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TITLE   QUALITY ASSURANCE STANDARD FOR DIGITAL PRODUCT DEFINITION
        AT BOEING SUPPLIERS

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ABSTRACT

Document D6-51991, Quality Assurance Standard for Digital Product Definition at Boeing Suppliers, provides uniform specifications for supplier control of Boeing Digital Product Definition (DPD) data.

MAINTENANCE

Maintenance of Document D6-51991, Quality Assurance Standard for Digital Product Definition at Boeing Suppliers, will be through the BCAG Supply Management and Procurement Quality Assurance Department. Revisions to D6-51991 must be in accordance with established procedures.

REFERENCES

The current issue of the following references is considered a part of this standard to the extent herein indicated.

D6-82479	Boeing Quality Management System Requirements for Suppliers

The following documents define specific Digital Product Definition (DPD) processes. Supplier shall contact Procurement Agent to request applicable document flowdown.

TA-PD-287	Electronic Exchange of Product Definition Data to Suppliers
DAC-SIM-099	Digital Data Packaging and Downloading
D6-56199	Hardware and Software Compatibility Requirements For Suppliers Use of BCAG CATIA Native Datasets As Authority for Design, Manufacturing and Inspection
D6-81491	Authority and Usage of CATIA Native, CATIA IGES and PDM STEP Datasets
D6-56643-700	IGES_CHK Program Users Guide
D6-56643-701	DEL_LAY Program Users Guide
D33200	Boeing Suppliers' Tooling Document
D6-82253	Digital Exchange Requirements for PDM STEP Part 21 Data
5G43	CATIA Process/Procedure Guide

PURPOSE

This standard establishes requirements for Boeing Suppliers' DPD Quality Assurance/Quality Control System. The requirements contained in this document are intended to facilitate supplier deployment of DPD technique and achieve technical coordination between customer, supplier, and subtier supplier.

SCOPE

This document is a supplement to the Boeing Quality Management System, D6-82479. It describes the requirements for supplier digital data system controls cited in BQMS Appendix A section 4.5.2 and Appendix B section 4.5. To use Boeing furnished datasets as authority for design, manufacture, and inspection, a supplier must be approved to a Boeing recognized quality system and comply with this document. Boeing shall document supplier compliance as a special capability in the approved supplier list.

These requirements provide the basis for suppliers to create and implement plans, user-level procedures and documentation. The supplier will have-defined and reliable configuration management and QA processes in place reflecting its methods of operation. Suppliers are required to maintain integrity of DPD type design though all operations as new DPD methods are deployed. It is anticipated that suppliers will utilize DPD processes to continuously improve the quality of delivered product.

The application of this document is required for all phases of design and inspection when Boeing Digital Product Definition data is used in Supplier DPD Systems to produce products(s) or digital data for product acceptance (including accountable tooling and tooling used for inspection).

If a supplier is sending Digital Product Definition data to Boeing, the requirements are obtained from the Procurement Contract Administrator and the purchase order, and the supplier must meet applicable data exchange requirements.

When referenced in the Purchase Order or General Terms Agreement/Contract this document is contractual. Boeing digital datasets are reference only (no design or inspection authority) unless the Supplier complies with the requirements of this document.

DEFINITIONS

AUTHORITY
Undisputed source of Boeing approved type design used for product manufacture and Quality Assurance acceptance with communication, access, release and change control procedures in place to ensure source integrity.

BOLD
Boeing On-Line Data – A system to view Boeing maintenance/repair documents, as well as scanned images of engineering and tooling drawing sheets.

CAD
Computer Aided Design - (1) Any computer system or program that supports the design process. (2) The use of computers to assist Engineering Design in developing, producing, and evaluating design, data and drawings. (For brevity, CAD is also referred to as the organization engaged in computer-aided design.)

CAE
Computer Aided Engineering - The use of computers to develop Engineering data to supplement Engineering Designs, used in product production and inspection.

Note: Specific for BCAG DCAC processes, CAE data is extracted from PDM in the form of hardcopy reports or electronic PDM STEP Dataset transactions. The Dataset contains Bill of Material (BOM) information (Parts Lists, Picture Sheet Data Lists, Tool Parts List etc.) used by Boeing and Suppliers to define and accept products.

CAM
Computer Aided Manufacturing – Also known as Numerical Control (NC). The use of computers and computer data in the development and production of a part (product) including fabrication, assembly, and installation.

CATIA
Computer-graphics Aided Three-dimensional Interactive Application.. A CAD system with interactive graphics design software modules used to create 3D and 2D geometric designs of products.

CMS
Coordinate Measurement Systems - Also known as Computer Aided Inspection (CAI) and Computer Aided Measurement Systems (CAMS). Measurement equipment such as Coordinate Measuring Machines (CMM), Laser Tracker, and Numerical Controlled machinery with inspection probe capability which are used to support inspection activity. (Note: All portable, three dimensional measuring systems, including Portable Arm Measuring Machines, Computer-aided Theodolites, Laser Tracker, and Photogrammetry (including Videogrammetry) systems require the Supplier to be approved per section 7.2 of this document.

CUSTOMER
The originator of a purchase order or contract for goods and/or services.

DATASET
A named compilation of related data made accessible to computerized system.

DDE
Digital Data Exchange - The BCAG (Puget Sound) application used to send digital data to suppliers electronically.

DERIVATIVE
A reproduction of all or part of an authority dataset. Derivatives include paper and mylar plots, tool designs, inspection datasets created to analyze as-built designs, check templates, numerical control (N/C) datasets/media, datasets with nominal values for CMS use, QA inspection plans and other extractions (dimensions, views, etc.) for inspection/measurement use.

DPD
Digital Product Definition – The electronic data elements that specify the geometry and all design requirements for a product (including notation and parts lists), and the use of this data throughout an integrated CAD/CAM and CMS system.

DPD QUALITY ASSURANCE PLAN
A comprehensive document describing the Quality System for management of digital data and DPD processes throughout a supplier's production facility. The requirements, procedures and process references described in the plan provide the basis for supplier organizations to implement user-level procedures and documentation.

ERS
Enhanced Reference System – A permanent reference system, established for the life of a tool, which is transferred from an existing reference system or created specifically for CMS. It is designed to provide a

large number of established coordinates. This allows rapid and accurate measurement in all areas of the tool.

FEATURE
Feature - Any hardware design attribute or characteristic. This includes physical portions of hardware such as a surface, face, edge, radius, hole, tab, slot, pin, etc., and requirements such as Non-Destructive Inspection (NDI) and Interchangeability and Replaceability (I&R). All features require validation to conform the product to the design authority. All features have associated notes and/or Geometric Dimensioning and Tolerancing Feature Control Frames (FCF). But one note or FCF may refer to several features.

GECS
Global Electronic Commerce System - The BCAG, Long Beach application used to package digital data and provide it electronically to suppliers via secure web gateway.

IGES
Initial Graphics Exchange Specification - The American National Standards Institute (ANSI) Data standard for the exchange of computer graphics generated product definition (no solids) between different manufacturers CAD/CAM systems.

INSPECTION PLAN
A description of 2D and/or 3D computer generated inspection media/methods, derived from authority DPD datasets, used to communicate inspection requirements and media usage to manufacturing and inspection areas. Typical plans include Engineering and Plan configuration/ traceability, overlay/setup instructions, and a list and/or graphic representation of the features to be inspected.

LEV
Low End Viewer – An entry level, visualization CAD system used to view, analyze, extract, and print dimensional and other required data from the DPD dataset.

MBD
Model Based Definition – A Boeing dataset containing the exact solid, its associated 3D geometry, and 3D annotation of the product's dimensions and tolerances to specify a complete product definition. This dataset does not contain a conventional 2D drawing. MBD is one possible format of DPD.

MDD
Master Dimension Definition - A mathematically-controlled surface definition which is computer-generated. This definition consists of control curves defining the surface in two planes and the information in a logical form necessary to develop the third plane and/or any cross section. Each surface is uniquely identified by number.

MDI
Master Dimensions Identifier - A number identifying an array of coordinate data used by Design, Manufacturing and Inspection to describe an element of a surface or product configuration. The data may be an extraction from an MDD or any CATIA/APT-designed surface.

MDR
Master Dimension Request -. A process used by Suppliers without demonstrated Digital Product Definition capability(s) per requirements of this document, to request and receive 3D surface definitions and/or inspection media extractions from Boeing. Data format may be printouts, disks, plots, etc. with evidence of Boeing QA Acceptance and traceability. Supplier shall contact Boeing Procurement Agent for process instructions.

MDS
Master Dimension Surface - A computer generated, mathematically-controlled CATIA 3D surface definition. Each surface is uniquely identified by number.

MEASUREMENT PLANNING
Process to coordinate all measurement activity for parts, assemblies or tooling products. A team including design, manufacturing and measurement (QA) specialists determine the measurement and/or validation methods and stage in production for all specified product features. Data is collected for both process control and product acceptance. Measurement planning seeks continuous improvement and innovative validation methods, including integration of manufacturing and measurement operations to reduce defects and cycle time.

PSN
Part Structure Navigator – A web application for exchanging secure data with suppliers.

PAS
Product Acceptance Software - DPD software (including CAD, LEV, data exchange, and CMS systems) used to inspect and accept parts, assemblies, tooling, and systems.
(NOTE: Not embedded or loadable Airborne S/W)

PDM STEP
Product Data Manager (PDM) dataset(s) in STEP format with Bill of Material (BOM) information (Parts Lists, Picture Sheet Data Lists, Tool Parts List, etc.) used by BCAG to define CAE requirements. This dataset can be communicated to Boeing Suppliers in a digital format.

PTF
CATIA Program Temporary Fixes – Software changes or additions, released by the software manufacturer, to correct user application problems before the next major software version is available. Reference D6-56199 for CATIA software version(s) and PTF(s) installed on BCAG CATIA systems.

PROCESS CONTROL
Use of in-process checks to determine performance parameters of manufacturing operations. Data collected is used to determine when adjustment is needed to reduce manufacturing variability.

PQAA
Procurement Quality Assurance Automation – The on-line Boeing record of approved suppliers, with information about supplier quality systems, manufacturing processes, DPD, and Airborne Software capabilities.

REDUCED CONTENT DRAWING/DATASET
Any DPD design dataset without full dimensioning of product features on a 2D sheet. This includes Reduced Dimension Drawings and "Simplified Drawings"which contain 2D sheets, and Model Based Definition which (typically) does not.

REFERENCE ONLY (REF)
Notation indicating features or datasets whose definition is not reliable and not authorized for design, manufacture or inspection.

REDARS
Reference Engineering Data Automated Retrieval System

SNET
Supplier Network – A network/telecommunication method for exchanging secure data with suppliers.

STEP
Standard for the Exchange of Product model data. – Standard developed by the International Standards Organization for exchange of digital product data. It seeks to improve upon IGES by increasing the ability to transfer entire product life-cycle data.

SUPPLIER
 A manufacturer working under Boeing contract(s), producing Boeing hardware.

SUB-TIER SUPPLIER
A manufacturer working under Supplier contract(s), producing Boeing hardware.

UNIGRAPHICS
A CAD system software with interactive graphics design modules for creating 3D and 2D geometric designs of products.

PUBLICATION OF REQUIREMENTS

1.0 Digital Product Definition Quality Assurance Plan and Procedures

1.1 The Supplier shall develop and maintain a comprehensive DPD Quality Assurance Plan and procedures to assure integrity of product Engineering and/or Tooling configuration is maintained throughout the Supplier's DPD system from receipt of Boeing data through creation of derivatives, to product acceptance and process improvement.

1.2 This plan shall specifically address the processes and techniques unique to all DPD processes including the delivery of authority data to measurement users in design, manufacturing, and quality organizations for product acceptance and process control.

1.3. It is recommended that supplier DPD Quality Assurance Plans describe a single, consistent configuration management and QA process to meet all customer (Boeing, other company, regulatory agency, etc.) DPD requirements. This plan shall remain in effect throughout the life of the contract. The Supplier will give prior notification to Boeing of changes to the DPD QA Plan.

1.4 Boeing reserves the right to survey and/or review the Supplier's DPD system to verify effectiveness of the Supplier's DPD Quality Assurance Plan and procedures.

1.5 Overall authority for the DPD Quality Assurance Plan shall be defined as a quality organization responsibility with procedures for change control and maintenance. The authority and responsibility for each element of the DPD Quality Assurance Plan shall be defined and documented to assure consistent implementation.

1.6 The Supplier shall include a flow diagram in the plan that graphically depicts the flow of data through the DPD system from receipt of Boeing DPD data, through all supplier user organizations creating derivatives, to product validation, and analysis of measurements for process improvements. The flow diagram shall specify all segregated, secure storage locations of authority and derivative media. The diagram shall specify all supplier departments/personnel responsible for performance of CAD/CAM operations, including the delivery of Boeing data to sub-tier suppliers.

1.7 Elements of the Quality Assurance Plan shall address, but not be limited to, the following elements in sections 2.0 through 11.0:

(Some of these sections may be addressed in other Supplier documents. If so, reference to these shall be made in the plan.)

2.0 Configuration Management and Media Security

2.1 The Supplier shall develop and maintain procedures to ensure the configuration of Boeing DPD controlled production hardware and tooling. Procedures will be in place to ensure that configuration of the following DPD systems are identified, controlled and recorded:

    a.   Product acceptance software (PAS)
    b.   Computerized Measurement Systems (CMS)
    c.   CAD/CAM software and datasets
    d.   Data Analysis Software
    e.   Supplier generated datasets (derivative datasets)
    f.   Datasets flowed to subtier suppliers

2.1.1 The supplier shall develop and maintain procedures for configuration identification and control of CAM software and datasets. Objective evidence for verification of numerically controlled machinery and dataset performance must be obtained no later than first production use and is required for release for production.

2.2 The Supplier shall develop and maintain procedures used to ensure the integrity and security of Customer supplied DPD data, Supplier extracted data and/or Supplier generated definition data.

2.2.1 These procedures shall include requirements for:

a. Storage of controlled data and digital product acceptance datasets.
b. Access and archiving procedures with read/write protection, including passwords which ensure access control.
c. Encryption protection for sending/receiving of electronically transmitted data.
d. Establishing and maintaining a data backup system, including remote storage and disaster recovery.

2.3 The supplier shall provide a system for formal release of DPD datasets, which ensures that only authority datasets are available for use in production and inspection. A record of the key identifiers of Boeing authority datasets (drawing, sheet, revision level and/or dataset name) and those key identifies and naming conventions created for authority supplier derivatives, must be readily available during measurement, verification and data analysis processes for product acceptance by supplier, sub-tier and Boeing QA representatives

2.3.1 A system for change accountability and configuration management for all datasets and dataset derivatives (including graphical/geometric electronic data, CAE datasets and Supplier hardcopy reports), will be maintained by the Supplier.

2.3.2 The Supplier shall comply with and reference in their DPD Quality Plan, applicable Boeing document(s) defining the authority status of geometric elements within Boeing-furnished DPD datasets.

3.0 Product Acceptance Software

3.1 The supplier shall document and maintain procedures for control of Product Acceptance Software (PAS).

3.1.1 Supplier must document and maintain PAS procedures, and reference applicable documents in their DPD Quality Assurance Plan. Procedures provide for identification of software for a QA application, control of the QA approved version for product acceptance, and control of obsolete software. All changes to PAS are documented and approved by supplier's QA.

3.1.2 Supplier will develop and maintain procedures for reporting, tracking and resolving software-related product acceptance problems

3.1.3 Procedures will be documented and maintained to prevent unauthorized changes, to limit personnel access to software files, separate archives for masters and duplicates. Supplier PAS storage methods will take measures to minimize deterioration, regeneration of errors, and to assure that reproduction of code occurs error free.

3.1.4   Supplier PAS must be verified prior to product acceptance use. The supplier will establish and maintain a procedure independent of the software developer to determine that the software, and subsequent revisions, accomplishes its intended function. A formal means of identifying approved PAS is required with configuration control and QA management procedures for relating the PAS to the product being accepted.

3.2   Software developed by suppliers requires plans and instructions for building, configuration management, loading and testing.

4.0   Internal Quality Audits

4.1   The Supplier shall develop and maintain procedures for auditing all operations affecting Boeing DPD data and related documentation to assure compliance with contractual requirements, software and production part quality standards, including the observance of security restrictions. The audit plan shall include provisions for audit of sub-tier Suppliers using DPD data on Boeing products and tooling.

4.2   Results of all audits will be documented and maintained for review by an authorized Boeing representative per contract requirements.

5.0   Problem Reporting and Corrective Action

5.1   The Supplier shall assure that non-conforming Digital Product Definition datasets are identified as discrepant, segregated and reviewed for disposition. Non-conforming Product Acceptance Software will have the deficient equipment identified and removed from service until discrepant items are resolved.

5.2   The Supplier shall develop and maintain procedures for reporting, tracking, and resolving all transmission, hardware, software and dataset problems and deficiencies.

6.0   Procurement Control

6.1   The Supplier will flow down the requirements of this document (D6-51991) to their sub-tier suppliers and document sub-tier supplier compliance when Boeing authority datasets or dataset derivatives are used for product acceptance.

6.2   The Supplier will be responsible to Boeing for the maintenance, change incorporation, use of datasets and observance of security restrictions by their sub-tiers for design, manufacturing, and inspection, as applicable.

6.3   Boeing reserves the right to survey and/or review the DPD quality assurance and configuration management systems of these sub-tiers.

7.0   Control of Measurement Equipment

7.1   The Supplier will develop and maintain a system for periodic certification of digital measurement equipment. These controls will provide records of date of certification, acceptance/rejection, and next certification due date. Measurement equipment will be physically identified in accordance with certification records. This includes all CMS equipment, N/C (CAM) equipment with calibrated inspection probe capability and plotters (used to produce drawings, mylars, or other inspection or tooling media.)

7.2 Suppliers using CMS for fabrication and/or inspection of Boeing products (parts and tools) must document their CMS processes. Suppliers must comply with the product acceptance software, measurement equipment, inspection media, and training requirements for portable CMS. Additional portable CMS requirements are stated below:

7.2.1 The supplier must document inventory of all components used for CMS measurements that effect the integrity of data collection. The supplier shall document and implement periodic calibration and certification of these components. Suppliers shall retain CMS original equipment manufacturer specifications for accuracy and repeatability certification. Calibration and measurement processes shall be traceable to NIST or equivalent standard, and meet original equipment manufacturer requirements.

7.2.2 The supplier shall develop and maintain CMS procedures for the following topics:

   a.   Setting scale
   b.   establishing and manipulating coordinate systems
   c.   data collection parameters
   d.   special targeting
   e.   QA acceptance criteria
   f.   operator calibrations
   g.   data format and storage

8.0 Inspection Media

8.1 The supplier shall ensure that all digital measurement operations performed on each part or tool are planned. Supplier's QA organizations are responsible, at a minimum, for digital inspection media, measurement instructions and analysis of data for product acceptance. Measurement planning shall give consideration to the following activities, as appropriate, in meeting the specified design requirements:

8.1.1 Description of the method and instructions for validation of each product feature for First Article Inspection, and documentation of the analysis of inspection and test results used as a basis for all quality/inspection adjustments. To validate product features with methods other than dimensional measurement, the supplier must document the media and/or process used.

8.1.2 Selection of specific stages of production to perform feature measurements to monitor production capability, ensure validation of all specified requirements, and integrate manufacturing and measurement processes.

8.1.3 Analysis and delivery of measurement data for engineering disposition, design improvement, process control and defect reduction.

8.2 The Supplier shall develop and maintain procedures to extract inspection media and other measurement data from DPD datasets, including delivery and control of the media. This will include documented Inspection Plans and/or equivalent procedures that:

   a.   Show data sources independent of manufacturing flows.
   b.   Are performed by qualified personnel.

c. Contain graphics and text sufficient to illustrate inspection operation and result for each product feature.

d. Are traceable to authority source and any additional derivative media used.

Note: Derivative datasets will be stored and readily comparable to the authority source.

8.2.1 When a supplier uses authority datasets for inspection purposes, any data extracted from those datasets used for product acceptance must have visible evidence of supplier's QA acceptance and be under configuration control. In addition, any output data generated from plots and CMS inspection processes must have evidence of Supplier's QA acceptance and be under configuration control. Traceability of CMS data back to the original Boeing authority dataset is required.

8.2.2 Data or datasets identified as "REFERENCE ONLY" may not be used for product acceptance purposes.

8.2.3 Supplier may use definition of MDD, MDI, MDS, or other digital definition, including IGES or STEP format, as authority for product acceptance, when supplied by Boeing according to an MDR process.

8.3 DPD datasets with reduced content, including MBD datasets without 2D views, may require users at supplier to extract information from the dataset sufficient to instruct and document manufacturing and inspection activity for the product. A LEV, 2D sketches/views, and/or datasets may be used to convey manufacturing and inspection information as required to fit the supplier's methods of operation. Note: Use of a LEV requires compliance with sections 3.0, 8.2, and 9.0 of this document, as applicable.

8.3.1 When planning measurements for product acceptance, supplier's QA must verify that all product design requirements—i.e., all features defined by feature control frames, annotation, notes and other specified requirements in the authority DPD dataset (and associated parts list), including dimensional and other properties—are identified and planned for inspection/validation.

8.4 Accuracy of plots used for inspection media will be verified prior to use.

9.0 Data Exchange Methods

9.1 The supplier shall document the current level of hardware, sofware and other digital system information (e.g. PTF(s), project files) required to maintain synchronization with Boeing supplied datasets and/or data exchange formats per applicable Boeing system(s) compatibility requirement documents. This includes CAD, LEV, data exchange, and other computing equipment that receives authority data and/or is installed/tested by Boeing. Supplier shall comply with and reference applicable synchronization documents in their DPD Quality Plan.

9.2 The supplier shall notify Boeing of their equipment configuration and changes to it when necessary to maintain synchronization requirements.

9.3 When Boeing DPD data containing 3D geometry is received in translated format (e.g., IGES, STEP), the supplier must verify their translation of each dataset, in order to maintain authority status.

10.0   Tooling

    10.1   The supplier shall describe procedures to ensure release, acceptance, identification, security, access and change control of tool design and tool inspection datasets. This includes ERS datasets, which will be accepted according to a documented installation procedure. Tooling datasets will have traceability to current authority Engineering and derivative Tooling dataset sources. The Engineering authority dataset(s) will be identified on the Tool Design when applicable.

    10.2   All digitally defined tools and physical inspection media (check fixtures, templates, etc.) will be traceable to the authority tool design dataset and any tool inspection datasets. These tools and tooling media will be accepted and periodically validated to the authority design at a frequency determined to ensure accuracy and repeatability of the tool before use. Periodic inspection of digitally defined tools will meet the requirements of section 8.0 of this document as applicable.

11.0   Training and Process Performer

    11.1   The supplier shall ensure that QA personnel have DPD system access and training adequate to perform digital product acceptance activities, including digital inspection media generation and 3D data collection. If these activities are performed by individuals other than the suppliers' Quality Assurance personnel, the supplier shall define the specific tasks and responsibilities that are authorized and the corresponding requirements and training necessary to perform those tasks.

    11.2   Suppliers shall develop and maintain records of the instruction syllabus and employee training records, including On the Job Training, for all DPD system users.

AUTHORITY AND RESPONSIBILITY OF AUTHORIZED
BOEING QUALITY ASSURANCE REPRESENTATIVES

The Boeing Quality Assurance Representative shall have access to supplier's DPD QA plan and related documentation.

The Boeing representative shall verify compliance and document the supplier's DPD capabilities.

The Boeing Representative shall maintain open lines of communication between Boeing, supplier, and subtier supplier, as required for technical coordination and to facilitate changing digital processes to improve product quality.

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	REVISIONS		
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A	Revised pages iii, 2, 3 & 4.	None recorded	
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D	Revised pages i, ii, iv, F1, F2, 1, 2, 3, 4, 5, 6, 7, 8, 9 & 10	03/30/94	B. Sutherland
E	Extensive revision of document to include upgrades to business process Renumbered pages of entire document	08/16/96	Prepared by: M. Swan Checked by: T. O'Day Approved by: A. A. Batali
F	Revision to add PDM STEP and update electronic business processes.	11/13/98	Prepared by: M. Singer Checked by: R. LeDoux Approved by: T. Haley
G	Extensive revision to provide supplier standard for Boeing enterprise	11/27/01	Prepared by: M. Singer Checked by: R. Smith Approved by: B. O'Dell