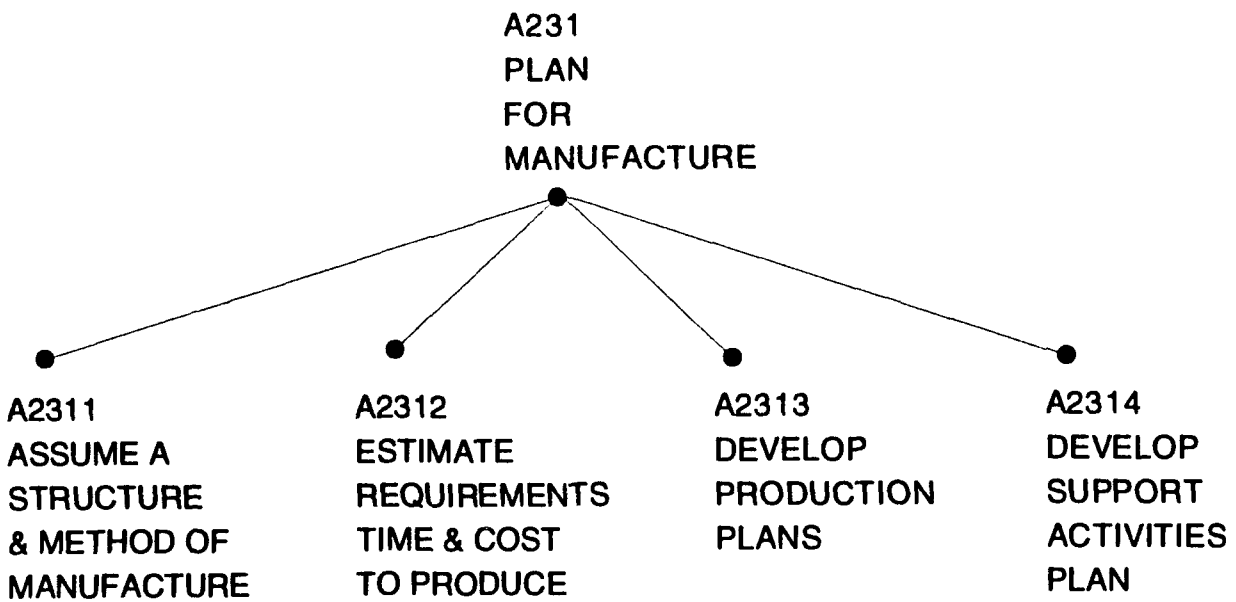

DA-3
A223354
PLAN TESTS AND
ANALYZE TEST
RESULTS
A2233541
PRODUCE TEST PART
CONFIGURATION
DOCUMENTS
A2233542
PRODUCE
TEST PLAN
A2233543
PERFORM TEST
SURVEILLANCE,
VALIDATION, AND
DATA REVIEW

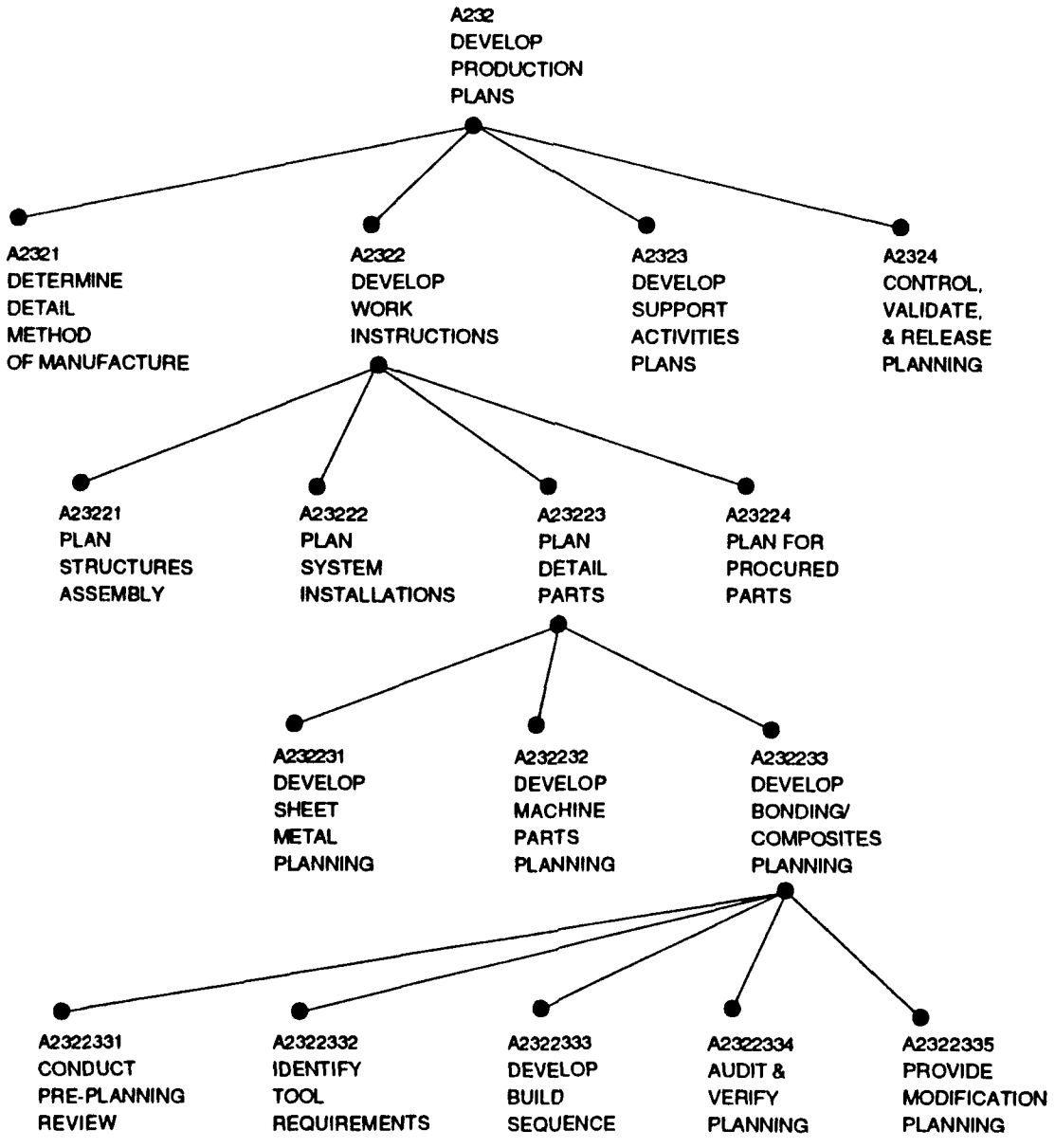

DA-4
A22336
CONDUCT DURABILITY
AND DAMAGE TOLERANCE
ANALYSES
A223361
CLASSIFY PARTS INTO
SAFETY OF FLIGHT/
FRACTURE CRITICAL
AND OTHERS
A223362
GUIDE MATERIAL
SELECTION AND SETTING
OF MATERIALS
ALLOWABLES
A223363
SET NON-DESTRUCTIVE
INSPECTION ALLOWABLES
CD-1
CD-2

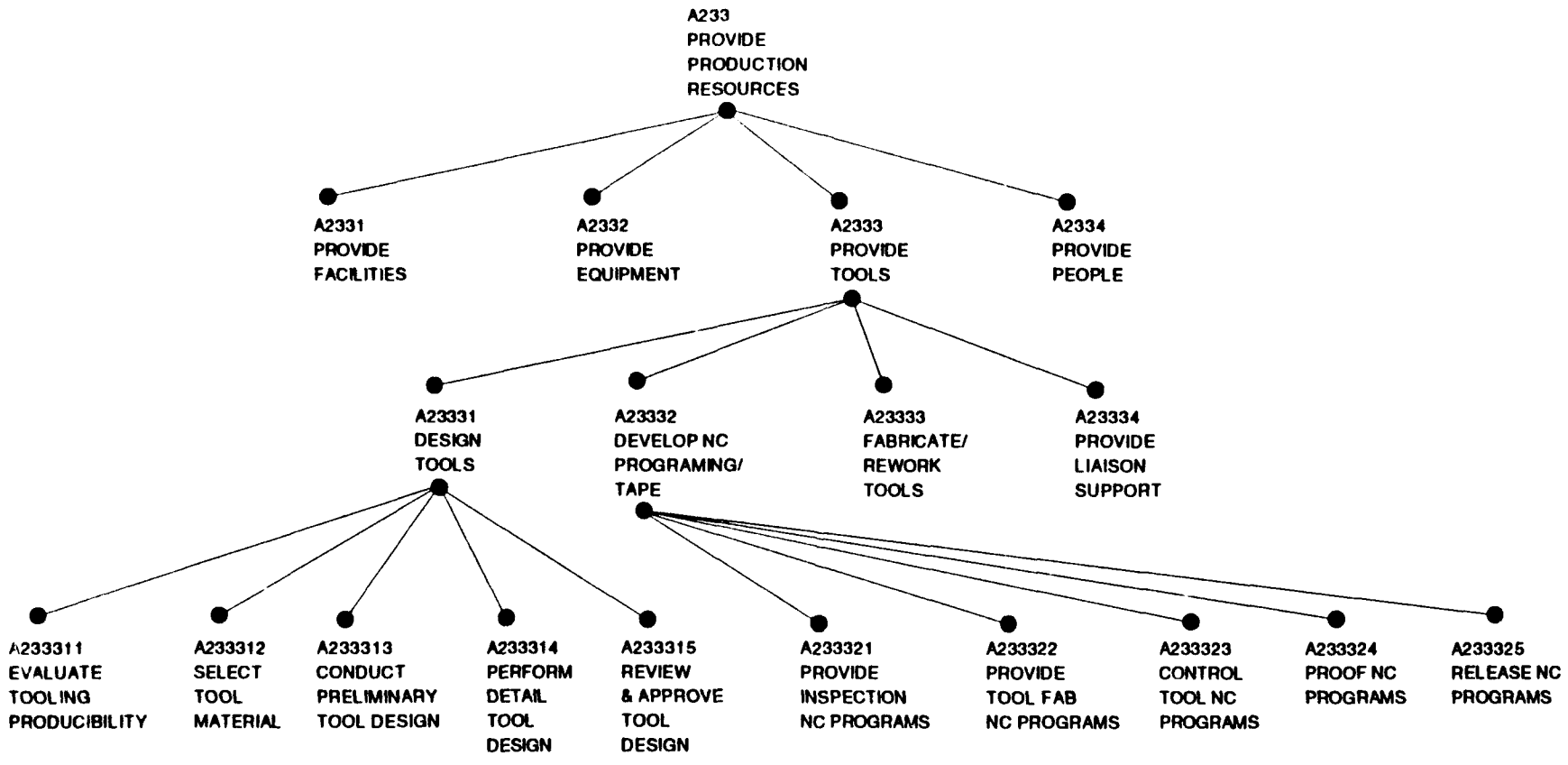

CD-1
A223361
CLASSIFY PARTS INTO SAFETY OF FLIGHT/FRACTURE CRITICAL AND OTHERS
A2233611
APPLY DAMAGE TOLERANCE CRITICAL SIZE TO SAFETY OF FLIGHT/FRACTURE CRITICAL ACSP
A2233612
APPLY DURABILITY AND ENVIRONMENTAI THREAT CRITERIA TO ALL OTHER ACSPs
A22336111
APPLY SIZE BASED ON SCRATCHES
A22336112
APPLY SIZE BASED ON DELAMINATIONS
A22336113
APPLY SIZE BASED ON IMPACTS

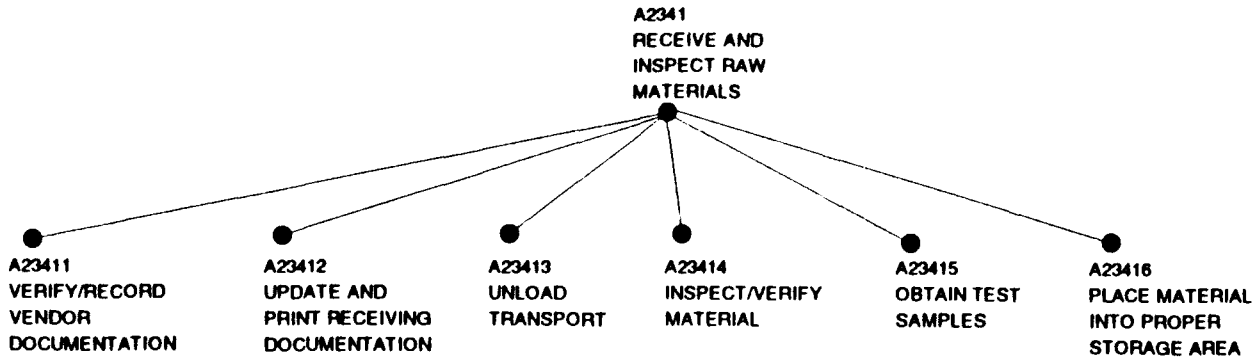

CD-2
A223362
GUIDE MATERIAL
SELECTION & SETTING
OF MATERIALS
ALLOWABLE
A2233621
GUIDE BASED ON
STACKING SEQUENCE
OPTIMIZATION
A2233622
GUIDE BASED ON
EDGE DELAMINATION
CRITERIA
A2233623
GUIDE BASED ON
SUB-LAMINATE
BUCKLING
CRITERIA
A2233624
GUIDE BASED ON
DESIGN DETAILS
A2233625
GUIDE BASED ON
EXPERIMENTAL
RESULTS/
VALIDATED
ANALYSIS
METHODS

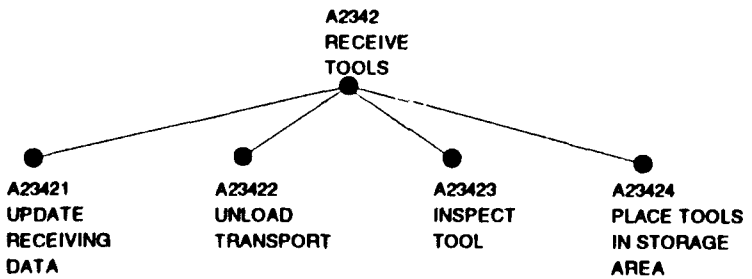

A23
BUILD AND
QA AN ACSP
A231
PLAN FOR
ACSP
MANUFACTURING
A232
DEVELOP ACSP
PRODUCTION PLAN
A233
PROVIDE ACSP
PRODUCTION
RESOURCES
A234
OBTAIN ACSP
MANUFACTURING
MATERIALS
A235
PRODUCE ACSP
PRODUCT
A236
PROVIDE
QUALITY
ASSURANCE
A2341
RECEIVE AND
INSPECT RAW
MATERIALS
A2342
RECEIVE
TOOLS
A2343
PREPARE AND
TRANSPORT ACSP
A2361
PERFORM NON-
DESTRUCTIVE
INSPECTIONS
A2362
PERFORM MATERIAL
EVALUATION/
CERTIFICATION
A2363
ANALYZE DEFECTS
AND DISPOSITION
PART OR MATERIAL
A2351
BUILD CORE
ASSEMBLIES
A2352
PERFORM
LAYUP
OPERATIONS
A2353
PERFORM ASSEMBLY
AND BAGGING
OPERATIONS
A2354
CURE AND
TEAR DOWN
PART
A2355
PERFORM TRIM
AND DRILL
OPERATIONS

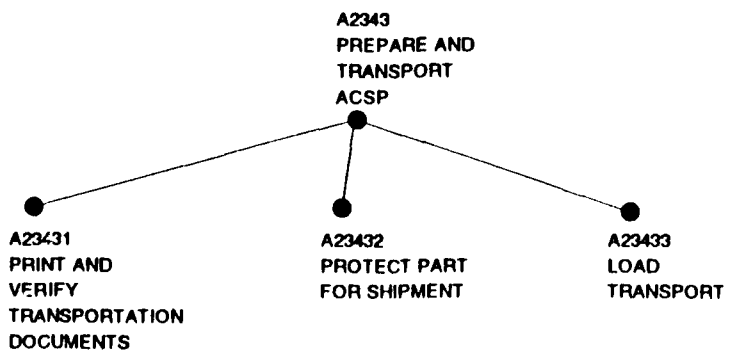

A231
PLAN
FOR
MANUFACTURE
A2311
ASSUME A
STRUCTURE
& METHOD OF
MANUFACTURE
A2312
ESTIMATE
REQUIREMENTS
TIME & COST
TO PRODUCE
A2313
DEVELOP
PRODUCTION
PLANS
A2314
DEVELOP
SUPPORT
ACTIVITIES
PLAN

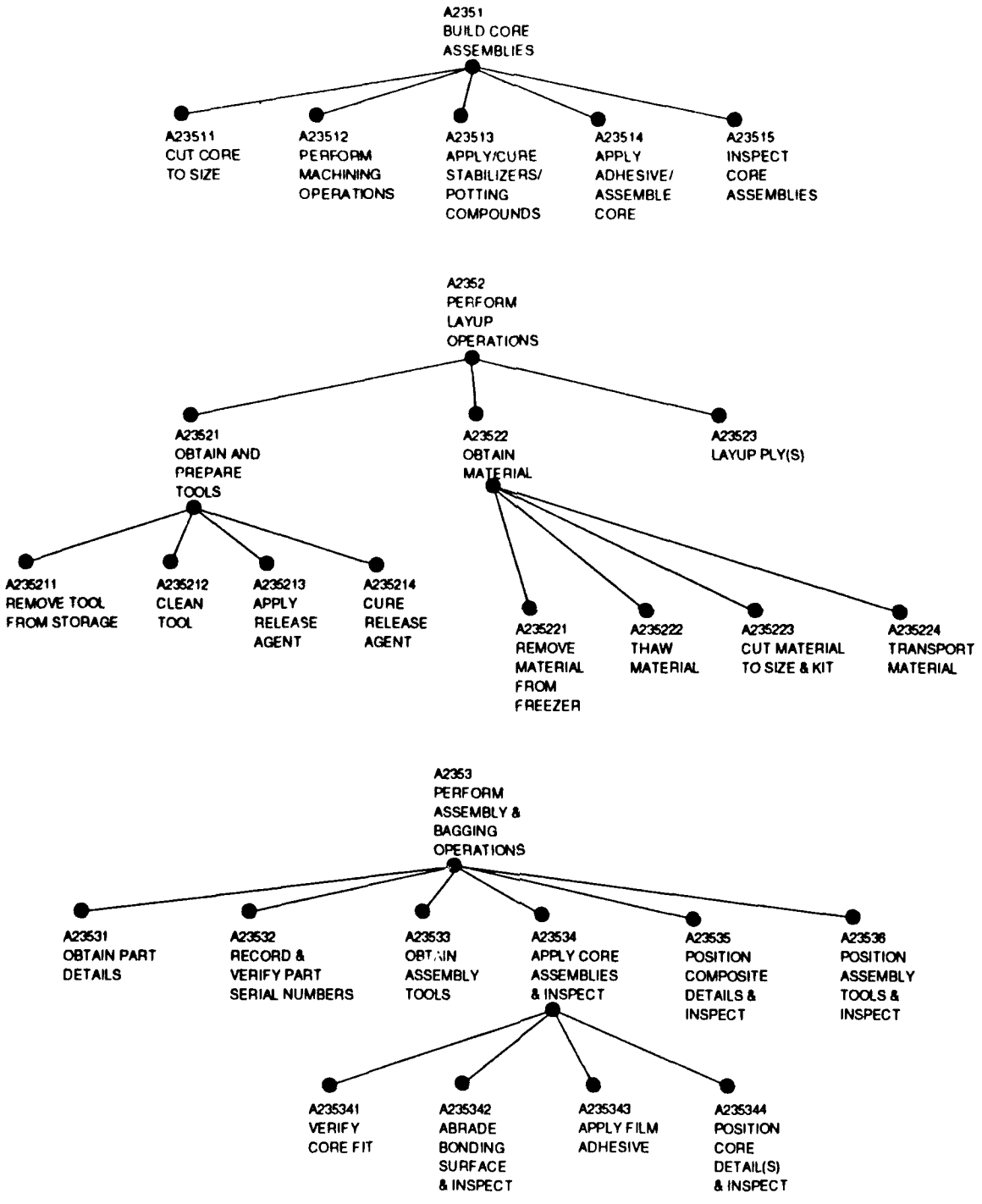

A232
DEVELOP
PRODUCTION
PLANS
A2321
DETERMINE
DETAIL
METHOD
OF MANUFACTURE
A2322
DEVELOP
WORK
INSTRUCTIONS
A2323
DEVELOP
SUPPORT
ACTIVITIES
PLANS
A2324
CONTROL,
VALIDATE,
& RELEASE
PLANNING
A23221
PLAN
STRUCTURES
ASSEMBLY
A23222
PLAN
SYSTEM
INSTALLATIONS
A23223
PLAN
DETAIL
PARTS
A23224
PLAN FOR
PROCURED
PARTS
A232231
DEVELOP
SHEET
METAL
PLANNING
A232232
DEVELOP
MACHINE
PARTS
PLANNING
A232233
DEVELOP
BONDING/
COMPOSITES
PLANNING
A2322331
CONDUCT
PRE-PLANNING
REVIEW
A2322332
IDENTIFY
TOOL
REQUIREMENTS
A2322333
DEVELOP
BUILD
SEQUENCE
A2322334
AUDIT &
VERIFY
PLANNING
A2322335
PROVIDE
MODIFICATION
PLANNING

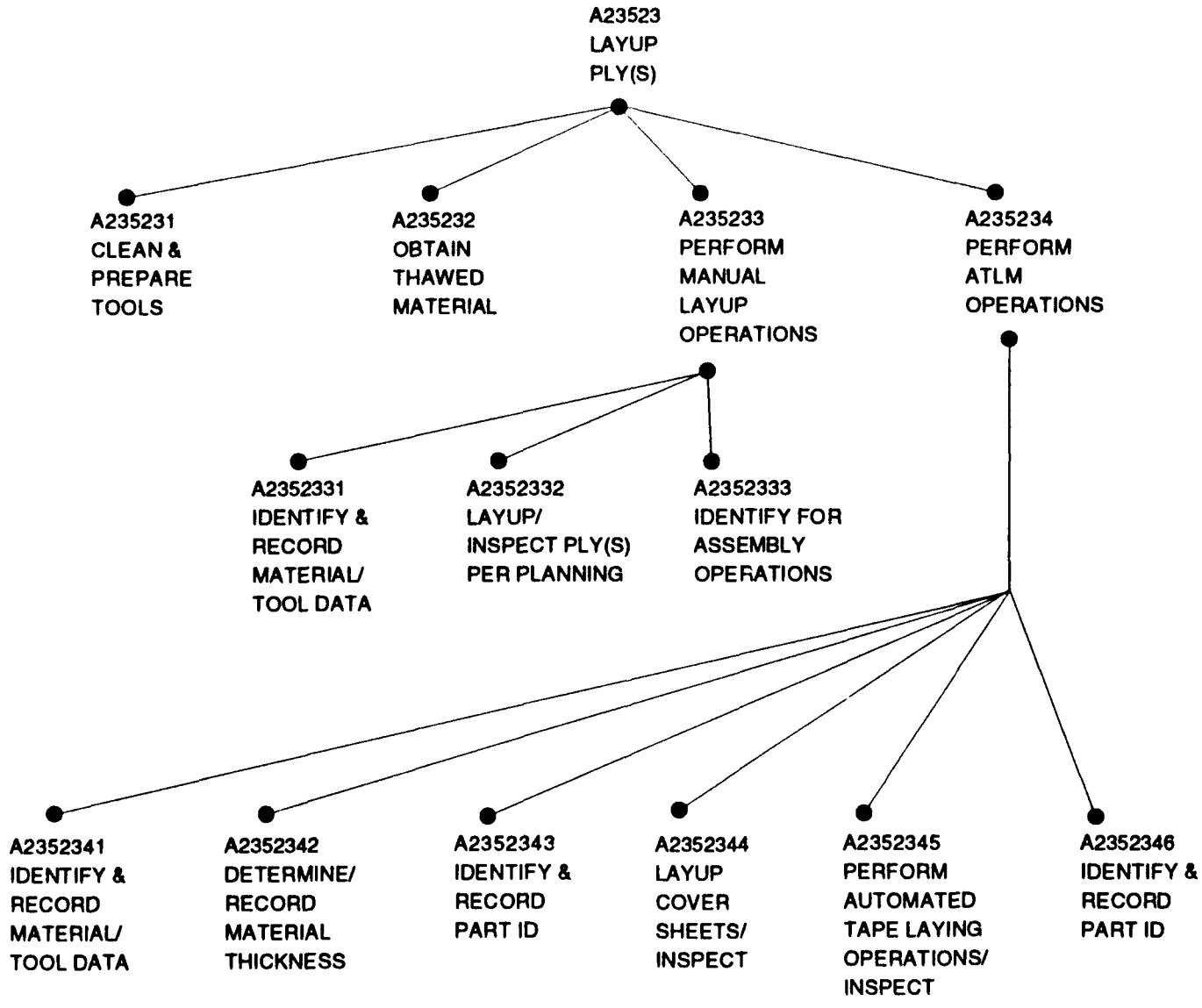

A233
PROVIDE
PRODUCTION
RESOURCES
A2331
PROVIDE
FACILITIES
A2332
PROVIDE
EQUIPMENT
A2333
PROVIDE
TOOLS
A2334
PROVIDE
PEOPLE
A23331
DESIGN
TOOLS
A23332
DEVELOP NC
PROGRAMING/
TAPE
A23333
FABRICATE/
REWORK
TOOLS
A23334
PROVIDE
LIAISON
SUPPORT
A233311
EVALUATE
TOOLING
PRODUCIBILITY
A233312
SELECT
TOOL
MATERIAL
A233313
CONDUCT
PRELIMINARY
TOOL DESIGN
A233314
PERFORM
DETAIL
TOOL
DESIGN
A233315
REVIEW
& APPROVE
TOOL
DESIGN
A233321
PROVIDE
INSPECTION
NC PROGRAMS
A233322
PROVIDE
TOOL FAB
NC PROGRAMS
A233323
CONTROL
TOOL NC
PROGRAMS
A233324
PROOF NC
PROGRAMS
A233325
RELEASE NC
PROGRAMS

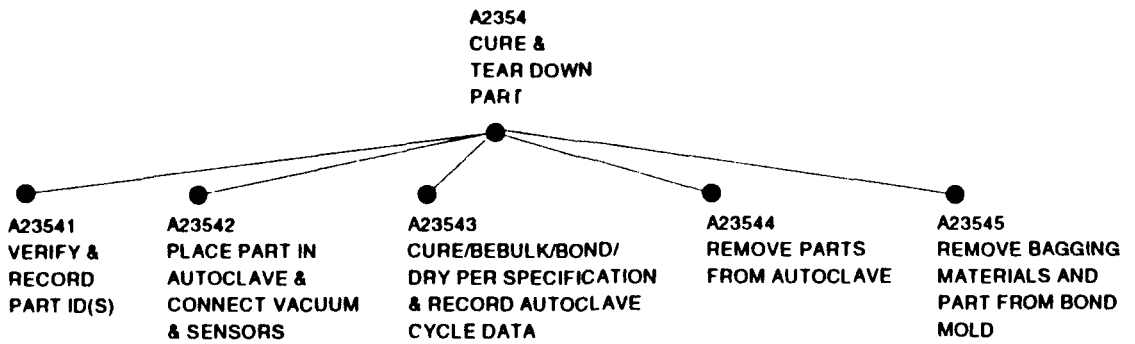

A2341
RECEIVE AND
INSPECT RAW
MATERIALS
A23411
VERIFY/RECORD
VENDOR
DOCUMENTATION
A23412
UPDATE AND
PRINT RECEIVING
DOCUMENTATION
A23413
UNLOAD
TRANSPORT
A23414
INSPECT/VERIFY
MATERIAL
A23415
OBTAIN TEST
SAMPLES
A23416
PLACE MATERIAL
INTO PROPER
STORAGE AREA

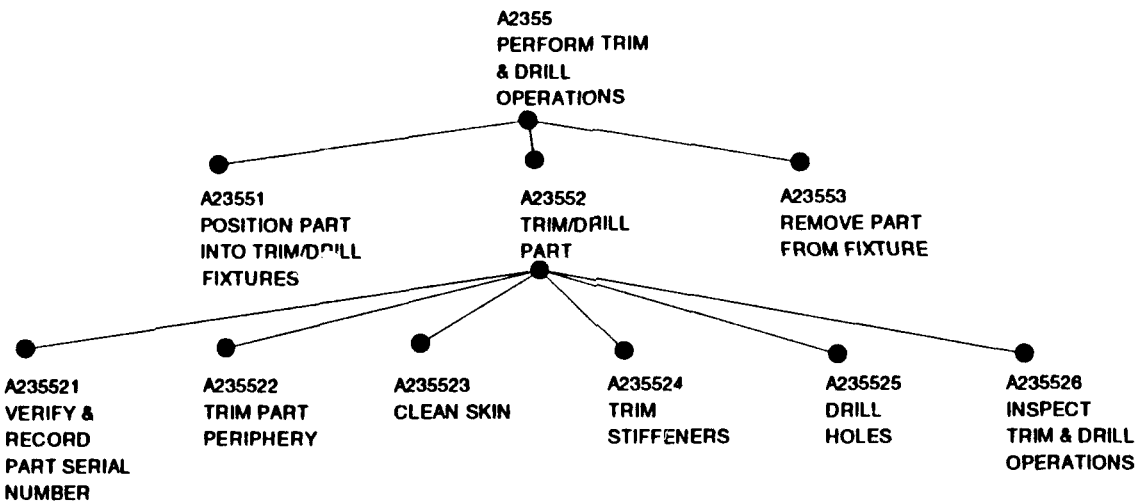

A2342
RECEIVE
TOOLS
A23421
UPDATE
RECEIVING
DATA
A23422
UNLOAD
TRANSPORT
A23423
INSPECT
TOOL
A23424
PLACE TOOLS
IN STORAGE
AREA

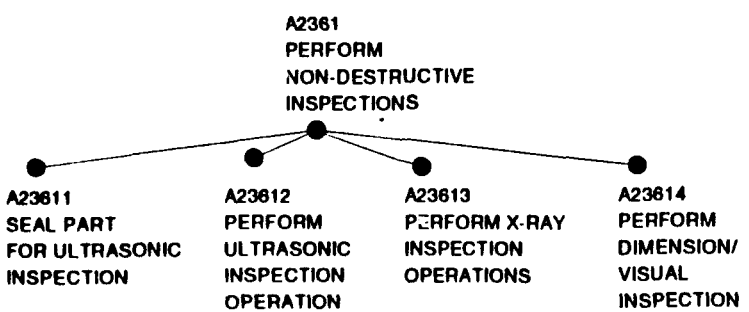

A2343
PREPARE AND
TRANSPORT
ACSP
A23431
PRINT AND
VERIFY
TRANSPORTATION
DOCUMENTS
A23432
PROTECT PART
FOR SHIPMENT
A23433
LOAD
TRANSPORT

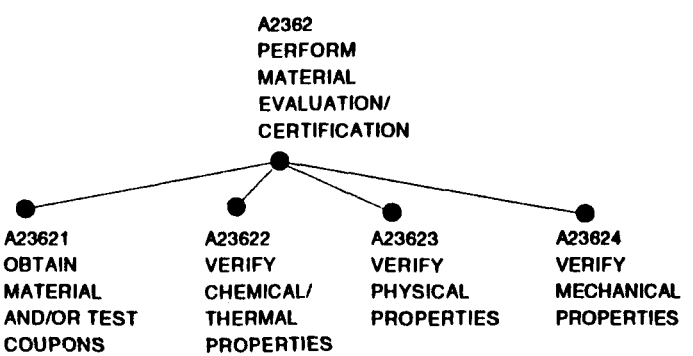

A2351
BUILD CORE
ASSEMBLIES
A23511
CUT CORE
TO SIZE
A23512
PERFORM
MACHINING
OPERATIONS
A23513
APPLY/CURE
STABILIZERS/
POTTING
COMPOUNDS
A23514
APPLY
ADHESIVE/
ASSEMBLE
CORE
A23515
INSPECT
CORE
ASSEMBLIES
A2352
PERFORM
LAYUP
OPERATIONS
A23521
OBTAIN AND
PREPARE
TOOLS
A23522
OBTAIN
MATERIAL
A23523
LAYUP PLY(S)
A235211
REMOVE TOOL
FROM STORAGE
A235212
CLEAN
TOOL
A235213
APPLY
RELEASE
AGENT
A235214
CURE
RELEASE
AGENT
A235221
REMOVE
MATERIAL
FROM
FREEZER
A235222
THAW
MATERIAL
A235223
CUT MATERIAL
TO SIZE & KIT
A235224
TRANSPORT
MATERIAL
A2353
PERFORM
ASSEMBLY &
BAGGING
OPERATIONS
A23531
OBTAIN PART
DETAILS
A23532
RECORD &
VERIFY PART
SERIAL NUMBERS
A23533
OBTAIN
ASSEMBLY
TOOLS
A23534
APPLY CORE
ASSEMBLIES
& INSPECT
A23535
POSITION
COMPOSITE
DETAILS &
INSPECT
A23536
POSITION
ASSEMBLY
TOOLS &
INSPECT
A235341
VERIFY
CORE FIT
A235342
ABRADE
BONDING
SURFACE
& INSPECT
A235343
APPLY FILM
ADHESIVE
A235344
POSITION
CORE
DETAIL(S)
& INSPECT


A23523
LAYUP
PLY(S)
A235231
CLEAN &
PREPARE
TOOLS
A235232
OBTAIN
THAWED
MATERIAL
A235233
PERFORM
MANUAL
LAYUP
OPERATIONS
A235234
PERFORM
ATLM
OPERATIONS
A2352331
IDENTIFY &
RECORD
MATERIAL/
TOOL DATA
A2352332
LAYUP/
INSPECT PLY(S)
PER PLANNING
A2352333
IDENTIFY FOR
ASSEMBLY
OPERATIONS
A2352341
IDENTIFY &
RECORD
MATERIAL/
TOOL DATA
A2352342
DETERMINE/
RECORD
MATERIAL
THICKNESS
A2352343
IDENTIFY &
RECORD
PART ID
A2352344
LAYUP
COVER
SHEETS/
INSPECT
A2352345
PERFORM
AUTOMATED
TAPE LAYING
OPERATIONS/
INSPECT
A2352346
IDENTIFY &
RECORD
PART ID


A2354
CURE &
TEAR DOWN
PART
A23541
VERIFY &
RECORD
PART ID(S)
A23542
PLACE PART IN
AUTOCLAVE &
CONNECT VACUUM
& SENSORS
A23543
CURE/DEBULK/BOND/
DRY PER SPECIFICATION
& RECORD AUTOCLAVE
CYCLE DATA
A23544
REMOVE PARTS
FROM AUTOCLAVE
A23545
REMOVE BAGGING
MATERIALS AND
PART FROM BOND
MOLD


A2355
PERFORM TRIM
& DRILL
OPERATIONS
A23551
POSITION PART
INTO TRIM/DRILL
FIXTURES
A23552
TRIM/DRILL
PART
A23553
REMOVE PART
FROM FIXTURE
A235521
VERIFY &
RECORD
PART SERIAL
NUMBER
A235522
TRIM PART
PERIPHERY
A235523
CLEAN SKIN
A235524
TRIM
STIFFENERS
A235525
DRILL
HOLES
A235526
INSPECT
TRIM & DRILL
OPERATIONS


A2361
PERFORM
NON-DESTRUCTIVE
INSPECTIONS
A23611
SEAL PART
FOR ULTRASONIC
INSPECTION
A23612
PERFORM
ULTRASONIC
INSPECTION
OPERATION
A23613
PERFORM X-RAY
INSPECTION
OPERATIONS
A23614
PERFORM
DIMENSION/
VISUAL
INSPECTION


A2362
PERFORM
MATERIAL
EVALUATION/
CERTIFICATION
A23621
OBTAIN
MATERIAL
AND/OR TEST
COUPONS
A23622
VERIFY
CHEMICAL/
THERMAL
PROPERTIES
A23623
VERIFY
PHYSICAL
PROPERTIES
A23624
VERIFY
MECHANICAL
PROPERTIES

2.3.3 Functional Activity Definitions

A0 Procure, Build, & Use an Aircraft Composite Structural Part (ACSP)

This activity covers the entire life-cycle of an ACSP as viewed from the combined activity groupings of the DoD needs analysis and procurement, Aerospace contractors, DoD's use and maintenance, and the raw material suppliers.

A1 Develop ACSP Needs & Procurement

This activity is the DoD Analysis of the ACSP needs based on the departments force structure needs and the state of ACSP technologies, along with the procurement process throughout the life cycle as managed at DoD level.

A2 Manage, Design, Build, & Support an Aircraft Composite Structural Part (ACSP)

This activity consists of all the contracted management of resources, design, build, and support of a typical ACSP,as done at the prime contracting Aerospace Company.

A21 Manage ACSP Integrated Product Development (IPD)

This activity involves managing all of the resources specific to a ACSP through the design, build, and support functions. This includes people, budgets, tools, materials, etc.

A22 Design & Analyze an ACSP

This activity involves the complete design and analysis life-cycle of the ACSP from the pre-proposal phase to product support in the field, as supported by the design function.

A221 Collect, Review, Define, & Distribute ACSP Requirements

All of the requirements generated through the various phases of ACSP product development, are collected, reviewed, defined, and distributed by the design function. These include the build and product support requirements along with other engineering functions such as electrical, hydraulic, etc.

A222 Perform ACSP Preliminary Design & Analyses

This activity involves developing several feasible ACSP design concepts, then performing trade studies to select the optimum concept to recommend for further development.

A2221 Prepare Preliminary ACSP Design

Develop feasible design concepts based on the various preliminary functional requirements for an ACSP. Develop the concepts to the detail necessary for Preliminary Design Reviews (PDR).

A2222 Conduct Preliminary ACSP Analyses

Conduct preliminary analyses to support the conceptual design function. Provide analytical support of the review of design data such as layouts and materials, the conduct baseline and trade studies and the definition of design criteria.

A22221 Review Design Data

Review conceptual layouts and geometry for structural adequacy and load paths.

A222211 Review Layouts

Review conceptual structural layouts for adequate load paths and feasibility.

A2222111 Review Geometry

Review conceptual geometry such as plies, stiffeners and cutouts for structural adequacy.

A2222112 Review Sizes

Review sizes such as thicknesses, total number of plies, and stiffener geometry for structural adequacy.

A2222113 Obtain Initial Weights and Balances

Apply computational and parametric weight estimation tools to estimate initial weights and the resulting balance.

A222212 Review Material Selections

Survey appropriate materials with the aim of selecting a composite or homogeneous material considering available data and performing tests as necessary.

A2222121 Select Composite or Homogeneous Material

Use weight, cost and structural performance criteria to select a composite or homogeneous material.

A2222122 Screen Available Materials

Use cost and structural performance criteria to screen available materials.

A2222123 Collect Existing Data

Collect existing data needed to support baseline and trade analyses, and the definition of design criteria.

A2222124 Define Development Program

Define a material development and test program to collect the materials data that is not already in existence.

A2222125 Collect Test Data

Perform a development and test program to collect the materials data that is not already in existence.

A2222126 Create Analysis Materials Property Database

Create the information structure for an Analysis Materials Property Database, and supporting software as necessary. Load the new and existing collected materials test data into the database.

A222213 Conduct Baseline Analyses

Conduct analyses of the initial conceptual configuration to provide a starting point for trade study analyses.

A2222131 Define Critical Dimensions

Use the results of the initial analyses to define the critical structural dimensions to provide adequate structural performance and margins of safety.

A2222132 Define Structural Configuration

Use the results of the initial analyses to define structural thicknesses and potential stiffeners.

A22221321 Define Initial Ply Orientations

Use the results of initial analyses to define the ply orientations.

A22221322 Define Initial Ply Distributions

Use the results of initial analyses to define the ply distributions.

A22221323 Define Initial Stiffener Geometry

Use the results of initial analyses to decide if stiffeners are required. If stiffeners are required, select the stiffener geometry.

A22221324 Define Initial Stiffener Orientation

Use the results of initial analyses to decide if stiffeners are required. If stiffeners are required, select the stiffener orientation.

A22221325 Define Initial Stiffener Distribution

Use the results of initial analyses to decide if stiffeners are required. If stiffeners are required, select the stiffener distribution.

A222214 Conduct Trade Study Analyses

Use the baseline structural configuration as a starting point for analytical optimization of critical dimensions and structural configurations subject to structural performance, cost and margin of safety constraints.

A2222141 Optimize Critical Dimensions

Perform analyses to optimize the critical dimensions of structural components.

A2222142 Optimize Structural Configuration

Perform analyses to optimize ply orientations and distributions, and stiffeners.

A22221421 Optimize Initial Ply Orientations

Perform analyses to optimize the ply orientations of the structural configuration.

A22221422 Optimize Initial Ply Distributions

Perform analyses to optimize the ply distributions of the structural configuration.

A22221423 Optimize Initial Stiffener Geometry

Perform analyses to optimize the stiffener geometry.

A22221424 Optimize Initial Stiffener Orientations

Perform analyses to optimize the stiffener orientations.

A22221425 Optimize Initial Stiffener Distribution

Perform analyses to optimize the stiffener distribution.

A2222143 Support Design Trades

Provide analyses to provide data to support design tradeoffs. An analysis of a part with a different stiffener distribution would be a typical task.

A22222 Define Design Criteria

Use the SOW specifications, expected environments and structural limits to define design criteria.

A222221 Review SOW Specifications

Review SOW requirements for clarity, completeness and sensibility.

A222222 Select Environments

Using SOW requirements and engineering judgement select the environmental criteria.

A222223 Select Limits

Using SOW (Statement of Work) requirements and engineering judgement select the design limits.

A2223 Select Optimum ACSP Design

Perform the necessary interdisciplinary studies on the candidate ACSP configurations to meet the desired performance, producibility and environment analyses. Select the best concept for prototyping and further refinement in the design activity.

A2224 Develop ACSP Prototype

Develop the design detail necessary for the fabrication of prototypes for substantiation of the preliminary design concept. Develop the test requirements to be used in the testing of the prototypes.

A223 Perform ACSP Detail Design & Analyses

Define & analyze every composite item used in this ACSP in its entirety, such that the data can be used to meet all downstream needs build/support functions and satisfy the approval performance requirements.

A2231 Obtain Detail ACSP Composite M&P (Materials & Processes) Data

Obtain information on the specific composite materials and processes to be used on the ACSP. Resolve material compatibility issues.

A2232 Create Detail ACSP Design

This is the creation of the ACSP detail data set which is a combination of geometry, parts lists and engineering notes.

A22321 Collect Baseline ACSP Design Data

The baseline ACSP, as created in the preliminary design and analyses trade studies, is selected for further detailing.

A22322 Build ACSP model/drawing tree

A model/drawing tree is developed for the ACSP, which specifies all the combinations of composite items used to create this part.

A22323 Prepare ACSP models & drawings

This the preparation of the ACSP models and drawings using the various automated tool sets.

A223231 Select ACSP model/drafting system

This activity involves the selection of the automated CAD tool set that best meets the design requirements of the ACSP.

A223232 Create ACSP geometry models

All of the geometry necessary to portray the ACSP is created in the form of models with the ability to show different views.

A223233 Create ACSP drawings

All of the drawings necessary to communicate the composite items of the ACSP are created.

A2232331 Create ACSP tooling interface drawings

All of the IML (Inner Mold Line) or OML (Outer Mold Line) tool interfaces to the ACSP are shown in the form of envelope drawings.

A2232332 Prepare detail ACSP component drawings

All of the detail drawings of the components within the ACSP are prepared.

A22323321 Select ACSP views

The ACSP views of the ACSP model are selected. They include a set of top, front, side, cross-sections, and views.

A22323322 Prepare ACSP detail views

The ACSP views selected are now detailed with dimension and notes that are necessary for the downstream build function.

A22323323 Prepare ACSP composite item details

All of the composite items that make up the ACSP are detailed in drawings. These include skins, stiffeners, fillers, core and the various combinations of these.

A223233231 Prepare ACSP skin design

Prepare all the design data necessary for the ACSP's skin. This activity will be tailoring the laminate design process to meet the basic constraints of a skin and/or those of the interfaces to stiffeners, fillers, and core type composite items.

A2232332311 Resolve ACSP skin interfaces and joints

Resolve skin interfaces and joints interfaces to other parts and any mechanical joints. Look at space constraints, attachment issues, and material compatibility.

A2232332312 Resolve ACSP skin size panel issues

Resolve all of the size issues regarding the skin, due to the tooling constraints and general laminate design rules.

A2232332313 Create ACSP skin detail drawings

Create all the ACSP skin detail drawings which includes all the skin's composite items, lay-up details, and the pertinent engineering composites notes.

A22323323131 Review ACSP skin manufacturing process issues

Review and resolve all of the manufacturing issues of the skin which involves the lay-up, tooling and inspection issues.

A22323323132 Resolve ACSP skin periphery constraints

Resolve all the skin's part periphery constraints due to the tooling, other part interfaces and skin edge parameters.

A22323323133 Resolve ACSP skin target layup orientation

Resolve all the skin's target layup orientation of the plies based on the design rules established for % 0,45, 90 on the subject area.

A22323323134 Resolve ACSP skin target thickness

Resolve the skin thickness target based on interfaces to other parts, or tooling constraints, which dictate a minimum gauge that may exceed the load requirements.

A22323323135 Determine ACSP Skin Ply Counts

Determine the skin's ply counts based on the guidelines established, due to the target lay-up orientations and target thickness.

A22323323136 Produce ACSP Skin Ply Stack-Up

Produce the ACSP's skin ply stack-up which shows the ply sequence, ply tables, and the specific ply periphery details.

A223233231361 Resolve ACSP Skin Ply Sequence

Resolve the ACSP's skin ply sequence by showing the laminate layer in the order of build-up from an IML or OML tool.

A223233231362 Create ACSP Skin Ply Tables

Create a ply table which denotes each ply's orientation and associated engineering composites notes.

A2232332313621 Attach ACSP Skin Part Numbers

A2232332313622 Attach ACSP Skin Ply Numbers

A2232332313623 Attach ACSP Skin Material Flagnote

A2232332313624 Attach ACSP Skin Fiber Orientation

A2232332313625 Attach ACSP Skin Splice Flagnote

A2232332313626 Attach ACSP Skin Revision Letter

A223233231363 Develop ACSP Skin Ply Periphery

Develop the ACSP's skin ply periphery based on tooling constraints in the basic areas and at the edges, and the geometrical interfaces to other part structures (stiffeners, cone, sub assemblies, etc.).

A223233231364 Attach ACSP skin ply call-outs

Attach the ply callouts to each ply in the ACSP's skin drawing, by associating a P# to each of the laminate plies.

A223233232 Prepare ACSP stiffener design

Based on the design requirements of the ACSP stiffener, prepare a design of a composite laminate that is shaped and separately or integrally bonded with a skin laminate.

A223233233 Prepare ACSP Filler Design

Based on the design requirements of the ACSP composite assembly, prepare a design of a composite filler that is shaped to fill a small area within a composite assembly.

A223233234 Prepare ACSP core design

Design the ACSP core based on the performance loads, manufacturing constraints and the other structural or non-structural interfaces.

A2232332341 Resolve ACSP Core Interfaces and Joints

Develop the interface details at the core to meet the requirements of the laminate skins, pad-ups, holes, recesses and other mating sub-assemblies.

A2232332342 Resolve ACSP Core Panel Size Issues

Resolve all of the ACSP core size issues due to the tooling, weight and density constraints that may necessitate splicing pieces together.

A2232332343 Create ACSP Core Detail Drawing

Create all the core detail drawings which includes details of the core envelope, material features, ribbon direction and core/skin interfaces.

A22323323431 Collect and lay-out ACSP's Core Geometry

Collect all the necessary geometry inputs necessary to lay out the core in a core stiffened part.

A22323323432 Maximize ACSP's Core Periphery

Maximize the core periphery based on its edge band parameters and interface to surrounding structure or non-structural parts.

A223233234321 Resolve Core Edge Band Issues

Resolve the core edge band to meet the edge margin of fasteners, clearance for the core layup/placement process and the necessary dimensional tolerances of the core, like surface flatness.

A223233234322 Integrate Interface Parameters

Integrate in the interfaces to the core at core periphery, such as surrounding structure.

A22323323433 Design ACSP's Core Thickness Density and Material Features

Design the core thickness and density to meet the weight and stress loads, along with meeting the minimum manufacturing process constraints.

A22323323434 Design ACSP's Core Transition Area

Design the core transition area to resolve the core top and bottom ramp radius along with the ramp angle.

A223233234341 Resolve Core Top Ramp Radius Parameters

Resolve the requirements necessary for the core top's ramp radius. This is dictated by manufacturing constraints of the core and its interface to the plies that are wrapped at the top.

A223233234342 Resolve Core Bottom Ramp Radius Parameters

Resolve the requirements necessary for the cone bottom's ramp radius. This is dictated by manufacturing constraints in the core and its interface to the plies wrap angle at the bottom.

A223233234343 Assess Ramp Angle Parameters

This is the design of the core's ramp angle based on loads and manufacturing process.

A22323323435 Design ACSP's Core Ribbon Direction

Design the core's ribbon direction to take advantage of the load paths due to bending or axial loads.

A22323323436 Design ACSP's Core/Skin Interfaces

Design all the core/skin interfaces necessary for the core stiffened part. This includes the adhesives, vapor barrier, pad-ups, holes, recesses and filler plies.

A223233234361 Collect ACSP's Core and Skin Details

Collect the core and skin details as developed on the respective drawings.

A223233234362 Resolve ACSP's Core Adhesive Designs

Attach the necessary adhesive layers between the core and skin to meet the requirements.

A223233234363 Resolve ACSP's Vapor Barrier Designs

Add adhesive systems with vapor barrier or add an additional tedlar layer as required by the environment.

A223233234364 Design ACSP's Item Locations for Core, Skins, Pad-Ups, Recesses, and Holes

Design in the location on the core assembly for all the items such as core, skins, pad-ups, recesses (ply drop off) and holes.

A223233234365 Attach ACSP's Filler Plies in Transition Areas

Attach filler plies in core periphery area in order to meet the target envelope, smooth transition and a solid laminate to eliminate voids. Due to the thin edges on a cast core, manufacturing takes the necessary measures to smooth that area.

A223233235 Integrate ACSP Composite Items

Integrate the ACSP composite item details to arrive at an ACSP based on the integration requirements.

A22323324 Attach ACSP dimensions and tolerances

This is the attachment of all the necessary dimensions and tolerances needed to meet the design objectives of the ACSP.

A22323325 Attach ACSP composites engineering notes

All of the composite specific engineering notes for the ACSP are attached. This included process specifications, change notes, material callouts, etc.

A22323326 Prepare & coordinate signature process

All of the responsible reviewers of the drawing, as noted in the signature block, are coordinated for their specific functional reviews then signature.

A2232333 Prepare & release ACSP EAMR's

All of the ACSP Engineering Advanced Material requests are prepared and released, so the material necessary for the build cycle will be on dock.

A2232334 Prepare ACSP composites assembly drawings

Assembly drawings showing the assembled composite items of the ACSP are prepared.

A2232335 Prepare ACSP installation drawings

All of the other sub-assemblies or assemblies that the ACSP is used on is drawn upon specific installation drawings. The installation process of the ACSP on other parts is shown here.

A223234 Update ACSP drawings & models

All of the design changes that come after the first ACSP drawing and model release are incorporated based on Drawing Change Notices.Changes before formal release are also made during the product development team process.

A22324 Build ACSP parts list

This is the parts list that makes up the ACSP and is associated to the released ACSP drawings.

A22325 Perform ACSP CDR functions

This activity involves an internal functional review and followed by the customer's critical design review of the detail design of the ACSP.

A2233 Conduct Detail ACSP Analyses

This activity involves all of the necessary static, dynamic, thermal, and mass property analyses required for the ACSP.

A22331 Conduct Static Loads Analyses

Conduct analyses to calculate the all types of loading, such as aerodynamic, inertial, etc. This activity is not detailed as there is no specialized composite application.

A22332 Conduct Thermal Analyses

Conduct analyses to calculate thermal loads from such sources as aerodynamic heating and engine waste heat. This activity is not detailed as it is not applicable to the selected part family.

A22333 Conduct Dynamic Analyses

Conduct analyses to evaluate the dynamic response of the structural part. This activity is not detailed as it is not applicable to the selected part family.

A22334 Conduct Mass Properties Analyses

Conduct analyses to evaluate the total weight and mass distribution of the structural part. This activity is not detailed as there is no specialized composite application..

A22335 Conduct Static Stress Analyses

Stress analysis is a contractual requirement for ACSP structures to insure the integrity of the airframe during usage within operational limits.

A223351 Conduct Handbook Analyses

Conduct static stress analyses using handbook formulas, calculator, pen and paper.

A223352 Conduct Finite Element Analyses (FEA)

Conduct static stress analysis using Finite Element Analysis techniques on digital computers.

A2233521 Generate Finite Element Models

Generate a discrete geometric approximation of the structural part. Generate and assign elemental connectivity, geometric and material attributes. Set boundary conditions and generate and assign the loading environment. Generate the directives necessary to control the analyses and resulting output.

A22335211 Generate Node Geometry

Discretize the surface or volume of the structural part by creating point geometry identical or related to the structural part geometry. Placement of the nodes on or within the structural part is governed by the fineness of the mesh needed to discretize the deflection and strain fields of the structural part under the applied loading environment.

A223352111 Hand Generate Node Geometry

Generate node geometry by measuring parts, scaling drawings, or freehand and hand input the nodal coordinate data into a computer disk file.

A223352112 Input Geometry from PDES/STEP Exchange File

Import geometry from a PDES/STEP file into a Finite Element mesh creation and editing program. Nodal geometry is then created from the computer representation of the structural part.

A223352113 Create Geometry from Existing Geometry

Nodal geometry is created from the existing computer representation of the structural part.

A22335212 Generate and Assign Element Connectivities

Connect element to corner, mid-edge, mid-face and mid-volume nodes to approximate the continuum of the structural part.

A22335213 Generate and Assign Element Attributes

Generate and assign element geometrical, material and ply related attributes.

A223352131 Generate and Assign Geometric Attributes

Generate and assign element geometric attributes such as thicknesses for surface elements, and areas and cross-section dimensions for curve elements.

A223352132 Generate and Assign Material Orientation Angles or Coordinate Systems

Generate and assign material orientation angles by relating elements to coordinate systems, or by individual calculations. Alternatively a material direction may be assigned to a coordinate system reference.

A223352133 Generate/Import and Assign Material Properties

Either generate, import or retrieve from a database material properties and assign them to appropriate elements.

A2233521331 Import and Assign Material Properties from PDES/STEP Exchange File

Import material properties from a PDES/STEP Exchange File, retrieve the necessary data, and assign the materials data to appropriate elements.

A2233521332 Import and Assign Material Properties from Materials Database

Import material properties from a PDES/STEP Exchange File, retrieve the necessary data, and assign the materials data to appropriate elements.

A2233531333 Generate and Assign Material Properties from Ply Properties, Stacking Sequence and Orientations

Generate material properties from ply properties, stacking sequence and orientations, and assign the materials data to appropriate elements.

A2233521334 Input and Assign Isotropic Material Property Matrices

Input material property matrices data, and assign the materials data to appropriate elements.

A2233522 Generate Finite Element Analysis Environment and Controls

Generate, set and assign Analysis environment data such as boundary constraints, loads, factors of safety, and set up the control of analysis output and the analysis procedure itself.

A22335221 Set and Assign Boundary Constraints and Releases

Set and assign boundary constraints and releases that approximate the support and/or symmetry boundary conditions for the analysis of the structural part.

A22335222 Generate and Assign Load Sets and Combinations.

Generate and assign nodal and elemental loadings that approximate the forces, temperatures and/or displacements acting on the structural part, and request the combination of load sets to approximate complicated loading conditions from simpler components.

A22335223 Generate and Assign Factors of Safety, Durability/Damage Tolerance Allowables

Generate and assign acceptable factors of safety, durability and damage tolerance allowables for elements.

A22335224 Generate and Assign Analysis Output Control Requests

Generate and assign output control requests for each of the types of data required to be output.

A223352241 Request Deflection Data Output

Request that deflection data be output from the Finite Element Analysis.

A223352241 Request Stress Data Output

Request that stress data be output from the Finite Element Analysis.

A223352242 Request Strain Data Output

Request that strain data be output from the Finite Element Analysis.

A223352243 Request Interlaminar Shear Data Output

Request that interlaminar shear data be output from the Finite Element Analysis.

A223352244 Request Reaction and Internal Load Data Output

Request that reaction and internal load data be output from the Finite Element Analysis.

A223352245 Request Generation/Output of Matrices

Request the generation and/or output of matrices such as reduced stiffness and substructures.

A22335225 Generate Analysis Procedure Controls

Generate the necessary directives to control the analysis process in the intended analysis code.

A2233523 Perform Finite Element Analysis

Perform linear or nonlinear analyses of the structural part by submitting the completed finite element model for analysis by the appropriate finite element analysis application.

A22335231 Perform Linear Analysis

Perform linear analysis of the structural part by submitting the completed finite element model to a finite element application that supports linear static analysis.

A22335232 Perform Nonlinear Stability Analysis

Perform nonlinear stability analysis of the structural part by submitting the completed finite element model to a finite element application that supports nonlinear static analysis.

A22335233 Perform Nonlinear Material Analysis

Perform nonlinear material analysis of the structural part by submitting the completed finite element model to a finite element application that supports nonlinear material static analysis.

A22335234 Perform Nonlinear Geometry Analysis

Perform nonlinear geometric analysis of the structural part by submitting the completed finite element model to a finite element application that supports nonlinear geometric static analysis.

A22335235 Perform Combined Geometric and Material Nonlinear Analysis

Perform combined nonlinear geometric and materia analysis of the structural part by submitting the completed finite element model to a finite element application that supports combined nonlinear geometric and material static analysis.

A2233524 Create Internal Loads/Stress Database

Create an internal loads and stress database by inputing data from an existing solution or a PDES/STEP Exchange File, and then document it with textual and graphical post-processing applications.

A22335241 Translate Data from FEA Solver

Translate analysis output data from an existing solution into an internal loads/stress database application.

A22335242 Translate Data from PDES/STEP Exchange File

Translate analysis output data from a PDES/STEP Exchange File into an internal loads/stress database application.

A22335243 Generate Textual Database Documentation

Generate textual documentation of the internal loads/stress database such as margin of safety distributions for skin elements, or a force freebody of a stiffener.

A22335244 Generate Graphical Database Documentation

Generate graphical documentation of the internal loads/stress database such as color fringe plots of strain distributions over a skin.

A223353 Conduct Detail Stress Analysis

Conduct part detail stress analysis of part details such as fasteners and cutouts. The internal loads/stress database is used to supply the input data for these analyses. These analyses are used to support drawing signout, and final documentation.

A2233531 Conduct Static Strength Analyses

Conduct various detail analyses such as bolted joint and cutout analyses to refine the finite element analyses of the structural part.

A22335311 Conduct Composite Bolted Joint Analyses

Conduct bolted joint analyses to refine the finite element analyses of the structural part.

A22335312 Conduct Composite Fastener Pull-Through Analyses

Conduct fastener pull through analyses to refine the finite element analyses of the structural part.

A22335313 Conduct Stiffener Pull-off Analyses

Conduct stiffener pull-off analyses to refine the finite element analyses of the structural part.

A22335314 Conduct Composite Cutout Analyses

Conduct cutout analyses to refine the finite element analyses of the structural part.

A22335315 Conduct Composite Point Stress Analysis

Conduct point stress analyses to refine the finite element analyses of the structural part.

A22335316 Conduct Panel Buckling Analysis

Conduct panel buckling analyses to refine the finite element analyses of the structural part.

A2233532 Conduct Fine Grid Finite Element Analysis

Conduct fine grid finite element analyses of details of the structural part that were not appropriate to include in the overall structural part finite element analysis.

A22335321 Generate Fine Grid Finite Element Model from Part Model

Use the existing structural part finite element model to provide a geometric basis for generating a finer grid mesh to provide more deflection and strain resolution for a detailed finite element analysis.

A22335322 Apply Loads/Boundary Conditions from Part Model

Use data from the internal loads/stress database to provide applied loads and displacements for the fine grid analysis.

A22335323 Perform Finite Element Analysis

Perform finite element analyses as in A2233522.

A22335324 Calculate Margins of Safety Based upon Fine Grid Analysis Results

Use data from overall structural part and fine grid finite element analyses to assign margins of safety for structural details of the structural part.

A2233533 Validate Drawings

Validate drawings of the structural part based upon information generated in the finite element and static strength analyses.

A2233534 Document Final Analysis

Write a final stress report documenting all analyses performed on the structural part.

A2233535 Develop Stress Equations

Develop parametric stress equations to simplify the application of detail structural part analyses.

A2233536 Establish Structural Operational Limits

Use output from all structural analyses to provide criteria to select operational limits for the aircraft fleet.

A223354 Plan Tests and Analyze Test Results

Plan and analyze the output from structural test of the structural part to validate analyses.

A2233541 Produce Test Part Configuration Documents

Produce documents to define the configuration of the part and supporting test fixtures.

A2233542 Produce Test Plan

Produce documents defining the testing of the structural part.

A2233543 Perform Test Surveillance, Validation and Data Review

Monitor the structural tests, validate the output, and review and document results.

A223355 Investigate Manufacturing Discrepancies

Perform static stress analyses to dispose of manufacturing discrepancies.

A22336 Conduct Durability and Damage Tolerance Analyses

Conduct durability and damage tolerance analyses to classify parts into critical and otherwise, guide material and allowables selection, set non-destructive inspection criteria.

A223361 Classify Parts into Safety of Flight/Fracture Critical and Others

Classify structural parts as safety of flight critical or otherwise based upon damage and environmental threats.

A2233611 Apply Damage Tolerance Criteria/Size to Safety of Flight/Fracture ACSP

Classify and apply structural parts as safety of flight critical based upon typical damage threats such as scratches, delaminations and impacts.

A22336111 Apply/Size Based on Scratches

Set criteria for allowable scratches in the surface of structural parts, and size the structural part to resist the threat.

A22336112 Apply/Size Based on Delaminations

Set criteria for delamination of structural parts, and size the structural part to resist the threat.

A22336113 Apply/Size Based on Impacts

Set criteria for impacts in the surface of structural parts, and size the structural part to resist the threat.

A2233612 Apply Durability and Environmental Threat Criteria to all other ACSPs

Classify ACSPs an non-safety of flight/fracture critical, and apply durability criteria and asses the effect of environmental threats to the ACSP.

A223362 Guide Material Selection and Set Material Allowables

Guide selection of materials that are durable and damage tolerant, and set material allowables based upon analytical and experimental criteria.

A2233621 Guide based on Stacking Sequence Optimization

Set and optimize material allowables based upon ply stacking sequence.

A2233622 Guide based on Edge Delamination Criteria

Set and optimize material allowables based upon edge delamination criteria and analyses.

A2233623 Guide based on Sub-Laminate Buckling Criteria

Set and optimize material allowables based upon sub-laminate buckling criteria and analyses.

A2233624 Guide based on Design Details

Set and optimize material allowables based upon design detail criteria and analyses.

A2233625 Guide based on Experimental Results/Validated Analysis Methods

Set and optimize material allowables based upon experimental results and correlated/validated analyses.

A223363 Set Non-Destructive Inspection Allowables

Set non-destructive inspection allowables based upon delamination and void content criteria.

A2234 Evaluate Detail ACSP Analyses

Evaluate all the detail performance and producibility analyses done on the ACSP. These include weight, thermal, static, and dynamic loads analyses and composite tooling studies. Resolve the strength, time, weight, and cost parameters for optimum, based on these analyses.

A224 Conduct ACSP Prototype Tests & Evaluation

All of the prototype tests needed to validate the performance and fit-up of the ACSP are conducted.

A225 Manage ACSP Configuration

All of the geometry and associated design data are manage for control of changes and release to other functions.

A23 Build and QA an ACSP

The conversion of a design into a finished product and quality assurance functions that assure that the product meets requirements. This is usually a repetitive function, continuing substantially throughout the product's life cycle. It receives the design from Design Functions and outputs the products, spare and repair parts, and technical data on each instance of the product.

A231 Plan for ACSP Manufacturing

Translate Engineering product data into manufacturing plans including major assembly breaks, sub-assembly breaks, major tools, facilities, and equipment requirements, as well as make-buy plans.

A2311 Assume a Structure & Method of Manufacture

Establish production breaks, Major Unit configurations, & major subassemblies, make tentative make or buy decisions and a tooling & assembly overall plan.

A2312 Estimate Requirements Time & Cost to Produce

Estimate resource needs, cost to purchase or make, and timing to start-up and production.

A2313 Develop Production Plans

Develop a top level plan of production including assembly, tooling and space, and detail part fabrication requirements.

A2314 Develop Support Activities Plan

Develop a strategy plan for meeting QA requirements, Materials plans, tooling policy, approach, and major requirements, facilities & equipment requirements, and Personnel Requirements.

A232 Develop ACSP Production Plans

Translate the overall strategy plans (developed in A1) into specific build activity definition suitable for shop floor worker

A2321 Determine Detail Method of Manufacture

Define a manufacturing bill of materials (BOM) and for each item of that BOM define a manufacturing method and vendor purchase plan.

A2322 Develop Work Instructions

Define the detail of the manufacturing method such that it can be released to the shop.

A23221 Plan Structures Assembly

Define the installation steps necessary to assemble the structure as well as define tools required.

A23222 Plan Systems Installations

Define the installation steps to install systems (electronic & hydraulic) as well as define tools required.

A23223 Plan Detail Parts

Complete definition of the raw material at the beginning of fabrication, define the fabrications steps, define the routing and detail of each step, and the tools required.

A232231 Develop Sheet Metal Planning

Define fabrication of parts from cutting and forming sheet metal.

A232232 Develop Machine Parts Planning

Define Machine Parts Fabrication including NC Programs, holding and cutting tools, and set-ups.

A23233 Develop Bonding/Composite Planning

Define Composite Part Fabrication detail planning.

A232331 Conduct Pre-planning Review

Design data is received and a preplanning review is conducted. Any design documentation issues are resolved.

A232332 Identify Tool Requirements

Tool requirements are identified and a request for tooling is created.

A232333 Develop Build Sequence

The steps necessary to build the composite part are identified and documented for shop floor distribution.

A232334 Audit & Verify Planning

The planning is reviewed for completeness and accuracy to the released design before it is released to build.

A232335 Provide Modification Planning

Modification of existing parts is prepared as required either as the result of design changes or rework for discrepancies.

A23224 Plan for Procured Parts

Add manufacturing requirements for procured parts.

A2323 Develop Support Activities Plans

Define Plans for support activities such as materials, quality assurance, tooling, facilities, equipment, and personnel.

A2324 Control, Validate, & Release Planning

Perform the administrative and managerial tasks necessary to assure that the planning is current with engineering definition and properly approved for production.

A233 Provide ACSP Production Resources

Provide facilities, equipment, tools, and people necessary to produce ACSP.

A2331 Provide Facilities

Plan, modify, and operate facilities necessary to produce ACSP.

A2332 Provide Equipment

Plan, modify, and operate equipment necessary to produce ACSP.

A2333 Provide Tools

Perform the tasks required to design, build, and control configuration of tools defined in A1 & A3.

A23331 Design Tools

Provide engineering definition of tools.

A233311 Evaluate Tooling Producibility

Conduct a tooling producibility review which creates a design criteria and request to design a tool.

A233312 Select Tool Material

Based on part and use criteria, select the material required for the face sheet. This decision considers in-house mfg capability, life required, and costs.

A233313 Conduct Preliminary Tool Design

Determine the approach to be used for the tool design, including supporting structure type, rigidity required, transportability requirements, autoclave loading and heating requirements, and bagging and pull-down requirements.

A233314 Perform Detail Tool Design

Complete the detail definition of the tool design, including presentation of the design in suitable format.

A233315 Review and Approve Tool Design

Validate Tool Design fit, form, & function . Validate tool design to product design. Release tool design to manufacture.

A23332 Develop NC Programs/Tapes

Provide the Numerical Control Programs needed to fabricate tools.

A233321 Provide Inspection NC Programs

Develop and Debug NC programs to inspect tool designs.

A233322 Provide Tool Fab NC Programs

Develop and Debug NC Programs to fabricate Tools.

A233323 Control Tool NC Programs

Create records and file NC work orders and data sets of tool fab NC programs.

A233324 Proof NC Programs

Schedule NC proofing and validate Tool NC program by simulation or on machine.

A233325 Release NC Programs

Transfer NC media to tool Fabrication Storage.

A23333 Fabricate/Rework Tools

Make and/or refurbish tools.

A23334 Provide Liaison Support

Support tool fabrication and tool tryout in production by providing expertise and resolution of problems.

A2334 Provide People

Plan, train, and provide people necessary to produce ACSP.

A234 Obtain ACSP Manufacturing Materials

Obtain all materials required to produce ACSP. This includes receiving, inspection, certification, and storage.

A2341 Receive & Inspect Raw Materials

Receive materials, and process and record critical information about the raw materials required to build composite parts. The operations include unloading and storing the materials and verifying that the materials were transported in an approved fashion. As in the case of refrigerated materials, that the proper temperature was maintained. Suitable test samples are taken and sent to the test lab.

A23411 Verify/Record Vendor Documentation

The information from the vendor must be verified as to the content of the shipment and the count/condition. Warehouse personnel verify the contents of the shipment and match that information against the shipper documentation.

A23412 Update & Print Receiving Documentation

The appropriate internal documentation recording the vendor, batch/lot, and material code are printed and placed with the material for identification.

A23413 Unload Transport

The contents of the transport are removed and placed in an inspection area.

A23414 Inspect/Verify Material

The contents are inspected per the inspection plan for that type of material. This inspection is to verify that the materials were not damaged during shipment and meet the basic requirements set forth in the inspection plan.

A23415 Obtain Test Samples

Most raw materials will have a sample randomly removed and sent to the test lab. Results of the inspection are recorded and determine if the material may be released for production use. This requires thawing of the frozen material.

A23416 Place Material into Proper Storage Area

After the inspection is completed and the test samples are removed the material will be placed into the proper storage area. Storage areas for cold storage must remain at or near 0 degree F. Ambient material must be stored in a clean, dry environment.

A2342 Receive Tools

Tools are received at the production facility in basically the same manner as materials. Critical information is captured and the tools are inspected. When the tools pass inspection they are released for production use.

A23421 Update Receiving Data

The arrival of the tool is logged into the appropriate information system.

A23422 Unload Transport

Using an appropriate material handling device the tool is removed from the transport and placed into the inspections area.

A23423 Inspect Tool

The tool is given an inspection per the appropriate inspection plan. Inspections may include visual and dimensional. When the tool passes inspection it will be released for production use.

A23424 Place Tools in Storage Area

After the inspection is completed the tool is placed into the proper storage area and the location of the tool recorded.

A2343 Prepare & Transport ACSP

When the part is complete it must be transported to the major assembly operation, or the customer, in a manner that prevents any damage to the part.

A23431 Print & Verify Transportation Documents

Information about the part must be printed or transferred to a medium that allow the data to be transmitted to the next operation or the customer. For transfer to subsequent operations the planning and manufacturing data must be verified. For parts to the customer all critical build and manufacturing data must be provided.

A23432 Protect Part for Shipment

The part will be wrapped in a protective layer of a protective material, usually bubble wrap. If the part is to be transported outside the plant, a suitable transportation container is used.

A23433 Load Transport

The part is placed on an appropriate transport vehicle and secured as to prevent damage or load shift during transport.

A235 Produce ACSP Product

The composite details are produced and assemble into the correct structure. Each step is completed and then inspected to ensure that the parts produced meet the design requirements.

A2351 Build Core Assemblies

The core details are cut to size and machined to shape. Additional operations may include the application of potting compound or stabilizers. Different pieces of core may also be attached together to form more complex/larger core assemblies.

A23511 Cut Core to Size

The core is removed from storage and cut to size per the instructions on the production planning.

A23512 Perform Machining Operations

After the core is cut to size the machining operations are completed. This usually consists of bevelling the edges using a stationary router. The machining operations are then inspected.

A23513 Apply/Cure Stabilizers/Potting Compounds

If required, potting compounds are used to fill the voids in the core and stabilizers are added to improve the rigidity of the material. After the compounds and stabilizers are added to the core they must be oven cured. Each operation is inspected and the oven cure cycle parameters are recorded.

A23514 Apply Adhesive/Assemble Core

If required by the size and shape of the core detail, multiple pieces of may be glued together to form a core assembly. Foaming adhesive is placed on the pieces of core and then the core is matted together. After the core is matted, the adhesive must ne oven cured. Each operation is inspected and the oven cure cycle parameters are recorded.

A23515 Inspect Core Assemblies

The final completed core assembly is given a final visual/dimensional inspection. The results of the inspection are recorded and the core assembly is released for use in the subsequent operations.

A2352 Perform Layup Operations

The layup operations may be competed manually or using automated equipment. These require placing pre-preg material on a bond mold that is the shape of the completed part. Layup involves placing many layers of material in various orientations on the tool. These operations are completed per the production planning for that part.

A23521 Obtain & Prepare Tools

The tool must be thoroughly cleaned and a release agent is applied to all bonding surfaces. The release agent prevents the part from sticking to the tool. The cleaning operation and the application of the release are inspected and the results are recorded.

A235211 Remove Tool From Storage

The location of the tool is obtained and the tool is taken to the tool clean area.

A235212 Clean Tool

The tool surface and undercarriage is carefully cleaned using a combination of dry compressed air and suitable solvents. The tool must be cleaned well enough to meet clean room specifications. The tool cleaning process is then inspected.

A235213 Apply Release Agent

The release agent is applied to the surface of the tool that will come into contact with any material. The coating is then inspected for proper coverage and thickness.

A235214 Cure Release Agent

The release may be air dried or oven cured. The drying time and method is recorded.

A23522 Obtain Material

Material for composite manufacturing fall into two categories; cold and ambient. Cold storage materials must be removed from storage and brought to room temperature prior to use. Ambient material are usually ready for use as is. The material identity must be verified against the production planning for the part.

A235221 Remove Material From Freezer

The material identity is verified and the material is removed from the freezer and placed in a thawing area. The date and time that the material is removed for the freezer must be recorded to monitor the out-time for that material.

A235222 Thaw Material

The material must remain in the thawing area until the material is all at room temperature. This will prevent condensation from forming when the material is used. The amount of time spent thawing must be recorded and fall within the specification for thawing time for that material.

A235223 Cut Material To Size & Kit

The thawed material is unrolled and cut to specific shapes per the production planning. The material may be cut either manually or on automated equipment. The pieces of material for a single part are then placed together in a material kit. The identity of the material and the pieces of the material in the kit are verified.

A235224 Transport Material

The material kits are transported to the layup station for subsequent operations.

A23523 Layup Ply(s)

The material is mechanically or manually placed onto the prepared bond mold surface. Each layer of material may contain one or more plies or material in various orientations. Each layer is inspected for material orientation and placement.

A235231 Clean & Prepare Tools

Prior to use each tool, both bond tools and assembly tools, are cleaned to prevent any contamination of the materials.

A235232 Obtain Thawed Material

The material is taken from the storage area to the layup station. The material involved may include roll of tape, rolls of pre-pregs, and kits of pre-cut material.

A235233 Perform Manual Layup Operations

The more complex parts require manual operations to place the material on the bond molds in the proper orientation

A2352331 Identify & Record Material/Tool Data

Prior to start up of the process all tools and materials must be verified against the production planning. The serial numbers of the tool and the batch/lot data for the material must be recorded to meet traceability requirements.

A2352332 Layup/Inspect Ply(s) per Planning

The material is placed in the proper orientation on the bond mold. The operator follows the instructions on the production planning and certifies each step as it is completed. As each layer is completed, bagging material is sealed over the ply and the layer is vacuum compacted. This ensures a tights fit of the material on top of the previous layer and removes any trapped air. The layer is then inspected to ensure the placement and orientation of the material is correct. This sequence of operations is repeated until all of the layers of material are in place.

A2352333 Identify for Assembly Operations

The competed structure must be marked for identification for subsequent operations. this usually involves using a special marking pen to place the serial number on the part surface.

A235234 Perform ATLM Operations

The less complex shapes have the material placed on the bond mold using automated equipment. The Automatic Tape Laying Machine is used to place 3-12 inch wide unidirectional tape on the bond molds.

A2352341 Identify & Record Material/Tool Data

Prior to start up of the process all tools and materials must be verified agonist the production planning. The serial numbers of the tool and the batch/lot data for the material must be recorded to meet traceability requirements.

A2352342 Determine/Record Material Thickness

A sample of the tape is layed up and cured in the lab to determine the per ply thickness of the material. This information is used by the ATLM and the NC program to determine the number of layers required to obtain the required part thickness. This information is recorded an then input into the NC program.

A2352343 Identify & Record Part ID

The serial number for the part is verified and recorded.

A2352344 Layup Cover Sheets/Inspect

The initial layers of broadgoods are manually placed in the bond mold and vacuum compacted. The operation is then inspected.

A2352345 Perform Automated Tape Laying operations/Inspect

The tape is layed in 3-12 inch strips along the surface of the bond mold. The NC program is designed to follow all contours. The head of the ATLM uses pressure to compact the tape as the material is dispensed. Each layer is inspected to verify the position and orientation of the material.

A2352346 Identify & Record Part ID

The serial number for the part is verified and recorded.

A2353 Perform Assembly and Bagging Operations

The various laminate details are bought to the assembly station. The details are then placed in the proper orientation for the completed part. When the part is fully assembled a vacuum bag is placed over the part.

A23531 Obtain Part Details

The laminate details are brought from the detail fabrication station or from the thawing area as appropriate.

A23532 Record & Verify Part Serial Numbers

The identity of the laminate details is verified against the production planning.

A23533 Obtain Assembly Tools

Several of the parts require specialized tools for the assembly process. These tools will be brought to the station and the tool serial numbers verified against the production planning.

A23534 Apply Core Assemblies & Inspect

If the part contains core assemblies, they will be brought to the station. A visual inspection is made to ensure the core has not been damaged during storage and transportation.

A235341 Verify Core Fit

The core is placed into position on the outer skin to ensure an exact fit. Any areas of contact that are out of tolerance will be corrected by machining the core.

A235342 Abrade Bonding Surface/Inspect

In order to ensure a good bond to the surface of cured skins the part surface must be lightly abraded prior to placement of the film adhesive. This process occurs outside of the clean room environment.

A235343 Apply Film Adhesive

One or more layers of film adhesive are placed over the contact area for the core.

A235344 Position Core Detail(s) & Inspect

Using core locating templates the core details/assemblies are placed into position. The locating templates are also used to inspect the position of the core.

A23535 Position Composite Details & Inspect

If any laminate details are required, they are placed into position using a appropriate locating template. The location of the detail is then verified.

A23536 Position Assembly Tools & Inspect

The assembly tools used to hold the core and laminate detail in place during the cure cycle are placed into position. The tool positions are then verified.

A23537 Bag Part/Leak Check

The autoclave bag is placed into position and sealed to the bond mold. A vacuum is applied and the bag is checked for leaks.

A2354 Cure & Tear Down Part

The part is placed into an autoclave and the proper cycle of heat and pressure is applied.

A23541 Verify & Record Part ID(s)

The identity and cure cycle requirements for each part is verified and recorded. Each part that will be in a single autoclave load is placed in the staging area.

A23542 Place Part in Autoclave & Connect Vacuum & Sensors

The parts are placed on a rack and all thermocouple, vacuum, and heat sensors are connected to the parts. The rack is then moved into the autoclave and the connections are made to the autoclave control system.

A23543 Cure/Debulk/Bond/Dry per Specification & Record Autoclave Cycle Data

All vacuum and sensors connections are verified and then the doors are closed on the autoclave. The appropriate cycle of heat and pressure is applied. All parameters about the cycle are recorded and verified.

A23544 Remove Parts from Autoclave

The vacuum and sensor connections are detached from the autoclave and the rack is removed. The connections are removed from the parts and the parts are removed from the rack. The parts are then placed in the tear down staging area.

A23545 Remove Bagging Materials and Part from Bond Mold

The bagging material are removed and discarded. the part is then separated from the bond mold and sent to the next operation. The bond mold is sent to the storage area to await the next cycle.

A2355 Perform Trim & Drill Operations

The periphery, internal cutouts, and holes are cut/drilled manually and using automated equipment.

A23551 Position Part into Trim/Drill Fixtures

The part is placed and secured in a fixture that will hold the part in placed while the trim & drill operations are competed. Some parts require individualized fixture while most use vacuum universal holding fixtures.

A23552 Trim/ Drill Part

The trimming operations are performed using manual routers, NC routers, abrasive water jet cutters, etc. Drilling operations are usually manual but may be performed utilizing NC drills. Each operations is inspected.

A235521 Verify & Record Part Serial Number

The part serial number is verified against the planning.

A235522 Trim Part Periphery

The periphery of the part is trimmed manually or using automated equipment. Each trimming operation step is inspected.

A235523 Clean Skin

After the trimming operation are completed the skin is blown clean and wiped with a suitable solvent.

A235524 Trim Stiffeners

The edges of each stiffeners are trimmed manually or using automated equipment. The trimming operation is then inspected.

A235525 Drill Holes

For manual drilling operations the part is placed into a drill fixture and the holes are drilled. Automated drilling involves placing the part into a holding fixture and then having the NC equipment drill the holes.

A235526 Inspect Trim & Drill Operations

Each trim and drill operation is inspected to ensure the operation is within tolerance. The results of the inspection are recorded.

A23553 Remove Part From Fixture

The part is removed from the fixture and cleaned.

A236 Provide Quality Assurance

All composite parts have the dimensions and internal structure of the parts inspected. Also the materials, tools, and personnel involved are certified.

A2361 Perform Non-Destructive Inspections

Verify that there are no voids, delaminations, porosity, cracks etc. are contained within the structure of the part. Also verify that all parts dimensions are within allowed tolerances.

A23611 Seal Part For Ultrasonic Inspection

Core stiffened panels are sealed prior to ultrasonic inspection.

A23612 Perform Ultrasonic Inspection Operation

The composite parts and standards are placed in the ultrasonic test equipment and are scanned. The technician will then evaluate the part based upon the variations in the attenuation levels between the part and the standard.

A23613 Perform X-ray Inspection Operations

Any parts that have anomalies that cannot be readily determined by the ultrasonic inspection are x-rayed. The part is loaded on a holding fixture and the questionable area is x-rayed. The x-ray operations are performed based upon inspection techniques that are developed for each part.

A23614 Perform Dimension/Visual Inspection

All parts are inspected using the engineering drawings to verify part dimensional tolerances. A visual inspection of all part surfaces is made to ensure no surface defects exist.

A2362 Perform Material Evaluation/Certification

All materials used in the manufacture of composite parts must be evaluated and certified prior to use. These tests evaluate the physical and mechanical properties of the materials and determine if they fall within accepted limits.

A23621 Obtain Material and/or Test Coupons

Material samples are obtained when the material arrives at the receiving dock. The material is thawed, if required, and appropriate samples are removed based on inspection plans. Test coupons are layed up along with part and are cut from the part during the trim operation. The material samples and test coupons are sent to the test lab area for storage. The raw material is then cured into test coupons for analysis.

A23622 Verify Chemical/Thermal Properties

The material is taken to test lab and the appropriate tests are completed. If the material test are within acceptable limits, the material is released for use by production. All test information is recorded.

A23623 Verify Physical Properties

The test coupons are descriptively tested to verify that the physical properties are within acceptable limits. The results of the test will determine if the material is acceptable. In the case of a part it will determine if the part cured properly.

A23624 Verify Mechanical properties

The test coupons are descriptively tested to verify that the physical properties are within acceptable limits. This determines if the part was properly cured.

A2363 Analyze Defects & Disposition Part or Material

The results of the inspections and tests that failed are carefully analyzed to determine if and how the problem can be corrected.

A3 Use & Maintain an ACSP

This activity is the DoD's use and maintenance of an ACSP. It also includes repair, redesign, and modification activities of an ACSP at an ALC.

A4 Develop & Prepare ACSP Materials

This activity is the material suppliers process of creating stock material for composite manufacturers. Basic material properties and allowables are addressed here.

3 CONCLUSIONS/RECOMMENDATIONS

This document identifies functional activities within the life-cycle of composite parts. Each of these functional activities require or generate particular information. These functional activities will serve as a basis for identifying and scoping the information needs for PAS-C.

A set of example composite parts were also collected that exemplify common aircraft structural parts. These parts will be used as a mechanism for guiding expert interview sessions and demonstration/validation data.

A conclusion that can be drawn from the completeness of work that has been documented above, is that an effective foundation for the process of gathering detail composite part information has been established. Within this information needs gathering process the current functional node trees will be updated to reflect the addition of knowledge from composite experts.

The Framework/Building-Block methodology that has being established for the PAS-C program is being utilized and refined. The refinement comes in the form of blending IDEF methodology with a collection of (functional view/ composite item) building-blocks. The initial results of this refinement will be exploited in completing the composite needs analysis (CDRL012). An overview of this refined needs analysis process is show in Figure 2 within Section 2.0 Methodology.

Based on the area addressed in the functional node trees, it is recommended that potential Application Protocols within PAS-C be focused on Analysis, Design, and Manufacturing areas. These areas can be addressed quite readily with the PAS-C team resources. The area of product support is not currently addressed in the functional node trees (section 2.3). It is recommended that resources at composite related Air Logistic Centers (ALCs) be appropriated so that their needs can be also established. The team perceives that implementing this technology within the ALC environment will have substantial cost benefits.

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REFERENCES

Program Master Plan for the PAS-C Program, Document No. PMG001.01.00, 30 August, 1991

PAS-C Sample Part Set, Document No. PASC003.01.00, 30 September, 1991

1991 Annual Report for the PAS-C Program, Document No. PASC004.01.00, 30 September, 1991

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APPENDIX A - FW/BB Methodology

The FW/BB methodology which is being used in developing a PDES Composites Application Protocol Suite accomplishes the following tasks:

- Standardize physical components
- Establish application views
- Determine characteristics and their aspects
- Determine relationships among characteristics and their aspects
- Define Application Protocol requirements
- Recommend Application Protocol Suites

The methodology begins by standardizing a set of fundamental physical components that make up a composite part. These components are called composite items (see figure 4). A composite item can be as basic as a fiber or as complex as a composite assembly. The key is that composite items can be combined to form all the possible combinations of composite parts. Figure 4 also shows how composite items combine together to make other composite items.

Next, a set of life-cycle application views are established by determining the product life-cycle applications and dividing them into groups. These views can be as general or specific as necessary in order to communicate with various composite experts. Most experts come from particular disciplines such as analysis, design, manufacturing, engineering, etc. Thus, an initial set of views is established based on traditional company organizations that the experts will recognize. Within each organizational view, smaller detailed views can be created to facilitate the knowledge gathering process. Building activity node trees and IDEF0 models will facilitate the documentation of these views.

Each building-block, shown in figure 3 as the intersection of a composite item and a view, is examined to determine if its particular view (set of activities) requires additions or modifications to information about it's particular composite item. This examination is accomplished by an interviewing process that takes place in each individual view environment by subject experts to determine these requirements. This identified information is grouped as characteristics. These characteristics are composed of different combinations of aspects such as shape, function, material, and process. Figure 32 describes this FW/BB terminology. Figure 33 gives an example of the aspects that make up a transition characteristic of a laminate detail from a design view. Once the interviews are completed, an industry review of this work must be made to verify its completeness and correctness. This will be done through the IGES/PDES Organization (IPO) Composites Committee and/or the PAS-C Industry Review Board.

The size of the next task, interrelating composite characteristics and their aspects, is based on the success of the interview process and the depth of the knowledge collected. First, the relationships between aspects of the same characteristic should be determined. The line labeled R1 in figure 3 depicts this type of relationship in the FW/BB methodology. Then, the relationships between characteristics of the same composite item should be identified from the same view and different views (along the view axis of figure 3). This should indicate real data dependencies and unique characteristic requirements. The detail integration is done on interrelating composite characteristics and their aspects. This detail integration is accomplished before creation of the actual information models. The detail integration and its positioning in the requirements gathering phase is a unique process of the FW/BB methodology. Other modeling methods attempt to perform most of this detail integration during the creation of the actual information model. Our methodology takes into account that the majority of the composite experts can not

communicate in a detailed information modeling environment such as IDEF1X but they can relate to an activity model (IDEF0). Specialized forms have been created to capture and communicate the necessary information to and from the composite expert for development of the scope, information requirements and the AAM. A snapshot of these forms are shown in figure 34.

Once the information has been adequately collected, a decision point is reached to determine which Application Protocols (APs), in terms of scoping direction, should be pursued. The three basic choices are to scope APs by:

- Identifying information within a particular view (could be a functional department)
- Selecting two different views and identify the information that is exchanged between them
- Selecting a particular composite item or a characteristic of a composite item and standardize on its informational content throughout its entire life cycle

Characteristics and Their Aspects

Figure 35 shows examples of three AP scope choices. This figure shows how different building-blocks can be combined into different types of APs. This methodology provides an effective way to collect enough views of a particular type of information (characteristic), figure 3, so that a standard characteristic can be created that supports those views. This methodology can be applied to a few composite items, yet achieve great returns towards establishing and integrating PDES application protocols as well as Application Protocol Suites for composites. In this methodology, the simpler composite items should be addressed first because of the interdependencies in more complex composite items. The methodology sets up a framework where expansion points for new APs are easily identified and defined. Industry is provided with a tool to establish standard composite items that become the basic building blocks that tie Application Protocol Suite APs together.

The standard information characteristics that are uncovered by the PAS-C FW/BB methodology will be represented by groups similar to the ARMs Units of Functionality (UoF). The PAS-C "UoFs" will assist in the ARM-to-AIM mapping and the integration of different APs. This methodology is not intended to replace the IPO/ISO integration techniques for resource models and APs. The PAS-C method will enhance the current IPO/ISO integration techniques by:

(1) providing a preliminary integration of well defined concepts for ARM and AIM development and integration, and
(2) sharing a building-block methodology for AS development. The PAS-C method will allow standardization of fundamental information constructs for a composite item through out any number of life-cycle phases.

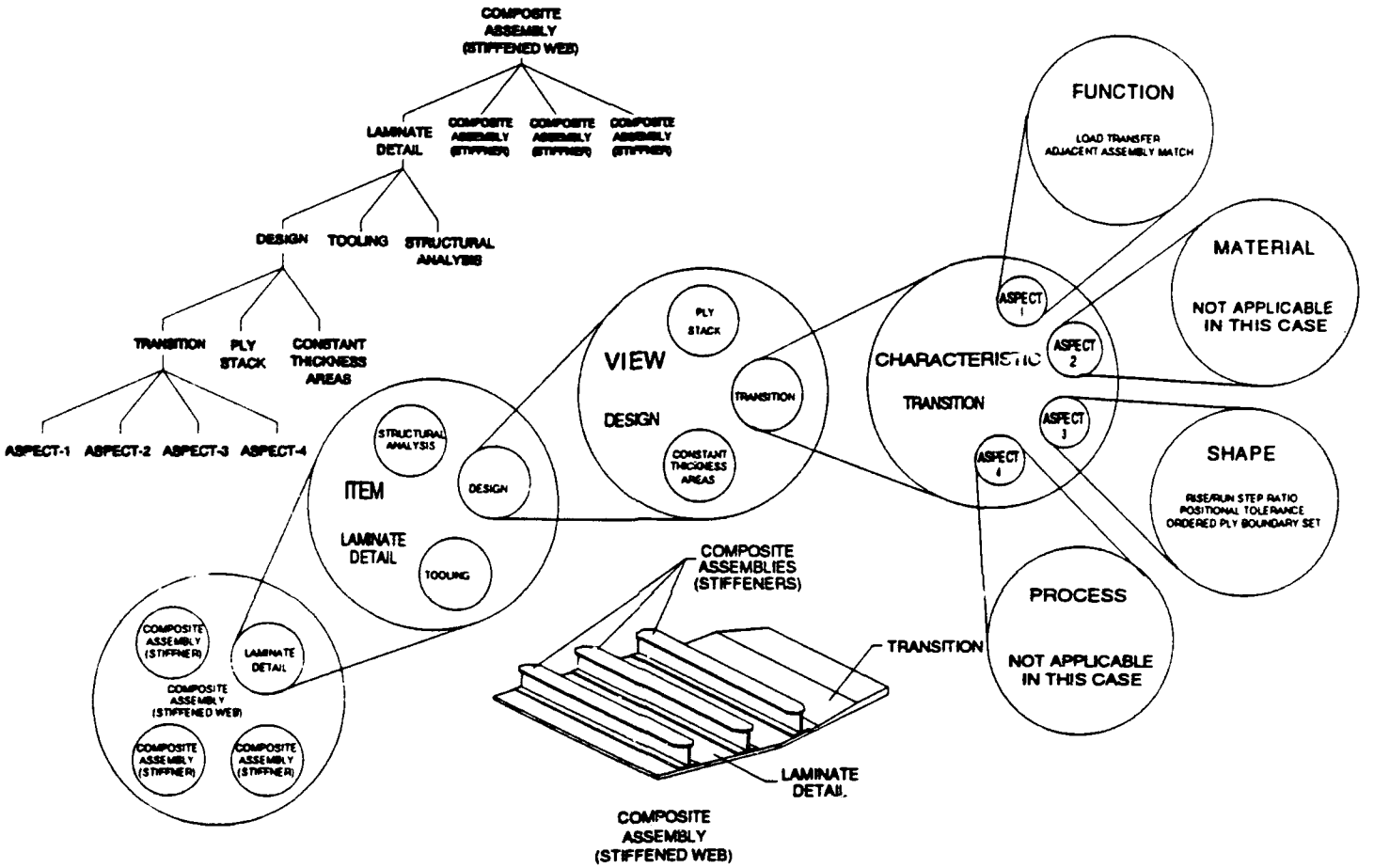

Figure 32 Aspects of a Transition Characteristic of a Laminate Detail from a Design View using FW/BB Terminology

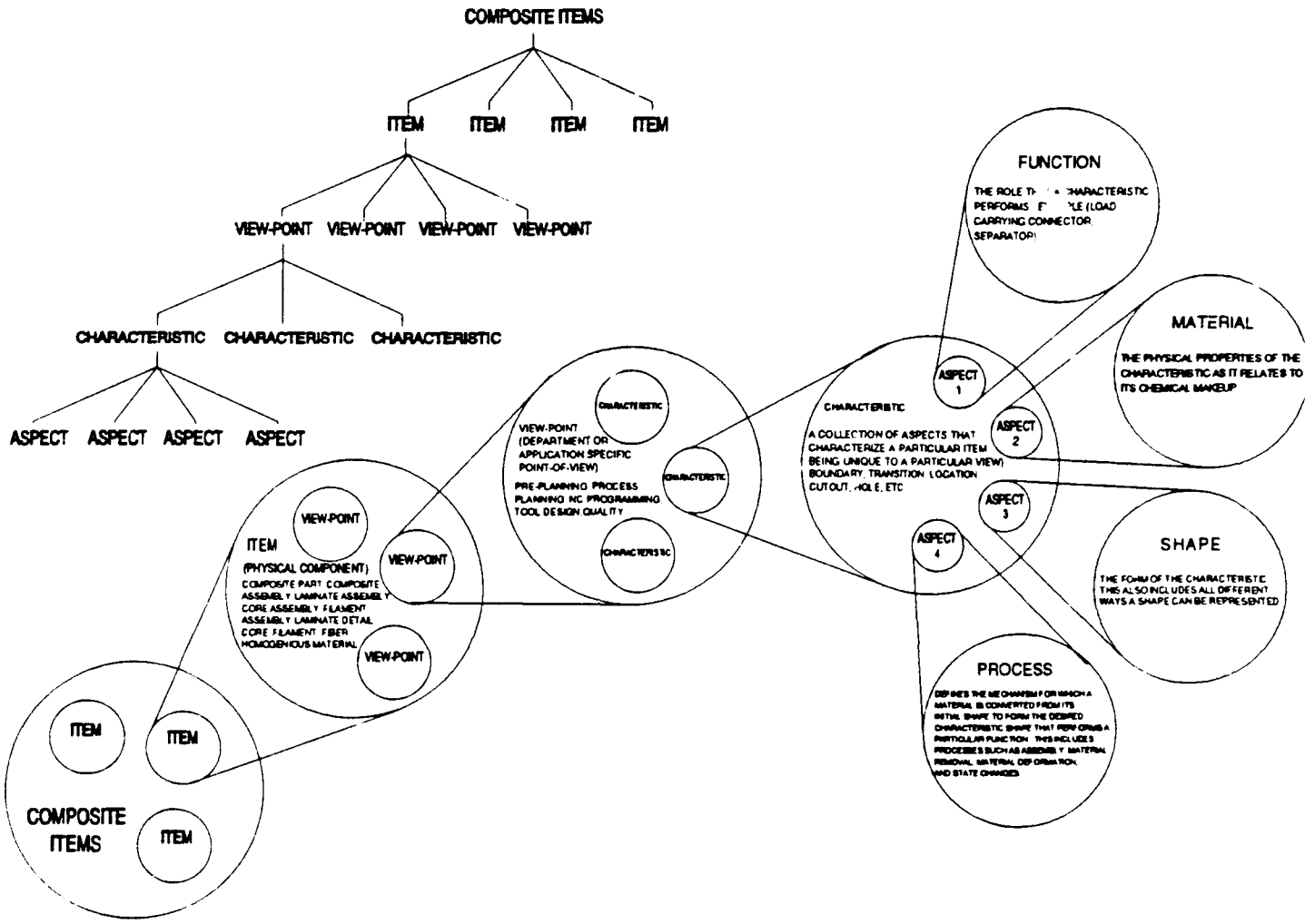

Figure 33 Framework/Building-Block Terminology Guides and Organizes Knowledge Collecting Process

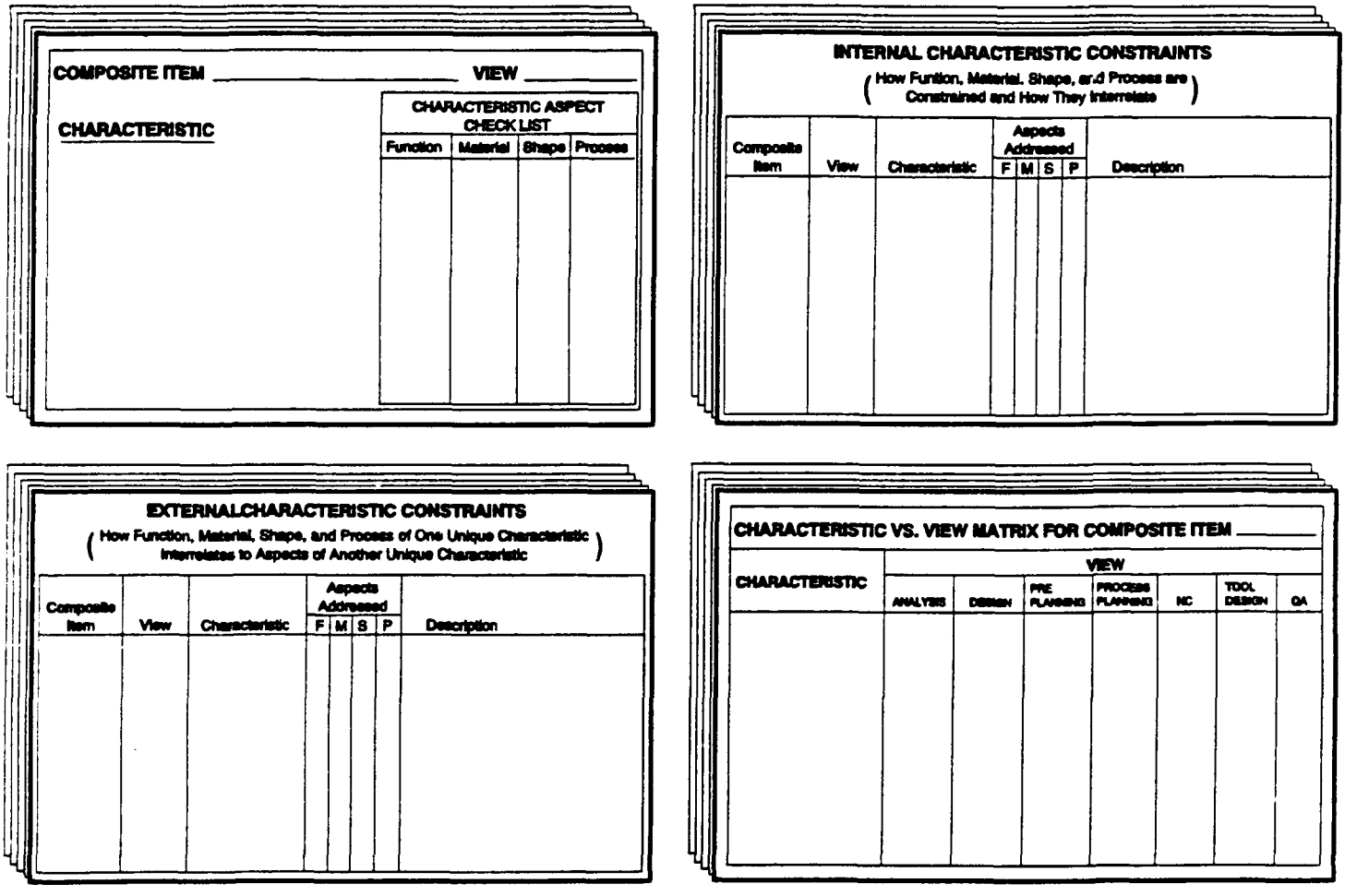

Figure 34 Forms that Capture Relationships Between Composite Characteristics and Their Aspects

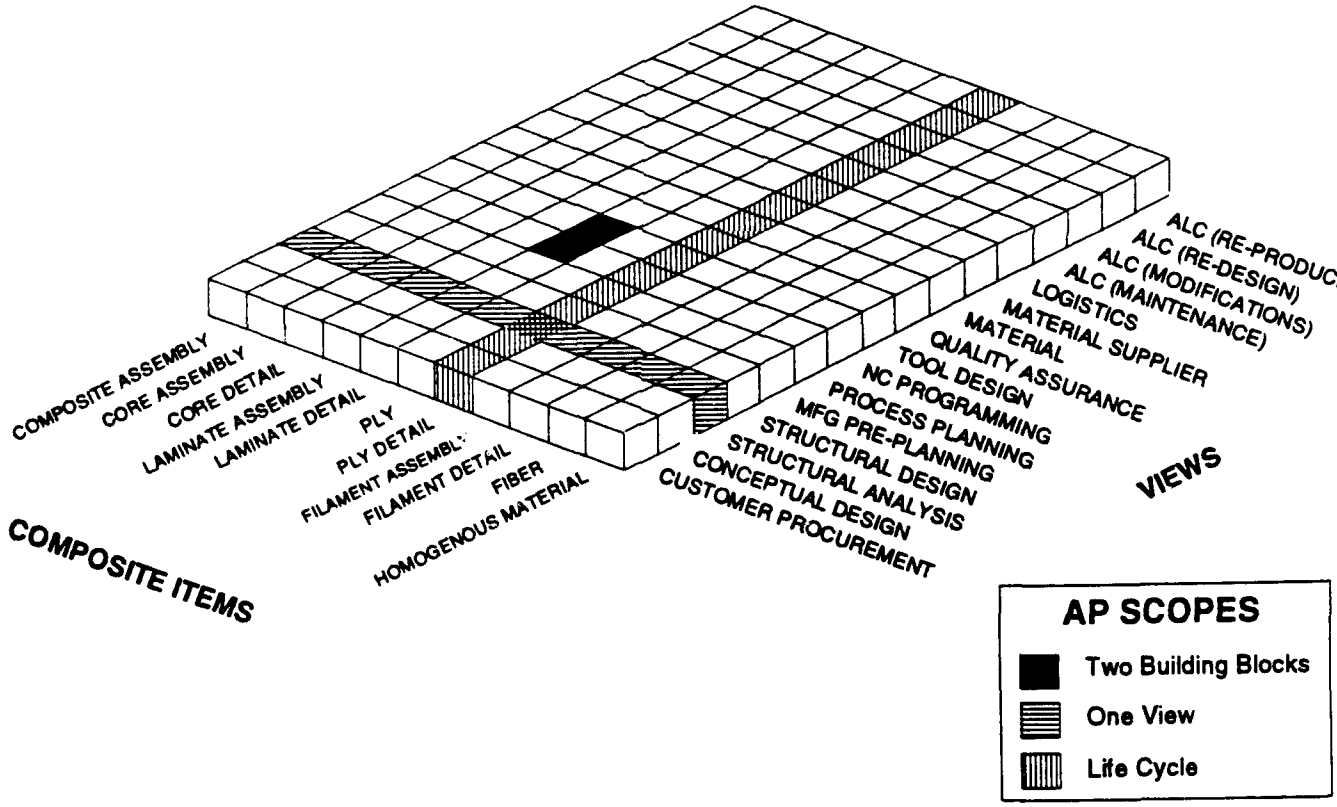

Figure 35 APs Scope Based on FW/BB

INDEX OF TERMS