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PDES APPLICATION PROTOCOL SUITE FOR  
COMPOSITE (PAS-C)

FUNCTIONAL NEEDS/STATE-OF-THE-ART COMPARISON  
FOR THE PAS-C PROGRAM

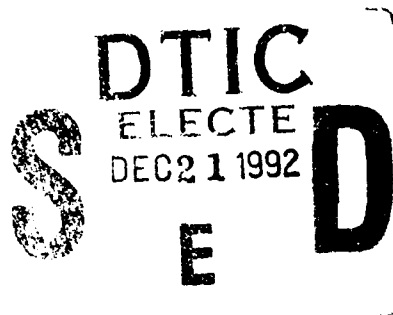


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This technical report has been reviewed and is approved for publication.

  
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## LIST OF ACRONYMS

|        |                                                              |
|--------|--------------------------------------------------------------|
| AAM    | Application Activity Model                                   |
| ACSP   | Aircraft Composite Structural Part                           |
| AECO   | Advanced Engineering Change Order                            |
| AIM    | Application Interpreted Model                                |
| ALC    | Air Logistics Center                                         |
| AP     | Application Protocol                                         |
| ARM    | Application Reference Model                                  |
| AS     | Application Protocol Suite                                   |
| BOM    | Bill of Materials                                            |
| BREP   | Boundary Representation                                      |
| CAD    | Computer Aided Design                                        |
| CAE    | Computer Aided Engineering                                   |
| CAGE   | Contractor And Government Entity                             |
| CAM    | Computer Aided Manufacturing                                 |
| CD     | Committee Draft                                              |
| CIM    | Computer Integrated Manufacturing                            |
| CSL    | Contoured Skin Laminate                                      |
| CSP    | Core Stiffened Panel                                         |
| D&T    | Dimensioning & Tolerancing                                   |
| DBMS   | Data Base Management System                                  |
| DDMC   | Defense Depot Maintenance Council                            |
| DIS    | Draft International Standard                                 |
| DMMIS  | Depot Maintenance Management Information System              |
| DoD    | Department of Defense                                        |
| ECN    | Engineering Change Notice                                    |
| ECP    | Engineering Change Proposal                                  |
| EDCARS | Engineering Data Computer Assisted Retrieval System          |
| EDSC   | Engineering Data Service Center                              |
| EMD    | Engineering Manufacturing Development                        |
| FEA    | Finite Element Analysis                                      |
| FEAC   | Finite Element Analysis Control                              |
| FEAM   | Finite Element Analysis Model                                |
| FEAR   | Finite Element Analysis Results                              |
| FFIM   | Form Features Information Model                              |
| FSD    | Full Scale Development                                       |
| FW/BB  | Framework/Building-Block                                     |
| GOSET  | Operational Group for the Standard for Exchange and Transfer |
| HoQ    | House of Quality                                             |
| ICOM   | Input, Control, Output, Mechanism                            |
| ICP    | Inventory Control Point                                      |
| IPIM   | Integrated Product Information Model                         |
| IPO    | IGES/PDES Organization                                       |

|         |                                                 |
|---------|-------------------------------------------------|
| IRB     | Industry Review Board                           |
| ISO     | International Organization for Standardization  |
| ManTech | Manufacturing Technology                        |
| NBS     | National Bureau of Standards                    |
| NC      | Numerical Control                               |
| NIST    | National Institute of Standards and Technology  |
| NSN     | National Stock Number                           |
| O&S     | Operation & Support                             |
| P&IC    | Production & Inventory Control                  |
| PALT    | Procurement Administrative Lead Time            |
| PAS-C   | PDES Application Protocol Suite for Composites  |
| PD      | Product Data                                    |
| PDD     | Product Definition Data                         |
| PDES    | Product Data Exchange using STEP                |
| PMAG    | Project Management Advisory Group               |
| QA      | Quality Assurance                               |
| QFD     | Quality Function Deployment                     |
| RAMP    | Rapid Acquisition of Manufactured Parts         |
| RDB     | Requirements Data Bank                          |
| RFP     | Request for Proposal                            |
| SDAI    | STEP Data Access Interface                      |
| SM-ALC  | Sacramento Air Logistics Center                 |
| SOTA    | State-of-the-Art                                |
| SOW     | Statement of Work                               |
| SPO     | System Program Office                           |
| SQL     | Structured (or Standard) Query Language         |
| STEP    | Standard for the Exchange of Product Model Data |
| TCA     | "T" Composite Assembly                          |
| TD      | Technical Data                                  |
| VIG     | Vendor Implementation Group                     |
| WG      | Working Group                                   |
| WSN     | Wirth Syntax Notation                           |

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## 1 INTRODUCTION

---

There are many challenges in developing standards that determine such items as formats, methodologies, and organization for data exchange, especially in the realm of emerging technology areas such as composites. One of the major managerial challenges in creating a PDES Application Protocol Suite for Composites (PAS-C) development strategy is to find the appropriate mix of elements where government, industry, and vendors can contribute and benefit. The greatest technical challenge is creating a development strategy where many diverse informational views pertaining to one piece of information are identified and then similarities distinguished to make a core of generic sharable information. The focus of this document is to refine the functional needs identified in *Functional Needs IDEF0 Activity and Information Needs for the PAS-C Program* [1], to correlate these composite part information exchange needs to resources in the PDES/STEP information models, and to prioritize the addressing of the voids identified during the comparison. The comparisons and prioritization provide insight into the breadth of the preliminary scopes of the Application Protocols (APs) for the PAS-C Program.

### 1.1 PAS-C Program Overview

The PAS-C Program addresses two critical national technologies - composites and product data exchange tools. Each of these emerging technologies exist in a dynamic environment. Not only are there fast paced technical changes, but there are also frequent changes in the organizations involved in formulating the technology. PAS-C has developed a set of approaches that will maximize the success of the PAS-C Program and minimize the risks associated with the changes that are on going in both the technology and the environment.

The awareness of the current PDES/STEP and composites environments and the ability to function effectively within those environments is critical to the success of the PAS-C Program. Composite information contains unique requirements, with both detail and assembly, and with material and process information closely intertwined. The complexity and volume of product data associated with a composite part is usually much greater than other types of parts.

The PAS-C Program has structured a unique technical approach for developing an Application Protocol Suite (AS) for composites. This Framework/Building-Block (FW/BB) methodology is designed to address the integratibility, extensibility and nesting of Application Protocols (APs). The building blocks shown in Figure 1 can be reused on multiple APs. After validation on PAS-C, this methodology will be a proven technique to implement Application Protocol Suites.

The approach being used in conducting the PAS-C Program is designed to maximize the consensus within the communities (composites, standards, software applications and government) with regard to the following PAS-C products: Composite Needs Analysis, PDES State-of-the-Art (SOTA) Assessment, PDES Voids, AS Development Strategies, AS Test and Demonstration

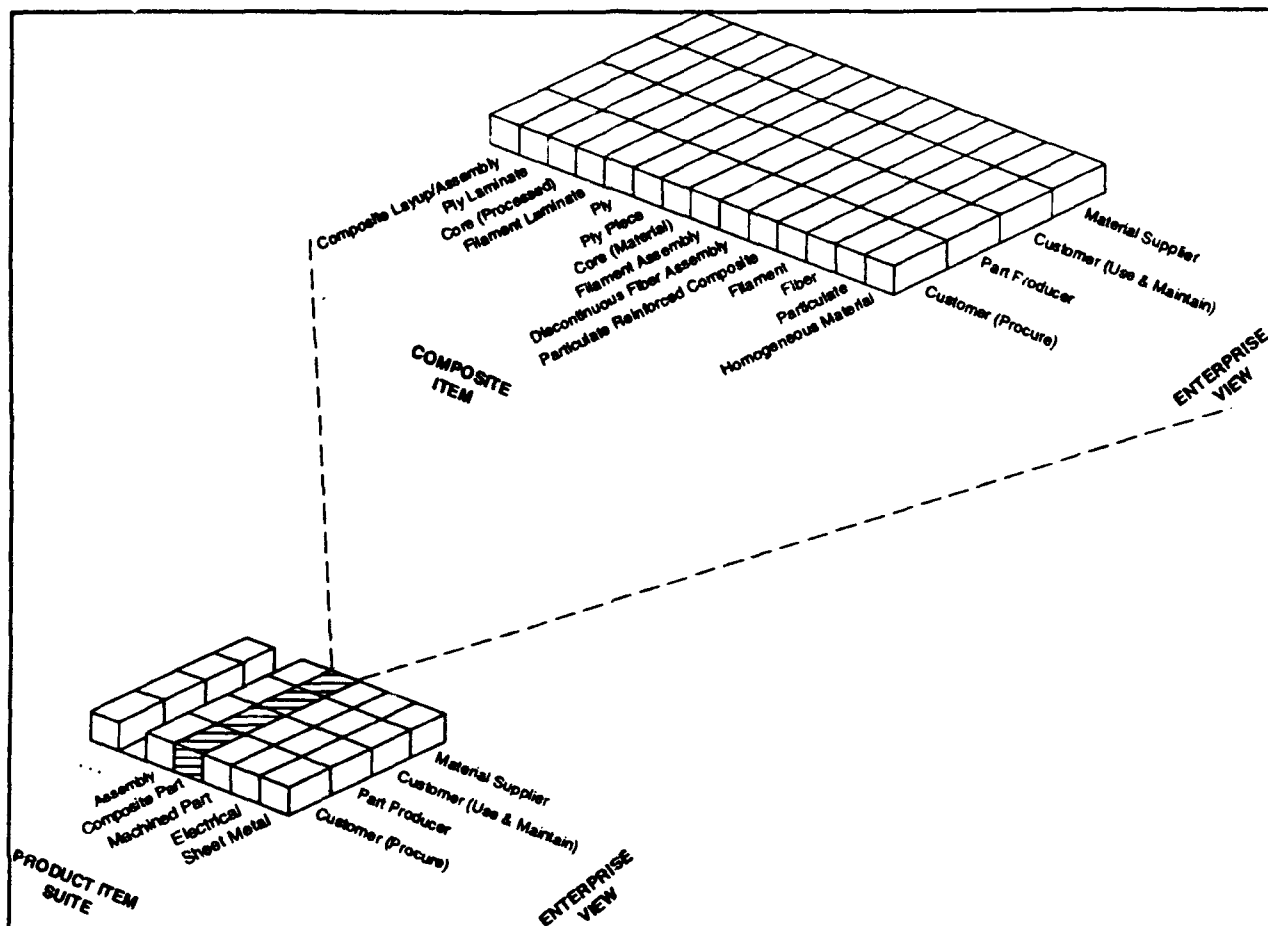


**Figure 1 Framework/Building-Block Structure for Composites Application Protocol Suite**

Criteria, Application Reference Models (ARMs) and Application Interpreted Models (AIMs). Achieving a consensus in these areas is important to the approach. An integrated set of activities is being utilized to achieve the greatest consensus possible in the least amount of time.

A goal of the PAS-C Program is to stimulate vendors to develop a set of software applications that will be used by the composites manufacturers. Several of the most important activities in the approach are:

- The IPO Composites Committee and other IPO/ISO committees to review and approve the SOTA, Application Activity Models (AAMs), ARMs, and AIMs,
- The Framework/Building-Block methodology for developing Needs Analysis and models,

- Industry Review Board and Vendor Implementation Group participation in developing the priority of voids, AS Strategy, Test and Demonstration Criteria and the demonstrations,
- Design of a risk management strategy based on consensus building among the industry, vendor, government and standards communities,
- Technology transfer centered on achieving concurrence with and ownership of the AS results of the program throughout all communities.

The Air Logistics Centers (ALCs) are being encouraged to participate at the onset of the program. Through the Vendor Implementation Group (VIG), vendors will understand the business case and be encouraged to develop commercial tools. The Industry Review Board (IRB) provides a forum for the Air Force, Industry, and the PDES community to review the progress of the PAS-C Program and provide guidance.

The PAS-C Program schedule consists of completing the PAS-C Program within 52 months and is divided into three phases. Air Force approval is required before commencing effort on Phases II and III. This schedule contains a 12 month duration for Phase I, a 24 month duration for Phase II, and a 12 month duration for Phase III. This is followed by a 4 month period for conducting the Industry/Government Debriefing and final report preparation and review.

Figure 2 provides the overall program roadmap. Output from each Phase provides the needed input to the next successive Phase. The results of the Needs Analysis tasks performed in Phase I form the basis for developing the Application Protocol Suite. Up to three Application Protocols are anticipated for the AS developed in Phase II. The schedule reflects the proposed development times for the ARM, AIM, and Testing Criteria for each of these Application Protocols. Phase III will use the AS developed in Phase II for a demonstration.

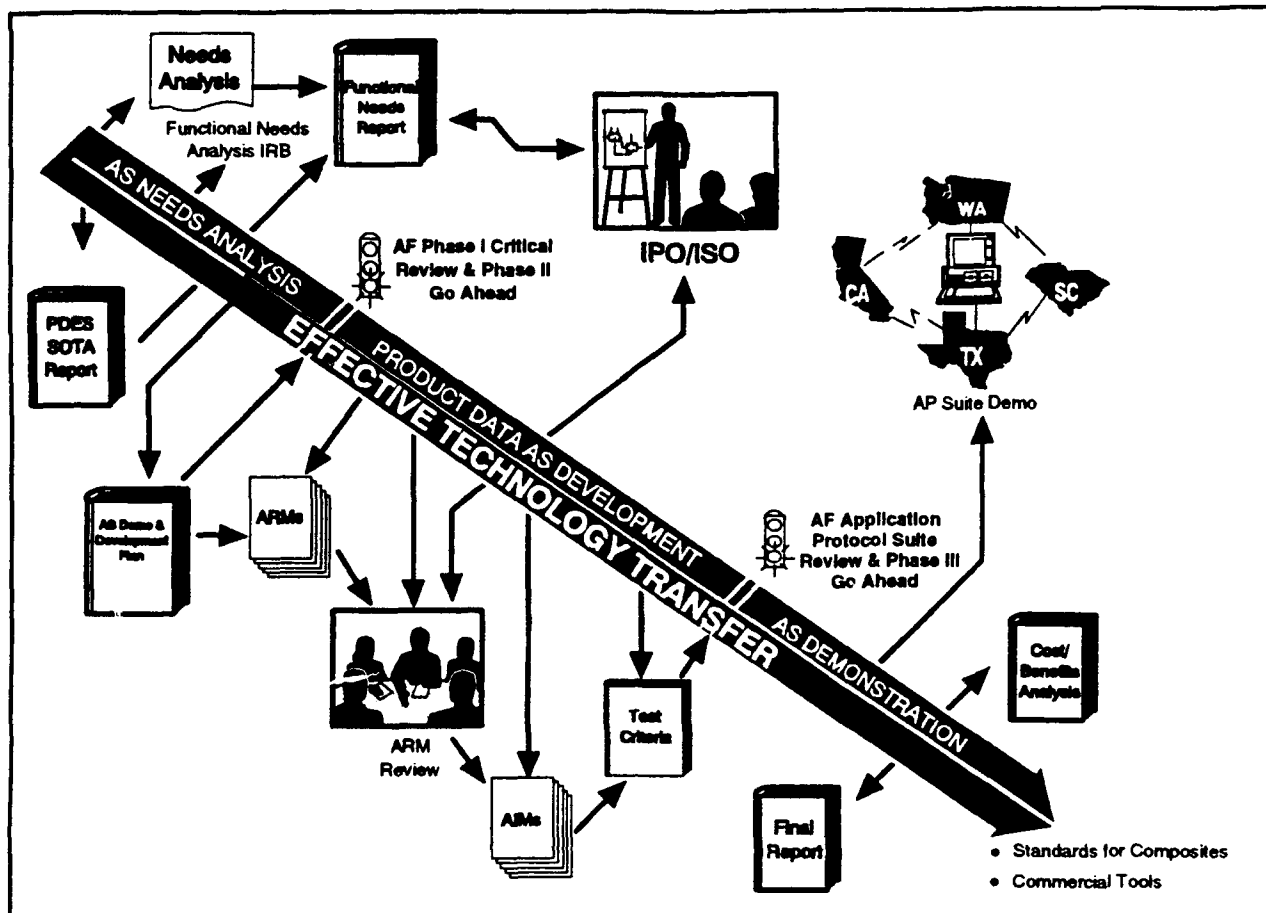


Figure 2 PAS-C Program Roadmap

## 1.2 Program Organization

The PAS-C Program organization is shown in Figure 3. An important part of the PAS-C Program is the Industry Review Board (IRB) which is comprised of both industry and government representatives (Composites Automation Consortium, Inc., DARPA, General Motors, IPO, Lockheed, Navy, Northrop and Universal Technologies). The IRB convenes at Air Force scheduled reviews to receive progress reports of the effort and offer guidance to the program team. The team is also aided by the Risk Management Board, made up of senior executives from the participating companies. This board meets periodically to provide advice on quality and risk management.

Another important aspect of the program organization is the Vendor Implementation Group (VIG). This group interacts with the team continuously to insure that the development of implementation tools (e.g., translators) is incorporated into its business strategy. The AS development tasks are performed by a team of composites and PDES/STEP experts from Boeing, General Dynamics and LTV.

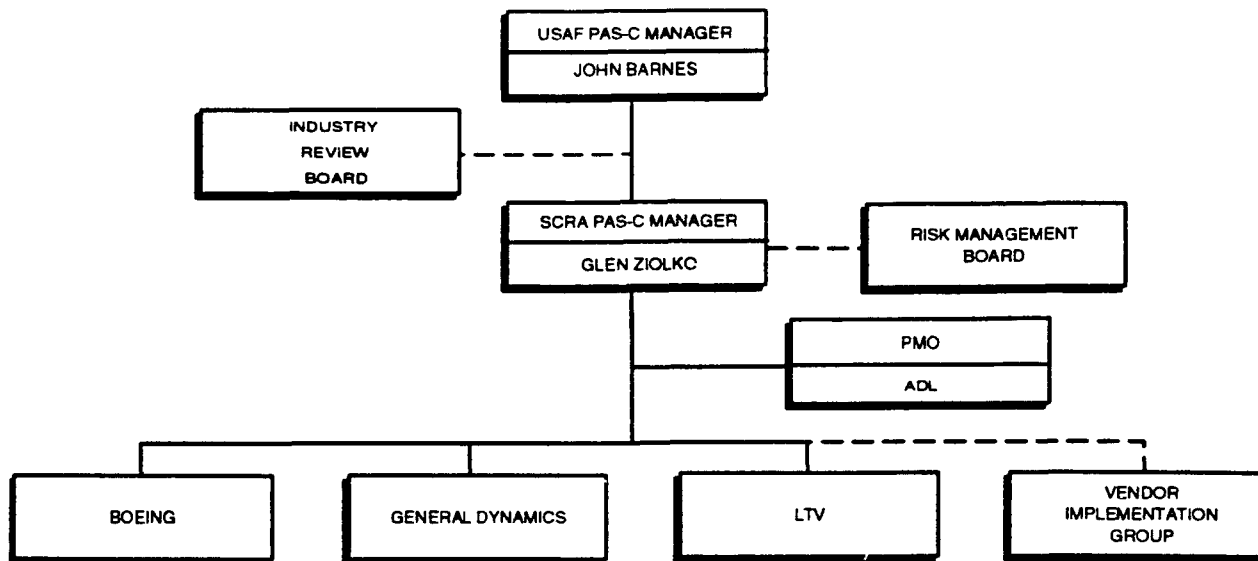


**Figure 3 PAS-C Program Organization**

### 1.3 Document Objectives

There are three major objectives of this document. The first objective is to record the refinement of the functional needs that were documented in reference [1]. Secondly this document records the correlation of these composite part information exchange needs to the available resources in the PDES/STEP information models. Finally, this document records the prioritization of the information exchange capability voids identified during the comparison. The body of this document is divided into four sections:

#### 2 METHODOLOGY

Defines the overall methodology for performing the refinement of the needs analysis, and for creating and interpreting the Quality Function Deployment (QFD) technique House of Quality (HoQ) assessment of information needs to PDES/STEP and PAS-C resources.

#### 3 NEEDS REFINEMENT

Contains the documentation of the refined information needs and their relationship to the activity models.

#### 4 CORRELATION OF COMPOSITE AND APPLICATION INFORMATION NEEDS TO PDES/STEP INFORMATION MODELS

Contains the documentation of the WHAT (Information Needs) versus HOW

(PDES/STEP Parts and their Schemas) matrix of the HoQ.

## 5 NEEDS TO VOIDS CORRELATION AND PRIORITIZATION

Contains the documentation of the WHAT (Information Needs) versus WHY (Importance of Needs) matrix, and the HOW MUCH (Development Tasks) versus HOW (PDES/STEP Parts and their Schemas) of the HoQ. Also contains the assessment of which voids are to be addressed by the PAS-C Program, or by the PDES/STEP community, and the coordination of those efforts.

These refinements, comparisons and prioritizations are used in the document *Scoping and Benefits Criteria (Volume II) for the PAS-C Program* [2] to set the preliminary scopes of the Application Protocol Suite.

---

## 2 NEEDS vs. STEP COMPARISON METHODOLOGY

---

### 2.1 Composites and Application Needs Analysis Refinement

The information needs documented in *Functional Needs IDEF0 Activity and Information Models for the PAS-C Program* [1] required update and refinement to reflect the current state of the PAS-C Program. Several of the terms and definitions have been updated, and several FW/BB views added. However, the key activity of the needs refinement is the forging of a relationship between the needs (characteristics) and the IDEF0 activity models. These relationships assure that the information documented by the two methods is consistent. The methodology of forging these relationships is a three step iterative process:

1. Review the characteristics list and associate each characteristic with node(s) in the IDEF0 activity model.
2. Add information needs (characteristics) to the FW/BB view that are required by the associated IDEF0 activities.
3. Add information needs (characteristics) that have been established from activities beyond those documented in reference [1]. These will primarily come from the evolving AP scope statements and external reviews.

The refined needs are then sorted and combined for input to the WHATs column in the House of Quality (HoQ) tables. The HoQ and Quality Function Deployment methodologies are discussed in the following sections.

If any of the revised characteristics do not have corresponding activities or ICOMs, the activities will be added to the existing activity models during the development of the Application Activity Models during the beginning of AP development in Phase II.

### 2.2 Quality Function Deployment (QFD)

#### 2.2.1 Overview of QFD

Quality Function Deployment (QFD) was developed to consider quality early in the design process. The method focuses on identifying requirements or objectives and then focusing development efforts on satisfying those requirements that yield the best return on investment. QFD is a simple method that appears complex when first introduced. The perception of complexity arises from the utilization of the primary QFD tool, the House of Quality chart. Figure 4 illustrates the HoQ used by the PAS-C team.

**WHATs:** A typical QFD analysis begins with the identification of the requirements/objectives (WHATs). This list is developed based upon pre-defined requirements or a collection of the "voice of the customer". WHATs are listed along the left hand side of the central matrix of the house of quality. For PAS-C, the needs analysis effort provided the "needs" for the program.

**HOWs:** The methods that can be used to satisfy the WHATs are referred to as HOWs. This list is usually referred to as quality characteristics. However, in the case of PAS-C, the hows are pre-defined to be the elements of the STEP standard.

**WHYs:** The right hand side of the central matrix are the WHYs. In a typical QFD analysis WHYs describe the market, e.g. why this product is needed (i.e., market niche). This is usually presented as customer groups that the product must satisfy. The PAS-C team utilized the WHY category as a list of benefit or success criteria for the program.

**HOW MUCHes:** HOW MUCHes are a list of the technical description of the market place. It includes priority information and targets or goals for the HOWs. As part of the PAS-C methodology, this category was used to assess the technical effort required to fill the identified composites' voids in STEP.

**WHATs vs. HOWs:** This is a correlation matrix in the center of the central matrix that defines how well the HOWs listed satisfy the WHATs. It is in this matrix that the level of ability to satisfy the needs is established. The PAS-C team utilized this matrix to identify the voids within STEP. The team used this analysis to assess the specific portion of the standard that would need to be worked to fill the void.

**WHATs vs. WHYs:** The right hand side matrix of the house is used to prioritize the WHATs. This is typically based upon marketing information that defines what the different customer groups perceive as important. The PAS-C team utilized this matrix to prioritize the PAS-C needs based upon their contribution to the success of the program and/or benefit of filling the void.

**HOW MUCHes vs. HOWs:** The bottom matrix of the house is typically used to define an objective means to assure that requirements have been met. The PAS-C team did not utilize this matrix, but rather used data in the WHAT vs. WHY matrix to assess and document the developmental costs associated with filling each void.

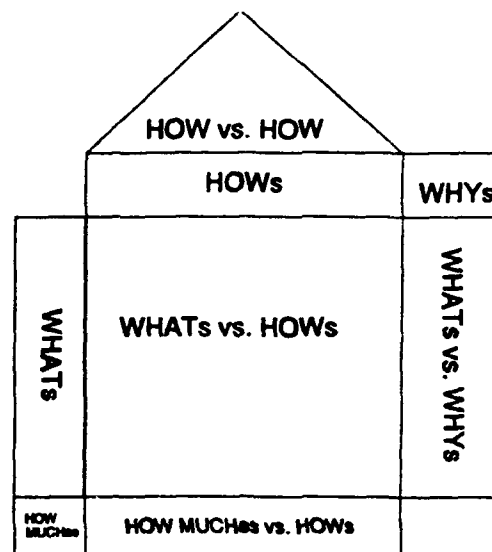


Figure 4 The House of Quality pulls all of the QFD elements together.

## 2.2.2 PAS-C Application of QFD

The PAS-C team utilized a computer based tool QFDCapture<sup>1</sup> to facilitate the creation and management of the data generated during the analysis phase. In attempting to apply the QFD method and tool to the task at hand, the PAS-C team modified the methodology. This section describes those modifications and a description of how to interpret the QFD analysis information presented in the rest of this document.

### 2.2.2.1 WHATs vs. HOWs

The PAS-C team utilized this matrix to identify the voids within STEP. The team used this analysis to assess the specific portion of the standard that would need to be worked to fill the void. One benefit to the PAS-C goals is that a high level mapping of PAS-C entities to STEP was performed and documented within the QFD data base. This report discusses the WHATs vs. HOWs analysis portion of the PAS-C QFD analysis activity.

#### 2.2.2.1.1 Mapping needs to STEP -- "The Comparison"

The process of mapping the needs to STEP capabilities involved reviewing the requirements listed in the *Functional Needs Report for the PAS-C Program* [3] and comparing those with the entity and schema content of the various STEP Parts. Those Parts and their Schemas that mapped to a PAS-C need were documented based upon the degree with which the data intent and structure of STEP satisfied the need.

The comparison results were documented in the HoQ matrix. The strength of the relationship received a value rating illustrated in Figure 5. A value of 9, or filled circle, indicates that the information requirement is strongly satisfied by that STEP Part. An open circle, value of 3, represents that the need is partially satisfied, but that Part is deemed as partially deficient in fulfilling the need. Voids are identified with a triangle, value 1, indicating that there is a potential match in name only and not in data content. A value of negative one, -1, indicates that the Part does not satisfy any of the PAS-C information need and probably should. The far right hand side of the HOWs lists "Void to be filled by Composite Resource Model". In each case where it was decided that a significant void remained which is outside the scope of any of the STEP Parts, a value of nine was assigned indicating that the composite resource model should be utilized to fill the void.

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<sup>1</sup> QFDCapture is a trademark of International TechneGroup Incorporated.

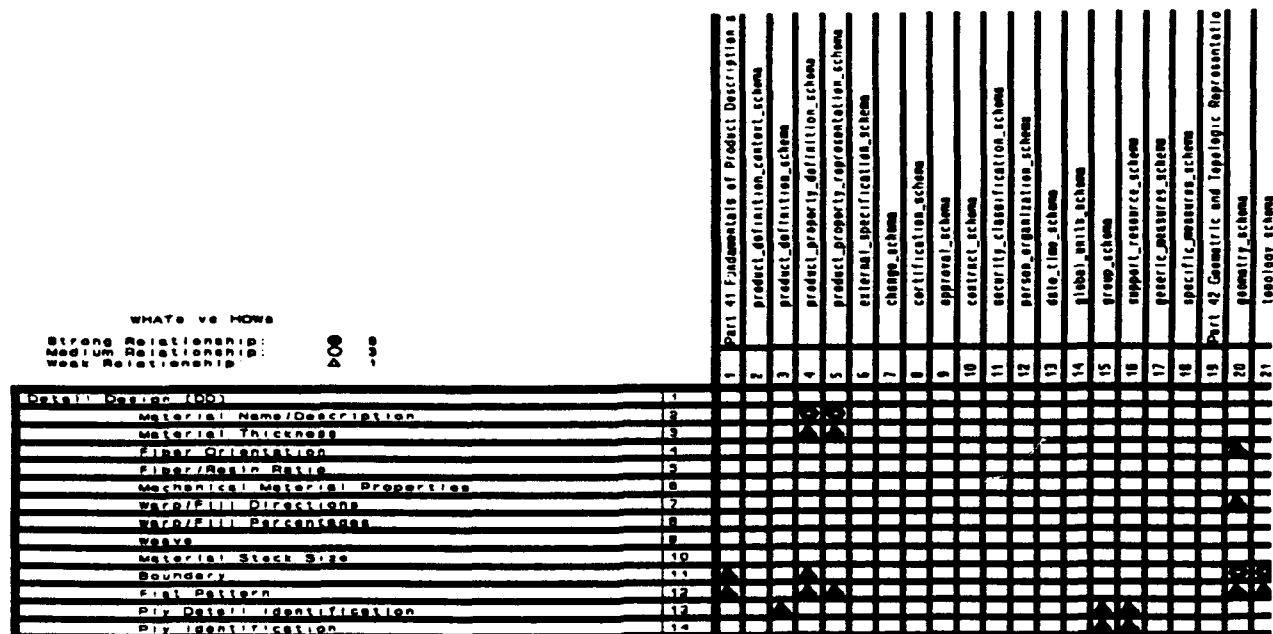


Figure 5 QFD compares PAS-C needs to STEP capabilities

### 2.2.2.1.2 Identifying Voids

The voids potentially to be addressed by the PAS-C Team are those areas of the matrix which have a triangle, value of 1, or a value of -1. Each matrix cell under "Void to be filled by Composite Resource Model" with a value of -1 are voids that should potentially be addressed by the PAS-C effort. The determination of which voids to fill is a function of how much effort is required to fill the void, what is the payback to PAS-C in filling the void, and the PAS-C resource limitations. The QFD process provides the methodology to relate these three components to each void identified.

### 2.2.2.2 HOW MUCHes vs. HOWs

The HOW MUCHes vs. HOWs was not populated. Instead, a Cost to Fill Void column was incorporated in the WHATs vs. WHYs matrix in order to assess the development activities and effort required to fill the voids.

### 2.2.2.3 WHATs vs. WHYs

The WHATs vs. WHYs matrix analyzes the PAS-C needs versus certain quantifiable aspects of the criteria that determine the success of the PAS-C program. The analysis provides a method to prioritize those needs based upon importance to the program success. The complete WHATs vs. WHYs analysis is provided later in this document.

#### **2.2.2.3.1 Prioritizing Needs**

The first column of the WHYs was determined by taking the WHATs (i.e. needs) and determining what percentage of the total activity for the subject area the WHAT had a bearing on. This column gives an indication of the time that the subject area utilized this data. The second column of the WHYs was determined by taking the percentage improvement that the domain expert thought a PDES/STEP implementation could have on their subject area and applying it to the WHATs. This data was formulated during the refinement of the data in the needs analysis discussed in Section 3. Figure 6 illustrates a ranking within the QFD House of Quality for these two different methods of prioritization. This prioritization provides an indication where possible payback could be realized.

#### **2.2.2.3.2 Estimating the Cost to Fill Voids**

The cost of filling the voids is identified in the Cost to Fill Void Column. The value is in terms of a normalized cost unit, labor hours. These values represent the cost estimate to perform each void filling task.

#### **2.2.2.3.3 Prioritizing Voids by Cost vs. Benefit**

Of key interest to the PAS-C Program is the cost benefit potential of filling each void identified during the needs comparison task. The combined ranking and rating of each need is coupled with the cost of filling the need. The result is a focused development activity directed towards the key areas of success and high benefit. The fourth column (CBA Ratio) gives the ratio of the cost (third column) to the benefit in the second column.

**Detailed Structural Design  
Whats vs. Whys**

Last Updated: 20 May 92  
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Last Updated: 20 May 92  
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|                                    | Weighting | <div>Percent Utilization</div> <div>Percent Improvement</div> <div>Cost to Fill Void</div> <div>CBA Ratio</div> <div>Cost to Include into AP3</div> <div>Inverse Normalized Cost</div> <div>Normalized Utilization</div> <div>Normalized Improvement</div> <div>Normalized Cost to Fill Void</div> <div>Weighted Avg Importance of Void</div> <div>Rank of Wgt'd Importance of Void</div> <div>Inverse Normalized Cost</div> <div>Normalized Cost to Include in AP</div> <div>Weighted Avg of Importance in AP</div> <div>Rank of Wgt'd Importance in AP</div> |      |      |      |      |      |      |      |      |      |      |      |      |      |      |    |
|------------------------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|----|
|                                    |           | 0.30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.20 | 0.50 | 0.00 | 0.50 | 0.50 | 0.30 | 0.20 | 0.50 | 0.00 | 0.00 | 0.50 | 0.00 | 0.00 | 0.00 |    |
| Fastener Holes & Cut Outs          | 1         | 62.8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 |      |      | 105  | 20   | 0    |      | 6.01 | 1    | 0.27 | 3    | 5.15 | 1    | 1    |    |
| Configuration Control Information  | 2         | 16.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1.00 |      |      | 105  | 5    | 10   |      | 3.58 | 2    | 0.27 | 3    | 3.72 | 3    | 2    |    |
| Mold/Bag Line Surface              | 3         | 28.7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.27 |      |      | 35   | 8    | 3    |      | 3.28 | 3    | 0.82 | 1    | 3.80 | 2    | 3    |    |
| Fiber/Resin Ratio                  | 4         | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1.00 | 16   | 0.0  | 35   | 0    | 3    | 10   | 2    | 3.26 | 4    | 0.82 | 1    | 3.42 | 6    | 4  |
| Material Name                      | 5         | 11.8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1.00 |      |      | 35   | 4    | 10   |      | 3.18 | 5    | 0.82 | 1    | 3.59 | 4    | 3    |    |
| Material Name/Description          | 6         | 11.8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1.00 |      |      | 35   | 4    | 10   |      | 3.18 | 6    | 0.82 | 1    | 3.59 | 5    | 8    |    |
| Material Thickness                 | 7         | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1.00 | 32   | 0.0  | 35   | 0    | 3    | 10   | 4    | 3.13 | 7    | 0.82 | 1    | 3.42 | 6    | 7  |
| Material Stock Size                | 8         | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1.00 |      |      | 35   | 3    | 10   |      | 3.01 | 8    | 0.82 | 1    | 3.42 | 6    | 8    |    |
| Ply Stock Size                     | 9         | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1.00 |      |      | 35   | 3    | 10   |      | 3.01 | 9    | 0.82 | 1    | 3.42 | 6    | 9    |    |
| Tolerances                         | 10        | 12.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.36 | 32   | 0.0  | 70   | 0    | 4    | 4    | 4    | 2.05 | 10   | 0.41 | 2    | 2.13 | 10   | 10 |
| Tooling Interface Information      | 11        | 5.40                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.54 | 25   | 0.0  | 35   | 0    | 2    | 6    | 3    | 1.78 | 11   | 0.82 | 1    | 2.03 | 12   | 11 |
| Laminate Thickness                 | 12        | 8.47                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.36 |      |      | 35   | 3    | 4    |      | 1.65 | 12   | 0.82 | 1    | 2.06 | 11   | 12   |    |
| Next Assembly Information          | 13        | 12.7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 |      |      | 70   | 4    | 0    |      | 1.21 | 13   | 0.41 | 2    | 1.42 | 13   | 13   |    |
| OML/IML Surface                    | 14        | 4.64                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.27 |      |      | 35   | 1    | 3    |      | 0.99 | 14   | 0.82 | 1    | 1.40 | 14   | 14   |    |
| Envelope                           | 15        | 3.51                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.15 | 16   | 0.0  | 35   | 0    | 1    | 2    | 2    | 0.81 | 15   | 0.82 | 1    | 1.07 | 16   | 15 |
| Ply Detail Interface               | 16        | 3.76                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.19 | 50   | 0.0  | 70   | 0    | 1    | 2    | 6    | 0.84 | 16   | 0.41 | 2    | 0.96 | 19   | 16 |
| Ply Stack                          | 17        | 7.77                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 | 50   | 0.0  | 70   | 0    | 2    | 0    | 6    | 0.82 | 17   | 0.41 | 2    | 0.94 | 20   | 17 |
| Panel Size                         | 18        | 7.39                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 |      |      | 35   | 2    | 0    |      | 0.72 | 18   | 0.82 | 1    | 1.13 | 15   | 18   |    |
| Boundary                           | 19        | 3.51                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.15 |      |      | 35   | 1    | 2    |      | 0.66 | 19   | 0.82 | 1    | 1.07 | 16   | 19   |    |
| Weight                             | 20        | 3.98                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 | 16   | 0.0  | 35   | 0    | 1    | 0    | 2    | 0.63 | 20   | 0.82 | 1    | 0.79 | 25   | 20 |
| Laminate Assembly Process          | 21        | 5.83                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 | 125  | 0.0  | 175  | 0    | 2    | 0    | 15   | 0.58 | 21   | 0.16 | 6    | 0.63 | 29   | 21 |
| Ply Detail Location                | 22        | 1.84                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.18 |      |      | 70   | 1    | 2    |      | 0.50 | 22   | 0.41 | 2    | 0.79 | 24   | 22   |    |
| Ply Table                          | 23        | 5.89                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 |      |      | 140  | 2    | 0    |      | 0.56 | 23   | 0.20 | 4    | 0.88 | 28   | 23   |    |
| Percentage (%) Ply Angle/Thickness | 24        | 5.83                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 |      |      | 35   | 2    | 0    |      | 0.55 | 24   | 0.82 | 1    | 0.96 | 18   | 24   |    |
| Damage Tolerance                   | 25        | 3.88                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 | 25   | 0.0  | 35   | 0    | 1    | 0    | 3    | 0.53 | 25   | 0.82 | 1    | 0.78 | 26   | 25 |
| Cross-Section Properties           | 26        | 3.88                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 | 25   | 0.0  | 105  | 0    | 1    | 0    | 3    | 0.53 | 25   | 0.27 | 3    | 0.50 | 40   | 26 |
| Material Specification             | 27        | 5.24                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 |      |      | 35   | 2    | 0    |      | 0.50 | 27   | 0.82 | 1    | 0.91 | 21   | 27   |    |
| Flat Pattern                       | 28        | 1.57                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.15 |      |      | 35   | 1    | 2    |      | 0.47 | 28   | 0.82 | 1    | 0.88 | 22   | 28   |    |
| Laminate Patch                     | 29        | 1.84                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 | 16   | 0.0  | 35   | 0    | 1    | 0    | 2    | 0.43 | 29   | 0.82 | 1    | 0.59 | 31   | 29 |
| Number of Ply Details              | 30        | 1.82                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 | 16   | 0.0  | 35   | 0    | 1    | 0    | 2    | 0.42 | 30   | 0.82 | 1    | 0.58 | 31   | 30 |
| Joints/Interfaces                  | 31        | 3.91                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 | 125  | 0.0  | 175  | 0    | 1    | 0    | 15   | 0.40 | 31   | 0.16 | 6    | 0.45 | 43   | 31 |
| Ply Quantities                     | 32        | 3.94                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 |      |      | 35   | 1    | 0    |      | 0.38 | 32   | 0.82 | 1    | 0.79 | 23   | 32   |    |
| Ply Transition                     | 33        | 3.88                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 |      |      | 35   | 1    | 0    |      | 0.37 | 33   | 0.82 | 1    | 0.78 | 26   | 33   |    |
| Filler Piles                       | 34        | 2.11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 | 25   | 0.0  | 35   | 0    | 1    | 0    | 3    | 0.26 | 34   | 0.82 | 1    | 0.61 | 30   | 34 |
| Strength                           | 35        | 1.84                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0.00 | 25   | 0.0  | 35   | 0    | 1    | 0    | 3    | 0.34 | 35   | 0.82 | 1    | 0.59 | 31   | 35 |

**Figure 6** Prioritizing Needs Using the QFD Method

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### **3 COMPOSITES and APPLICATIONS INFORMATION NEEDS ANALYSIS REFINEMENT**

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The information needs documented in reference [1] have been updated and refined. Several of the terms and definitions have been updated, and several FW/BB views added and documented in this section.

The key activity of the needs refinement has been the forging of a relationship between the needs (characteristics) and the IDEF0 activity models. The refined characteristics tables for Design, Analysis and Manufacturing are presented in Appendices B, C, and D. These refined characteristics are used in Section 4 to populate the WHAT column of the three HoQ's for Design, Analysis and Manufacturing.

#### **3.1 Revised Terminology**

The revised functional view names, building block titles and two new building blocks are listed below. These revisions are cross referenced (where possible) with the names and titles as documented in reference [1].

##### **3.1.1 Revised Functional Views**

Old: Detail Design

New: Detail Structural Design

##### **3.1.2 Revised Building Block Titles**

Old: Detail Structural Analysis - Core Detail

New: Detail Structural Analysis - Core (Material and Processed - Machined)

Old: Detail Structural Analysis - Core Assembly

New: Detail Structural Analysis - Core (Processed - Assembly)

Old: Detail Structural Analysis - Composite Layup Assembly (Core Assembly/Ply Laminate(Flat)/Ply Layup)

New: Detail Structural Analysis - Composite Layup/Assembly (Ply Laminate (Flat)/Core/Ply Laminate - Core Stiffened Panel)

Old: Detail Structural Analysis - Composite Layup Assembly (Ply Laminate (Angle)/Ply Laminate (Angle)/Filament Detail (Filler)/Ply Laminate (Cap))  
New: Detail Structural Analysis - Composite Layup/Assembly (Ply Laminate (Angle)/Ply Laminate (Angle)/Filament Laminate (Radius Filler)/Ply Laminate (Cap) - "T" Composite Assembly)

Old: Preliminary Structural Analysis - Core Detail  
New: Preliminary Structural Analysis - Core (Material and Processed - Machined)

Old: Preliminary Structural Analysis - Composite Layup Assembly (Core Assembly/Ply Laminate(Flat)/Ply Layup)  
New: Preliminary Structural Analysis - Composite Layup/Assembly (Ply Laminate (Flat)/Core/Ply Laminate - Core Stiffened Panel)

Old: Preliminary Structural Analysis - Composite Layup Assembly (Ply Laminate (Angle)/Ply Laminate (Angle)/Filament Detail (Filler)/Ply Laminate (Cap))  
New: Preliminary Structural Analysis - Composite Layup/Assembly (Ply Laminate (Angle)/Ply Laminate (Angle)/Filament Laminate (Radius Filler)/Ply Laminate (Cap) - "T" Composite Assembly)

Old: Structural Test - Composite Layup Assembly (Core Assembly/Ply Laminate(Flat)/Ply Layup)  
New: Structural Test - Composite Layup/Assembly (Ply Laminate (Flat)/Core/Ply Laminate - Core Stiffened Panel)

Old: Structural Test - Composite Layup Assembly (Ply Laminate (Angle)/Ply Laminate (Angle)/Filament Detail (Filler)/Ply Laminate (Cap))  
New: Structural Test - Composite Layup/Assembly (Ply Laminate (Angle)/Ply Laminate (Angle)/Filament Laminate (Radius Filler)/Ply Laminate (Cap) - "T" Composite Assembly)

Old: Detail Structural Design - (Filler)  
New: Detail Structural Design - (Tow)

Old: Detail Structural Design - Core - Machined  
New: Detail Structural Design - Core (Processed - Machined)

Old: Detail Structural Design - Core - Formed  
New: Detail Structural Design - Core (Processed - Formed)

Old: Detail Structural Design - Core - Stabilized  
New: Detail Structural Design - Core (Processed - Stabilized)

Old: Detail Structural Design - Composite Assembly Core Stiffened Panel (CSP) - Core/Ply Laminate/Ply Laminate  
New: Detail Structural Design - Composite Layup/Assembly (Ply Laminate (Flat)/Core/Ply Laminate - Core Stiffened Panel)

Old: Detail Structural Design - "T" Composite Assembly - LD Angle/LD (Angle)/Filament Laminate (Filler)/LD (Cap)  
New: Detail Structural Design - Composite Layup/Assembly (Ply Laminate (Angle)/Ply Laminate (Angle)/Filament Laminate (Radius Filler)/Ply Laminate (Cap) - "T" Composite Assembly)

Old: Manufacturing Planning - (Filler)  
New: Manufacturing Planning - (Radius Filler)

Old: Manufacturing Planning - Core - (Machined)  
New: Manufacturing Planning - Core (Processed - Machined)

Old: Manufacturing Planning - Core Assembly  
New: Manufacturing Planning - Core (Processed - Assembly)

Old: Manufacturing Planning - Composite Layup/Assembly (Core Stiffened Panel)  
New: Manufacturing Planning - Composite Layup Assembly (Ply Laminate (Flat)/Core/Ply Laminate - Core Stiffened Panel)

Old: Manufacturing Planning - Composite Layup Assembly ('T')  
New: Manufacturing Planning - Composite Layup/Assembly (Ply Laminate (Angle)/Ply Laminate (Angle)/Filament Laminate (Radius Filler)/Ply Laminate (Cap) - "T" Composite Assembly)

Old: NC Programming - (Filler)  
New: NC Programming - (Radius Filler)

Old: NC Programming - Core - (Machined)  
New: NC Programming - Core (Processed - Machined)

Old: NC Programming - Core Assembly  
New: NC Programming - Core (Processed - Assembly)

Old: NC Programming - Composite Layup Assembly (Core Stiffened Panel)  
New: NC Programming - Composite Layup/Assembly (Ply Laminate (Flat)/Core/Ply Laminate - Core Stiffened Panel)

Old: NC Programming - Composite Layup Assembly ('T')

New: NC Programming - Composite Layup/Assembly (Ply Laminate (Angle)/Ply Laminate (Angle)/Filament Laminate (Radius Filler)/Ply Laminate (Cap) - "T" Composite Assembly)

Old: Process Planning - (Filler)

New: Process Planning - (Radius Filler)

Old: Process Planning - Core - (Machined)

New: Process Planning - Core (Processed - Machined)

Old: Process Planning - Core Assembly

New: Process Planning - Core (Processed - Assembly)

Old: Process Planning - Composite Layup Assembly (Core Stiffened Panel)

New: Process Planning - Composite Layup/Assembly (Ply Laminate (Flat)/Core/Ply Laminate - Core Stiffened Panel)

Old: Process Planning - Composite Layup Assembly ('T')

New: Process Planning - Composite Layup/Assembly (Ply Laminate (Angle)/Ply Laminate (Angle)/Filament Laminate (Radius Filler)/Ply Laminate (Cap) - "T" Composite Assembly)

Old: Tool Design - (Filler)

New: Tool Design - (Radius Filler)

Old: Tool Design - Core - (Machined)

New: Tool Design - Core (Processed - Machined)

Old: Tool Design - Core Assembly

New: Tool Design - Core (Processed - Assembly)

Old: Tool Design - Composite Layup Assembly (Core Stiffened Panel)

New: Tool Design - Composite Layup/Assembly (Ply Laminate (Flat)/Core/Ply Laminate - Core Stiffened Panel)

Old: Tool Design - Composite Layup Assembly ('T')

New: Tool Design - Composite Layup/Assembly (Ply Laminate (Angle)/Ply Laminate (Angle)/Filament Laminate (Radius Filler)/Ply Laminate (Cap) - "T" Composite Assembly)

### **3.1.3 Revised Characteristics**

#### **Analysis**

Old: Ply Detail Normal

New: Ply Piece Normal

Old: N/A

New: Assembly Reference Orientation

#### **Detail Structural Design**

Old: Ply Detail Identification

New: Ply Piece Identification

Old: Ply Detail Interface

New: Ply Piece Interface

Old: Ply Detail Location

New: Ply Piece Location

Old: Number of Ply Details

New: Number of Ply Pieces

Old: N/A

New: Make From Core Identifier

#### **Manufacturing**

Old: Core Detail Position

New: Core Position

Old: N/A

New: Number of Ply Pieces

### 3.1.4 Additional Building Blocks

| <i>DETAIL STRUCTURAL DESIGN (DSD) - FILAMENT LAMINATE (RADIUS FILLER)</i> |                                                                                     |               |
|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------|
| Filament Laminate Identification                                          | The assigned filament laminate number and description.                              | A22324        |
| Cross Section                                                             | Shape of cross section(s) and area(s).                                              | A223233223133 |
| Length                                                                    | Length of cross section area(s).                                                    | A223233223133 |
| Filament Assembly Constituents                                            | Type and quantity of filament assemblies (ex. Tow) that make up filament laminates. | A22324        |

| <i>DETAIL STRUCTURAL ANALYSIS - FILAMENT LAMINATE (RADIUS FILLER)</i> |                                                                                       |  |
|-----------------------------------------------------------------------|---------------------------------------------------------------------------------------|--|
| Filament Laminate Identification                                      | The assigned filament laminate number and descriptor.                                 |  |
| Cross Section                                                         | The shape of the filament laminate cross-section(s) and area(s).                      |  |
| Length                                                                | The length of the filament laminate cross-section area(s).                            |  |
| Filament Assembly Constituents                                        | Type and quantity of filament assemblies (ex:tow) that make up the filament laminate. |  |

### 3.2 Design

The results of the mappings of the Design data indicated that many of the "building-block" characteristics do not map well to the activity models. The activity models detail the generalized approaches to developing composites designs whereas the characteristics represent details pertaining to aspects of the end-result of designing the characteristics. In other cases, some characteristics mapped to high level activity nodes that were not decomposed into their respective activities therefore the mapping of all similar characteristics point to one high level node and not to the specific activity that would result in the generation of the characteristic. The following information explains the justification for mappings that do not have an exact correlation between the characteristics and activities:

#### A223233223 Create ACSP Data:

- This section is divided into three sections: TCA, CSL, & CSP. Within this section, only ANGLE, CONTOURED, and FILLER are specifically handled. Types such as FLAT would be included in the characteristic partition called CAP; however, CAP is not

decomposed within the activity models in order to evaluate what its activities entail.

**A22323322312 Prepare TCA CAP Design:**

- All characteristics of the CAP design are included in one activity node number because the activity models are not decomposed further.

**A223233223221 Resolve CSP Core Edge Band Issues:**

- The output of this activity is being expanded to include the core "splice geometry". This expanded definition will allow the design characteristic to be mapped.

**A22323335 Attach Filler Plies in Transition Area:**

- This activity is being mapped to all characteristics requiring filler plies, even though it is found under "Integrate & Prepare CSP Assembly Drawings". A better mapping would be to some aspect of "detailed individual composite designs".

**A22322 Build Model and Drawing Tree:**

- This activity needs to have a decomposition activity model because of the projected scope of the Design application protocol.

**A22324 Build Parts List:**

- This activity needs to have a decomposition activity model because of the projected scope of the Design application protocol.

**A226 Manage Configuration of ACSP Data:**

- This activity node needs to be decomposed because it exports "configuration managed designs" which correlates to the projected scope of the Design application protocol.

**PLY PIECE design category:**

- Most characteristics are being mapped to CSL because it is assumed that a contour can also be flat.

**PLY design category:**

- Most characteristics are being mapped to CSL because it is assumed that a contour can also be flat.

**PLY LAMINATE - GENERAL FLAT design category:**

- Most characteristics are being mapped to CSL because it is assumed that a contour can also be flat.

**PLY LAMINATE - ANGLE design category:**

- LAMINATE SYMMETRY does not map to the activity model, but could possibly be mapped to A2222113 (Obtain ACSP Initial Weights and Balances).

**PLY LAMINATE - CAP design category:**

- Most characteristics from this category are being mapped to A22323322312 (Prepare TCA Cap Design) because this is the furthest the activity model is broken down.

**COMPOSITE ASSEMBLY CORE STIFFENED PANEL (CSP) - CORE/PLY LAMINATE/PLY LAMINATE design category:**

- Design characteristic "ASSEMBLY SYMMETRY" does not map to the activity model, but possibly could be mapped to A2222113 (Obtain initial Weights & Balances).

The specific Design revised characteristics and activity reference tables are documented in Appendix B.

### **3.3 Analysis**

There were four characteristics added to the Analysis tables. Three of the additions were required after the scopes were reviewed in IPO and ISO committees. The fourth was required after reviewing the ICOMS of the activities referenced by the characteristics documented in reference [1].

**ANALYSIS QUALITY/COMPLETENESS characteristic:**

The Analysis Quality/Completeness characteristic was suggested during the NAFEMS CAD/FE Data Exchange Working Group (which is a strong supporter of ISO FEA committee) review of the activity models. This characteristic is not supported by the activity model, so there can be no activity reference. The activities needed will be added in Phase II of the PAS-C program during the Application Activity Model (AAM) development phase.

**ANALYSIS DECISION DATA and CONFIGURATION CONTROL DATA characteristics:**

The Analysis Decision Data and Configuration Control Data characteristics were included upon reviewing the ICOMS of the referenced activities.

**LAMINATE PATCH characteristic:**

The Laminate Patch characteristic was included during the development and review of the AP Summary Sheet scope statements.

The specific Analysis revised characteristics and activity reference tables are documented in Appendix C.

### **3.4 Manufacturing**

The additional characteristics identified for Manufacturing were for the activity node A231, Plan for Manufacture. This Activity has as outputs Manufacturing, Bill-of-Materials, and Manufacturing Plan. These were not represented in the previous characteristics and were added in this process.

#### **MANUFACTURING BILL OF MATERIALS:**

Manufacturing Bill-of-Materials (BOM) is a new breakdown of the parts and materials required to build the part based on the manufacturing process. This BOM often has subassemblies for the major composite items which make up a composite part.

#### **MANUFACTURING PLAN:**

The Manufacturing Plan is the high level description of the steps necessary to manufacture the part. Part of the Manufacturing Bill-of-Materials is the ability to specify material to the activity Procure Manufacturing Materials. The two characteristics stock size and material amount were added to be able to do this.

#### **NC PROGRAMMING, PROCESS PLANNING, TOOL DESIGN:**

No new characteristics were identified for NC Programming, Process Planning, or Tool Design, the other major functional views considered in scope for this AP.

The specific Manufacturing revised characteristics and activity reference tables are documented in Appendix D.

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## **4 CORRELATION of COMPOSITES and APPLICATION INFORMATION NEEDS to PDES/STEP MODEL**

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### **4.1 PAS-C Needs to PDES/STEP Comparison**

The composite and application information needs have been correlated to the PDES/STEP Parts and Schemas using the WHAT (Information Needs) vs. HOW (PDES/STEP Parts and their Schemas) matrix of the House of Quality. Three tables have been developed, one each for Detail Structural Design, Detail Structural Analysis, and Manufacturing. Each of the characteristics is correlated to the Part(s) and Schema(s) that contain partial or complete resources to supply entities for the creation of the APs.

#### **4.1.1 Design**

Figure 7 documents the WHAT vs. HOW matrix of the Detail Structural Design House of Quality. Sixty-five percent of the Design characteristics are satisfied by the resources within STEP, such that specialization of the entities within the AP will fulfill the need.

Of the fifty-five design characteristics only nineteen were identified to have voids within STEP. It was established that six of these were significant voids in that they did not have any corresponding resources in STEP. The significant voids occurred in areas such as, assembly or interface definition, manufacturing process, and damage tolerance.

Eighteen or thirty-three percent of the design characteristics were strongly supported by STEP. These characteristics dealt mostly with geometry, orientation, product identification, and material.

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[illegible]

### Figure 7 Design Characteristics Mapped to STEP Resources

#### **4.1.2 Analysis**

The majority of the analysis characteristics correlated well to the present PDES/STEP resources. Of the forty-six characteristics, only three were judged to be complete voids, with one other judged to be a partial void. In the process of correlating the characteristics to the PDES/STEP resources an assumption was made that the majority of the composite needs could be met by specializing existing resources rather than creating special resources in a Composites information model.

Slightly more than half of the Analysis characteristics turned out to have strong geometric relationships. Of these most were concerned with establishing direction or orientation, the rest concerned mostly boundaries and surfaces.

Figure 8 documents the WHAT vs. HOW matrix of the Detail Structural Analysis House of Quality.

Let's start with the first one: "I am a  
a type of person, I am"

DATE: 06/06/2014

Strong Relationship:  
 Moderate Relationship:  
 Weak Relationship:

[illegible]

**Figure 8 Analysis Characteristics Mapped to STEP Resources**

### **4.1.3 Manufacturing**

Approximately half of the manufacturing characteristics correlated well to the present PDES/STEP resources. Of the characteristics, twenty were judged to be significant voids, with twelve others judged to be minimal voids. In the process of correlating the characteristics to the PDES/STEP resources an assumption was made that, from the manufacturing view point, several of these voids could not be met by specializing existing resources (the approach taken when evaluating voids from an analysis and design viewpoint). The use of Application Interpreted Constructs (AICs) from other APs may provide an alternate method for filling these voids. The AIC concept has not been definitized nor implemented at this time. Therefore, this approach will be evaluated for addressing voids during Phase II.

Figure 9 documents the WHAT vs. HOW matrix of the Manufacturing House of Quality.

|                          |    |    |
|--------------------------|----|----|
| Mr. and Mrs. J. H. Smith | 10 | 10 |
| Miss Jane Smith          | 10 | 10 |
| Thos. Smith              | 10 | 10 |

[illegible]

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## **4.2 PDES/STEP Identified Voids**

The identification of voids within the existing STEP Parts was performed by evaluating the data need defined by the Composite Item Characteristics to the data content of STEP. This comparison process is described in the previous section. The voids identified exist where there is minimal or no support for the Characteristic. These occurrences are identified in the QFD WHAT vs. HOW matrix with a triangle, value of one representing minimal coverage, or a -1 indicating a complete lack of support.

### **4.2.1 Design**

The Design voids are documented in the WHAT versus HOW matrix illustrated in Figure 10. Figure 10 is a shortened version of the matrix presented in Section 4.1.3 that contains only the characteristics that are voids for the sake of clarity.

There are nineteen identified characteristics which require further information definition than what is provided in STEP. These nineteen characteristics can be placed into the following categories; Properties, Manufacturing Process, Shape, Assembly, Tolerance, and Material. It is expected that most of these voids can be filled by the creation or modification of one to five entities each with their corresponding functions, rules, constraints, and documentation.

### **4.2.2 Analysis**

The Analysis voids are documented in the WHAT versus HOW matrix documented in Figure 11. Figure 11 is a shortened version of the matrix presented in Section 4.1.3 that contains only the characteristics that are voids for the sake of clarity.

There are four identified characteristics that require additional PDES/STEP resources. The Analysis Quality/Completeness void was a characteristic that was added to reflect review comments after the work on reference [1] was completed, and there is presently nothing in Part 104 (Finite Element Analysis) that addresses this need. The Test Results void is also not addressed in Part 104. The Analysis Decision Data void is partially addressed, but some enhancement will be required to fulfill PAS-C needs. The Weight void could be addressed either by a Composites model, or by the PDES/STEP Integrated Resources.

It is expected that these voids, and the weak relationships can be addressed by minimal modification to existing PDES/STEP resources.

### **4.2.3 Manufacturing**

The Manufacturing voids are documented in the WHAT versus HOW matrix documented in Figure 12. Figure 12 is a shortened version of the matrix presented in Section 4.1.3 that contains only the characteristics that are voids for the sake of clarity.

Unit Number: 48 MAY 82  
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| Design Characteristics                                                  |      | STEP                                                                    |      |
|-------------------------------------------------------------------------|------|-------------------------------------------------------------------------|------|
| Design Characteristics                                                  | STEP | Design Characteristics                                                  | STEP |
| 1. Part 41 Fundamentals of Product Description and Support              | 1    | 1. Part 41 Fundamentals of Product Description and Support              | 1    |
| 2. product_definition_scheme                                            | 2    | 2. product_definition_scheme                                            | 2    |
| 3. product_definition_scheme                                            | 3    | 3. product_definition_scheme                                            | 3    |
| 4. product_definition_scheme                                            | 4    | 4. product_definition_scheme                                            | 4    |
| 5. product_definition_scheme                                            | 5    | 5. product_definition_scheme                                            | 5    |
| 6. external_specification_scheme                                        | 6    | 6. external_specification_scheme                                        | 6    |
| 7. change_scheme                                                        | 7    | 7. change_scheme                                                        | 7    |
| 8. certification_scheme                                                 | 8    | 8. certification_scheme                                                 | 8    |
| 9. control_scheme                                                       | 9    | 9. control_scheme                                                       | 9    |
| 10. control_scheme                                                      | 10   | 10. control_scheme                                                      | 10   |
| 11. security_classification_scheme                                      | 11   | 11. security_classification_scheme                                      | 11   |
| 12. system_organization_scheme                                          | 12   | 12. system_organization_scheme                                          | 12   |
| 13. data_type_scheme                                                    | 13   | 13. data_type_scheme                                                    | 13   |
| 14. global_data_scheme                                                  | 14   | 14. global_data_scheme                                                  | 14   |
| 15. group_scheme                                                        | 15   | 15. group_scheme                                                        | 15   |
| 16. support_resource_scheme                                             | 16   | 16. support_resource_scheme                                             | 16   |
| 17. security_classification_scheme                                      | 17   | 17. security_classification_scheme                                      | 17   |
| 18. security_classification_scheme                                      | 18   | 18. security_classification_scheme                                      | 18   |
| 19. Part 42 Quantitative and Topologic Representations                  | 19   | 19. Part 42 Quantitative and Topologic Representations                  | 19   |
| 20. geometry_scheme                                                     | 20   | 20. geometry_scheme                                                     | 20   |
| 21. topology_scheme                                                     | 21   | 21. topology_scheme                                                     | 21   |
| 22. geometric_shape_scheme                                              | 22   | 22. geometric_shape_scheme                                              | 22   |
| 23. Part 43 Representation Structures                                   | 23   | 23. Part 43 Representation Structures                                   | 23   |
| 24. representation_structuralization                                    | 24   | 24. representation_structuralization                                    | 24   |
| 25. Part 44 Product Structure Configuration                             | 25   | 25. Part 44 Product Structure Configuration                             | 25   |
| 26. product_structuralization                                           | 26   | 26. product_structuralization                                           | 26   |
| 27. product_structuralization                                           | 27   | 27. product_structuralization                                           | 27   |
| 28. configuration_management                                            | 28   | 28. configuration_management                                            | 28   |
| 29. Part 45 Materials                                                   | 29   | 29. Part 45 Materials                                                   | 29   |
| 30. material                                                            | 30   | 30. material                                                            | 30   |
| 31. Part 46 Visual Representation                                       | 31   | 31. Part 46 Visual Representation                                       | 31   |
| 32. presentation_organization_scheme                                    | 32   | 32. presentation_organization_scheme                                    | 32   |
| 33. presentation_definition_scheme                                      | 33   | 33. presentation_definition_scheme                                      | 33   |
| 34. presentation_representation_scheme                                  | 34   | 34. presentation_representation_scheme                                  | 34   |
| 35. presentation_representation_scheme                                  | 35   | 35. presentation_representation_scheme                                  | 35   |
| 36. Part 47 Tolerances                                                  | 36   | 36. Part 47 Tolerances                                                  | 36   |
| 37. tolerance_scheme                                                    | 37   | 37. tolerance_scheme                                                    | 37   |
| 38. Part 48 Each Family                                                 | 38   | 38. Part 48 Each Family                                                 | 38   |
| 39. form_features_scheme                                                | 39   | 39. form_features_scheme                                                | 39   |
| 40. form_features_representation_scheme                                 | 40   | 40. form_features_representation_scheme                                 | 40   |
| 41. Part 49 Product Life Cycle Support                                  | 41   | 41. Part 49 Product Life Cycle Support                                  | 41   |
| 42. product_life_cycle_support                                          | 42   | 42. product_life_cycle_support                                          | 42   |
| 43. Part 50 Process Data                                                | 43   | 43. Part 50 Process Data                                                | 43   |
| 44. process_planning_scheme                                             | 44   | 44. process_planning_scheme                                             | 44   |
| 45. Part 51 Part Surface Condition                                      | 45   | 45. Part 51 Part Surface Condition                                      | 45   |
| 46. surface_condition_scheme                                            | 46   | 46. surface_condition_scheme                                            | 46   |
| 47. Part 52 Drawing Representation                                      | 47   | 47. Part 52 Drawing Representation                                      | 47   |
| 48. drawing_definition_scheme                                           | 48   | 48. drawing_definition_scheme                                           | 48   |
| 49. drawing_definition_scheme                                           | 49   | 49. drawing_definition_scheme                                           | 49   |
| 50. dimension_standard_scheme                                           | 50   | 50. dimension_standard_scheme                                           | 50   |
| 51. dimension_standard_scheme                                           | 51   | 51. dimension_standard_scheme                                           | 51   |
| 52. Part 53 Finite Element Analysis Representation                      | 52   | 52. Part 53 Finite Element Analysis Representation                      | 52   |
| 53. fea_scheme                                                          | 53   | 53. fea_scheme                                                          | 53   |
| 54. Part 54 Explicit Modeling                                           | 54   | 54. Part 54 Explicit Modeling                                           | 54   |
| 55. explicit_modeling                                                   | 55   | 55. explicit_modeling                                                   | 55   |
| 56. Part 55 Associative Representation                                  | 56   | 56. Part 55 Associative Representation                                  | 56   |
| 57. associative_representation                                          | 57   | 57. associative_representation                                          | 57   |
| 58. Part 56 Confirmation Controlled 3D System                           | 58   | 58. Part 56 Confirmation Controlled 3D System                           | 58   |
| 59. scheme Part 56                                                      | 59   | 59. scheme Part 56                                                      | 59   |
| 60. Part 57 Mechanical Design Using Wireframe                           | 60   | 60. Part 57 Mechanical Design Using Wireframe                           | 60   |
| 61. wireframe_scheme                                                    | 61   | 61. wireframe_scheme                                                    | 61   |
| 62. Part 58 Mechanical Design Using Surface Representation              | 62   | 62. Part 58 Mechanical Design Using Surface Representation              | 62   |
| 63. srs_scheme                                                          | 63   | 63. srs_scheme                                                          | 63   |
| 64. Part 59 Data Transfer of Wireframe Models using Physical File       | 64   | 64. Part 59 Data Transfer of Wireframe Models using Physical File       | 64   |
| 65. wireframe_transfer                                                  | 65   | 65. wireframe_transfer                                                  | 65   |
| 66. Part 60 Design Rule for the Development of Sheet Metal Dies & Molds | 66   | 66. Part 60 Design Rule for the Development of Sheet Metal Dies & Molds | 66   |
| 67. sheet_metal_rule                                                    | 67   | 67. sheet_metal_rule                                                    | 67   |
| 68. Part 61 Life Cycle Product Change Process                           | 68   | 68. Part 61 Life Cycle Product Change Process                           | 68   |
| 69. product_change_management                                           | 69   | 69. product_change_management                                           | 69   |
| 70. Part 62 Assembly Design Using                                       | 70   | 70. Part 62 Assembly Design Using                                       | 70   |
| 71. assembly_design_using                                               | 71   | 71. assembly_design_using                                               | 71   |

Figure 10 Design Characteristics not Completely Satisfied by STEP.

**Deliberate Self-Harm**  
**State vs. Memo**

30

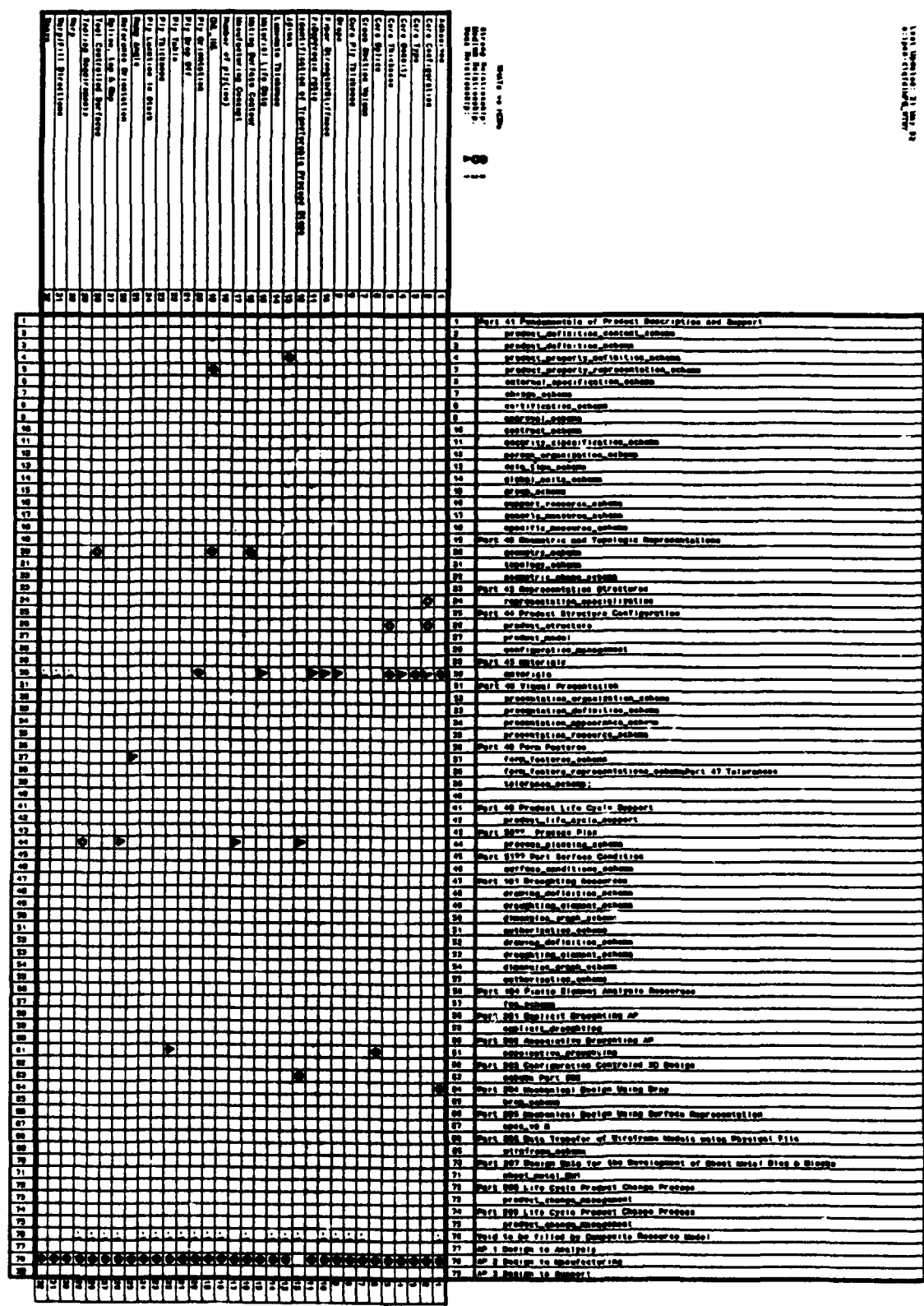


**Figure 12 Manufacturing Voids within STEP from a PAS-C View**

STEP Part 41 (Fundamentals of Product Description and Support) as it presently exist does not include incorporation of STEP Part 45 (Materials). A planned change for the next STEP release would be this incorporation. Until this occurs, it is difficult to ascertain how these two models will incorporate the unique needs of composite materials. This need is critical since composites represents a unique requirement of viewing the materials both as a finished part and as individual constituents. The Materials Schema as it exists is designed to define composite parts but not necessarily all of the individual constituent materials. Materials which is furnished in higher level processed forms, such as core, is not covered. Material such as weave, cloth, broadgoods, and impregnated materials are represented by description only in the present materials model.

The other major voids could be categorized as in-process part definition required. As a whole, they are definition of composite items in the various stages of production. The overall problem is one that a composite part is an assembly of individual pieces which through the manufacturing process are transformed into an inseparable piece part. The design and manufacturing definition must not only be able to document the end characteristics of a piece part but also must be able to define the individual constituents, many of which, such as a ply piece, do not normally show up in a design or manufacturing bill of materials. These shape problems are compounded by the manufacturing process which normally creates oversize parts which are trimmed to shape, and shapes are determined by lay-up in tooling in predefined locations and orientations. Thus the voids identified to be filled with the composite model were largely the composite items ply and ply piece.

Four voids and ten weak relationships were identified in the first area of materials, particularly in the area of core materials. Twenty voids were identified to be filled by the composite's model, and they are related to information normally obtained in a ply table and or the manufacturing specifications which specify things such as laps and gaps of plies. These voids include the concept of joints which is not covered adequately by existing resources.

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## 5 NEEDS to VOIDS CORRELATION and PRIORITIZATION

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### 5.1 WHAT vs. WHY QFD Analysis

The WHAT (Information Needs) versus WHY (Importance of Needs) matrix of the HoQ was used to record certain quantifiable aspects of the criteria that determine the success of the PAS-C program. The analysis provides a method to prioritize the needs and voids based upon importance to the program success.

#### Design

The Design WHAT versus WHY table is documented in Figure 13. The priority of addressing the voids is indicated in column 11, "Rank of Wgt'd Importance of Void. The priority of addressing the characteristics within the application protocol is indicated in column 15, "Rank of Wgt'd Importance in AP".

Analysis of these rankings indicates that the voids are spread throughout the spectrum when viewed from their importance to the application protocol. Half of the estimated cost to fill the voids is contained within the top 52% of the characteristics. Seventy percent of the cost to fill the voids is within the top 76% of the characteristics. From a development perspective, this indicates that working the voids should occur based upon the priority of the characteristic within the AP, as shown in Table 1.

Table 1 Design to Analysis Voids

| Priority | Design Characteristics                |
|----------|---------------------------------------|
| 6        | Material Thickness                    |
| 6        | Fiber/Resin Ratio                     |
| 10       | Tolerances                            |
| 12       | Tooling Interface Information         |
| 16       | Envelope                              |
| 19       | Ply Detail Interface                  |
| 20       | Ply Stack                             |
| 25       | Weight                                |
| 26       | Damage Tolerance                      |
| 29       | Laminate Assembly Process             |
| 30       | Filler Plies                          |
| 31       | Strength                              |
| 31       | Laminate Patch                        |
| 37       | Number of Ply Details                 |
| 37       | Finish Notes                          |
| 40       | Cross-Section Properties              |
| 43       | Joints/Interfaces                     |
| 52       | Core Splice                           |
| 55       | Core Stiffened Panel Assembly Process |

Detailed Structural Design  
White vs. Wavy

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|                                                 |  |                                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|-------------------------------------------------|--|----------------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| Last Updated: 20 May 92<br>c:\pas-clr61253_VTWV |  |                                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Percent Utilization              |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Percent Improvement              |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Cost to Fill Void                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | C&B Ratio                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Cost to Include into AP3         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Inverse Normalized Cost          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Normalized Utilization           |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Normalized Improvement           |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Normalized Cost to Fill Void     |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Weighted Avg Importance of Void  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Rank of Wgt'd Importance of Void |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Inverse Normalized Cost          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Normalized Cost to Include in AP |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Weighted Avg of Importance in AP |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Rank of Wgt'd Importance in AP   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | Weighting                        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 4                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 5                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 6                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 7                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 8                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 9                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 10                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 11                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 12                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 13                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 14                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 15                               |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 1                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 2                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  | 3                                |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                 |  |                                  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Figure 13 Design Characteristics are Prioritized by Importance and Cost

## Analysis

The Analysis WHAT versus WHY table is documented in Figure 14. As with design, the priority of addressing the voids is indicated in column 11. The priority of working the characteristics into the AP is listed in column 15.

Three of the voids are near the bottom of the importance to the AP ranking. Eighty four percent of the cost of filling the voids is contained within the bottom thirty percent of the characteristics when ranked by importance to the AP. Analysis of the relative rankings of the voids indicates that the voids should be worked as they are encountered according to their importance to the AP, as illustrated in Table 2 .

**Table 2** Analysis Voids Prioritized by Importance to the AP

| Priority | Analysis Characteristics      |
|----------|-------------------------------|
| 5        | Weight                        |
| 32       | Analysis Decision Data        |
| 32       | Analysis Quality/Completeness |
| 46       | Test Results                  |

**Detailed Structural Analysis  
Ways vs. Ways**

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|                                 | Weighting | Analysis Characteristics |                     |                   |           |                          |                            |                        |                        |                              |                             |                             |                            |                            |                                |                             |
|---------------------------------|-----------|--------------------------|---------------------|-------------------|-----------|--------------------------|----------------------------|------------------------|------------------------|------------------------------|-----------------------------|-----------------------------|----------------------------|----------------------------|--------------------------------|-----------------------------|
|                                 |           | 1                        | 2                   | 3                 | 4         | 5                        | 6                          | 7                      | 8                      | 9                            | 10                          | 11                          | 12                         | 13                         | 14                             | 15                          |
|                                 |           | Percent Utilization      | Percent Improvement | Cost to Fill Void | CSA Ratio | Cost to Include into API | Inverse Normalized Cost to | Normalized Utilization | Normalized Improvement | Normalized Cost to Fill Void | Weighted Average Importance | Rank of Weighted Importance | Inverse Normalized Cost to | Normalized Cost to Include | Weighted Average of Importance | Rank of Weighted Importance |
|                                 |           | 0.30                     | 0.20                | 0.30              | 0.00      | 0.50                     | 0.00                       | 0.30                   | 0.30                   | 0.30                         | 0.00                        | 0.00                        | 0.30                       | 0.00                       | 0.00                           | 0.00                        |
| Next Assembly Information       | 1         | 85.00                    | 7.500               |                   |           | 35.0                     |                            | 12                     | 2                      |                              | 4.062                       | 1                           | 0.75                       | 1                          | 4.442                          | 1                           |
| Configuration Control Data      | 2         | 60.00                    | 7.500               |                   |           | 35.0                     |                            | 6                      | 2                      |                              | 3.724                       | 2                           | 1.18                       | 1                          | 2.220                          | 2                           |
| Laminate Thickness(es)          | 3         | 31.00                    | 10.35               |                   |           | 35.0                     |                            | 4                      | 5                      |                              | 2.154                       | 4                           | 1.18                       | 1                          | 2.750                          | 3                           |
| Laminate Properties             | 4         | 30.40                    | 13.00               |                   |           | 45.0                     |                            | 5                      | 4                      |                              | 2.260                       | 3                           | 0.82                       | 1                          | 2.733                          | 4                           |
| Weight                          | 5         | 45.00                    | 3.750               | 35                | 0.000     | 25.0                     | 0.00                       | 6                      | 1                      | 16                           | 1.835                       | 6                           | 1.18                       | 1                          | 2.531                          | 5                           |
| Joints                          | 6         | 45.00                    | 3.750               |                   |           | 45.0                     |                            | 6                      | 1                      |                              | 1.835                       | 6                           | 0.82                       | 1                          | 2.388                          | 6                           |
| Detailed Structural Analysis    | 7         | 32.80                    | 12.26               |                   |           | 1000                     |                            | 4                      | 4                      |                              | 1.805                       | 5                           | 0.84                       | 24                         | 2.005                          | 7                           |
| Assembly List                   | 8         | 16.00                    | 12.60               |                   |           | 35.0                     |                            | 2                      | 4                      |                              | 1.303                       | 15                          | 1.18                       | 1                          | 1.961                          | 8                           |
| Material Thickness              | 9         | 18.00                    | 12.60               |                   |           | 35.0                     |                            | 2                      | 4                      |                              | 1.303                       | 15                          | 1.18                       | 1                          | 1.961                          | 8                           |
| Contoured OML/IML Surface       | 10        | 23.40                    | 10.05               |                   |           | 45.0                     |                            | 3                      | 3                      |                              | 1.471                       | 8                           | 0.82                       | 1                          | 1.935                          | 10                          |
| OML/IML Surface                 | 11        | 23.40                    | 10.05               |                   |           | 45.0                     |                            | 3                      | 3                      |                              | 1.471                       | 8                           | 0.82                       | 1                          | 1.935                          | 10                          |
| Reference Orientation           | 12        | 23.40                    | 10.05               |                   |           | 45.0                     |                            | 3                      | 3                      |                              | 1.471                       | 8                           | 0.82                       | 1                          | 1.935                          | 10                          |
| Combined Material Properties    | 13        | 23.40                    | 10.05               |                   |           | 35.0                     |                            | 3                      | 3                      |                              | 1.471                       | 8                           | 0.75                       | 1                          | 1.650                          | 13                          |
| Cross-Section Properties        | 14        | 23.40                    | 10.05               |                   |           | 35.0                     |                            | 3                      | 3                      |                              | 1.471                       | 8                           | 0.75                       | 1                          | 1.650                          | 13                          |
| Boundary                        | 15        | 23.40                    | 10.05               |                   |           | 80.0                     |                            | 3                      | 3                      |                              | 1.471                       | 8                           | 0.67                       | 1                          | 1.607                          | 15                          |
| Boundary/Envelope               | 16        | 23.40                    | 10.05               |                   |           | 80.0                     |                            | 3                      | 3                      |                              | 1.471                       | 8                           | 0.67                       | 1                          | 1.607                          | 15                          |
| Cell Size                       | 17        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Core Normal                     | 18        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Fiber Volume                    | 19        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Pill Surface                    | 20        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Finish                          | 21        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Material Name/Description       | 22        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Ply Detail Normal               | 23        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Ply Sequence Number             | 24        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Ramp Angle                      | 25        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Resin Content                   | 26        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Ribbon Direction                | 27        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Warp/Fill Directions            | 28        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Warp/Fill Percentages           | 29        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Weave                           | 30        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Adhesive                        | 31        | 0.400                    | 0.300               |                   |           | 35.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 1.18                       | 1                          | 1.270                          | 17                          |
| Analysis Decision Data          | 32        | 5.000                    | 7.500               | 35                | 0.014     | 35.0                     | 0.00                       | 1                      | 2                      | 18                           | 0.821                       | 43                          | 1.18                       | 1                          | 1.217                          | 32                          |
| Analysis Quality/Completeness   | 33        | 5.000                    | 7.500               | 35                | 0.130     | 35.0                     | 0.00                       | 1                      | 2                      | 18                           | 0.821                       | 43                          | 1.18                       | 1                          | 1.217                          | 32                          |
| Bottom Surface                  | 34        | 0.400                    | 0.300               |                   |           | 45.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 0.82                       | 1                          | 1.146                          | 34                          |
| Ply it is a part of             | 35        | 0.400                    | 0.300               |                   |           | 45.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 0.82                       | 1                          | 1.146                          | 34                          |
| Ply Normal                      | 36        | 0.400                    | 0.300               |                   |           | 45.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 0.82                       | 1                          | 1.146                          | 34                          |
| Stack Normal                    | 37        | 0.400                    | 0.300               |                   |           | 45.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 0.82                       | 1                          | 1.146                          | 34                          |
| Top Surface                     | 38        | 0.400                    | 0.300               |                   |           | 45.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 0.82                       | 1                          | 1.146                          | 34                          |
| Warp Surface                    | 39        | 0.400                    | 0.300               |                   |           | 45.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 0.82                       | 1                          | 1.146                          | 34                          |
| Reference Normal                | 40        | 0.400                    | 0.300               |                   |           | 45.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 0.82                       | 1                          | 1.146                          | 34                          |
| Ply Table                       | 41        | 0.400                    | 0.300               |                   |           | 80.0                     |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 0.67                       | 1                          | 1.019                          | 41                          |
| Laminate Patch                  | 42        | 0.400                    | 0.300               |                   |           | 110                      |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 0.37                       | 3                          | 0.672                          | 42                          |
| Mechanical Material Properties  | 43        | 0.400                    | 0.300               |                   |           | 300                      |                            | 1                      | 2                      |                              | 0.602                       | 17                          | 0.13                       | 7                          | 0.752                          | 43                          |
| Shape                           | 44        | 0.400                    | 0.300               |                   |           |                          |                            | 1                      | 2                      |                              | 0.602                       | 17                          |                            |                            | 0.682                          | 44                          |
| Preliminary Structural Analysis | 45        | 5.000                    | 3.500               |                   |           | 000                      |                            | 1                      | 2                      |                              | 0.306                       | 45                          | 0.65                       | 18                         | 0.532                          | 45                          |
| Test Results                    | 46        | 5.000                    | 3.750               | 300               | 0.016     | 300                      | 0.01                       | 1                      | 1                      | 38                           | 0.406                       | 46                          | 0.13                       | 7                          | 0.475                          | 46                          |

**Figure 14 Analysis Characteristics are Prioritized by Importance and Cost**

## Manufacturing

The Manufacturing WHAT versus WHY table is documented in Figure 15.

Analysis of the relative rankings of the voids indicates that the voids should be worked as they are encountered according to their importance to the AP, as illustrated in, as illustrated in Table 3.

**Table 3** Manufacturing Voids Prioritized by Importance to the AP.

| Priority | Manufacturing Characteristics                |
|----------|----------------------------------------------|
| 3        | Core Type                                    |
| 4        | Tool Controlled Surfaces                     |
| 5        | Mating Surface Contour                       |
| 7        | Ramp Angle                                   |
| 8        | Core Density                                 |
| 8        | Core Thickness                               |
| 9        | Joints                                       |
| 12       | Warp/Fill Directions                         |
| 13       | OML_IML                                      |
| 14       | Fiber Strength/Stiffness                     |
| 16       | Adhesives                                    |
| 18       | Core Configuration                           |
| 18       | Reference Orientation                        |
| 22       | Warp                                         |
| 28       | Laminate Thickness                           |
| 28       | Ply Location in Stack                        |
| 31       | Number of Ply(ies)                           |
| 31       | Ply Table                                    |
| 31       | Splice, Lap & Gap                            |
| 37       | Cross Section Volume                         |
| 38       | Tooling Requirements                         |
| 39       | Material Life Data                           |
| 39       | Weave                                        |
| 39       | Drape                                        |
| 39       | Fiber/Resin Ratio                            |
| 39       | Core Splice                                  |
| 39       | Manufacturing Concept                        |
| 48       | Core Ply Thickness                           |
| 48       | Ply Thickness                                |
| 53       | Ply Orientation                              |
| 53       | Ply Drop Off                                 |
| 53       | Identification of Transferable Process Steps |

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Manufacturing  
What's vs Why

|                                              | Weighting | Manufacturing What's vs Why |      |     |      |      |      |   |   |    |      |    |    |    |      |       |
|----------------------------------------------|-----------|-----------------------------|------|-----|------|------|------|---|---|----|------|----|----|----|------|-------|
|                                              |           | 1                           | 2    | 3   | 4    | 5    | 6    | 7 | 8 | 9  | 10   | 11 | 12 | 13 | 14   | 15    |
| Adhesives                                    | 1         | 12.0                        | 0.00 | 10  | 0.00 | 35.0 | 0.72 | 2 | 2 | 1  | 1.37 | 18 |    | 1  | 1.01 | 18.00 |
| Assembly or Layout                           | 2         | 7.50                        |      |     |      | 35.0 |      | 1 |   |    | 0.40 | 22 |    | 1  | 0.40 | 40.00 |
| Boundary                                     | 3         | 24.4                        | 2.28 |     |      | 140. |      | 4 | 4 |    | 2.14 | 3  |    | 4  | 2.14 | 1.000 |
| Compaction                                   | 4         | 3.00                        |      |     |      | 35.0 |      | 1 |   |    | 0.20 | 58 |    | 1  | 0.20 | 53.00 |
| Contour                                      | 5         | 4.30                        | 0.45 |     |      | 35.0 |      | 1 | 1 |    | 0.40 | 40 |    | 1  | 0.40 | 30.00 |
| Core Configuration                           | 6         | 15.0                        | 0.45 | 10  | 0.02 | 35.0 | 0.72 | 3 | 1 | 1  | 1.37 | 17 |    | 1  | 1.00 | 18.00 |
| Core Type                                    | 7         | 10.0                        | 0.02 | 10  | 0.00 | 70.0 | 1.16 | 4 | 4 | 1  | 2.28 | 1  |    | 2  | 1.70 | 3.000 |
| Core Density                                 | 8         | 10.0                        | 0.02 | 10  | 0.12 | 35.0 | 0.72 | 3 | 4 | 1  | 1.04 | 3  |    | 1  | 1.50 | 0.000 |
| Core Thickness                               | 9         | 15.0                        | 2.02 | 10  | 0.12 | 35.0 | 0.72 | 3 | 4 | 1  | 1.05 | 8  |    | 1  | 1.50 | 0.000 |
| Core Splice                                  | 10        | 4.30                        | 0.45 | 5   | 0.00 | 105. | 2.02 | 1 | 1 | 0  | 1.50 | 13 |    | 3  | 0.40 | 30.00 |
| Core Detail Position                         | 11        | 14.0                        | 0.45 |     |      | 35.0 |      | 2 | 1 |    | 0.01 | 20 |    | 1  | 0.01 | 24.00 |
| Core Assembly Tolerances                     | 12        | 12.0                        | 0.45 |     |      | 140. |      | 2 | 1 |    | 0.00 | 31 |    | 4  | 0.00 | 25.00 |
| Core Assembly Surface Contour                | 13        | 12.0                        | 0.45 |     |      | 35.0 |      | 2 | 1 |    | 0.00 | 31 |    | 1  | 0.00 | 25.00 |
| Cross Section Volume                         | 14        | 7.05                        | 0.40 | 25  | 0.01 | 35.0 | 0.46 | 1 | 1 | 2  | 0.00 | 34 |    | 1  | 0.50 | 37.00 |
| Cure Ply Thickness                           | 15        | 7.50                        |      | 25  |      | 35.0 | 0.46 | 1 | 2 |    | 0.03 | 41 |    | 1  | 0.40 | 40.00 |
| Drape                                        | 16        | 4.50                        | 0.45 | 50  | 0.00 | 70.0 | 0.23 | 1 | 1 | 4  | 0.52 | 45 |    | 2  | 0.40 | 30.00 |
| Fiber Strength/Stiffness                     | 17        | 0.40                        | 0.02 | 25  | 0.00 | 35.0 | 0.46 | 2 | 4 | 2  | 1.42 | 15 |    | 1  | 1.10 | 14.00 |
| Fiber Orientation                            | 18        | 3.00                        | 1.57 |     |      | 35.0 |      | 1 | 3 |    | 0.70 | 30 |    | 1  | 0.70 | 20.00 |
| Fiber/Resin Ratio                            | 19        | 4.50                        | 0.45 | 10  | 0.04 | 70.0 | 1.16 | 1 | 1 | 1  | 0.00 | 37 |    | 3  | 0.40 | 30.00 |
| Forecasted Part Quantities                   | 20        | 7.50                        |      |     |      | 70.0 |      | 1 |   |    | 0.40 | 32 |    | 2  | 0.40 | 40.00 |
| Hard Detail Locations                        | 21        | 15.0                        | 0.45 |     |      | 105. |      | 3 | 1 |    | 1.00 | 25 |    | 3  | 1.00 | 18.00 |
| Identification of Transferable Process Steps | 22        | 3.00                        |      | 25  |      |      | 0.46 | 1 | 2 |    | 0.42 | 47 |    |    | 0.20 | 53.00 |
| Joints                                       | 23        | 15.0                        | 2.02 | 125 | 0.01 | 175. | 0.00 | 3 | 4 | 11 | 1.04 | 12 |    | 5  | 1.50 | 0.000 |
| Laminate Thickness                           | 24        | 3.00                        | 1.57 | 25  | 0.00 | 35.0 | 0.46 | 1 | 3 | 2  | 1.02 | 23 |    | 1  | 0.70 | 20.00 |
| Manufacturing Process                        | 25        | 7.50                        |      |     |      | 200. |      | 1 |   |    | 0.40 | 53 |    | 5  | 0.40 | 40.00 |
| Material Quantity                            | 26        | 4.50                        | 0.45 |     |      | 70.0 |      | 1 | 1 |    | 0.40 | 40 |    | 2  | 0.40 | 30.00 |
| Material Stock Size                          | 27        | 11.4                        | 1.57 |     |      | 70.0 |      | 2 | 3 |    | 1.10 | 22 |    | 2  | 1.10 | 17.00 |
| Material Name                                | 28        | 0.40                        | 0.02 |     |      |      |      | 2 | 4 |    | 1.10 | 30 |    | 1  | 1.10 | 14.00 |
| Material Life Data                           | 29        | 4.50                        | 0.45 | 10  | 0.04 | 35.0 | 1.16 | 1 | 1 | 1  | 0.00 | 37 |    | 1  | 0.40 | 30.00 |
| Material Amount                              | 30        | 0.50                        | 0.27 |     |      | 35.0 |      | 1 | 0 |    | 0.44 | 46 |    | 1  | 0.44 | 30.00 |
| Material Thickness                           | 31        | 0.40                        | 2.02 |     |      | 35.0 |      | 2 | 4 |    | 1.10 | 20 |    | 1  | 1.10 | 14.00 |
| Material Type/Description                    | 32        | 10.7                        | 2.02 |     |      |      |      | 4 | 4 |    | 1.70 | 0  |    | 1  | 1.70 | 4.000 |
| Mating Surface Contour                       | 33        | 15.0                        | 2.02 | 25  | 0.00 | 35.0 | 0.46 | 3 | 4 | 2  | 1.02 | 0  |    | 1  | 1.50 | 0.000 |
| Manufacturing Concept                        | 34        | 4.50                        | 0.45 | 40  | 0.01 | 140. | 0.23 | 1 | 1 | 3  | 0.55 | 44 |    | 4  | 0.40 | 20.00 |
| Manufacturing BOM                            | 35        | 4.50                        | 0.45 |     |      | 105. |      | 1 | 1 |    | 0.40 | 40 |    | 2  | 0.40 | 20.00 |
| Next Assembly Information                    | 36        | 15.0                        |      |     |      | 35.0 |      | 3 |   |    | 0.00 | 33 |    | 1  | 0.00 | 27.00 |
| Number of ply(ies)                           | 37        | 0.00                        | 0.45 | 30  | 0.00 | 70.0 | 0.23 | 1 | 1 | 4  | 0.72 | 30 |    | 2  | 0.00 | 31.00 |
| On, In                                       | 38        | 15.2                        | 1.57 | 30  | 0.03 | 70.0 | 0.23 | 3 | 3 | 4  | 1.50 | 14 |    | 2  | 1.50 | 13.00 |
| Ply Orientation                              | 39        | 3.00                        |      | 25  |      | 35.0 | 0.46 | 1 | 2 |    | 0.43 | 47 |    | 1  | 0.00 | 50.00 |
| Ply Drop Off                                 | 40        | 3.00                        |      | 75  |      | 105. | 0.15 | 1 | 0 |    | 0.20 | 55 |    | 3  | 0.20 | 53.00 |
| Ply is Part of                               | 41        | 7.70                        | 1.57 |     |      | 35.0 |      | 1 | 3 |    | 0.00 | 26 |    | 1  | 0.00 | 32.00 |
| Ply Table                                    | 42        | 0.00                        | 0.45 | 25  | 0.04 | 70.0 | 0.46 | 1 | 1 | 2  | 0.04 | 30 |    | 2  | 0.00 | 31.00 |
| Ply Thickness                                | 43        | 7.50                        |      | 15  |      | 35.0 | 0.77 | 1 | 1 |    | 0.70 | 37 |    | 1  | 0.40 | 40.00 |
| Ply Location in Stock                        | 44        | 3.00                        | 1.57 | 25  | 0.00 | 35.0 | 0.46 | 1 | 3 | 2  | 1.02 | 23 |    | 1  | 0.70 | 20.00 |
| Rolling Compounds                            | 45        | 0.00                        | 0.45 |     |      | 105. |      | 1 | 1 |    | 0.00 | 42 |    | 2  | 0.00 | 21.00 |
| Ramp Angle                                   | 46        | 10.7                        | 3.16 | 00  | 0.00 | 70.0 | 0.23 | 2 | 0 | 4  | 1.05 | 7  |    | 2  | 1.70 | 7.000 |
| Reference Orientation                        | 47        | 15.0                        | 0.45 | 25  | 0.01 | 35.0 | 0.46 | 3 | 1 | 2  | 1.24 | 10 |    | 1  | 1.00 | 10.00 |
| Resin Direction                              | 48        | 10.2                        | 3.16 |     |      | 35.0 |      | 3 | 0 |    | 2.13 | 3  |    | 1  | 2.13 | 2.000 |
| Splice, Lap & Gap                            | 49        | 0.00                        | 0.45 | 200 | 0.00 | 040. | 0.05 | 1 | 1 | 17 | 0.03 | 40 |    | 2  | 0.00 | 31.00 |
| Stabilizers                                  | 50        | 0.00                        | 0.45 |     |      | 35.0 |      | 1 | 1 |    | 0.00 | 42 |    | 1  | 0.00 | 31.00 |
| Tolerances                                   | 51        | 10.7                        | 2.02 |     |      |      |      | 4 | 4 |    | 1.70 | 0  |    | 1  | 1.70 | 4.000 |
| Tool Controlled Surfaces                     | 52        | 10.7                        | 2.02 | 25  | 0.00 | 35.0 | 0.46 | 4 | 4 | 2  | 2.02 | 4  |    | 1  | 1.70 | 4.000 |
| Tooling Requirements                         | 53        | 11.2                        |      | 00  |      | 70.0 | 0.04 | 2 | 7 |    | 0.07 | 30 |    | 2  | 0.00 | 30.00 |
| Warp                                         | 54        | 7.70                        | 1.57 | 25  | 0.00 | 35.0 | 0.46 | 1 | 0 | 2  | 1.22 | 10 |    | 1  | 0.00 | 32.00 |
| Warp/Fill Directions                         | 55        | 10.2                        | 2.02 | 15  | 0.12 | 35.0 | 0.77 | 2 | 4 | 1  | 1.70 | 11 |    | 1  | 1.30 | 12.00 |
| Ways                                         | 56        | 4.50                        | 0.45 | 15  | 0.03 | 35.0 | 0.77 | 1 | 1 | 1  | 0.70 | 35 |    | 1  | 0.40 | 30.00 |

Figure 15 Manufacturing Characteristics are Prioritized by Importance and Cost

## **5.2 Void Development & Scoping**

The strategy for addressing the voids is best described using the symbology within the QFD WHATs vs. HOWs matrix. The voids identified with triangles require modification to existing resource entities. The PAS-C team will work with the IPO/ISO respective committee resources to get these voids filled. Those voids that are identified with a -1 will be addressed by the PAS-C team. Activities will be coordinated with the IPO/ISO regarding all voids to be filled.

Emphasis will be placed on filling all the voids identified. However, due to resource constraints in the PAS-C program and the IPO/ISO, it is possible that the lower priority voids may not be addressed. As stated previously in this section, the voids will be worked in the order of importance to the APs. Those voids that resources are not sufficient to address will not be filled.

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## **6 CONCLUSIONS and RECOMMENDATIONS**

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The PAS-C program has successfully developed, matured, and applied a methodology to gather and rank the information needs required to produce an Application Protocol Suite for Composites.

The terminology has been refined and reflected in the characteristic and building block names in the tables presented in Appendices B, C, and D. During the creation of these tables a relationship was forged between the information needs (characteristics) and the IDEF0 activity models developed in reference [1].

The Quality Function Deployment House of Quality (HoQ) methodology was used to correlate the information needs to available PDES/STEP resources. The HoQ was also used to identify voids in the STEP Part resources where needs were not met, and to prioritize the needs with respect to both benefits to the PAS-C program and to cost.

All but a few of the voids found during the development of this document were not judged to be serious. It is recommended that the majority of the identified voids be addressed by the PAS-C Application Protocol Suite, with the remainder to be addressed by liaison with the PDES/STEP effort to enhance the PDES/STEP information model resources.

Based upon the comparison of PAS-C needs to PDES/STEP resources, it appears that the IPO/ISO has addressed the more critical areas of information. This analysis has indicated that there are no critical voids within PDES/STEP that would adversely alter PAS-C goals. It is concluded that the risk of relying on PDES/STEP development processes and resources is manageable.

## REFERENCES

1. Functional Needs IDEF0 Activity and Information Models for the PAS-C Program, Document No. PASC006.01.00, 9 January, 1992.
2. Scoping and Benefits Criteria (Volume II) for the PAS-C Program, Document No. PASC008.01.00, 14 May, 1992.
3. Functional Needs Report for the PAS-C Program, Document No. PASC002.02.00, 30 September, 1991.

## **APPENDICES**

## **APPENDIX A - PAS-C Related Documents**

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

Functional Needs Report for the PAS-C Program, Document No. PASC002.01.00, 30 September, 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

PDES State-of-the-Art (SOTA) Assessment for the PAS-C Program, Document No. PASC005.01.00, 23 December, 1991

Functional Needs IDEF0 Activity and Information Models for the PAS-C Program, Document No. PASC006.01.00, 9 January, 1992

Scoping and Benefits Criteria (Volume I - Executive Summary and Overview) for the PAS-C Program, Document No. PASC007.01.00, 14 May, 1992

Scoping and Benefits Criteria (Volume II) for the PAS-C Program, Document No. PASC008.01.00, 14 May, 1992

Functional Needs/State-of-the-Art Comparison for the PAS-C Program, Document No. PASC009.01.00, 28 May, 1992

Development and Demonstration Plan for the PAS-C Program, Document No. PASC010.01.00, 28 May, 1992

Request for PAS-C documentation should be made to  
WL/MTTB, Wright-Patterson AFB, Ohio 45433-6533

## **APPENDIX B - Design Refined Information Needs**

| VIEW - COMPOSITE ITEM                                                           |                                                                                                                                             | Node Activity Reference |
|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| Characteristic                                                                  | Description                                                                                                                                 | Activity Reference      |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - FILAMENT ASSEMBLY (FABRIC)</b>              |                                                                                                                                             |                         |
| Material Name/Description                                                       | A woven material that primarily includes graphite, fiberglass, aramid fibers with or without different pre-preg matrices (epoxies).         | A22323324, A22324       |
| Material Thickness                                                              | The cured fabric thickness per ply.                                                                                                         | A222212                 |
| Fiber Orientation                                                               | The greater amount of either the 0° or 90° fiber direction in a weave.                                                                      | A222212                 |
| Fiber/Resin Ratio                                                               | The volume percentage of fiber to resin in a fabric.                                                                                        | A22324                  |
| Mechanical Material Properties                                                  | The basic ply's load carrying properties in a cured state, which is fiber material dependent in both 0° or 90° vector.                      | A2231                   |
| Warp/Fill Directions                                                            | See fiber orientation.                                                                                                                      | A2222121                |
| Warp/Fill Percentages                                                           | The ratio of 0° or 90° in the weave.                                                                                                        | A2222121                |
| Weave                                                                           | The different types of braiding in the fabric.                                                                                              | A222212                 |
| Material Stock Size                                                             | The width and length of the raw fabric                                                                                                      | A2222121                |
| * Construction Planes                                                           | The construction plane(s) that render the desired views of an ACSP.                                                                         | A22323221               |
| ** Configuration Control Information                                            | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc.                                                                | A22322, A22324, A226    |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - FILAMENT ASSEMBLY (UNIDIRECTIONAL TAPE)</b> |                                                                                                                                             |                         |
| Material Name/Description                                                       | A unidirectional material that primarily includes graphite, fiberglass, aramid fiber with or without different pre-preg matrices (epoxies). | A22323324, A22324       |
| Material Thickness                                                              | The cured unidirectional thickness.                                                                                                         | A222212                 |
| Fiber/Resin Ratio                                                               | The volume percentage of fiber to resin in tape.                                                                                            | A22324                  |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                              |                                                                                                         | <b>Node Activity Reference</b> |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                     | <b>Description</b>                                                                                      | <b>Activity Reference</b>      |
| Mechanical Material Properties                                            | The unidirectional ply's load carrying properties in a cured stated, which is fiber material dependent. | A2231                          |
| Material Stock Size                                                       | The width of the tape as supplied by the vendor.                                                        | A22324, A2222121               |
| ** Configuration Control Information                                      | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc.                            | A22322, A22324, A226           |
|                                                                           |                                                                                                         |                                |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - FILAMENT ASSEMBLY (TOW)</b>           |                                                                                                         |                                |
| Material Name/Description                                                 | The graphite or fiberglass unidirectional fiber with or without different pre-preg matrices.            | A22323324, A22324              |
| Mechanical Material Properties                                            | See Unidirectional.                                                                                     | N/A                            |
| Fiber/Resin Ratio                                                         | The volume percentage of fiber to resin.                                                                | A22324                         |
| Material Stock Size                                                       | The random size of the fiber arrangement as supplied by the vendor.                                     | A22324                         |
|                                                                           |                                                                                                         |                                |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - FILAMENT LAMINATE (RADIUS FILLER)</b> |                                                                                                         |                                |
| Filament Laminate Identification                                          | The assigned filament laminate number and description.                                                  | A22324                         |
| Cross Section                                                             | Shape of cross section(s) and area(s).                                                                  | A223233223133                  |
| Length                                                                    | Length of cross section area(s).                                                                        | A223233223133                  |
| Filament Assembly Constituents                                            | Type and quantity of filament assemblies (ex. Tow) that make up filament laminates.                     | A22324                         |
| ** Configuration Control Information                                      | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc.                            | A22322, A22324, A226           |
|                                                                           |                                                                                                         |                                |
|                                                                           |                                                                                                         |                                |
|                                                                           |                                                                                                         |                                |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                      |                                                                                                             | <b>Node Activity Reference</b> |
|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                             | <b>Description</b>                                                                                          | <b>Activity Reference</b>      |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - PLY Piece</b> |                                                                                                             |                                |
| Filament Assembly Characteristics                 | The tape & fabric characteristics as described in more detail in the Filament Assembly section.             | N/A                            |
| Boundary                                          | The end of ply piece plan view of either a flat or lofted surface.                                          | A22323222                      |
| Flat Pattern                                      | This the end of ply of an unfolded boundary.                                                                | A22323222                      |
| Fiber Orientation                                 | Direction of the primary load carrying filaments.                                                           | A2231                          |
| Ply Piece Identification                          | The assigned ply piece number when ply piece equals one (1) the ply piece identification is the ply number. | A2232332232622                 |
| * Construction Planes                             | The construction plane(s) that render the desired views of an ACSP.                                         | A22323221                      |
| ** Configuration Control Information              | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc.                                | A22322, A22324, A226           |
|                                                   |                                                                                                             |                                |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - PLY</b>       |                                                                                                             |                                |
| Ply Piece Characteristics                         | The ply piece characteristics as described in the prior section.                                            | N/A                            |
| Boundary                                          | The end of ply plan view of either a flat or lofted surface.                                                | A22323222                      |
| Ply Identification                                | The assigned ply number.                                                                                    | A22323324                      |
| Ply Piece Interface                               | Where the ply piece (EOP) meet in either a butt, overlap or gap orientation.                                | A223233221, A22323324          |
| Ply Piece Location                                | The relative location of the ply piece in relationship to each other in the plan view.                      | A223233221                     |
| Number of Ply Pieces                              | The number of Ply Pieces in a ply and when the Ply Pieces equals one (1) it is a ply.                       | A22323324                      |
| * Construction Planes                             | The construction plane(s) that render the desired views of an ACSP.                                         | A22323221                      |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                        |                                                                                              | <b>Node Activity Reference</b>                                    |
|---------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| <b>Characteristic</b>                                               | <b>Description</b>                                                                           | <b>Activity Reference</b>                                         |
| <b>** Material Specification</b>                                    | The data that describes the physical responses of a composite material.                      | A2232334,<br>A22323322311623<br>A2232332232623<br>A22323322331623 |
| <b>** Configuration Control Information</b>                         | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc.The number       | A22322, A22324,<br>A226                                           |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - PLY LAMINATE (GENERAL FLAT)</b> |                                                                                              |                                                                   |
| Envelope                                                            | The envelope of the part in the XYZ planes.                                                  | A22323222                                                         |
| Laminate Thickness                                                  | The dimension of the ply set-up.                                                             | A22323323                                                         |
| Mold/Bag Line Surface                                               | The laminate surface in contact with mold or bag.                                            | A2232331                                                          |
| Fastener Holes & Cut Outs                                           | The removed portions of the laminate part.                                                   | A223233223312                                                     |
| Ply Characteristics                                                 | The ply characteristics as described in the prior section.                                   | N/A                                                               |
| Ply Stack                                                           | A subset of ply table consisting of sequence and location.                                   | A223233223261                                                     |
| Ply Table                                                           | A matrix of the ply laminate characteristics.                                                | A223233223262                                                     |
| Tolerances                                                          | The dimensional tolerances of the part due to conventional design/build constraints.         | A22323323                                                         |
| Ply Transition                                                      | The drop off of plies in the laminate.                                                       | A223233223263                                                     |
| Damage Tolerance                                                    | The ability to resist damage in the normal operating environment in its life cycle.          | A22342                                                            |
| Strength                                                            | The capacity to carry loads.                                                                 | A2231, A2234                                                      |
| Weight                                                              | The density characteristic times the volume of the part.                                     | A2231                                                             |
| Percentage (%) Ply Angle/Thickness                                  | The percentage of ply orientations in a given thickness per material type per material type. | A22323322312                                                      |
| Laminate Properties                                                 | The combined mechanical properties of the laminate.                                          | A2231                                                             |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                                                         |                                                                                       | <b>Node Activity Reference</b>                             |
|----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|------------------------------------------------------------|
| <b>Characteristic</b>                                                                                                | <b>Description</b>                                                                    | <b>Activity Reference</b>                                  |
| Laminate Patch                                                                                                       | A constant thickness area of a ply laminate.                                          | A22323322324                                               |
| Laminate Symmetry                                                                                                    | The balancing of the ply orientations with respect to the neutral axis.               | A2222113                                                   |
| Laminate Assembly Process                                                                                            | The sequence of assembling the laminate in the shop.                                  | A22323322312                                               |
| Filler Plies                                                                                                         | Plies added to meet the design tolerances.                                            | A223233335                                                 |
| Next Assembly Information                                                                                            | The necessary characteristics of adjoining parts. Reference information only.         | A22322, A2232333, A226                                     |
| ** Finish Notes                                                                                                      | Engineering notes specifying end-item finish requirements.                            | A22323324                                                  |
| ** Ply Stock Size                                                                                                    | Engineering specified stock size estimate.                                            | A22324                                                     |
| ** Ply Quantities                                                                                                    | The number of plies within a laminate based on the target thickness and orientations. | A223233223115, A22323322325, A223233223315                 |
| ** Material Specifications                                                                                           | The data that describes the physical responses of a composite material.               | A2232334, A22323322311623, A2232332232623, A22323322331623 |
| * Construction Planes                                                                                                | The construction plane(s) that render the desired views of an ACSP.                   | A22323221                                                  |
| ** Configuration Control Information                                                                                 | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc..         | A22322, A22324, A226                                       |
|                                                                                                                      |                                                                                       |                                                            |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - PLY LAMINATE - (GENERAL CONTOURED WRAPPABLE - CONTOURED SKIN LAMINATE (CSL))</b> |                                                                                       |                                                            |
| Envelope                                                                                                             | The envelope of the part in the XYZ planes.                                           | A22323222                                                  |
| Laminate Thickness                                                                                                   | The dimension of the ply set-up.                                                      | A22323322324                                               |
| Contoured Mold/Bag Line Surface                                                                                      | The laminate surface in contact with mold or bag.                                     | A2232331                                                   |
| Fastener Holes & Cut Outs                                                                                            | The removed portions of the laminate part.                                            | A22323                                                     |

- \* Additions required by activities
- \*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>       |                                                                                              | <b>Node Activity Reference</b>                   |
|------------------------------------|----------------------------------------------------------------------------------------------|--------------------------------------------------|
| <b>Characteristic</b>              | <b>Description</b>                                                                           | <b>Activity Reference</b>                        |
| Ply Characteristics                | The ply characteristics as described in the prior section.                                   | N/A                                              |
| Ply Stack                          | A subset of ply table consisting of sequence and location.                                   | A223233223261                                    |
| Ply Table                          | A matrix of the ply laminate characteristics.                                                | A223233223262                                    |
| Tolerances                         | The dimensional tolerances of the part due to conventional design/build constraints.         | A22323323                                        |
| Ply Transition                     | The drop off of plies in the laminate.                                                       | A223233223263                                    |
| Damage Tolerance                   | The ability to resist damage in the normal operating environment in its life cycle.          | A22342                                           |
| Strength                           | The capacity to carry loads.                                                                 | A2231, A2234                                     |
| Weight                             | The density characteristic times the volume of the part.                                     | A2233,<br>A2232332232623                         |
| Percentage (%) Ply Angle/Thickness | The percentage of ply orientations in a given thickness per material type per material type. | A22323322324                                     |
| Laminate Patch                     | A constant thickness area of a ply laminate.                                                 | A22323322324                                     |
| Laminate Properties                | The combined mechanical properties of the laminate.                                          | A2231                                            |
| Laminate Symmetry                  | The balancing of the ply orientations with respect to the neutral axis.                      | A2222113                                         |
| Laminate Assembly Process          | The sequence of assembling the laminate in the shop.                                         | A223233223261                                    |
| Filler Plies                       | Plies added to meet the design tolerances.                                                   | A223233335                                       |
| Next Assembly Information          | The necessary characteristics of adjoining parts. Reference information only.                | A22322, A2232333,<br>A226                        |
| ** Finish Notes                    | Engineering notes specifying end-item finish requirements.                                   | A22323324                                        |
| ** Ply Quantities                  | The number of plies within a laminate based on the target thickness and orientation.         | A223233223115,<br>A22323323325,<br>A223233223315 |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                 |                                                                                      | <b>Node Activity Reference</b>                                   |
|--------------------------------------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------|
| <b>Characteristic</b>                                        | <b>Description</b>                                                                   | <b>Activity Reference</b>                                        |
| ** Material Specifications                                   | The data that describes the physical responses of a composite material.              | A2232334<br>A22323322311623<br>A2232332232623<br>A22323322331623 |
| ** Ply Stock Size                                            | Engineering specified stock size estimate.                                           | A22324                                                           |
| * Tooling Interface Information                              | The Inner Mold Line (IML) and Outer Mold Line (OML) of the ACSP.                     | A2232331                                                         |
| ** Configuration Control Information                         | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc.         | A22322, A22324, A226                                             |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - PLY LAMINATE (ANGLE)</b> |                                                                                      |                                                                  |
| Envelope                                                     | The envelope of the part in the XYZ planes.                                          | A22323222,<br>A223233223112                                      |
| Laminate Thickness                                           | The dimension of the ply set-up.                                                     | A223233223114                                                    |
| Mold/Bag Line Surface                                        | The laminate surface in contact with mold or bag.                                    | A223233                                                          |
| Fastener Holes & Cut Outs                                    | The removed portions of the laminate part.                                           | A2232332231                                                      |
| Ply Characteristics                                          | The ply characteristics as described in the prior section.                           | N/A                                                              |
| Ply Stack                                                    | Ply stack is a subset of ply table consisting of sequence and location.              | A223233223113,<br>A2232332231161                                 |
| Ply Table                                                    | A matrix of the laminate characteristics.                                            | A2232332231162                                                   |
| Tolerances                                                   | The dimensional tolerances of the part due to conventional design/build constraints. | A22323323                                                        |
| Ply Transition                                               | The drop off of plies in the laminate.                                               | A2232332231163                                                   |
| Damage Tolerance                                             | The ability to resist damage in the normal operating environment in its life cycle.  | A22342,<br>A22323322311623                                       |
| Strength                                                     | The capacity to carry loads.                                                         | A2234, A2231,<br>A22323322311623                                 |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>       |                                                                                              | <b>Node Activity Reference</b>                                   |
|------------------------------------|----------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| <b>Characteristic</b>              | <b>Description</b>                                                                           | <b>Activity Reference</b>                                        |
| Weight                             | The density characteristic times the volume of the part.                                     | A2233,<br>A22323322311623                                        |
| Percentage (%) Ply Angle/Thickness | The percentage of ply orientations in a given thickness per material type per material type. | A223233223114                                                    |
| Laminate Patch                     | A constant thickness area of a ply laminate.                                                 | A22323322324                                                     |
| Laminate Properties                | The combined mechanical properties of the laminate.                                          | A2231                                                            |
| Cross-Section Properties           | The mechanical properties of the cross-sectional area.                                       | A22323322311623                                                  |
| Angle Location                     | The Angle location relative to the position in the assembly.                                 | A223233331                                                       |
| Laminate Symmetry                  | The balancing of the ply orientations with respect to the neutral axis.                      | A222113                                                          |
| Laminate Assembly Process          | The sequence of assembling the laminate in the shop.                                         | A2232332231161                                                   |
| Filler Plies                       | Plies added to meet the design tolerances.                                                   | A223233335,<br>A223233223132                                     |
| Next Assembly Information          | The necessary characteristics of adjoining parts. Reference information only.                | A22322, A2232333,<br>A226                                        |
| * Construction Planes              | The construction plane(s) that render the desired views of an ACSP.                          | A22323221                                                        |
| ** Finish Notes                    | Engineering notes specifying end-item finish requirements.                                   | A22323324                                                        |
| ** Ply Quantities                  | The number of plies within a laminate based on the target thickness and orientations.        | A223233223115,<br>A22323322325,<br>A223233223315                 |
| ** Material Specifications         | The data that describes the physical responses of a composite material.                      | A2232334<br>A22323322311623<br>A2232332232623<br>A22323322331623 |
| ** Ply Stock Size                  | Engineering specified stock size estimate.                                                   | A22324                                                           |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                               |                                                                                              | <b>Node Activity Reference</b> |
|------------------------------------------------------------|----------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                      | <b>Description</b>                                                                           | <b>Activity Reference</b>      |
| ** Configuration Control Information                       | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc.                 | A22322, A22324, A226           |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - PLY LAMINATE (CAP)</b> |                                                                                              |                                |
| Boundary                                                   | The outline of a ply laminate plan view of either a flat or lofted surface.                  | A22323322312                   |
| Laminate Thickness                                         | The dimension of the ply set-up.                                                             | A22323322312                   |
| OML/IML Surface                                            | The outer mold line and either mold line surface of the cap.                                 | A22323322312                   |
| Joints/Interfaces                                          | The removed portions of the laminate part.                                                   | A22323322312                   |
| Ply Stack                                                  | Ply stack is a subset of ply table consisting of sequence and location.                      | A22323322312                   |
| Ply Table                                                  | A matrix of the laminate characteristics.                                                    | A22323322312                   |
| Tolerances                                                 | The dimensional tolerances of the part due to conventional design/build constraints.         | A22323322312                   |
| Ply Drop Off                                               | The drop off of plies in the laminate.                                                       | A22323322312                   |
| Damage Tolerance                                           | The ability to resist damage in the normal operating environment in its life cycle.          | A22323322312                   |
| Strength                                                   | The capacity to carry loads.                                                                 | A2234, A2231                   |
| Laminate Patch                                             | A constant thickness area of a ply laminate.                                                 | A22323322324                   |
| Weight                                                     | The density characteristic times the volume of the part.                                     | A2233                          |
| Percentage (%) Ply Angle/Thickness                         | The percentage of ply orientations in a given thickness per material type per material type. | A22323322312                   |
| Laminate Properties                                        | The combined mechanical properties of the laminate.                                          | A2231                          |
| Cross-Section Properties                                   | The mechanical properties of the cross-sectional area.                                       | A22323322312                   |
| Cap Location                                               | The Cap location relative to the position in the assembly.                                   | A22323322312                   |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                  |                                                                                                                               | <b>Node Activity Reference</b>                                   |
|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| <b>Characteristic</b>                                         | <b>Description</b>                                                                                                            | <b>Activity Reference</b>                                        |
| Next Assembly Information                                     | The necessary characteristics of adjoining parts. Reference information only.                                                 | A22322, A2232333, A226                                           |
| * Construction Planes                                         | The construction plane(s) that render the desired views of an ACSP.                                                           | A22323221                                                        |
| ** Finish Notes                                               | Engineering notes specifying end-item finish requirements.                                                                    | A22323324                                                        |
| ** Ply Quantities                                             | The number of plies within a laminate based on the target thickness and orientations.                                         | A223233223115, A22323322325, A223233223315                       |
| ** Material Specifications                                    | The data that describes the physical responses of a composite material.                                                       | A2232334<br>A22323322311623<br>A2232332232623<br>A22323322331623 |
| ** Ply Stock Size                                             | Engineering specified stock size estimate.                                                                                    | A22324                                                           |
| ** Configuration Control Information                          | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc..                                                 | A22322, A22324, A226                                             |
|                                                               |                                                                                                                               |                                                                  |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - CORE (MATERIAL STOCK)</b> |                                                                                                                               |                                                                  |
| Material Name                                                 | A ribbon or foam oriented material that primarily includes fiberglass, phenolic and metals. (Material Supplier/Material Type) | A2232332233233                                                   |
| Material Thickness                                            | This is thickness parallel to the cell direction as supplied by the vendor.                                                   | A22324                                                           |
| Ribbon Direction                                              | The direction of continuous ribbon.                                                                                           | A223233223325                                                    |
| Core Density                                                  | The weight per unit volume.                                                                                                   | A2232332233232                                                   |
| Mechanical Material Properties                                | The load carrying properties.                                                                                                 | A2231                                                            |
| Material Stock Size                                           | The thickness, width and length of the core as supplied by the vendor.                                                        | A22324                                                           |
| Core Stock Characteristics                                    | The characteristics of the core as described in more detail in the previous section.                                          | N/A                                                              |
| Envelope                                                      | The envelope of the part in the XYZ planes.                                                                                   | A22323222                                                        |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                        |                                                                                                           | <b>Node Activity Reference</b>                                   |
|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| <b>Characteristic</b>                                               | <b>Description</b>                                                                                        | <b>Activity Reference</b>                                        |
| Flat Pattern                                                        | The edge of core of an unfolded envelope.                                                                 | A22323222                                                        |
| Core Detail Identification                                          | When core detail equals one (1) then the ply detail identification is the ply number.                     | A22323322331622                                                  |
| Ramp Angle                                                          | The chamfered angle of the core edge.                                                                     | A223233223324                                                    |
| Core Detail Thickness                                               | The height of the core at any given location.                                                             | A2232332233231                                                   |
| Core Detail Characteristics                                         | The characteristics as described in more detail in the previous section.                                  | N/A                                                              |
| ** Material Specifications                                          | The data that describes the physical responses of a composite material.                                   | A2232334<br>A22323322311623<br>A2232332232623<br>A22323322331623 |
| ** Configuration Control Information                                | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc.                              | A22322, A22324, A226                                             |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - CORE (PROCESSED - MACHINED)</b> |                                                                                                           |                                                                  |
| Core (Material - Stock) Characteristics                             | The characteristics as described in detail structural design core/material - stock) after being machined. | N/A                                                              |
| Envelope                                                            | The envelope of the core in the XYZ planes.                                                               | A22323222                                                        |
| Ramp Angle                                                          | The chamfered angle of the core edge.                                                                     | A223233223324                                                    |
| Core Splice                                                         | The core detail interface.                                                                                | A2232332233221                                                   |
| Core Thickness                                                      | The height of the core at any given location.                                                             | A2232332233231                                                   |
| Core Holes & Cut Outs                                               | The removed portions of the core.                                                                         | A2232332233222                                                   |
| Tolerances                                                          | The dimensional tolerances of the part due to conventional design/build constraints.                      | A22323323                                                        |
| Damage Tolerance                                                    | The ability to resist damage in the normal operating environment in its life cycle.                       | A22342                                                           |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                      |                                                                                                                                        | <b>Node Activity Reference</b> |
|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                             | <b>Description</b>                                                                                                                     | <b>Activity Reference</b>      |
| Combined Mechanical Material Properties                           | The combined load carrying properties.                                                                                                 | A2231                          |
| Make From Core Identifier                                         | The type of core (material or processed) which this core (processed - machined) is made from and its configuration control identifier. | A22324                         |
| * Construction Planes                                             | The construction plane(s) that render the desired views of an ACSP.                                                                    | A22323221                      |
| ** Tooling Interface Information                                  | The Inner Mold Line (IML) and Outer Mold Line (OML) of the ACSP.                                                                       | A2232331                       |
| ** Configuration Control Information                              | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc.                                                           | A22322, A22324, A226           |
|                                                                   |                                                                                                                                        |                                |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - CORE (PROCESSED - FORMED)</b> |                                                                                                                                        |                                |
| Boundary/Envelope                                                 | The boundary/envelope of the part in the XYZ planes.                                                                                   | A22323222                      |
| Ramp Angle                                                        | The chamfered angle of the core edge.                                                                                                  | A223233223324                  |
| Core Splice                                                       | The core detail interface.                                                                                                             | A2232332233221                 |
| Core Density                                                      | The weight per unit volume.                                                                                                            | A2232332233232                 |
| Core Thickness                                                    | The height of the core at any given location.                                                                                          | A2232332233231                 |
| Joints/Interfaces                                                 | The removed portions of the laminate part.                                                                                             | A2232332233163                 |
| Ribbon Direction                                                  | The direction of continuous ribbon.                                                                                                    | A223233223325                  |
| Material Name                                                     | A ribbon or foam oriented material that primarily includes gloss phenolic and metals.                                                  | A2232332233233                 |
| Tolerances                                                        | The dimensional tolerances of the part due to conventional design/build constraints.                                                   | A22323323                      |
| Panel Size                                                        | The length and width of the panel within the next assembly.                                                                            | A223233334                     |
| Damage Tolerance                                                  | The ability to resist damage in the normal operating environment in its life cycle.                                                    | A22342                         |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                          |                                                                                                                                      | <b>Node Activity Reference</b> |
|-----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                 | <b>Description</b>                                                                                                                   | <b>Activity Reference</b>      |
| Mechanical Material Properties                                        | The combined load carrying properties.                                                                                               | A2231                          |
| OML/IML Surface                                                       | The laminate surface in contact with mold or bag.                                                                                    | A2232331                       |
| Make From Core Identifier                                             | The type of core (material or processed) which this core (processed - formed) is made from and its configuration control identifier. | A22324                         |
| * Construction Planes                                                 | The construction plane(s) that render the desired views of an ACSP.                                                                  | A22323221                      |
| * Tooling Interface Information                                       | The Inner Mold Line (IML) and Outer Mold Line (OML) of the ACSP.                                                                     | A2232331                       |
| ** Configuration Control Information                                  | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc.                                                         | A22322, A22324, A226           |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - CORE (PROCESSED - STABILIZED)</b> |                                                                                                                                      |                                |
| Boundary/Envelope                                                     | The boundary/envelope of the part in the XYZ planes.                                                                                 | A2232322                       |
| Ramp Angle                                                            | The chamfered angle of the core edge.                                                                                                | A223233223324                  |
| Core Splice                                                           | The core detail interface.                                                                                                           | A2232332233221                 |
| Core Density                                                          | The weight per unit volume.                                                                                                          | A2232332233232                 |
| Core Thickness                                                        | The height of the core at any given location.                                                                                        | A2232332233231                 |
| Joints/Interfaces                                                     | The removed portions of the laminate part.                                                                                           | A2232332233163                 |
| Ribbon Direction                                                      | The direction of continuous ribbon.                                                                                                  | A223233223325                  |
| Material Name                                                         | A ribbon or foam oriented material that primarily includes fiberglass, phenolic and metals.                                          | A2232332233233                 |
| Tolerances                                                            | The dimensional tolerances of the part due to conventional design/build constraints.                                                 | A2232333                       |
| Panel Size                                                            | The length and width of panel within the next assembly.                                                                              | A223233334                     |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                                                                    |                                                                                                                                          | <b>Node Activity Reference</b> |
|---------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                                                                           | <b>Description</b>                                                                                                                       | <b>Activity Reference</b>      |
| Damage Tolerance                                                                                                                | The ability to resist damage in the normal operating environment in its life cycle.                                                      | A22342                         |
| Mechanical Material Properties                                                                                                  | The combined load carrying properties.                                                                                                   | A2231                          |
| Make From Core Identifier                                                                                                       | The type of core (material or processed) which this core (processed - stabilized) is made from and its configuration control identifier. | A22324                         |
| Stabilizer                                                                                                                      | An injected material to and in support of the core ribbon.                                                                               | A2232332233223                 |
| ** Configuration Control Information                                                                                            | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc.                                                             | A22322, A22324, A226           |
|                                                                                                                                 |                                                                                                                                          |                                |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - COMPOSITE LAYUP/ASSEMBLY (PLY LAMINATE (FLAT)/CORE/PLY LAMINATE - CORE STIFFENED PANEL)</b> |                                                                                                                                          |                                |
| Core Characteristics                                                                                                            | The characteristics as described in more detail in the core section.                                                                     | N/A                            |
| Ply Laminate Characteristics                                                                                                    | These are characteristics as described in more detail in the ply laminate section.                                                       | N/A                            |
| Adhesive (type)                                                                                                                 | A bonding agent between the core and the laminate. Note: This includes an X-ply for smoothing.                                           | A223233332                     |
| Fastener Holes & Cut Outs                                                                                                       | The removed portions of the core.                                                                                                        | A2232332233222, A223233334     |
| Ply Table                                                                                                                       | A matrix of the Assembly characteristics.                                                                                                | A2232332233162                 |
| Envelope                                                                                                                        | The envelope of the part in the XYZ planes.                                                                                              | A22323222                      |
| Thickness                                                                                                                       | The combined sandwich thickness.                                                                                                         | A223233223314, A2232332233231  |
| Mold/Bag Line Surface                                                                                                           | The laminate surface in contact with mold or bag.                                                                                        | A2232331                       |
| Tolerances                                                                                                                      | The dimensional tolerances of the part due to conventional design/build constraints.                                                     | A22323323                      |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                                                                                                                               |                                                                                                         | <b>Node Activity Reference</b> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                                                                                                                                      | <b>Description</b>                                                                                      | <b>Activity Reference</b>      |
| Panel Size                                                                                                                                                                                 | The length and width of panel within the next assembly.                                                 | A223233334                     |
| Damage Tolerance                                                                                                                                                                           | The ability to resist damage in the normal operating environment in its life cycle.                     | A22342                         |
| Strength                                                                                                                                                                                   | The capacity to carry loads.                                                                            | A2234, A2231                   |
| Weight                                                                                                                                                                                     | The density characteristic times the volume of the part.                                                | A2233,<br>A223233223323        |
| Core Stiffened Panel Assembly Process                                                                                                                                                      | The sequence of assembling the laminate and the core in the core assembly.                              | A223233332,<br>A223233335      |
| Filler Characteristics                                                                                                                                                                     | These are characteristics as described in more detail in the filament assembly (radius filler) section. | N/A                            |
| Assembly Symmetry                                                                                                                                                                          | The balancing of the ply orientations with respect to the neutral axis.                                 | A2222113                       |
| Next Assembly Information                                                                                                                                                                  | These are necessary characteristics of adjoining parts. Reference information only.                     | A22322, A2232333,<br>A226      |
| ** Configuration Control Information                                                                                                                                                       | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc.                            | A22322, A22324,<br>A226        |
| <b>DETAIL STRUCTURAL DESIGN (DSD) - COMPOSITE LAYUP/ASSEMBLY (PLY LAMINATE (ANGLE)/PLY LAMINATE (ANGLE)/FILAMENT LAMINATE (RADIUS FILLER)/PLY LAMINATE (CAP) - "T" COMPOSITE ASSEMBLY)</b> |                                                                                                         |                                |
| Ply Laminate Angle) Characteristics                                                                                                                                                        | These are characteristics as described in more detail in the Angle section.                             | N/A                            |
| Filament Laminate (Radius Filler) Characteristics                                                                                                                                          | These are characteristics as described in more detail in the Filler section.                            | N/A                            |
| Ply Laminate (Cap) Characteristics                                                                                                                                                         | These are characteristics as described in more detail in the Cap section.                               | N/A                            |
| Joints/Interfaces                                                                                                                                                                          | The removed portions of the laminate part.                                                              | A2232332233163                 |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>         |                                                                                      | <b>Node Activity Reference</b> |
|--------------------------------------|--------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                | <b>Description</b>                                                                   | <b>Activity Reference</b>      |
| Panel Size                           | The length and width of panel within the next assembly.                              | A223233314                     |
| Tolerances                           | The dimensional tolerances of the part due to conventional design/build constraints. | A22323323                      |
| Damage Tolerance                     | The ability to resist damage in the normal operating environment in its life cycle.  | A22342                         |
| Strength                             | The capacity to carry loads.                                                         | A2234, A2231                   |
| Weight                               | The density characteristic times the volume of the part.                             | A2222113, A2233                |
| * Tooling Interface Information      | The Inner Mold Line (IML) and Outer Mold Line (OML) of the ACSP.                     | A2232331                       |
| ** Configuration Control Information | Effectivities, Contract Number, Drawing ID, Drawing Title, Part Number, etc.         | A22322, A22324, A226           |

\* Additions required by activities

\*\* Additions required by AP scope

## **APPENDIX C - Analysis Refined Information Needs**

| <b>VIEW - COMPOSITE ITEM</b>                                   |                                                                                                                                                                                                                         | <b>Node Activity Reference</b> |
|----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                          | <b>Description</b>                                                                                                                                                                                                      | <b>Activity Reference</b>      |
| <b>DETAIL STRUCTURAL ANALYSIS - FILAMENT ASSEMBLY (FABRIC)</b> |                                                                                                                                                                                                                         |                                |
| Material Name/Description                                      | The name of the material system and a description including the following: warp and fill fibers, resin, manufacturer(s), tow size, toughened/untoughened, thermoset/thermoplastic, applicable specifications.           | A223352133                     |
| Material Thickness                                             | Nominal theoretical thickness of the Filament Assembly (Fabric) when cured in a laminate that corresponds to fiber volume and resin content.                                                                            | A223352131<br>A223352132       |
| Reference Orientation                                          | The basic orientation direction of the fabric relative to an established coordinate system.                                                                                                                             | A223352132                     |
| Warp/Fill Directions                                           | The warp and fill directions with respect to the reference orientation. The warp direction is established by the fibers that are oriented longitudinally in the fabric, fill are the fibers that cross the warp fibers. | A223352133                     |
| Warp/Fill Percentages                                          | The percentage of fiber in the warp and fill directions. The percentages are assumed to add to 100%.                                                                                                                    | A223352133                     |
| Fiber Volume                                                   | Percentage of the total laminate volume composed of fibers.                                                                                                                                                             | A223352133                     |
| Resin Content                                                  | Percentage of the total material weight composed of resin.                                                                                                                                                              | A223352133                     |

\* Additions required by activities

\*\* Additions required by AP scope

| VIEW - COMPOSITE ITEM          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Node Activity Reference |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| Characteristic                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Activity Reference      |
| Mechanical Material Properties | <p>The mechanical properties of the Filament Assembly (Fabric) including:</p> <ul style="list-style-type: none"> <li>Density</li> <li>Warp Youngs Modulus - Compression</li> <li>Fill Youngs Modulus - Compression</li> <li>Warp Youngs Modulus - Tension</li> <li>Fill Youngs Modulus - Tension</li> <li>Through the Thickness Youngs Modulus (33)</li> <li>Poisson's Ratio (12, 23, 13)</li> <li>Shear Modulus (12, 23, 13)</li> <li>Warp Thermal Coefficient</li> <li>Fill Thermal Coefficient</li> <li>Through the Thickness Thermal Coefficient (33)</li> <li>Shear Thermal Coefficient (12,23, 13)</li> <li>Warp Moisture Absorption Coefficient</li> <li>Fill Moisture Absorption Coefficient</li> <li>Through the Thickness Moisture Absorption Coefficient (33)</li> <li>Strain Allowables <ul style="list-style-type: none"> <li>Warp Compressive</li> <li>Fill Compressive</li> <li>Through the Thickness Compressive (33)</li> </ul> </li> <li>Warp Tensile</li> <li>Fill Tensile</li> <li>Through the Thickness Tensile (33)</li> <li>Positive Shear (12, 23, 13)</li> <li>Negative Shear (12, 23, 13)</li> <li>Stress Allowables <ul style="list-style-type: none"> <li>Warp Compressive</li> <li>Fill Compressive</li> <li>Through the Thickness Compressive (33)</li> </ul> </li> <li>Warp Tensile</li> <li>Fill Tensile</li> <li>Through the Thickness Tensile (33)</li> <li>Shear (12, 23, 13)</li> <li>Characteristic Dimension for Tension (Fastener Analysis)</li> <li>Characteristic Dimension for Compression (Fastener Analysis)</li> <li>Miscellaneous Properties</li> </ul> | A223352133              |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                 |                                                                                                                                                                                                 | <b>Node Activity Reference</b> |
|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                        | <b>Description</b>                                                                                                                                                                              | <b>Activity Reference</b>      |
| Weave                                                        | Style of weaving used to form the fabric. Some examples include: five harness stain, crows foot, twill.                                                                                         | A223352133                     |
| Finish                                                       | The sizing put on the tows prior to weaving and resin impregnation.                                                                                                                             | A223352133                     |
|                                                              |                                                                                                                                                                                                 |                                |
| <b>DETAIL STRUCTURAL ANALYSIS - FILAMENT ASSEMBLY (TAPE)</b> |                                                                                                                                                                                                 |                                |
| Material Name/Description                                    | The name of the material system and a description including the following: fibers, resin, manufacturer(s), tow size, toughened/untoughened, thermoset/thermoplastic, applicable specifications. | A223352133                     |
| Material Thickness                                           | Nominal theoretical thickness of the Filament Assembly (Tape) when cured in a laminate that corresponds to fiber volume and resin content.                                                      | A223352131                     |
| Fiber Volume                                                 | Percentage of the total laminate volume composed of fibers.                                                                                                                                     | A223352133                     |
| Resin Content                                                | Percentage of the total material weight composed of resin.                                                                                                                                      | A223352133                     |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Node Activity Reference</b> |
|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                       | <b>Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Activity Reference</b>      |
| <b>Mechanical Material Properties</b>                       | <p>The mechanical properties of the Filament Assembly including:</p> <p>Density</p> <p>Youngs Modulus - Compression (11, 22, 33)</p> <p>Youngs Modulus - Tension (11, 22, 33)</p> <p>Poisson's Ratio (12, 23, 13)</p> <p>Shear Modulus (12, 23, 13)</p> <p>Thermal Coefficient (11, 22)</p> <p>Through the Thickness Thermal Coefficient (33)</p> <p>Shear Thermal Coefficient (12, 23, 13)</p> <p>Moisture Absorption Coefficient (11, 22)</p> <p>Strain Allowables</p> <p>Compressive (11, 22, 33)</p> <p>Tensile (11, 22, 33)</p> <p>Positive Shear (12, 23, 13)</p> <p>Negative Shear (12, 23, 13)</p> <p>Stress Allowables</p> <p>Compressive (11, 22, 33)</p> <p>Tensile (11, 22, 33)</p> <p>Shear (12, 23, 13)</p> <p>Characteristic Dimension for Tension (Fastener Analysis)</p> <p>Characteristic Dimension for Compression (Fastener Analysis)</p> <p>Miscellaneous Properties</p> | A223352133                     |
| <b>DETAIL STRUCTURAL ANALYSIS - FILAMENT LAMINATE (TOW)</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                |
| <b>Material Name/Description</b>                            | <p>The name of the material system and a description including the following: fibers, resin manufacturer(s), tow size, toughened/untoughened, thermoset/thermoplastic, grade and type callouts for adhesive (if present), applicable specifications.</p> <p>Material Thickness</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | A223352133                     |
| <b>Fiber Volume</b>                                         | Percentage of the total laminate volume composed of fibers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | A223352133                     |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Node Activity Reference</b> |
|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                 | <b>Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Activity Reference</b>      |
| Resin Content                                                         | Percentage of the total material weight composed of resin.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | A223352133                     |
| Mechanical Material Properties                                        | The mechanical properties of the Filament Assembly (Filler) including:<br>Density<br>Youngs Modulus - Compression (11, 22, 33)<br>Youngs Modulus - Tension (11, 22, 33)<br>Poisson's Ratio (12, 23, 13)<br>Shear Modulus (12, 23, 13)<br>Thermal Coefficient (11, 22)<br>Through the Thickness Thermal Coefficient (33)<br>Shear Thermal Coefficient (12, 23, 13)<br>Moisture Absorption Coefficient (11, 22)<br>Strain Allowables<br>Compressive (11, 22, 33)<br>Tensile (11, 22, 33)<br>Positive Shear (12, 23, 13)<br>Negative Shear (12, 23, 13)<br>Stress Allowables<br>Compressive (11, 22, 33)<br>Tensile (11, 22, 33)<br>Shear (12, 23, 13)<br>Characteristic Dimension for Tension (Fastener Analysis)<br>Characteristic Dimension for Compression (Fastener Analysis)<br>Miscellaneous Properties | A223352133                     |
| Shape                                                                 | The cross-sectional geometry of the filler if it is preformed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | A223352133                     |
| <b>DETAIL STRUCTURAL ANALYSIS - FILAMENT LAMINATE (RADIUS FILLER)</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |
| Filament Laminate Identification                                      | The assigned filament laminate number and descriptor.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                |
| Cross Section                                                         | The shape of the filament laminate cross-section(s) and area(s).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                  |                                                                                                                               | <b>Node Activity Reference</b> |
|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                         | <b>Description</b>                                                                                                            | <b>Activity Reference</b>      |
| Length                                        | The length of the filament laminate cross-section area(s).                                                                    |                                |
| Filament Assembly Constituents                | Type and quantity of filament assemblies (ex: tow) that make up the filament laminate.                                        |                                |
|                                               |                                                                                                                               |                                |
| <b>DETAIL STRUCTURAL ANALYSIS - PLY PIECE</b> |                                                                                                                               |                                |
| Boundary                                      | The location of the outer contiguous perimeter of a Ply Piece.                                                                | A223352132                     |
| Reference Orientation                         | The basic orientation direction of the Ply Piece relative to an established coordinate system.                                | A223352132                     |
| Ply it is a part of                           | Reference to the ply that the Ply Piece is a part of.                                                                         | A223352132                     |
| Filament Assembly Characteristics             | A reference to a Filament Assembly, including all the characteristics of that Filament Assembly.                              | N/A                            |
| OML/IML Surface                               | The surfaces that define the Outer Mold Line (OML) or Inner Mold Line (IML) of the Ply Piece.                                 | A223352132                     |
| Ply Piece Normal                              | A normal to the OML or IML surface of the Ply Piece positive in the direction of ascending Ply Sequence Number.               | A223352132                     |
| Warp Surface                                  | The side of the woven fabric where the material is composed of yarns running lengthwise to the fabric.                        | A223352133                     |
| Fill Surface                                  | The side of the woven fabric where the majority of the visible weave is composed of yarns running in the width of the fabric. | A223352133                     |
|                                               |                                                                                                                               |                                |
| <b>DETAIL STRUCTURAL ANALYSIS - PLY</b>       |                                                                                                                               |                                |
| Boundary                                      | The location of the outer contiguous perimeter of a Ply.                                                                      | A223352132                     |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                    |                                                                                                                                                                                                       | <b>Node Activity Reference</b> |
|-----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                           | <b>Description</b>                                                                                                                                                                                    | <b>Activity Reference</b>      |
| Reference Orientation                                           | The basic orientation direction of the Ply relative to an established coordinate system.                                                                                                              | A223352132                     |
| Ply Piece Characteristics                                       | A reference to a list of Ply Piece(s) including all the characteristics of the member Ply Piece(s).                                                                                                   | N/A                            |
| Ply Sequence Number                                             | The Ply Sequence Number is the order in which the Plies are laid down on the tool. The first Ply laid down is ply number 1, and the remaining Plies are assigned sequence numbers in ascending order. | A223352132                     |
| OML/IML Surface                                                 | The surfaces that define the Outer Mold Line (OML) or Inner Mold Line (IML) of the Ply.                                                                                                               | A223352132                     |
| Ply Normal                                                      | A normal to the OML or IML surface of the Ply Piece positive in the direction of ascending Ply Sequence Number.                                                                                       | A223352132                     |
| <b>DETAIL STRUCTURAL ANALYSIS - PLY LAMINATE (GENERAL FLAT)</b> |                                                                                                                                                                                                       |                                |
| Boundary                                                        | The location of the outer contiguous flat perimeter of a General Flat Ply Laminate.                                                                                                                   | A223352132                     |
| Laminate Thickness(es)                                          | The theoretical cured laminate thicknesses that are a sum of the Ply thicknesses specified in the Ply Table.                                                                                          | A223352131<br>A223352132       |
| OML/IML Surface                                                 | The surface that define the Outer Mold Line (OML) or Inner Mold Line (IML) of the General Flat Ply Laminate.                                                                                          | A223352132                     |
| Ply Table                                                       | A list of references of the constituent Plies and all their characteristics and associated Ply Sequence Numbers.                                                                                      | A223352132                     |
| Detail Structural Analysis                                      | The static stress analysis and durability/damage tolerance analysis of a General Flat Ply Laminate.                                                                                                   | A22335<br>A22336               |
| Weight                                                          | The weight of the General Flat Ply Laminate.                                                                                                                                                          | A22334                         |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                 |                                                                                                                                                | <b>Node Activity Reference</b>        |
|------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| <b>Characteristic</b>                                                        | <b>Description</b>                                                                                                                             | <b>Activity Reference</b>             |
| Joints                                                                       | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load. | A223353<br>A223233223<br>A223233163   |
| Next Assembly Information                                                    | References to the attachment of the part to adjoining parts.                                                                                   | A223353<br>A22322<br>A2232333<br>A226 |
| Laminate Properties                                                          | The mechanical Laminate Properties of the various Laminate Thicknesses of the General Flat Ply Laminate.                                       | A223352133                            |
| Stack Normal                                                                 | A normal to the OML or IML surface of the General Flat Ply Laminate, positive on the direction of ascending Ply Sequence Number.               | A223352132                            |
| Reference Orientation                                                        | The basic orientation direction of the General Flat Ply Laminate relative to an established coordinate system.                                 | A223352132                            |
| **Configuration Control Data                                                 | Information such as effectivities, contract, drawing, serial, and part numbers.                                                                | A226                                  |
| **Analysis Quality/Completeness                                              | An assessment of the quality of the finite element model (convergence, etc.), and of the completeness of the stress analysis of the part.      | ?                                     |
| *Analysis Decision Data                                                      | Data that records the decisions and idealizations made during the stress analysis.                                                             | A223351                               |
| **Laminate Patch                                                             | A constant thickness area of a ply laminate.                                                                                                   | A223352132                            |
| <b>DETAIL STRUCTURAL ANALYSIS - PLY LAMINATE (GENERAL CONTOUR/WRAPPABLE)</b> |                                                                                                                                                |                                       |
| Boundary/Envelope                                                            | The location of the outer contiguous three-dimensional perimeter of a General Contour/Wrappable Ply Laminate.                                  | A223352132                            |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b> |                                                                                                                                                | <b>Node Activity Reference</b>        |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| <b>Characteristic</b>        | <b>Description</b>                                                                                                                             | <b>Activity Reference</b>             |
| Laminate Thickness(es)       | The theoretical cured Laminate Thicknesses that are a sum of the Ply thicknesses specified in the Ply Table.                                   | A223352131<br>A223352132              |
| Contoured OML/IML Surface(s) | The surface(s) that define the Outer Mold Line (OML) or Inner Mold Line (IML) of the General Contour/Wrappable Ply Laminate.                   | A223352132                            |
| Ply Table                    | A list of references of the constituent Plies and all their characteristics and associated Ply Sequence Numbers.                               | A223352132                            |
| Detail Structural Analysis   | The static stress analysis and durability/damage tolerance analysis of a General Contour/Wrappable Ply Laminate.                               | A22335<br>A22336                      |
| Weight                       | The weight of the General Contour/Wrappable Ply Laminate.                                                                                      | A22334                                |
| Joints                       | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load. | A223353<br>A223233223<br>A223233163   |
| Next Assembly Information    | References to the attachment of the part to adjoining parts.                                                                                   | A223352<br>A22322<br>A2232333<br>A226 |
| Laminate Properties          | The mechanical Laminate Properties of the various Laminate Thicknesses of the General Contour/Wrappable Ply Laminate.                          | A223352133                            |
| Stack Normal                 | A normal to the OML or IML surface of the General Contour/Wrappable Ply Laminate, positive on the direction of ascending Ply Sequence Number.  | A223352132                            |
| Reference Orientation        | The basic orientation direction of the General Contour/Wrappable Ply Laminate relative to an established coordinate system.                    | A223352132                            |
| **Configuration Control Data | Information such as effectivities, contract, drawing, serial, and part numbers.                                                                | A226                                  |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                     |                                                                                                                                                | <b>Node Activity Reference</b>        |
|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| <b>Characteristic</b>                                            | <b>Description</b>                                                                                                                             | <b>Activity Reference</b>             |
| <b>**Analysis Quality/Completeness</b>                           | An assessment of the quality of the finite element model (convergence, etc.), and of the completeness of the stress analysis of the part.      | ?                                     |
| <b>*Analysis Decision Data</b>                                   | Data that records the decisions and idealizations made during the stress analysis.                                                             | A223351                               |
| <b>**Laminate Patch</b>                                          | A constant thickness area of a ply laminate.                                                                                                   | A223352132                            |
| <b>DETAIL STRUCTURAL ANALYSIS - PLY LAMINATE (ANGLE AND CAP)</b> |                                                                                                                                                |                                       |
| <b>Boundary/Envelope</b>                                         | The location of the outer contiguous three-dimensional perimeter of a General Contour/Wrappable Ply Laminate.                                  | A223352132                            |
| <b>Laminate Thickness(es)</b>                                    | The theoretical cured Laminate Thicknesses that are a sum of the Ply thicknesses specified in the Ply Table.                                   | A223352131<br>A223352132              |
| <b>Contoured OML/IML Surface(s)</b>                              | The surface(s) that define the Outer Mold Line (OML) or Inner Mold Line (IML) of an Angle/Cap Ply Laminate.                                    | A223352132                            |
| <b>Ply Table</b>                                                 | A list of references of the constituent Plies and all their characteristics and associated Ply Sequence Numbers.                               | A223352132                            |
| <b>Detail Structural Analysis</b>                                | The static stress analysis and durability/damage tolerance analysis of an Angle Ply Laminate.                                                  | A22335<br>A22336                      |
| <b>Weight</b>                                                    | The weight of the General Contour/Wrappable Ply Laminate.                                                                                      | A22334                                |
| <b>Joints</b>                                                    | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load. | A223353<br>A223233223<br>A223233163   |
| <b>Next Assembly Information</b>                                 | References to the attachment of the part to adjoining parts.                                                                                   | A223353<br>A22322<br>A2232333<br>A226 |

- \* Additions required by activities
- \*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                 |                                                                                                                                                                                             | <b>Node Activity Reference</b> |
|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                        | <b>Description</b>                                                                                                                                                                          | <b>Activity Reference</b>      |
| Cross Section Properties                                                     | The beam bending properties of the Angle cross section (moments of inertia, etc.)                                                                                                           | A223352131                     |
| Laminate Properties                                                          | The mechanical Laminate Properties of the various Laminate Thicknesses of an Angle/Cap Ply Laminate.                                                                                        | A223352133                     |
| Reference Orientation                                                        | The basic orientation direction of the Angle/Cap Ply Laminate relative to an established coordinate system.                                                                                 | A223352132                     |
| **Configuration Control Data                                                 | Information such as effectivities, contract, drawing, serial, and part numbers.                                                                                                             | A226                           |
| **Analysis Quality/Completeness                                              | An assessment of the quality of the finite element model (convergence, etc.), and of the completeness of the stress analysis of the part.                                                   | ?                              |
| *Analysis Decision Data                                                      | Data that records the decisions and idealizations made during the stress analysis.                                                                                                          | A223351                        |
| **Laminate Patch                                                             | A constant thickness area of a ply laminate.                                                                                                                                                | A223352132                     |
|                                                                              |                                                                                                                                                                                             |                                |
| <b>DETAIL STRUCTURAL ANALYSIS - CORE (MATERIAL AND PROCESSED - MACHINED)</b> |                                                                                                                                                                                             |                                |
| Material Name/Description                                                    | The name of the material system and a description including the following: fibers, resin, manufacturer(s), toughened/untoughened, thermoset/thermoplastic/metal, applicable specifications. | A223352133                     |
| Boundary/Envelope                                                            | The location of the outer contiguous three-dimensional perimeter surface of a Core.                                                                                                         | A223352132                     |
| Ramp Angle                                                                   | The angle of the boundary envelope surface where it intersects the Core Top or Bottom Surface.                                                                                              | A223352132 ?                   |

\* Additions required by activities  
 \*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                    |                                                                                                                                                | <b>Node Activity Reference</b>        |
|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| <b>Characteristic</b>                                           | <b>Description</b>                                                                                                                             | <b>Activity Reference</b>             |
| Joints                                                          | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load. | A223353<br>A223233223<br>A223233163   |
| Next Assembly Information                                       | References to the attachment of the part to adjoining parts.                                                                                   | A223353<br>A22322<br>A2232333<br>A226 |
| Ribbon Direction                                                | The continuous Ribbon Direction of the Core.                                                                                                   | A223352132                            |
| Cell Size                                                       | The size of the honeycomb cells of the Core.                                                                                                   | A223352133                            |
| Weight                                                          | The weight of the Core.                                                                                                                        | A223353                               |
| Material Properties                                             | The mechanical Material Properties of the Core.                                                                                                | A223352133                            |
| Core Normal                                                     | A direction normal to the Top Surface of the Core positive from the Bottom Surface to the Top Surface.                                         | A223352132                            |
| Top Surface                                                     | The surface that the Core Normal is defined with respect to.                                                                                   | A223352132                            |
| Bottom Surface.                                                 | The surface located on the negative core normal direction from the top surface.                                                                | A223352132                            |
| **Configuration Control Data                                    | Information such as effectivities, contract, drawing, serial, and part numbers.                                                                | A226                                  |
| <b>DETAIL STRUCTURAL ANALYSIS - CORE (PROCESSED - ASSEMBLY)</b> |                                                                                                                                                |                                       |
| Boundary/Envelope                                               | The location of the outer contiguous three-dimensional perimeter surface of a Core Assembly.                                                   | A223352132                            |
| Core (Material & Processed) Characteristics                     | A reference to a list of Core including all the characteristics of the member Core.                                                            | N/A                                   |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                                                                |                                                                                                                                                      | <b>Node Activity Reference</b>        |
|-----------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| <b>Characteristic</b>                                                                                                       | <b>Description</b>                                                                                                                                   | <b>Activity Reference</b>             |
| Joints                                                                                                                      | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load.       | A223353<br>A223233223<br>A223233163   |
| Next Assembly Information                                                                                                   | References to the attachment of the part to adjoining parts.                                                                                         | A223353<br>A22322<br>A2232333<br>A226 |
| Reference Orientation                                                                                                       | The basic orientation direction of the Core Assembly relative to an established coordinate system.                                                   | A223352132                            |
| Assembly List                                                                                                               | A list specifying the assembly of the constituent Core. Constituent Core coordinate systems are assembled with respect to the Reference Orientation. | A223352131<br>A223352132              |
| **Configuration Control Data                                                                                                | Information such as effectivities, contract, drawing, serial, and part numbers.                                                                      | A226                                  |
|                                                                                                                             |                                                                                                                                                      |                                       |
| <b>DETAIL STRUCTURAL ANALYSIS - COMPOSITE LAYUP/ASSEMBLY (PLY LAMINATE (FLAT)/CORE/PLY LAMINATE - CORE STIFFENED PANEL)</b> |                                                                                                                                                      |                                       |
| Core Characteristics                                                                                                        | A reference to a Core including all the characteristics of the Core.                                                                                 | N/A                                   |
| Ply Laminates Characteristics                                                                                               | A reference to two Ply Laminates (also known as face sheets) including all the characteristics of the Ply Laminates.                                 | N/A                                   |
| Adhesive (type)                                                                                                             | The adhesive used to bond the face sheets to the Core Assembly.                                                                                      | A223352133                            |
| Joints                                                                                                                      | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load.       | A223353<br>A223233223<br>A223233163   |
| Next Assembly Information                                                                                                   | References to the attachment of the part to adjoining parts.                                                                                         | A223353<br>A22322<br>A2232333<br>A226 |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>    |                                                                                                                                                                                           | <b>Node Activity Reference</b> |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>           | <b>Description</b>                                                                                                                                                                        | <b>Activity Reference</b>      |
| Boundary/Envelope               | The location of the outer contiguous three-dimensional perimeter of a Composite Assembly.                                                                                                 | A223352132                     |
| OML/IML Surfaces                | The surface(s) that define the Outer Mold Line (OML) or Inner Mold Line (IML) of a bond tool surface of a Composite Assembly.                                                             | A223352132                     |
| Detail Structural Analysis      | The static stress analysis and durability/damage tolerance analysis of a Composite Assembly.                                                                                              | A22335<br>A22336               |
| Weight                          | The weight of the Composite Assembly.                                                                                                                                                     | A22334                         |
| Combined Material Properties    | The smeared (equivalent) mechanical Material Properties of the Composite Assembly.                                                                                                        | A223352133                     |
| Reference Orientation           | The basic orientation direction of the Composite Assembly relative to an established coordinate system.                                                                                   | A223352132                     |
| Reference Normal                | A direction normal to the top surface of the Core Assembly bond mold surface positive in the part direction from the surface.                                                             | A223352132                     |
| Assembly List                   | A list specifying the assembly of the face sheets and Core Assembly. Core Detail and face sheet coordinate systems are assembled with respect to the Core Assembly Reference Orientation. | A223352131<br>A223352132       |
| **Configuration Control Data    | Information such as effectivities, contract, drawing, serial, and part numbers.                                                                                                           | A226                           |
| **Analysis Quality/Completeness | An assessment of the quality of the finite element model (convergence, etc.), and of the completeness of the stress analysis of the part.                                                 | ?                              |
| *Analysis Decision Data         | Data that records the decisions and idealizations made during the stress analysis.                                                                                                        | A223351                        |
| **Laminate Patch                | A constant thickness area of a ply laminate.                                                                                                                                              | A223352132                     |

\* Additions required by activities

\*\* Additions required by AP scope

| VIEW - COMPOSITE ITEM                                                                                                                                                                       |                                                                                                                                                | Node Activity Reference               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| Characteristic                                                                                                                                                                              | Description                                                                                                                                    | Activity Reference                    |
| <b>DETAIL STRUCTURAL ANALYSIS - COMPOSITE LAYUP/ASSEMBLY (PLY LAMINATE (ANGLE) / PLY LAMINATE (ANGLE) / FILAMENT LAMINATE (RADIUS FILLER)/ PLY LAMINATE (CAP) - "T" COMPOSITE ASSEMBLY)</b> |                                                                                                                                                |                                       |
| Ply Laminate (Angle) Characteristics                                                                                                                                                        | A reference to two Ply Laminates (Angle) including all the characteristics of the Ply Laminates.                                               | N/A                                   |
| Filament Laminate (Radius Filler) Characteristics                                                                                                                                           | A reference to a Filament Laminate (Radius Filler) including all the characteristics of the Filament Laminate Detail.                          | N/A                                   |
| Ply Laminate (Cap) Characteristics                                                                                                                                                          | A reference to a Ply Laminate (Cap) including all the characteristics of the Ply Laminate.                                                     | N/A                                   |
| Joints                                                                                                                                                                                      | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load. | A223353<br>A223233223<br>A223233163   |
| Next Assembly Information                                                                                                                                                                   | References to the attachment of the part to adjoining parts.                                                                                   | A223353<br>A22322<br>A2232333<br>A226 |
| Cross Section Properties                                                                                                                                                                    | The beam bending properties of the Composite Assembly cross section (moments of inertia, etc.)                                                 | A223352131                            |
| Detail Structural Analysis                                                                                                                                                                  | The static stress analysis and durability/damage tolerance analysis of a Composite Assembly.                                                   | A22335<br>A22336                      |
| Weight                                                                                                                                                                                      | The weight of the Composite Assembly.                                                                                                          | A22334                                |
| Boundary/Envelope                                                                                                                                                                           | The location of the outer contiguous three-dimensional perimeter of a Composite Assembly.                                                      | A223352132                            |
| Reference Orientation                                                                                                                                                                       | The basic orientation direction of the Composite Assembly relative to an established coordinate system.                                        | A223352132                            |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                         |                                                                                                                                                                                                        | <b>Node Activity Reference</b> |
|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                | <b>Description</b>                                                                                                                                                                                     | <b>Activity Reference</b>      |
| Assembly List                                                        | A list specifying the assembly of the two angles, filler and cap into a Composite assemble Assembly. Angle, filler and cap coordinate systems are assembled with respect to the Reference Orientation. | A223352131<br>A223352132       |
| **Configuration Control Data                                         | Information such as effectivities, contract, drawing, serial, and part numbers.                                                                                                                        | A226                           |
| **Analysis Quality/Completeness                                      | An assessment of the quality of the finite element model (convergence, etc.), and of the completeness of the stress analysis of the part.                                                              | ?                              |
| *Analysis Decision Data                                              | Data that records the decisions and idealizations made during the stress analysis.                                                                                                                     | A223351                        |
| **Laminate Patch                                                     | A constant thickness area of a ply laminate.                                                                                                                                                           | A223352132                     |
| <b>PRELIMINARY STRUCTURAL ANALYSIS - PLY LAMINATE (GENERAL FLAT)</b> |                                                                                                                                                                                                        |                                |
| Boundary                                                             | The location of the outer contiguous flat perimeter of a General Flat Ply Laminate.                                                                                                                    | A2222132<br>A2222142           |
| Laminate Thickness(es)                                               | The theoretical cured laminate thicknesses that are a sum of the Ply thicknesses specified in the Ply Table.                                                                                           | A2222132<br>A2222142           |
| OML/IML Surface                                                      | The surface that define the Outer Mold Line (OML) or Inner Mold Line (IML) of the General Flat Ply Laminate.                                                                                           | A2222132<br>A2222142           |
| Ply Orientations                                                     | A list of ply orientations defined with respect to the reference orientation. Note that this information is combined with the Ply Percentages to provide a complete laminate description.              | A2222132<br>A2222142           |
| Ply Percentages                                                      | The percentage of total theoretical laminate thickness in each ply orientation.                                                                                                                        | A2222132<br>A2222142           |

- \* Additions required by activities
- \*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                      |                                                                                                                                                                                  | <b>Node Activity Reference</b> |
|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                             | <b>Description</b>                                                                                                                                                               | <b>Activity Reference</b>      |
| Preliminary Structural Analysis                                                   | Analytical trade studies to define and optimize structural configurations producing preliminary thicknesses, ply orientations and stiffener/core cross section/geometry/spacing. | A2222                          |
| Weight                                                                            | The weight of the General Flat Ply Laminate.                                                                                                                                     | A2222132<br>A2222142           |
| Joints                                                                            | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load.                                   | ?                              |
| Next Assembly Information                                                         | References to the attachment of the part to adjoining parts.                                                                                                                     | ?                              |
| Laminate Properties                                                               | The mechanical Laminate Properties of the various Laminate Thicknesses of the General Flat Ply Laminate.                                                                         | A22221                         |
| Stack Normal                                                                      | A normal to the OML or IML surface of the General Flat Ply Laminate, positive on the direction of ascending Ply Sequence Number.                                                 | A2222132<br>A2222142           |
| Reference Orientation                                                             | The basic orientation direction of the General Flat Ply Laminate relative to an established coordinate system.                                                                   | A2222132<br>A2222142           |
| **Analysis Quality/Completeness                                                   | An assessment of the quality of the finite element model (convergence, etc.), and of the completeness of the stress analysis of the part.                                        | ?                              |
| *Analysis Decision Data                                                           | Data that records the decisions and idealizations made during the stress analysis.                                                                                               | A223351                        |
| **Laminate Patch                                                                  | A constant thickness area of a ply laminate.                                                                                                                                     | A223352132                     |
| <b>PRELIMINARY STRUCTURAL ANALYSIS - PLY LAMINATE (GENERAL CONTOUR/WRAPPABLE)</b> |                                                                                                                                                                                  |                                |
| Boundary/Envelope                                                                 | The location of the outer contiguous three-dimensional perimeter of a General Contour/Wrappable Ply Laminate.                                                                    | A2222132<br>A2222142           |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>    |                                                                                                                                                                                           | <b>Node Activity Reference</b> |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>           | <b>Description</b>                                                                                                                                                                        | <b>Activity Reference</b>      |
| Laminate Thickness(es)          | The theoretical cured Laminate Thicknesses that are a sum of the Ply thicknesses specified in the Ply Table.                                                                              | A2222132<br>A2222142           |
| Contoured OML/IML Surface(s)    | The surface(s) that define the Outer Mold Line (OML) or Inner Mold Line (IML) of the General Contour/Wrappable Ply Laminate.                                                              | A2222132<br>A2222142           |
| Ply Orientations                | A list of ply orientations defined with respect to the reference orientation. Note that this information is combined with the Ply Percentages to provide a complete laminate description. | A2222132<br>A2222142           |
| Ply Percentages                 | The percentage of total theoretical laminate thickness in each ply orientation.                                                                                                           | A2222132<br>A2222142           |
| Preliminary Structural Analysis | Analytical trade studies to define and optimize structural configurations producing preliminary thicknesses, ply orientations and stiffener/core cross section/geometry/spacing.          | A2222                          |
| Weight                          | The weight of the General Contour/Wrappable Ply Laminate.                                                                                                                                 | A2222132<br>A2222142           |
| Joints                          | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load.                                            | ?                              |
| Next Assembly Information       | References to the attachment of the part to adjoining parts.                                                                                                                              | ?                              |
| Laminate Properties             | The mechanical Laminate Properties of the various Laminate Thicknesses of the General Contour/Wrappable Ply Laminate.                                                                     | A22221                         |
| Stack Normal                    | A normal to the OML or IML surface of the General Contour/Wrappable Ply Laminate, positive on the direction of ascending Ply Sequence Number.                                             | A2222132<br>A2222142           |
| Reference Orientation           | The basic orientation direction of the General Contour/Wrappable Ply Laminate relative to an established coordinate system.                                                               | A2222132<br>A2222142           |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                          |                                                                                                                                                                                           | <b>Node Activity Reference</b> |
|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                 | <b>Description</b>                                                                                                                                                                        | <b>Activity Reference</b>      |
| <b>**Analysis Quality/Completeness</b>                                | An assessment of the quality of the finite element model (convergence, etc.), and of the completeness of the stress analysis of the part.                                                 | ?                              |
| <b>*Analysis Decision Data</b>                                        | Data that records the decisions and idealizations made during the stress analysis.                                                                                                        | A223351                        |
| <b>**Laminate Patch</b>                                               | A constant thickness area of a ply laminate.                                                                                                                                              | A223352132                     |
| <b>PRELIMINARY STRUCTURAL ANALYSIS - PLY LAMINATE (ANGLE AND CAP)</b> |                                                                                                                                                                                           |                                |
| <b>Boundary/Envelope</b>                                              | The location of the outer contiguous three-dimensional perimeter of an Angle/Cap Ply Laminate.                                                                                            | A2222132<br>A2222142           |
| <b>Laminate Thickness(es)</b>                                         | The theoretical cured Laminate Thicknesses that are a sum of the Ply thicknesses specified in the Ply Table.                                                                              | A2222132<br>A2222142           |
| <b>Contoured OML/IML Surface(s)</b>                                   | The surface(s) that define the Outer Mold Line (OML) or Inner Mold Line (IML) of an Angle/Cap Ply Laminate.                                                                               | A2222132<br>A2222142           |
| <b>Ply Orientations</b>                                               | A list of ply orientations defined with respect to the reference orientation. Note that this information is combined with the Ply Percentages to provide a complete laminate description. | A2222132<br>A2222142           |
| <b>Ply Percentages</b>                                                | The percentage of total theoretical laminate thickness in each ply orientation.                                                                                                           | A2222132<br>A2222142           |
| <b>Preliminary Structural Analysis</b>                                | Analytical trade studies to define and optimize structural configurations producing preliminary thicknesses, ply orientations and stiffener/core cross section/geometry/spacing.          | A2222                          |
| <b>Weight</b>                                                         | The weight of the General Contour/Wrappable Ply Laminate.                                                                                                                                 | A2222132<br>A2222142           |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                        |                                                                                                                                                                                             | <b>Node Activity Reference</b> |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                               | <b>Description</b>                                                                                                                                                                          | <b>Activity Reference</b>      |
| Joints                                                                              | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load.                                              | ?                              |
| Next Assembly Information                                                           | References to the attachment of the part to adjoining parts.                                                                                                                                | ?                              |
| Cross Section Properties                                                            | The beam bending properties of the Angle cross section (moments of inertia, etc.)                                                                                                           | A2222132<br>A2222142           |
| Laminate Properties                                                                 | The mechanical Laminate Properties of the various Laminate Thicknesses of an Angle/Cap Ply Laminate.                                                                                        | A22221                         |
| Reference Orientation                                                               | The basic orientation direction of the Angle/Cap Ply Laminate relative to an established coordinate system.                                                                                 | A2222132<br>A2222142           |
| **Analysis Quality/Completeness                                                     | An assessment of the quality of the finite element model (convergence, etc.), and of the completeness of the stress analysis of the part.                                                   | ?                              |
| *Analysis Decision Data                                                             | Data that records the decisions and idealizations made during the stress analysis.                                                                                                          | A223351                        |
| **Laminate Patch                                                                    | A constant thickness area of a ply laminate.                                                                                                                                                | A223352132                     |
|                                                                                     |                                                                                                                                                                                             |                                |
| <b>PRELIMINARY STRUCTURAL ANALYSIS - CORE (MATERIAL &amp; PROCESSED - MACHINED)</b> |                                                                                                                                                                                             |                                |
| Material Name/Description                                                           | The name of the material system and a description including the following: fibers, resin, manufacturer(s), toughened/untoughened, thermoset/thermoplastic/metal, applicable specifications. | A22221                         |
| Boundary/Envelope                                                                   | The location of the outer contiguous three-dimensional perimeter surface of a Core.                                                                                                         | A2222132<br>A2222142           |

- \* Additions required by activities
- \*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                                                                     |                                                                                                                                                                                                  | <b>Node Activity Reference</b> |
|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                                                                            | <b>Description</b>                                                                                                                                                                               | <b>Activity Reference</b>      |
| Joints                                                                                                                           | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load. May or may not require Next Assembly information. | A2222132<br>A2222142           |
| Ribbon Direction                                                                                                                 | The continuous Ribbon Direction of the Core.                                                                                                                                                     | A2222132<br>A2222142           |
| Weight                                                                                                                           | The weight of the Core.                                                                                                                                                                          | A2222132<br>A2222142           |
| Material Properties                                                                                                              | The mechanical Material Properties of the Core.                                                                                                                                                  | A22221                         |
| Core Normal                                                                                                                      | A direction normal to the Top Surface of the Core positive from the Bottom Surface to the Top Surface.                                                                                           | A2222132<br>A2222142           |
| Top Surface                                                                                                                      | The surface that the Core Normal is defined with respect to.                                                                                                                                     | A2222132<br>A2222142           |
| Bottom Surface.                                                                                                                  | The surface located on the negative core normal direction from the top surface.                                                                                                                  | A2222132<br>A2222142           |
| <b>PRELIMINARY STRUCTURAL ANALYSIS - COMPOSITE LAYUP/ASSEMBLY (PLY LAMINATE (FLAT)/CORE/PLY LAMINATE - CORE STIFFENED PANEL)</b> |                                                                                                                                                                                                  |                                |
| Core Characteristics                                                                                                             | A reference to a Core including all the characteristics of the Core.                                                                                                                             | N/A                            |
| Ply Laminates Characteristics                                                                                                    | A reference to two Ply Laminates (also known as face sheets) including all the characteristics of the Ply Laminates.                                                                             | A2222132<br>A2222142           |
| Adhesive (type)                                                                                                                  | The adhesive used to bond the face sheets to the Core.                                                                                                                                           | A2222132<br>A2222142           |
| Joints                                                                                                                           | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load.                                                   | ?                              |
| Next Assembly Information                                                                                                        | References to the attachment of the part to adjoining parts.                                                                                                                                     | ?                              |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>    |                                                                                                                                                                                      | <b>Node Activity Reference</b> |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>           | <b>Description</b>                                                                                                                                                                   | <b>Activity Reference</b>      |
| Boundary/Envelope               | The location of the outer contiguous three-dimensional perimeter of a Composite Assembly.                                                                                            | A2222132<br>A2222142           |
| OML/IML Surfaces                | The surface(s) that define the Outer Mold Line (OML) or Inner Mold Line (IML) of a bond tool surface of a Composite Assembly.                                                        | A2222132<br>A2222142           |
| Preliminary Structural Analysis | Analytical trade studies to define and optimize structural configurations producing preliminary thicknesses, ply orientations and stiffener/core cross section/geometry/spacing.     | A2222                          |
| Weight                          | The weight of the Composite Assembly.                                                                                                                                                | A2222132<br>A2222142           |
| Combined Material Properties    | The smeared (equivalent) mechanical Material Properties of the Composite Assembly.                                                                                                   | A22221                         |
| Assembly Reference Orientation  | The basic orientation direction of the Composite Assembly relative to an established coordinate system.                                                                              | A2222132<br>A2222142           |
| Reference Normal                | A direction normal to the top surface of the Core Assembly bond mold surface positive in the part direction from the surface.                                                        | A2222132<br>A2222142           |
| Assembly List                   | A list specifying the assembly of the face sheets and Core Assembly. Core Detail and face sheet coordinate systems are assembled with respect to the Assembly Reference Orientation. | A2222132<br>A2222142           |
| **Analysis Quality/Completeness | An assessment of the quality of the finite element model (convergence, etc.), and of the completeness of the stress analysis of the part.                                            | ?                              |
| *Analysis Decision Data         | Data that records the decisions and idealizations made during the stress analysis.                                                                                                   | A223351                        |
| **Laminate Patch                | A constant thickness area of a ply laminate.                                                                                                                                         | A223352132                     |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                                                                                                                                     |                                                                                                                                                                                  | <b>Node Activity Reference</b> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                                                                                                                                            | <b>Description</b>                                                                                                                                                               | <b>Activity Reference</b>      |
| <b>PRELIMINARY STRUCTURAL ANALYSIS - COMPOSITE LAYUP/ASSEMBLY (PLY LAMINATE (ANGLE) / PLY LAMINATE (ANGLE) / FILAMENT LAMINATE (RADIUS FILLER)/ PLY LAMINATE (CAP) - "T" COMPOSITE ASSEMBLY)</b> |                                                                                                                                                                                  |                                |
| Ply Laminate (Angle) Characteristics                                                                                                                                                             | A reference to two Ply Laminates (Angle) including all the characteristics of the Ply Laminates.                                                                                 | N/A                            |
| Filament Laminate (Radius Filler) Characteristics                                                                                                                                                | A reference to a Filament Laminate (Radius Filler) including all the characteristics of the Filament Laminate.                                                                   | N/A                            |
| Ply Laminate (Cap) Characteristics                                                                                                                                                               | A reference to a Ply Laminate (Cap) including all the characteristics of the Ply Laminate.                                                                                       | N/A                            |
| Joints                                                                                                                                                                                           | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load.                                   | ?                              |
| Next Assembly Information                                                                                                                                                                        | References to the attachment of the part to adjoining parts.                                                                                                                     | ?                              |
| Cross Section Properties                                                                                                                                                                         | The beam bending properties of the Composite Assembly cross section (moments of inertia, etc.)                                                                                   | A2222132<br>A2222142           |
| Preliminary Structural Analysis                                                                                                                                                                  | Analytical trade studies to define and optimize structural configurations producing preliminary thicknesses, ply orientations and stiffener/core cross section/geometry/spacing. | A2222                          |
| Weight                                                                                                                                                                                           | The weight of the Composite Assembly.                                                                                                                                            | A2222132<br>A2222142           |
| Boundary/Envelope                                                                                                                                                                                | The location of the outer contiguous three-dimensional perimeter of a Composite Assembly.                                                                                        | A2222132<br>A2222142           |
| Reference Orientation                                                                                                                                                                            | The basic orientation direction of the Composite Assembly relative to an established coordinate system.                                                                          | A2222132<br>A2222142           |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                         |                                                                                                                                                                                                                 | <b>Node Activity Reference</b> |
|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                | <b>Description</b>                                                                                                                                                                                              | <b>Activity Reference</b>      |
| Assembly List                                        | A list specifying the assembly of the two angles, filler and cap into a Composite assemble Assembly. Angle, filler and cap coordinate systems are assembled with respect to the Assembly Reference Orientation. | A2222132<br>A2222142           |
| **Analysis Quality/Completeness                      | An assessment of the quality of the finite element model (convergence, etc.), and of the completeness of the stress analysis of the part.                                                                       | ?                              |
| *Analysis Decision Data                              | Data that records the decisions and idealizations made during the stress analysis.                                                                                                                              | A223351                        |
| **Laminate Patch                                     | A constant thickness area of a ply laminate.                                                                                                                                                                    | A223352132                     |
| <b>STRUCTURAL TEST - PLY LAMINATE (GENERAL FLAT)</b> |                                                                                                                                                                                                                 |                                |
| Boundary                                             | The location of the outer contiguous flat perimeter of a General Flat Ply Laminate.                                                                                                                             | A2233541                       |
| Laminate Thickness(es)                               | The theoretical cured laminate thicknesses that are a sum of the Ply thicknesses specified in the Ply Table.                                                                                                    | A2233541                       |
| OML/IML Surface                                      | The surface that define the Outer Mold Line (OML) or Inner Mold Line (IML) of the General Flat Ply Laminate.                                                                                                    | A2233541                       |
| Test Results                                         | The results of structural tests preformed on a General Flat Ply Laminate.                                                                                                                                       | A2233543                       |
| Weight                                               | The weight of the General Flat Ply Laminate.                                                                                                                                                                    | A2233543                       |
| Joints                                               | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load.                                                                  | A2233541                       |
| Next Assembly Information                            | References to the attachment of the part to adjoining parts.                                                                                                                                                    | A2233541                       |

- \* Additions required by activities
- \*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                      |                                                                                                                                                | <b>Node Activity Reference</b> |
|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                             | <b>Description</b>                                                                                                                             | <b>Activity Reference</b>      |
| Laminate Properties                                               | The as tested mechanical Laminate Properties of the various Laminate Thicknesses of the General Flat Ply Laminate.                             | A2233543                       |
| Reference Orientation                                             | The basic orientation direction of the General Flat Ply Laminate relative to an established coordinate system.                                 | A2233541                       |
| **Configuration Control Data                                      | Information such as effectivities, contract, drawing, serial, and part numbers.                                                                | A226                           |
| *Analysis Decision Data                                           | Data that records the decisions and idealizations made during the stress analysis.                                                             | A223351                        |
|                                                                   |                                                                                                                                                |                                |
| <b>STRUCTURAL TEST - PLY LAMINATE (GENERAL CONTOUR/WRAPPABLE)</b> |                                                                                                                                                |                                |
| Boundary/Envelope                                                 | The location of the outer contiguous three-dimensional perimeter of a General Contour/Wrappable Ply Laminate.                                  | A2233541                       |
| Laminate Thickness(es)                                            | The theoretical cured Laminate Thicknesses that are a sum of the Ply thicknesses specified in the Ply Table.                                   | A2233541                       |
| Contoured OML/IML Surface(s)                                      | The surface(s) that define the Outer Mold Line (OML) or Inner Mold Line (IML) of the General Contour/Wrappable Ply Laminate.                   | A2233541                       |
| Test Results                                                      | The results of structural tests preformed on a General Contour/Wrappable Ply Laminate.                                                         | A2233543                       |
| Weight                                                            | The weight of the General Contour/Wrappable Ply Laminate.                                                                                      | A2233543                       |
| Joints                                                            | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load. | A2233541                       |
| Next Assembly Information                                         | References to the attachment of the part to adjoining parts.                                                                                   | A2233543                       |
| Laminate Properties                                               | The as tested mechanical Laminate Properties of the various Laminate Thicknesses of the General Contour/Wrappable Ply Laminate.                | A2233541                       |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                                                                                                                     |                                                                                                                               | <b>Node Activity Reference</b> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                                                                                                                            | <b>Description</b>                                                                                                            | <b>Activity Reference</b>      |
| Reference Orientation                                                                                                                                                            | The basic orientation direction of the General Contour/Wrappable Ply Laminate relative to an established coordinate system.   | A2233541                       |
| **Configuration Control Data                                                                                                                                                     | Information such as effectivities, contract, drawing, serial, and part numbers.                                               | A226                           |
| *Analysis Decision Data                                                                                                                                                          | Data that records the decisions and idealizations made during the stress analysis.                                            | A223351                        |
| <b>STRUCTURAL TEST - COMPOSITE LAYUP/ASSEMBLY (PLY LAMINATE (FLAT)/CORE/PLY LAMINATE - CORE STIFFENED PANEL)</b>                                                                 |                                                                                                                               |                                |
| Boundary/Envelope                                                                                                                                                                | The location of the outer contiguous three-dimensional perimeter of a Composite Assembly.                                     | A2233541                       |
| OML/IML Surfaces                                                                                                                                                                 | The surface(s) that define the Outer Mold Line (OML) or Inner Mold Line (IML) of a bond tool surface of a Composite Assembly. | A2233541                       |
| Test Results                                                                                                                                                                     | The results of structural tests performed on a Composite Assembly.                                                            | A2233543                       |
| Weight                                                                                                                                                                           | The weight of the Composite Assembly.                                                                                         | A2233543                       |
| Combined Material Properties                                                                                                                                                     | The as tested smeared (equivalent) mechanical Material Properties of the Composite Assembly.                                  | A2233543                       |
| Reference Orientation                                                                                                                                                            | The basic orientation direction of the Composite Assembly relative to an established coordinate system.                       | A2233541                       |
| **Configuration Control Data                                                                                                                                                     | Information such as effectivities, contract, drawing, serial, and part numbers.                                               | A226                           |
| *Analysis Decision Data                                                                                                                                                          | Data that records the decisions and idealizations made during the stress analysis.                                            | A223351                        |
| <b>STRUCTURAL TEST - COMPOSITE LAYUP/ASSEMBLY (PLY LAMINATE (ANGLE) / PLY LAMINATE (ANGLE) / FILAMENT LAMINATE (RADIUS FILLER)/ PLY LAMINATE (CAP) - "T" COMPOSITE ASSEMBLY)</b> |                                                                                                                               |                                |

\* Additions required by activities

\*\* Additions required by RF scope

| <b>VIEW - COMPOSITE ITEM</b> |                                                                                                                                                | <b>Node Activity Reference</b> |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>        | <b>Description</b>                                                                                                                             | <b>Activity Reference</b>      |
| Joints                       | Description of the attachment mechanisms (e.g. bolts, adhesives, etc.) and structural configuration//members joined together to transfer load. | A2233541                       |
| Next Assembly Information    | References to the attachment of the part to adjoining parts.                                                                                   | A2233541                       |
| Cross Section Properties     | The as tested beam bending properties of the Composite Assembly cross section (moments of inertia, etc.)                                       | A2233543                       |
| Test Results                 | The results of structural tests performed on a Composite Assembly.                                                                             | A2233543                       |
| Weight                       | The weight of the Composite Assembly.                                                                                                          | A2233543                       |
| Boundary/Envelope            | The location of the outer contiguous three-dimensional perimeter of a Composite Assembly.                                                      | A2233541                       |
| Reference Orientation        | The basic orientation direction of the Composite Assembly relative to an established coordinate system.                                        | A2233541                       |
| **Configuration Control Data | Information such as effectivities, contract, drawing, serial, and part numbers.                                                                | A226                           |
| *Analysis Decision Data      | Data that records the decisions and idealizations made during the stress analysis.                                                             | A223351                        |

\* Additions required by activities

\*\* Additions required by AP scope

## **APPENDIX D - Manufacturing Refined Information Needs**

| <b>VIEW - COMPOSITE ITEM</b>                                        |                                                                                                                                   | <b>Node Activity Reference</b> |
|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                               | <b>Description</b>                                                                                                                | <b>Activity Reference</b>      |
| <b>MANUFACTURING PLANNING - FILAMENT ASSEMBLY (FABRIC/TAPE/TOW)</b> |                                                                                                                                   |                                |
| Material Type/Description                                           | Define the type of material such as graphite, fiberglass, etc. Determine the manufacturing method required.                       | A2315                          |
| Material Thickness                                                  | The nominal thickness of one layer of the material.                                                                               | A2315                          |
| Weave                                                               | The manner in which the a fabric is formed by interlacing yams in a specific pattern.                                             | A2315                          |
| Drape                                                               | The ability of a material to form to a contour                                                                                    | A2315                          |
| Material Name                                                       | The manufacturer of the material and any brand name and/or product identifier.                                                    | A2315                          |
| Fiber/resin ratio                                                   | The ratio between the fiber content and the amount of resin present in a composite material. Determine requirements for bleeding. | A2315                          |
| Warp/Fill Directions                                                | The direction of the longitudinally oriented yam in a woven fabric./ The yam in a fabric that crosses the warp.                   | A2315                          |
| Fiber Strength/Stiffness                                            | The ability of the tape fibers to resist bending.                                                                                 | A2315                          |
| Material Life Data                                                  | The storage requirements, shelf life, working life, and out time limits for the materials                                         | A2315                          |
| Stock Size                                                          | Physical dimensions describing material as it is purchased.                                                                       | A2315                          |
| <b>MANUFACTURING PLANNING - FILAMENT LAMINATE (RADIUS FILLER)</b>   |                                                                                                                                   |                                |
| Material Name/Description                                           | The manufacturer of the material and any brand name and/or product identifier.                                                    | A2315                          |
| Material Quantity                                                   | The amount (number of strands of tow) required to produce the required cross section of the filler.                               | A23151,A2153                   |
| Cross Section Volume                                                | The volume of a cross section of the filler.                                                                                      | A23151,A23153                  |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                 |                                                                                                                                                                             | <b>Node Activity Reference</b> |
|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                        | <b>Description</b>                                                                                                                                                          | <b>Activity Reference</b>      |
| Boundary                                     | The cross sectional shape and length of the filler.                                                                                                                         | A23151,A2353                   |
| Material Life Data                           | The storage requirements, shelf life, working life, and out time limits for the materials                                                                                   | A2315                          |
| Material Amount                              | The total quantity of material to produce filler.                                                                                                                           |                                |
|                                              |                                                                                                                                                                             |                                |
| <b>MANUFACTURING PLANNING - PLY PIECE</b>    |                                                                                                                                                                             |                                |
| None                                         |                                                                                                                                                                             |                                |
|                                              |                                                                                                                                                                             |                                |
| <b>MANUFACTURING PLANNING - PLY</b>          |                                                                                                                                                                             |                                |
| Boundary                                     | The edge of the ply detail (EOP).                                                                                                                                           | A2315                          |
| Filament Laminate Characteristics            | Inherit characteristics of Filament Laminate                                                                                                                                | A2315                          |
| Material Amount                              | The total quantity of material to produce                                                                                                                                   | A2315                          |
| <b>MANUFACTURING PLANNING - PLY LAMINATE</b> |                                                                                                                                                                             |                                |
| Ply Characteristics                          | Inherit characteristics of ply                                                                                                                                              | A2315                          |
| Number of ply(ies)                           | How many ply(ies) make up this ply laminate.                                                                                                                                | A2315                          |
| Ply Table                                    | Information on the position and orientation of each ply.                                                                                                                    | A2315                          |
| Boundary                                     | The edge of the laminate.                                                                                                                                                   | A2315                          |
| Tolerances                                   | The tolerance requirements relative to the ply laminate.                                                                                                                    | A2315                          |
| Splice, lap & gap                            | The requirements for splice location and overlapping/gaps in plies.                                                                                                         | A2315                          |
| Tool Controlled Surfaces                     | The surfaces of the ply laminate that come in contact with tool surfaces for the purpose of controlling certain aspects of the laminate (dimensions, surface finish, etc.). | A2315                          |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                |                                                                                                                                                                          | <b>Node Activity Reference</b> |
|-------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                       | <b>Description</b>                                                                                                                                                       | <b>Activity Reference</b>      |
| Contour                                                     | A geometric definition of the surface of the laminate (may or may not be flat). The amount of contour is defined by the deviation of the laminate from a planar surface. | A2315                          |
| Mfg Concept                                                 | General definition of how to produce                                                                                                                                     | A2315                          |
| Mfg BOM                                                     | Manufacturing Defined Bill of Materials                                                                                                                                  | A2315                          |
| <b>MANUFACTURING PLANNING - CORE (PROCESSED - MACHINED)</b> |                                                                                                                                                                          |                                |
| Boundary                                                    | The edge of the core.                                                                                                                                                    | A2315                          |
| Core Splice                                                 | The location of the splice where the core will be attached to another core.                                                                                              | A2315                          |
| Core Thickness                                              | The finished thickness of the core.                                                                                                                                      | A2315                          |
| Core Density                                                | The pounds per cubic foot of honeycomb core based upon the foil gauge or thickness and cell size.                                                                        | A2315                          |
| Ramp Angle                                                  | The angle of segments of the core that are tapered.                                                                                                                      | A2315                          |
| Joints                                                      | The general area of contact.                                                                                                                                             | A2315                          |
| Tolerances (thickness, location)                            | The degree of accuracy required when manufacturing the ACSP.                                                                                                             | A2315                          |
| Ribbon Direction                                            | The direction the strips of material that make up the cells of the honeycomb.                                                                                            | A2315                          |
| Core Type                                                   | The type of core being used (e.g., nomex, HFT, HRP, etc.)                                                                                                                | A2315                          |
| Core Configuration                                          | The configuration of the cells (i.e., hex, flex, or over extended)                                                                                                       | A2315                          |
| Mating Surface Contour                                      | The contour (see above) of the mating surface to the core.                                                                                                               | A2315                          |
| Mfg Concept                                                 | General definition of how to produce                                                                                                                                     | A2315                          |
| Material Amount                                             | Definition of amount of stock material to produce                                                                                                                        | A2315                          |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                                                            |                                                                                           | <b>Node Activity Reference</b> |
|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                                                                   | <b>Description</b>                                                                        | <b>Activity Reference</b>      |
| <b>MANUFACTURING PLANNING - CORE (PROCESSED - ASSEMBLY)</b>                                                             |                                                                                           |                                |
| Core (Processed - Machined) Characteristics                                                                             | Inherit the characteristics of the machined core                                          | A2315                          |
| Adhesives                                                                                                               | Identity of the adhesives that will be used to assembly the details.                      | A2315                          |
| Potting Compounds                                                                                                       | Identity of the potting compounds that will be used.                                      | A2315                          |
| Stabilizers                                                                                                             | Identity of the stabilizers that will be used.                                            | A2315                          |
| Boundary                                                                                                                | The outside edge of the core assembly.                                                    | A2315                          |
| Core Position                                                                                                           | The position of the details that make up the assembly. Includes location and orientation. | A2315                          |
| Core Assembly Tolerances                                                                                                | The orientation and positional tolerances for the assembly.                               | A2315                          |
| Core Assembly Surface Contour                                                                                           | The relative contour of the surface of the core assembly.                                 | A2315                          |
| Hard Detail Locations                                                                                                   | The location of any hard details (fasteners, etc.) within the core assembly.              | A2315                          |
| Mfg Concept                                                                                                             | General definition of how to produce                                                      | A2315                          |
| <b>MANUFACTURING PLANNING - COMPOSITE LAYUP/ASSEMBLY (PLY LAMINATE (FLAT)/CORE/PLY LAMINATE - CORE STIFFENED PANEL)</b> |                                                                                           |                                |
| Core Characteristics                                                                                                    | Inherit characteristics from the core assembly.                                           | A2315                          |
| Ply Laminate Characteristics                                                                                            | Inherit characteristics from the ply laminates.                                           | A2315                          |
| Reference Orientation                                                                                                   | The orientation of the core and skins relative to the tool (rosette).                     | A2315                          |
| Adhesives (type)                                                                                                        | The type of adhesive being used and its thickness.                                        | A2315                          |
| Boundary                                                                                                                | The size and shape of the core stiffened panel.                                           | A2315                          |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                                                                                                                       |                                                                                                                            | <b>Node Activity Reference</b>     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| <b>Characteristic</b>                                                                                                                                                              | <b>Description</b>                                                                                                         | <b>Activity Reference</b>          |
| Location Tolerances                                                                                                                                                                | The positional accuracy required for the core assembly in the final cured ACSP.                                            | A2315                              |
| Mfg Concept                                                                                                                                                                        | General Definition of how to produce                                                                                       | A2315                              |
| Mfg BOM                                                                                                                                                                            | Manufacturing defined Bill of Materials                                                                                    | A2315                              |
| <b>MANUFACTURING PLANNING - COMPOSITE LAYUP/ASSEMBLY (PLY LAMINATE (ANGLE)/PLY LAMINATE (ANGLE)/FILAMENT LAMINATE (RADIUS FILLER)/PLY LAMINATE (CAP) - "T" COMPOSITE ASSEMBLY)</b> |                                                                                                                            |                                    |
| Ply Laminate Characteristics                                                                                                                                                       | Inherit characteristics from the ply laminates.                                                                            | A2315                              |
| Reference Orientation                                                                                                                                                              | The orientation of the laminates and filler relative to the tool.                                                          | A2315                              |
| Adhesives (type)                                                                                                                                                                   | The identify of any adhesives required in the layup and the thickness.                                                     | A2315                              |
| Boundary                                                                                                                                                                           | The dimensions of the completed assembly.                                                                                  | A2315                              |
| Mfg Concept                                                                                                                                                                        | General definition of how to produce                                                                                       | A2315                              |
| Mfg BOM                                                                                                                                                                            | Manufacturing defined Bill of Materials                                                                                    | A2315                              |
| Location Tolerances                                                                                                                                                                | The positional accuracy required for the completed assembly.                                                               | A2315                              |
| <b>NC PROGRAMMING - FILAMENT ASSEMBLY (FABRIC/TAPE)</b>                                                                                                                            |                                                                                                                            |                                    |
| Material Type/Description                                                                                                                                                          | Define the type of material such as graphite, fiberglass, etc. Determine the manufacturing method required.                | A233211,A233212, A233213,A233214   |
| Material Thickness                                                                                                                                                                 | The nominal thickness of one layer of the material.                                                                        | A233211, A233212, A233213, A233214 |
| Material Stock Size                                                                                                                                                                | The form in which the material will be purchased. Such as 12" wide tape on a 120' roll. This is an output of the mfg plan. | A233211, A233212, A233213, A233214 |
| Material Name                                                                                                                                                                      | The manufacturer of the material and any brand name and/or product identifier.                                             | A233211, A233212, A233213, A233214 |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                              |                                                                                                                   | <b>Node Activity Reference</b>     |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|------------------------------------|
| <b>Characteristic</b>                                     | <b>Description</b>                                                                                                | <b>Activity Reference</b>          |
| Warp/Fill Directions                                      | The direction of the longitudinally oriented yarn in a woven fabric./ The yarn in a fabric that crosses the warp. | A233211, A233212, A233213, A233214 |
| Fiber Strength/Stiffness                                  | The ability of the tape fibers to resist bending.                                                                 | A233211, A233212, A233213, A233214 |
|                                                           |                                                                                                                   |                                    |
| <b>NC PROGRAMMING - FILAMENT LAMINATE (RADIUS FILLER)</b> |                                                                                                                   |                                    |
| None                                                      |                                                                                                                   |                                    |
| <b>NC PROGRAMMING - PLY PIECE</b>                         |                                                                                                                   |                                    |
| Boundary                                                  | The geometric data describing the EOP.                                                                            | A233211, A233212, A233213, A233214 |
| Warp                                                      | The warp direction of the material.                                                                               | A233211, A233212, A233213, A233214 |
| Fiber Orientation                                         | The orientation of the fabric within the ply detail.                                                              | A233211, A233212, A233213, A233214 |
| Tolerance                                                 | The accuracy of the dimensions required when producing the ply detail.                                            | A233211, A233212, A233213, A233214 |
| Ply it is Part of                                         | The identity of the parent ply.                                                                                   | A233211, A233212, A233213, A233214 |
|                                                           |                                                                                                                   |                                    |
| <b>NC PROGRAMMING - PLY</b>                               |                                                                                                                   |                                    |
| Boundary                                                  | The edge of the ply detail (EOP).                                                                                 | A233211, A233212, A233213, A233214 |
| OML/IML                                                   | Identify if the ply is IML or OML.                                                                                | A233211, A233212, A233213, A233214 |
| Ply location in stack                                     | The location of the ply within the stack.                                                                         | A233211, A233212, A233213, A233214 |
| Filament Assembly Characteristics                         | Inherit characteristics of Filament Assembly                                                                      | A233211, A233212, A233213, A233214 |
|                                                           |                                                                                                                   | A233211, A233212, A233213, A233214 |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>            |                                                                                                                                                                             | <b>Node Activity Reference</b>     |
|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| <b>Characteristic</b>                   | <b>Description</b>                                                                                                                                                          | <b>Activity Reference</b>          |
| <b>NC PROGRAMMING - PLY LAMINATE</b>    |                                                                                                                                                                             |                                    |
| Ply Characteristics                     | Inherit characteristics of ply                                                                                                                                              | A233211, A233212, A233213, A233214 |
| Laminate Thickness                      | The thickness of the laminate.                                                                                                                                              | A233211, A233212, A233213, A233214 |
| Boundary                                | The edge of the laminate.                                                                                                                                                   | A233211, A233212, A233213, A233214 |
| Tolerances                              | The tolerance requirements relative to the ply laminate.                                                                                                                    | A233211, A233212, A233213, A233214 |
| Tool Controlled Surfaces                | The surfaces of the ply laminate that come in contact with tool surfaces for the purpose of controlling certain aspects of the laminate (dimensions, surface finish, etc.). | A233211, A233212, A233213, A233214 |
|                                         |                                                                                                                                                                             |                                    |
| <b>NC PROGRAMMING - CORE (MACHINED)</b> |                                                                                                                                                                             |                                    |
| Boundary                                | The edge of the core (material).                                                                                                                                            | A233211, A233212, A233213, A233214 |
| Core Thickness                          | The finished thickness of the core.                                                                                                                                         | A233211, A233212, A233213, A233214 |
| Core Density                            | The pounds per cubic foot of honeycomb core based upon the foil gauge or thickness and cell size.                                                                           | A233211, A233212, A233213, A233214 |
| Ramp Angle                              | The angle of segments of the core that are tapered.                                                                                                                         | A233211, A233212, A233213, A233214 |
| Joints                                  | The general area of contact.                                                                                                                                                | A233211, A233212, A233213, A233214 |
| Material Stock Size                     | The length and width of the material as it comes from the vendor.                                                                                                           | A233211, A233212, A233213, A233214 |
| Tolerances (thickness, location)        | The degree of accuracy required when manufacturing the ACSP.                                                                                                                | A233211, A233212, A233213, A233214 |
| Ribbon Direction                        | The direction the strips of material that make up the cells of the honeycomb.                                                                                               | A233211, A233212, A233213, A233214 |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                                                                                                               |                                                                                                                   | <b>Node Activity Reference</b>     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|------------------------------------|
| <b>Characteristic</b>                                                                                                                                                      | <b>Description</b>                                                                                                | <b>Activity Reference</b>          |
| Core Type                                                                                                                                                                  | The type of core being used (e.g., nomex, HFT, HRP, etc.)                                                         | A233211, A233212, A233213, A233214 |
| Mating Surface Contour                                                                                                                                                     | The contour (see above) of the mating surface to the core.                                                        | A233211, A233212, A233213, A233214 |
|                                                                                                                                                                            |                                                                                                                   |                                    |
| <b>NC PROGRAMMING - CORE (PROCESSED - ASSEMBLY)</b>                                                                                                                        |                                                                                                                   |                                    |
| None                                                                                                                                                                       |                                                                                                                   |                                    |
|                                                                                                                                                                            |                                                                                                                   |                                    |
| <b>NC PROGRAMMING - COMPOSITE LAYUP ASSEMBLY (PLY LAMINATE (FLAT)/CORE/PLY LAMINATE CORE STIFFENED PANEL)</b>                                                              |                                                                                                                   |                                    |
| None                                                                                                                                                                       |                                                                                                                   |                                    |
|                                                                                                                                                                            |                                                                                                                   |                                    |
| <b>NC PROGRAMMING - COMPOSITE LAYUP ASSEMBLY (PLY LAMINATE (ANGLE)/PLY LAMINATE (ANGLE)/FILAMENT LAMINATE (RADIUS FILLER)/PLY LAMINATE (CAP) - "T" COMPOSITE ASSEMBLY)</b> |                                                                                                                   |                                    |
| None                                                                                                                                                                       |                                                                                                                   |                                    |
|                                                                                                                                                                            |                                                                                                                   |                                    |
| <b>PROCESS PLANNING - FILAMENT ASSEMBLY (FABRIC/TAPE)</b>                                                                                                                  |                                                                                                                   |                                    |
| Material Type/Description                                                                                                                                                  | Define the type of material such as graphite, fiberglass, etc. Determine the manufacturing method required.       | A23215                             |
| Warp/Fill Direction                                                                                                                                                        | The direction of the longitudinally oriented yarn in a woven fabric./ The yarn in a fabric that crosses the warp. | A23215                             |
|                                                                                                                                                                            |                                                                                                                   |                                    |
| <b>PROCESS PLANNING - FILAMENT LAMINATE (RADIUS FILLER)</b>                                                                                                                |                                                                                                                   |                                    |
| Material Quantity                                                                                                                                                          | The amount (number of strands of tow) required to produce the required cross section of the filler.               | A23215                             |
| Cross Section Volume                                                                                                                                                       | The volume of a cross section of the filler.                                                                      | A23215                             |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>           |                                                                                                   | <b>Node Activity Reference</b> |
|----------------------------------------|---------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                  | <b>Description</b>                                                                                | <b>Activity Reference</b>      |
|                                        |                                                                                                   | A23215                         |
| <b>PROCESS PLANNING - PLY PIECE</b>    |                                                                                                   |                                |
| Boundary                               | The geometry of the edge of the ply.                                                              | A23215                         |
| Warp/Fill Direction                    | The warp direction and whether its position is relevant.                                          | A23215                         |
| Tolerance                              | The accuracy required when producing the ply.                                                     | A23215                         |
| Ply it is a Part of                    | Which ply contains this detail.                                                                   | A23215                         |
| Filament Assembly Characteristics      | Inherit the Filament Assembly characteristics.                                                    | A23215                         |
|                                        |                                                                                                   | A23215                         |
| <b>PROCESS PLANNING - PLY</b>          |                                                                                                   |                                |
| Boundary                               | The edge of the ply (EOP).                                                                        | A23215                         |
| Ply Piece Characteristics              | Inherit characteristics of Ply Piece                                                              | A23215                         |
| Splice, Laps & Gap                     | Information about where and what type of splices are allowed and the allowable gaps and overlaps. | A23215                         |
| Tolerance                              | The accuracy required when producing the ply.                                                     | A23215                         |
| Number of Ply Pieces                   | How many ply piece make up ply.                                                                   |                                |
| OML/IML                                | Any special requirements for the OML/IML plies.                                                   | A23215                         |
| Tooling Requirements.                  | A listing of the tools required to produce or layup the ply.                                      | A23215                         |
|                                        |                                                                                                   | A23215                         |
| <b>PROCESS PLANNING - PLY LAMINATE</b> |                                                                                                   |                                |
| Ply Characteristics                    | Inherit characteristics of ply                                                                    | A23215                         |
| Number of ply(ies)                     | How many ply(ies) make up this ply laminate.                                                      | A23215                         |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                          |                                                                                                                                                                             | <b>Node Activity Reference</b> |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                 | <b>Description</b>                                                                                                                                                          | <b>Activity Reference</b>      |
| Ply Table                                             | Information on the position and orientation of each ply.                                                                                                                    | A23215                         |
| Boundary                                              | The edge of the laminate.                                                                                                                                                   | A23215                         |
| Tolerances                                            | The tolerance requirements relative to the ply laminate.                                                                                                                    | A23215                         |
| Splice, lap & gap                                     | The requirements for splice location and overlapping/gaps in plies.                                                                                                         | A23215                         |
| Tool Controlled Surfaces                              | The surfaces of the ply laminate that come in contact with tool surfaces for the purpose of controlling certain aspects of the laminate (dimensions, surface finish, etc.). | A23215                         |
| OML/IML                                               | Geometry of the OML/IML surfaces                                                                                                                                            | A23215                         |
| Ply Drop Off                                          | The locations of the ply drop offs within the laminate.                                                                                                                     | A23215                         |
| Ply Orientation                                       | The orientation of the plies within the laminate.                                                                                                                           | A23215                         |
| Warp                                                  | The warp direction of the plies and if it is relevant to the layup.                                                                                                         | A23215                         |
| Compaction                                            | Instructions for the compaction requirements for this layup.                                                                                                                | A23215                         |
|                                                       |                                                                                                                                                                             |                                |
| <b>PROCESS PLANNING - CORE (PROCESSED - MACHINED)</b> |                                                                                                                                                                             |                                |
| Boundary                                              | The edge of the core.                                                                                                                                                       | A23215                         |
| Ramp Angle                                            | The angle of segments of the core that are tapered. Used for illustration purposes only.                                                                                    | A232153                        |
| Ribbon Direction                                      | The direction the strips of material that make up the cells of the honeycomb. Used for illustration purposes only.                                                          | A232153                        |
| Core Type                                             | The type of core being used (e.g., nomex, HFT, HRP, etc.)                                                                                                                   | A23215                         |
| Core Configuration                                    | The configuration of the cells (i.e., hex, flex, or over extended)                                                                                                          | A23215                         |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                                                                                                                 |                                                                                 | <b>Node Activity Reference</b> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                                                                                                                        | <b>Description</b>                                                              | <b>Activity Reference</b>      |
|                                                                                                                                                                              |                                                                                 |                                |
| <b>PROCESS PLANNING - CORE (PROCESSED - ASSEMBLY)</b>                                                                                                                        |                                                                                 |                                |
| Core (Processed - Machined) Characteristics                                                                                                                                  | Inherit the characteristics of the machined core                                | A23215                         |
| Adhesives (type)                                                                                                                                                             | Identity of the adhesives that will be used to assembly the details.            | A23215                         |
| Potting Compounds                                                                                                                                                            | Identity of the potting compounds that will be used.                            | A23215                         |
| Stabilizers                                                                                                                                                                  | Identity of the stabilizers that will be used.                                  | A23215                         |
| Hard Detail Locations                                                                                                                                                        | The location of any hard details (fasteners, etc.) within the core assembly.    | A23215                         |
|                                                                                                                                                                              |                                                                                 | A23215                         |
| <b>PROCESS PLANNING - COMPOSITE LAYUP ASSEMBLY (PLY LAMINATE (FLAT)/CORE/PLY LAMINATE - CORE STIFFENED PANEL)</b>                                                            |                                                                                 |                                |
| Core Characteristics                                                                                                                                                         | Inherit characteristics from the core.                                          | A23215                         |
| Ply Laminate Characteristics                                                                                                                                                 | Inherit characteristics from the ply laminates.                                 | A23215                         |
| Reference Orientation                                                                                                                                                        | The orientation of the core and skins relative to the tool (rosette).           | A23215                         |
| Adhesives (type)                                                                                                                                                             | The type of adhesive being used and its thickness.                              | A23215                         |
| Location Tolerances                                                                                                                                                          | The positional accuracy required for the core assembly in the final cured ACSP. | A23215                         |
| Tooling requirements                                                                                                                                                         | A listing of the tools required to layup the Core Stiffened Panel.              | A23215                         |
|                                                                                                                                                                              |                                                                                 |                                |
| <b>PROCESS PLANNING - COMPOSITE LAYUP/ASSEMBLY (PLY LAMINATE (ANGLE)/PLY LAMINATE (ANGLE)/FILAMENT LAMINATE (RADIUS FILLER)/PLY LAMINATE (CAP) - "T" COMPOSITE ASSEMBLY)</b> |                                                                                 |                                |
| Ply Laminate Characteristics                                                                                                                                                 | Inherit characteristics from the ply laminates.                                 | A23215                         |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                           |                                                                                                             | <b>Node Activity Reference</b> |
|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                  | <b>Description</b>                                                                                          | <b>Activity Reference</b>      |
| Reference Orientation                                  | The orientation of the laminates and filler relative to the tool.                                           | A23215                         |
| Adhesives (type)                                       | The identify of any adhesives required in the layup and the thickness.                                      | A23215                         |
| Location Tolerances                                    | The positional accuracy required for the completed assembly.                                                | A23215                         |
| Tooling requirements                                   | A listing of the tools required to layup the 'T' stiffener.                                                 | A23215                         |
| Filler Characteristics                                 | Inherit the characteristics of the filler.                                                                  | A23215                         |
| Identification of Transferable Process Steps.          | A description of the process steps that may be performed at more than one station (transferred).            | A23215                         |
|                                                        |                                                                                                             |                                |
| <b>TOOL DESIGN - FILAMENT ASSEMBLY (FABRIC)</b>        |                                                                                                             |                                |
| Material Type                                          | Define the type of material such as graphite, fiberglass, etc. Determine the manufacturing method required. | A2331                          |
|                                                        |                                                                                                             |                                |
| <b>TOOL DESIGN - FILAMENT ASSEMBLY (TAPE)</b>          |                                                                                                             |                                |
| Material Type                                          | Define the type of material such as graphite, fiberglass, etc. Determine the manufacturing method required. | A2331                          |
|                                                        |                                                                                                             |                                |
| <b>TOOL DESIGN - FILAMENT LAMINATE (RADIUS FILLER)</b> |                                                                                                             |                                |
| Boundary                                               | The cross sectional shape and length of the filler.                                                         | A2331                          |
| Manufacturing Process                                  | A description of the manufacturing process that will be used to produce the radius filler.                  | A2331                          |
|                                                        |                                                                                                             |                                |
| <b>TOOL DESIGN - PLY PIECE</b>                         |                                                                                                             |                                |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                     |                                                                                                                                                                             | <b>Node Activity Reference</b> |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                            | <b>Description</b>                                                                                                                                                          | <b>Activity Reference</b>      |
| None                                             |                                                                                                                                                                             |                                |
|                                                  |                                                                                                                                                                             |                                |
| <b>TOOL DESIGN - PLY</b>                         |                                                                                                                                                                             |                                |
| Boundary                                         | The edge of the ply piece (EOP).                                                                                                                                            | A2331                          |
| Filament Assembly Characteristics                | Inherit characteristics of Filament Assembly                                                                                                                                | A2331                          |
| Tooling Requirements                             | A listing of the tools required to layup the ply.                                                                                                                           | A2331                          |
| OML/IML                                          | Define whether the ply is OML or IML.                                                                                                                                       | A2331                          |
| Cure Ply Thickness                               | The thickness of the ply when it is cured in this part configuration.                                                                                                       | A2331                          |
|                                                  |                                                                                                                                                                             |                                |
| <b>TOOL DESIGN - PLY LAMINATE</b>                |                                                                                                                                                                             |                                |
| Ply Characteristics                              | Inherit characteristics of ply                                                                                                                                              | A2331                          |
| Ply Thickness                                    | The thickness of the laminate after curing.                                                                                                                                 | A2331                          |
| Boundary                                         | The edge of the laminate.                                                                                                                                                   | A2331                          |
| Tolerances                                       | The tolerance requirements relative to the ply laminate.                                                                                                                    | A2331                          |
| Tool Controlled Surfaces                         | The surfaces of the ply laminate that come in contact with tool surfaces for the purpose of controlling certain aspects of the laminate (dimensions, surface finish, etc.). | A2331                          |
| OML/IML                                          | Geometry of the IML and OML surfaces.                                                                                                                                       | A2331                          |
|                                                  |                                                                                                                                                                             |                                |
| <b>TOOL DESIGN - CORE (PROCESSED - MACHINED)</b> |                                                                                                                                                                             |                                |
| Boundary                                         | The edge of the core.                                                                                                                                                       | A2331                          |
| Core Thickness                                   | The finished thickness of the core.                                                                                                                                         | A2331                          |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                     |                                                                                                                                                      | <b>Node Activity Reference</b> |
|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                            | <b>Description</b>                                                                                                                                   | <b>Activity Reference</b>      |
| Core Density                                     | The pounds per cubic foot of honeycomb core based upon the foil gauge or thickness and cell size.                                                    | A2331                          |
| Joints                                           | The general area of contact.                                                                                                                         | A2331                          |
| Material Stock Size                              | The length and width of the material as it comes from the vendor.                                                                                    | A2331                          |
| Tolerances (thickness, location)                 | The degree of accuracy required when manufacturing the ACSP.                                                                                         | A2331                          |
| Ribbon Direction                                 | The direction the strips of material that make up the cells of the honeycomb.                                                                        | A2331                          |
| Core Type                                        | The type of core being used (e.g., nomex, HFT, HRP, etc.)                                                                                            | A2331                          |
| Core Configuration                               | The configuration of the cells (i.e., hex, flex, or over extended)                                                                                   | A2331                          |
| Mating Surface Contour                           | The contour (see above) of the mating surface to the core.                                                                                           | A2331                          |
| Tooling Requirements                             | A list of the tools required to layup the laminate.                                                                                                  | A2331                          |
|                                                  |                                                                                                                                                      |                                |
| <b>TOOL DESIGN - CORE (PROCESSED - ASSEMBLY)</b> |                                                                                                                                                      |                                |
| Core (Processed - Machined) Characteristics      | Inherit the characteristics of the machined core                                                                                                     | A2331                          |
| Boundary                                         | The outside edge of the core assembly.                                                                                                               | A2331                          |
| Core Detail Position                             | The position of the details that make up the assembly. Includes location and orientation that will be used to mark reference directions on the tool. | A2331                          |
| Core Assembly Tolerances                         | The orientation and positional tolerances for the assembly.                                                                                          | A2331                          |
| Core Assembly Surface Contour                    | The relative contour of the surface of the core assembly.                                                                                            | A2331                          |

- \* Additions required by activities
- \* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b>                                                                                                                                            |                                                                                 | <b>Node Activity Reference</b> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>                                                                                                                                                   | <b>Description</b>                                                              | <b>Activity Reference</b>      |
| Hard Detail Locations                                                                                                                                                   | The location of any hard details (fasteners, etc.) within the core assembly.    | A2331                          |
|                                                                                                                                                                         |                                                                                 |                                |
| <b>TOOL DESIGN - COMPOSITE LAYUP/ASSEMBLY (PLY LAMINATE (FLAT)/CORE/PLY LAMINATE - CORE STIFFENED PANEL)</b>                                                            |                                                                                 |                                |
| Core Characteristics                                                                                                                                                    | Inherit characteristics from the core.                                          | A2331                          |
| Ply Laminate Characteristics                                                                                                                                            | Inherit characteristics from the ply laminates.                                 | A2331                          |
| Reference Orientation                                                                                                                                                   | The orientation of the core and skins relative to the tool (rosette).           | A2331                          |
| Boundary                                                                                                                                                                | The size and shape of the core.                                                 | A2331                          |
| Location Tolerances                                                                                                                                                     | The positional accuracy required for the core assembly in the final cured ACSP. | A2331                          |
| Tooling Requirements                                                                                                                                                    | A listing of the tools required to assemble the core.                           | A2331                          |
| Forecasted Part Quantities                                                                                                                                              | The number of assemblies that will have to be built with this tool.             | A2331                          |
| Next Assembly Information                                                                                                                                               | The attachment points of the finished part to other parts.                      | A2331                          |
|                                                                                                                                                                         |                                                                                 |                                |
| <b>TOOL DESIGN - COMPOSITE LAYUP ASSEMBLY (PLY LAMINATE (ANGLE)/PLY LAMINATE (ANGLE)/FILAMENT LAMINATE (RADIUS FILLER)/PLY LAMINATE (CAP) - "T" COMPOSITE ASSEMBLY)</b> |                                                                                 |                                |
| Ply Laminate Characteristics                                                                                                                                            | Inherit characteristics from the ply laminates.                                 | A2331                          |
| Reference Orientation                                                                                                                                                   | The orientation of the laminates and filler relative to the tool.               | A2331                          |
| Boundary                                                                                                                                                                | The dimensions of the completed assembly.                                       | A2331                          |
| Location Tolerances                                                                                                                                                     | The positional accuracy required for the completed assembly.                    | A2331                          |
| Tooling Requirements                                                                                                                                                    | A listing of the tools required to assembly this ACSP.                          | A2331                          |

\* Additions required by activities

\*\* Additions required by AP scope

| <b>VIEW - COMPOSITE ITEM</b> |                                                                     | <b>Node Activity Reference</b> |
|------------------------------|---------------------------------------------------------------------|--------------------------------|
| <b>Characteristic</b>        | <b>Description</b>                                                  | <b>Activity Reference</b>      |
| Next Assembly                | The attachment points of the finished part to other parts.          | A2331                          |
| Forecasted Part Quantities   | The number of assemblies that will have to be built with this tool. | A2331                          |
| Assembly or Layup            | Are any of the parts in the assembly process already cured?         | A2331                          |

\* Additions required by activities

\*\* Additions required by AP scope

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