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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 (DPD) at Boeing Suppliers, provides uniform specifications for supplier control of Boeing Digital Product Definition data.

Maintenance

Maintenance of Document D6-51991, Quality Assurance Standard for Digital Product Definition at Boeing Suppliers, will be through the Supply Chain and Supplier Quality organizations.

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 processes and to achieve technical coordination between Boeing, supplier and sub-tier supplier.

Scope

This document is a supplement to the Boeing Quality Management System (QMS) Requirements for suppliers, document D6-82479, and describes the requirements for supplier digital data system controls. To use Boeing furnished datasets as authority for design, manufacture or inspection of product and/or tooling, a supplier must comply with this document. Boeing shall document supplier compliance as approved in the Boeing SQ Supplier Data System.

These requirements provide the basis for suppliers to create and implement plans, user level procedures and process documentation for the use of DPD. Individual Boeing divisions, sites or programs may provide additional requirements. The supplier shall have defined and reliable configuration management and Quality Assurance (QA) processes in place reflecting its methods of operation. Supplier is required to maintain integrity of DPD through all operations when new DPD methods are deployed. It is expected 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 ISO9001 as supplemented by AS9100 or the suppliers QMS when Boeing DPD data is used in Supplier's computing systems and procedures to produce product(s) or digital data for product acceptance (including accountability of tooling and tooling used for inspection).

If a supplier is sending digital product definition data to Boeing, the requirements are obtained from the procurement agent and the purchase order, and the supplier must meet applicable data exchange requirements.

Authority and Responsibility of Authorized Boeing Supplier Quality Representatives

The Boeing supplier quality representative shall have access to supplier's documented DPD process and related documentation for the purpose of verification of supplier's conformance and to document the supplier's capabilities related to DPD, Model Based Definition (MBD), Coordinate Measurement Systems (CMS) and Plotters used to create inspection media.

Supplier shall maintain open lines of communication between their Boeing supplier quality DPD representative, Boeing, and sub-tier supplier(s) as required for technical coordination and to facilitate changing DPD processes to improve product quality.

1. Digital Product Definition Quality Assurance Procedures and Documented Processes

1.1. **Documented Processes -** The Supplier, supplier subdivision and supplier sub-tiers shall develop and maintain comprehensive documented DPD processes and/or referenced procedures that assure integrity of product and/or tooling configuration is maintained throughout the supplier's QMS from receipt of Boeing data through creation of derivatives to product acceptance and process improvement.

1.1.1. The supplier's documented process shall specifically address the processes and techniques unique to all DPD processes beginning with the receipt of DPD data from Boeing through the product life cycle.

1.1.2. The supplier's documented process shall specify all departmental organizations responsible for performance of CAD/CAM/CAI operations including organizations responsible for the delivery of Boeing data or supplier derived data to sub-tier suppliers.

1.1.3. It is recommended that supplier documented DPD processes describe a single, consistent configuration management and QA process to meet all customer DPD requirements (Boeing, other companies, regulatory agencies, etc.) This documented process shall remain in effect throughout the life of the contract.

1.1.4. Boeing reserves the right to survey and/or review the supplier's QMS to verify effectiveness of the supplier's documented DPD processes and procedures.

1.1.5. Elements of the documented DPD processes shall address, but not be limited tothe elements in sections 1.0 thru 10.0. The sections in D6-51991 may be addressed in other supplier documents. If so, reference to the document and sections shall be made in the documented process.

1.1.6. Supplier's documentation shall be available in English in addition to supplier'snative language.

1.1.7. Additionally, program specific requirements not provided in this document shallbe implemented.

1.2. **Flow Diagram -** The supplier shall include a flow diagram or equivalent in their documented process including process ownership that graphically depicts the flow of data through the DPD system from receipt of Boeing DPD data through the product life cycle.

1.2.1. The flow diagram shall identify the documented DPD processes, and or work instructions associated with control of the datasets and derivatives.

1.2.2. In lieu of flow diagram, supplier may provide a complete relational diagram oftheir internal procedures to the requirements of this document.

1.3. **Responsibilities -** The quality organization shall be responsible for the documented DPD processes with procedures for change control and notification to affected organizations. The authority and responsibility for each element of the documented DPD processes shall be defined and documented to assure consistent implementation.

1.3.1. The supplier shall notify their Boeing DPD Rep within 30 calendar days of implementing anychanges to:

a) The Documented DPD Processes

b) CATIA synchronization per D6-56199

c) CAD, CAM (when used for product acceptance), CAI software additions,updates or changes

d) Addition of new coordinate measurement system (CMS) or CNC On-machine probing equipment

e) Quality manager or key personnel.

2. Configuration Management and Media Security

2.1. **Media Security -** The Supplier shall develop and maintain documented processes used to ensure the integrity and security of Boeing provided datasets or Specification Control Drawing (SCD) in digital definition (CAD Format). This may include the use of envelope datasets, supplier created CAD/CAM/CAI datasets, type design and tool designs. Integrity and security of datasets shall include requirements for:

2.1.1. Secure storage and retention of Boeing provided DPD, supplier created DPD derivatives, and digital inspection media used for product acceptance.

2.1.2. The supplier shall assure that datasets found discrepant are suspended from use and originator is contacted for disposition.

2.1.3. Archiving procedures with read/write protection which ensure access control per the time specified per program or contract requirements. This includes authority datasets, derivatives and digital inspection media used for product acceptance.

2.1.4. Encryption protection for sending/receiving of electronically transmitted data.

2.1.5. Establishing and maintaining a secure data backup and storage system whether local or remote, a disaster recovery process for authority datasets, derivatives and digital inspection media used for product acceptance.

2.1.6. Access control with permission and/or password protection shall be established in order to ensure that Boeing provided datasets shall not be inadvertently modified. This process shall include derivative datasets released for manufacturing and inspection.

2.1.7. Supplier will have a process to manage and maintain (addition/removal of) supplier employee access to Boeing technical data systems such as REDARS,Enovia, Team Center, etc.

2.2. **Configuration Management and Traceability -** The supplier shall develop and maintain documented processes to ensure configuration control of all Boeing provided datasets, supplier created CAD/CAM/CAI datasets, Special Tooling, type design, tool designs and datasets sent to sub-tier suppliers used in the production or inspection of Boeing products. These procedures shall include the following:

2.2.1. Formal release process of DPD data which ensures that only current authorized DPD datasets and derivatives are available for use in production and inspection.

2.2.2. The supplier shall ensure the Boeing authority dataset(s), planning and allderivative DPD data used to manufacture and inspect product is traceable tothe authority dataset and retained as part of that products acceptance package.

2.2.3. Supplier shall be able to demonstrate traceability of all product planning and DPD derivatives to the current authority dataset including filename, revision and extension. Additionally, derivatives shall have their own revision control system in addition to the product/tool revision.

2.2.4. A documented process for change control and retention for all authority datasetsand dataset derivatives including engineering, manufacturing engineering, Bill of Material, SSP's, SPECO's and CAE datasets, Etc.

2.2.5. A documented process that includes segregation, storage and retention of non-current (obsolete) authority datasets and dataset derivatives.

2.2.6. Supplier shall have a documented process to generate digitized manufacturing/inspection data from Boeing provided full scale engineering Mylarplots or from any authority physical representation. This process shall ensure integrity of derived dimensions and include review, release and configuration control.

2.3. **Engineering Type Design -** A supplier who performs Type Design or Tool Design for Boeing using Boeing provided SCD, MDD, MDI, MDS, TDI in digital definition (CAD Format), shall develop a documented process per section 1.0 of this document.

2.3.1. The supplier shall describe documented processes for design and development to ensure:

a) Customer acceptance of design and changes to design

b) Configuration Management and Identification

c) Media Security, including local or remote storage and transmittal using encryption protection between supplier sub divisions or sub-tier suppliers.

d) Access and change control of engineering and tool design

e) DPD control when providing datasets or derivatives to supplier sub divisions or sub-tier suppliers

f) Designs shall have traceability to Boeing provided authority definition.

g) Type Design or Tool Design must meet data exchange requirements for Boeing.

2.3.2. Design and development outputs shall meet the program requirements for design and shall identify any critical items, including any key characteristics, and specific actions to be taken for these items.

2.3.3. The design shall provide the data required to allow the product to be identified, manufactured, and inspected. This includes the specifications necessary to define and maintain the configuration and the design features of the product. (E.g. material, process, features, annotation, specification, notes, and manufacturing andassembly data needed to ensure conformity of the product).

2.3.4. When required by contract, the supplier shall have a process to perform predetermined periodic design reviews to Boeing requirements to ensure that all requirements have beenmet.

2.3.5. A Design Supplier that performs Product Design/Tool Design creation/Design tasks, and uses their own design(s) and QMS exclusively to manufacture and inspect the product or tool purchased by Boeing. The scope of DPD at Non-Manufacturing suppliers shall be limited to a documented process per section 1.0 of this document. In addition, elements of the documented DPD processes shall address, but not be limited to those operations in D6-51991 sections 2.0, 4.0, 5.0, 8.0, and 10.0 regarding a secure and configuration managed environment to communicate, create, and maintain the designs and/or intellectual property they own for the purpose of delivering their designed and maintained product(s) or tool(s) to Boeing.

3. Product Acceptance Software (PAS)

3.1. **Commercial Off The Shelf Software -** The supplier shall document and maintain documented processes for the control of Product Acceptance Software (PAS). PAS includes software used in the acceptance of special tooling and products.

3.1.1. Supplier must document and maintain PAS procedures and reference applicable documents in their documented DPD processes. Documented results shall provide for identification of software name, software version and validation results when used for QA applications.

3.1.2. Procedures or processes will be maintained to prevent unauthorized changes, to limit personnel access to software files, and to archive masters and duplicates.

3.1.3. Supplier should request objective evidence or certification/accreditation (independent) of the software manufacture per ASME B89.4.10 or equivalent. The supplier shall maintain documentation for certification/accreditationas a means of identifying approved PAS, version control and QA management approval. Sample testing of existing product and tool programs following new or revised PAS installation to verify compatibility is considered a best practice.

3.1.4. In the event supplier is unable to obtain objective evidence or certification of the PAS from the software manufacturer, supplier is responsible for verifying PAS prior to product acceptance use. Examples of PAS functionality verification include using calibrated standards, known physical artifacts or embedded software to test feature construction and output accuracy. Examples include algorithm testing, GD&T functions, temperature compensation, CAD translations and software that controls hardware when those software functionalities are used.

3.2. **Computer Aided Manufacturing Software -** When used for inspection (i.e. CNC On-machine probing, etc.) the supplier shall develop and maintain documented processesfor configuration identification and control of CAM software and must meet the requirements of sections 3.1.1 through 3.1.4.

3.2.1. Supplier must verify numerically controlled software prior to product acceptanceand maintain records.

3.3. **Supplier Developed Software -** Software developed by suppliers requires plans and instructions for building, configuration management, loading and testing of code. Supplier developed software, and subsequent revisions, will require independent testing and meet the requirement in sections 3.1.1 through 3.1.4 to ensure the software accomplishes its intended function.

4. Internal Quality Audits

4.1. Internal Audits - Internal Audit procedures shall include provisions for auditing all operations annually affecting DPD data and related documentation to assure compliance with contractual requirements, software and production part quality standards, and the observance of security restrictions.

4.1.1. The audit plan shall include provisions for auditing sub-tier suppliers that useDPD data to manufacture or inspect Boeing product or tooling.

4.1.2. The audit plan shall address all requirements of the latest revision of D6-51991 including notification from sub-tier to supplier of items listed in section 1.3.1.

4.1.3. Results of all audits shall be documented and maintained for review by anauthorized Boeing representative per contract requirements

5. Procurement Control

5.1. **Sub-tier Supplier Activity -** The supplier shall flow down the requirements of this document (D6-51991 or equivalent supplier document) to sub-tier suppliers and document sub- tier supplier compliance when Boeing authority datasets or dataset derivatives are used for manufacturing or product acceptance. This would include design collaboration when design responsibility is shared with sub-tier suppliers.

5.1.1. The supplier shall be responsible to Boeing for the maintenance, change incorporation, use of DPD and observance of security restrictions by sub-tiers for design, manufacturing and inspection.

5.1.2. The supplier shall establish procedural controls to assure Boeing DPD transferred (authority or derivative) between their company divisions and all levels of sub-tier suppliers shall be in compliance with this document.

5.1.3. The supplier shall determine scope of DPD sub-tier supplier approvals based on their ability to interpret and maintain control, configuration of DPD/MBD data and CMS for acceptance of products and/or tools. Criteria for selection, evaluation and re-evaluation shall be established. Records of the results of evaluations and any necessary actions arising from the evaluation shall be maintained.

5.1.4. The supplier shall continue to approve sub-tier suppliers and measurement service providers. It is recommended that suppliers recognize the Nadcap M&I accreditation of sub-tier suppliers. Nadcap accreditation does not relieve suppliers ofthe responsibility to monitor and measure sub-tier performance.

5.2. **Export Control -** Flow down to sub-tier suppliers shall include ITAR, MLA, MA, TAA, and EAR requirements.

5.3. **Boeing Right of Entry -** Boeing reserves the right to survey and/or review the DPDquality assurance and configuration management systems of sub-tiers.

6. Control of MeasurementEquipment

6.1. **Calibration -** The supplier shall implement and maintain a documented process for the calibration and recall of monitoring and measuring equipment. Calibration shall be traceable to NIST or equivalent international standards.

6.1.1. These controls shall provide records of date of acceptance/rejection and next maintenance due date. Measurement equipment shall be physically identified in accordance with certification records. This includes all CMS equipment including CMS sub-components, N/C (CAM) equipment used for inspection, Optical Laser Template (OLT's), and plotters used to produce Mylars or other inspection or tooling media.

6.2. **CMS -** Suppliers using CMS and OLT's for fabrication and/or inspection of Boeing products (parts and tools) must document and control their processes.

NOTE: When an OLT is used to verify Boeing product, it must be Qualified by a Boeing team with representatives from the Material and Process and QA organizations or their delegates (Reference BSS7120).

6.2.1. Additional CMS requirements are stated below and require capability approval by Boeing.

6.2.2. The supplier and its sub-tier suppliers utilizing CMS and OLT must have documented user level processes or documented procedures that provide adequate asset care, equipment setup, operation, training, and QA proceduralmethods to perform acceptance of measurements.

Supplier shall determine the applicability and document the criteria to perform the following: (any exclusion shall be approved by the Boeing DPD representative)

a) Purpose / Scope – Overview or statement of specific equipment and its intendeduse.

b) Calibration – Supplier shall define calibration intervals and maintain a system for periodic maintenance of measurement equipment. The supplier must document inventory of all specific components used for CMS and OLT measurement that could affect the integrity of data collection. This inventory shall include but not limited to calibrated CMM reference sphere and Laser Tracker target accessories (e.g. bushings, adapters, sphere mounts, bar/rod, probing, drift nest, supports, all reflector types, etc.) and weather station equipment.

c) Production Process Verification - Supplier shall implement process verification activities to ensure the measurement system is capable of measuring tolerances used to accept or reject products.

d) Product Acceptance Software – Supplier shall perform Product Acceptance Software testing per section 3.0.

e) Field Checks / Probe Calibration / Set up shall be performed – Establish criteria for field checks / probe calibrations / set up to ensure data and system accuracy prior to collecting measurement data.

f) Drift Points / Stability – For all Portable CMS equipment drift point analysis is required to ensure stability between the equipment and object being measured. Drift points must be attached to the object being measured and a record of drift points measured and acceptance tolerance used, before and after measurements, is required as objective evidence. It is also recommended that Drift Points be measured periodically during the survey as an indication of on-going stability, particularly for long surveys.

g) Temperature Compensation / Scale Factors – The product dimensional characteristics being verified must meet the engineering definition requirements at 68 degrees Fahrenheit as defined in ANSI/ASME Y14.5 and ANSI B89.6.2. Product temperature shall be recorded for all CMS measurements and documented on inspection reports.

   1) When product is measured in a controlled environment the allowable deviation from 68 degrees F shall be documented by the supplier basedon product material, size and allowable tolerances. A process, often referred to as soak time, shall be defined, documented and followed to ensure product is at the correct temperature at the time of measurement.

   2) When products are measured in an uncontrolled environment, or the process often referred to as soak time has not been followed, a documented process to compensate for thermal effects of the objects being measured is required. Objective evidence is required for temperature compensation when using scale bars, artifacts or temperature calculation. Supplier shall document their temperature compensation process which includes planning for pre, post and during measurement survey analysis. Scale bars shall be of a similar material and CTE to the object being measured and soak to the same temperature as the object being measured.

h) Establish Coordinate System – Establish criteria for changing the coordinate system from a CMS coordinate system to a local part or tool coordinate system (e.g. tolerances, datum targets, datum features, tooling holes, tool enhanced reference system or best fit). Establishment of coordinate systems shall be in accordance with customer engineering definition and ANSI/ASME Y14.5 as applicable. Best Fit alignment shall not be used for production hardware acceptance unless contractually authorized by Boeing engineering and evidenceof authorization shall accompany final inspection reports.

i) Multiple Station Set-up Criteria – When moving CMS equipment or product is moved from one location to another, or combining CMS equipment during a survey, supplier shall document their process and acceptance tolerance. A minimum of seven adequately distributed Common Points used as reference forrepositioning/adding the CMS equipment during a survey shall be verified and recorded as objective evidence.

j) Data Collection Parameters – Establish measurement guidelines and specific collection parameters for the CMS equipment prior to collecting measurement data. (E.g. point density will match the part complexity, point labels, time/distance separation parameters, apex angles, distance limitations).

k) Data Analysis – Establish guidelines for the evaluation of 3D point data to tool engineering, engineering datasets, point maps or drawings.

l) Reports – Establish standard process for CMS reports shall include job information, coordinate system establishment (i.e., alignment to datum A,B,C and any additional alignment to datum D,E,F, datum targets, etc), object temperature, data analysis, measured results, point maps. Reports shall include feature identification, nominal (X, Y, Z), actual (X, Y, Z), tolerance and deviation. When products are measured in an uncontrolled environment CMS reports shall also include, scale bar and drift point measurements. Reports shall be in English and in inches unless directed otherwise by customer contract.

m) Record Retention –The Supplier's QMS shall define the CMS documented information to be retained which demonstrate the conformity of products to engineering requirements. The supplier shall retain per contractual requirements and provide to the customer upon request.

6.2.3. Boeing will recognize a supplier's option to become Nadcap Measurement and Inspection (M&I) approved in lieu of the applicable CMS portion of a Boeing DPD audit for fixed CMM, Laser Tracker or Articulating Arm measurement devices. Boeing reserves the right to survey and/or review the supplier's CMS to verify its effectiveness and compliances.

7. Inspection Media

7.1. **Inspection Planning for Validation -** When product or tool engineering definition 2D drawings include digitally defined surfaces/features (3D models), the supplier must ensure inspection of these surfaces/features. Supplier's QA organizations are responsible, at a minimum, for inspection media/derivative, measurement instructions and analysis of data for product acceptance. Inspection planning shall include the following activities, as appropriate, in meeting the specified design requirements:

7.1.1. Description of the method and instructions for validation of each digitally defined product feature for first article inspection and production parts.

7.1.2. To validate digitally defined product features with methods other than CMS inspection the supplier must document the media and/or process used.

7.2. **Inspection Media -** The Supplier shall develop and maintain documented processes to create inspection media/derivative from DPD datasets. These shall assure:

a) Media is independently derived from and traceable to the authority dataset Mediamust be under configuration control

b) Media contains graphics, annotations, text, and GD&T to illustrate inspection operations

c) Coordinate system, alignment and datum features are defined Part/Tool set up instructions

d) Media is created by qualified personnel

e) A media review process exists (checker, checklist or peer/team review)

7.2.1. Document the establishment of the coordinate system, datum targets and datum features.

7.2.2. Digitized manufacturing/inspection data generated from Boeing provided full scale engineering Mylar plots must have evidence of QA acceptance.

7.2.3. Data or datasets identified as "Pre-Release" or “REFERENCE ONLY" shall not be used for product acceptance purposes. Any use of this data for manufacturing or design is at the risk of the supplier.

7.2.4. Supplier may use definition of MDD, MDI, MDS, TDI, loft surfaces or other digital definition, including IGES or STEP format, as authority for product acceptance when supplied by Boeing according to a Master Dimensions Request (MDR) process.

7.3. **Reduced Content Drawings -** Suppliers who receive reduced content drawings with an associated 3D model, must be able to extract information from the 3D model sufficient for manufacturing and inspection in addition to the 2D drawing.

7.3.1. Suppliers must identify and document for manufacturing and inspection, thefollowing requirements at a minimum.

a) All features identified on the 2D drawing

b) Features of the 3D model not defined by the 2D drawing

c) Fabrication & manufacturing process specifications

d) Flag notes, parts list and other specified requirements

e) SSP’s and SPECO’s

7.4. **Printed Wire Boards (PWB) -** PWB suppliers that have been provided 100% Boeing defined 2D drawings are exempt from the D6-51991 approval.

7.5. **Model Based Definition (MBD) -** Suppliers who receive Engineering and/or Tooling MBD datasets must extract information from the dataset sufficient for manufacturing and inspection activity for the product. Additionally, utilizing MBD requires a capability assessment by a Boeing Supplier Quality DPD.

7.5.1. Supplier’s QA must verify that derivative media used contains all design implicit and explicit requirements (e.g., all features defined by GD&T, annotations, specifications, notes and other specified requirements in the authority MBD dataset and associated parts list including dimensional and other properties) are identified and planned for inspection/validation.

Note: 2D drawings, 2D sketches/views or a Low End Viewer (LEV) may be used toconvey manufacturing and inspection information as required to fit the supplier’s methods of operation.

7.6. **First Article Inspection -** All explicit and implicit design characteristics within the engineering shall be positively identified within the FAI plan. This shall include all engineering characteristics requiring traceability:

a) All features annotated within the 3D model (explicit)

b) Features of the 3D model not annotated (implicit)

c) All characteristics applicable on the 2D drawings/reduced content drawings

d) All applicable notes and material lists

e) All feature tolerances per the standard / general notes.

7.7. **Boeing Provided Plots -** Boeing plotted media used for manufacturing and inspection shall be requested through procurement agent.

7.7.1. **Boeing Product Definition Template (PDT)** - Suppliers using Boeing PDTs shall order, control and perform verification prior to use of Boeing PDTs in accordance with D950-11288-1 Product Definition Template (PDT) Requirements, Validation and Verification Processes, and Handling Instructions for Plot Centers and Supplier Use.

7.8. **Supplier Created Plotted Media -** Suppliers and its sub-tier suppliers creating plots for product acceptance must have a documented procedure. These procedures shall include the following, at a minimum, and require capability approval by Boeing Supplier Quality DPD representative:

a) Plotter calibration – Follow OEM process for calibration and adjustment and independent validation to NIST or equivalent.

b) Plotting Environment – Equipment located in temperature and humidity controlled environment to meet product requirements. (Typically, 68 degree Fahrenheit (with +/- 2 degree variance) and 50% Humidity (with +/- 5% variance))

c) Verification of engineering definition – Verification of developed flat pattern and plot verification features

d) Plotted media material - should be minimum .005 inches thick polyester film. Paper plots may be approved on a case by case basis for tolerances greater than +/-.10 inches.

e) Part number Identification & revision - Traceability to the Boeing authoritydataset

f) Validation of plotted media - Acceptance criteria of plot accuracy prior to stamping and releasing plot to manufacturing or inspection

g) Quality acceptance stamping – Date, Temperature, Humidity, Accuracy and evidence of inspection.

h) Accuracy of plots used for inspection – Plotted media will be verified prior to use in the environment where they are used. (Manufacturing or Inspection, etc.)

Note: The tightest product tolerance that can be reasonably inspected with a Mylar overlay is +/- 0.030 inch after grid check or defined verification features check has been performed.

7.8.1. **Verification of plot accuracy -** Suppliers must establish a documented process for the criteria and frequency for verifying plot accuracy prior to their use in production, part manufacturing, or inspection, following the initial verification at release. The process must include, at a minimum:

a) The responsibility for verifying plot/mylar accuracy by production or inspection end user.

b) The tolerance indicated on the plot accuracy stamp reflects the accuracy at the time of creation. The supplier must define the frequency of plot accuracy verifications throughout its usable life, until it is destroyed or becomes obsolete.

c) Plot verifications when environmental changes may affect accuracy.

d) Measure to ensure the accuracy of the grid lines, or defined verification features vertically, horizontally and diagonally to verify plots. Grid lines are usually plotted in 10-inch increments. Check the grid lines from the first to the last grid line or defined verification features. Grid lines shall be within a tolerance of +/-.020 up to 100 inches and within +.030/-.010 over 100 inches.

Note: A calibrated steel scale (Starrett or equivalent) is recommended to check the grid lines for accuracy.

7.8.2. **Environmental Controls -** Plotting equipment shall be located in a temperatureand humidity controlled environment. Development and validation of plots will be done in an environmentally controlled area using a real time monitoring system for temperature and relative humidity.

Note: The tolerance noted in the plot accuracy stamp is the accuracy of the plot at the time it was generated and does not relieve the user of the responsibility to verify the plot at the time of use.

7.8.3. **Handling and Storage -** To maintain media accuracy and stability, plots are recommended to be handled and stored as followed:

7.8.3.1. Plots should be handled according to the following recommendations.Failure to follow these recommendations may shorten the usable life:

a) Do not roll less than 3 inches inside diameter

b) Do not expose the media to heat generating sources. This may include laserprinters, computer monitors, copy machines, air compressors, transformers,batteries, engines and sunlit enclosed places.

c) Do not fold, crease or damage in anyway, as this also effects the dimensional stability.

7.8.3.2. To maintain accuracy and stability, it is recommended that plots be stored in:

a) In a dust free, non-condensing moisture and chemical free area

b) Temperature from 65 to 80 degrees Fahrenheit and relative humidity from 45 to 55 percent.

7.8.4. **Destruction of Obsolete/Unusable -** All materials and computing media of any kind containing BOEING PROPRIETARY information shall be disposed of by methods that ensure that all Boeing proprietary information is destroyed so that none of it can be reconstructed from the residue or remains. Disposal methods may include recycling, shredding, burning, etc. and are dependent upon the resources at any given company/supplier facility. Recycling may be used only where procedures are in place to assure continuous security controls throughout the recycling process. The methods used for large-scale disposal shall be approved by Supply Chain / Procurement Agent / Property Management.

8. Data Exchange Methods

8.1. **CAD Compatibility Requirements** (BCA only – commonly referred to as synchronization) **-** Suppliers shall maintain the current level of software, software revisions and other digital system information required to maintain compatibility with Boeing supplied datasets and/or data exchange formats per applicableBoeing system(s) requirement documents.

8.1.1. For Boeing Commercial Airplanes divisions (BCA) see D6-56199 Hardware and software compatibility requirements for supplier's use of BCA CATIA native datasets as authority for design, manufacturing and inspection. 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 documented DPD processes.

8.1.2. Supplier must have a documented process that ensures they can translate,receive and validate all authority datasets without change to the data integrity.

8.1.3. The use of 3D-PDF is for viewing annotation, and shall require authority 3Dsurface geometry for manufacturing and inspection use.

8.2. **Translations** - When suppliers with native CAD Software receive their Authority dataset in the same CAD System (native to native) and manage their process which includes manufacturing and inspection software using the same Native system and version, translation verification is not mandatory due to lower risk but recommended as an industry best practice**.** When suppliers translate from Native CAD format to alternate formats including CATIA V4 to CATIA V5 or Native to STEP suppliers are responsible for all dataset translations and must have a clear documented process for each. The documented process must include a method to verify the accuracy of translations. Suppliers must be able to demonstrate the CAD translation process, including verification/interrogation methods used, and the ability to identify known discrepancies.

8.2.1. Acceptance criteria for accuracy of translated surface profile/geometry, (tolerance) must be determined by the supplier, and must ensure the end product will be within engineering tolerance/specification. Objective evidence validating thesuppliers' documented translation process must be retained. (Typical allowable deviation is 1/10th of the tightest engineering tolerance)

8.2.2. The verification process for translation of datasets containing 3D annotation (i.e. feature control frames, dimensions, text, and/or surface geometry) must ensure that all intended entities are accounted for in the translated media.

8.2.3. Suppliers receiving Boeing authority STEP format datasets supplemented with a 2D DWG, 3D-PDF or SUPPAR STEP formats throughout their product realization and inspection processes are not required to perform data translation validation. It is strongly recommended data translation validation remain a best practice to mitigate potential errors.

9. Special Tooling

9.1. **Tool Design -** The supplier shall describe documented processes to ensure release, acceptance, identification, security, access and change control of tool design and tool inspection datasets. Tooling datasets shall have traceability to current authority engineering and derivative tooling dataset sources. The engineering authority dataset(s) shall be identified on the tool design when applicable.

9.1.1. Tool Designs shall be produced using authority data and when required bycontract be approved by Boeing authorized personnel.

9.1.2. The supplier shall ensure that when Tool Design responsibility is flowed down tosub-tier suppliers, the sub-tier supplier will be approved by the supplier.

9.2. **Traceability -** All digitally defined special tooling and physical inspection media (check fixtures, templates, etc.) will be identified and traceable to the engineering authority dataset, tool design dataset and any tool inspection datasets.

9.3. **Inspection -** These tools and tooling media shall be dimensionally accepted and periodically validated to the authority design at a frequency determined to ensure accuracy and repeatability of the tool before use.

10. Training and Process Performer

10.1. **DPD Training -** Suppliers shall define training requirements to assure competence and shall maintain employee training records, including on-the-job-training,for all DPD system users (e.g. Quality, IT, planning, purchasing, tooling, contract reviewand Mfg).

10.1.1. The supplier shall ensure that all personnel having DPD system access have completed training adequate to perform digital product acceptance activities including digital inspection media generation, performance of inspections and 3Ddata collection.

10.1.2. Syllabus shall include training criteria necessary to ensure proficiency of process performers (e.g. planning, programmers, quality, tooling, CMS etc.) to interpret current ASME Y14.5 Dimensioning and Tolerancing (GD&T).

10.1.3. Training shall be updated due to changes driven by new equipment, software or Boeing program requirements. Training must support the part complexity, for example the measurement density required for complex parts.

10.1.4. If Quality activities are performed by individuals other than the supplier's quality assurance personnel, the supplier shall define the specific tasks and responsibilities that are authorized and the training necessary to perform those tasks.

Glossary

Acronym or Term	Definition
3D-PDF	Converts 3D designs including text, flag notes, symbols and GD&T from CAD applications. Allows suppliers to provide screen captures with 3D viewing (rotation, panning, zooming) capability to their downstream users. *No 3D geometry interrogation allowed only 3D viewing capabilities.
ANNOTATION	Dimensions, tolerances, notes, text and symbology visible without any interrogation of the model.
AUTHORITY	Undisputed source of Boeing approved dataset used for product manufactureand quality assurance acceptance.
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. (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 for use 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.
CAI	Computer Aided Inspection - Also known as Coordinate Measurement Systems (CMS) and Computer Aided Measurement Systems (CAMS). Measurement equipment such as Coordinate Measuring Machines (CMM), Laser Tracker, and numerical controlled machinery with inspection probe capability used to support inspection activity.
CAM	Computer Aided Manufacturing – Also known as numerical control (NC). The use of computers and computer data in the development and production of all part types (products) 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), Portable Coordinate Measurement Machine (PCMM), Laser Tracker, Laser Radar, Photogrammetry and numerical controlled machinery which are used to support inspection activity.
Common Points	A minimum of seven measured points with X, Y & Z coordinate values used to assist in the orientation of additional measurement instruments into the instrument network such as theodolites, laser tracker, PCMM, laser radar, scanners and photogrammetry camera stations.

CUSTOMER	The party (individual, project, or organization internal to or external to the company) responsible for accepting the product or for authorizing payment. Customers may or may not be users.
DATASET	Information prepared and maintained by electronic means (CAD/CAM), and provided by electronic data access, interchange, transfer, or on electronic media. Note: PDF file (Example: Full scale 2D engineering Mylar plots in pdf format) is not considered dataset and is not in the scope of DPD.)
DERIVATIVE	The 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, Planning (i.e. Manufacturing, Inspection, etc…), and other extractions (dimensions, views, etc.) for inspection/measurement use.
DRIFT POINT(S)	A point or set of points, measured at least twice (at a minimum, at the start and finish of a measurement survey) used to determine the relative stability between the device performing the measurements and the object being measured. When the distance between a pair of drift points is analyzed a very small distance indicates stability, where as a larger distance indicates instability
DPD	Digital Product Definition – The electronic data elements that specify the 3D Computer Aided Design (CAD) geometry and all design requirements for a product (including notation and parts lists), and the use of this data throughout an integrated CAD/Computer Aided Manufacturing (CAM) and Coordinate Measurement Systems (CMS).
EAR	Export Administration Regulations. This is the Dep't of Commerce agency, (Commercial or Dual Use)
Enhanced Reference System	A permanent reference system, established for the life of a tool, which is documented from a design reference system or created specifically for CMS. The ERS is used to provide a large number of known points coordinate for use in tool transformations; 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 nondestructive 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) and one note or FCF may refer to several features.
Global STEP	Is an approval for all BDS sites using a standard technical data package (TDP) which includes a STEP SUPPAR or STEP 3D-PDF process for delivering suppliers authority datasets.
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 (Criteria)	A description of 2D and/or 3D computer generated inspection media/methods derived from authority DPD datasets and used to communicate inspection requirements and media usage to manufacturing and inspection areas. Typical inspection plans include engineering and plan configuration/traceability, overlay/setup instructions and a list and/or graphic representation of the features to be inspected.
ITAR	International Traffic in Arms Regulations - Dep't of State (Military)
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.
MA	Manufacturing Agreement- an agreement whereby a US person grants a foreign person an authorization to manufacture defense articles abroad and which involves or contemplates: 1. The export of technical data or defense articles or the performance of a defense service: or 2. The use by the foreign person of technical data or defense articles previously exported by the US person
MBD	Model Based Definition – A Boeing dataset containing the exact solid, it's associated 3D geometry and 3D annotation of the product's dimensions and tolerances (and may include parts/notes list) to specify a complete product definition. This dataset does not contain a conventional 2D drawing. MBD is one possible format of DPD. (Note: Model Based Definition is the undisputed source of definition)
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 receives 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 mathematically defined 3D surface generated using computer aided design. Each surface is uniquely identified by number.
MLA	Manufacturing License Agreements - Authorizes a US manufacturer to supply manufacturing knowledge (related to defense) to a foreign party. All foreign recipients must be named as parties to (or as "authorized sub licensees" under) the agreement.
PAS	PAS is considered software that performs product or tooling acceptance without subsequent inspection. Common PAS applications include: CMS software

	(CMM, Laser Trackers, Laser Radar, PCMM's), CAD translators, and CAD Analysis Software. 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.
REDUCED CONTENT DRAWINGS	Any DPD design dataset without full dimensioning of product features on a 2D sheet. This includes Reduced Dimension Drawings (RDD), Minimally Dimension Drawings (MDD), and Simplified Dimension Drawings (SDD) which contain reference to 3D surface definition or CAD geometry.
REFERENCE ONLY (REF)	(1) Notation indicating which layers or features of a design are not reliable or authorized for manufacturing and inspection use. (2) Marked "Reference Only" datasets whose definition is not reliable and not authorized for design, manufacture or inspection.
SCALE BAR	A device used to verify that the proper scale factor has been applied to a three-dimensional measurement survey. The device generally consists of a bar with at least two or more fixed points. The distance between point pairs is determined, certified and is traceable to an international standard. In some metrology applications the Scale Bar may also be used to set scale (e.g. theodolite, photogrammetry).
SCD	Specification Control Drawing - A type of picture sheet geometry or book which depicts functional and physical interfaces, performance requirements, and quality assurance requirements to enable development and procurement of an Item (assembly or system) by an outside supplier.
Soak Time	A defined and documented process to insure product or tool has reached the required/ target temperature prior to measurement. The defined and documented process must take into account CTE influenced parameters appropriate to their actual products in production : A Plan should analyze and plan-for specific soak times based upon part number/family dimensional CTE characteristics (thickness's, cross-sections, over-all lengths, etc), setting either prescribed time or minimum acceptable soak time appropriate to parts/ part families under review with adjustments possible with part size and other calculated CTE risks
SPECO	Specification Outside Processing - The SPECO is provided to an external site or supplier to define the required condition of delivery (COD) of the part or assembly for a specific deliverable. The SPECO is part of the Make/Buy package. This package consists of the SPECO, along with Interchangeability and Replaceability (I&R) requirements, and any other applicable supporting engineering/manufacturing documentation.

SPECIAL TOOLING	Tools of such a specialized nature that, without modification or alteration, their use is limited to the development and/or manufacture of production parts and assemblies. Examples of these tools include jigs, fixtures, molds, patterns and gages as identified by site specific documentation. See D33200-1 and D950-11059-1
SSP	Specification Plan - Specification plan communicates BCA manufacturing configuration requirements.
STEP	Standard for the Exchange of Product model data. – Standard developed by the International Standards Organization for exchange of digital product data.
SUB-TIER SUPPLIER	An entity of the prime contracted company and not directly contracted by Boeing, providing products or services for Boeing programs
SUPPAR	SUPPAR is a Boeing proprietary process utilizing UFUNC program which extracts critical 3D annotation (text, flag notes, symbols and GD&T) defined by the design and converts it to a model dependent (STEP) format. SUPPAR stands for SUPplier PARts, to create a supplier friendly user format. The converted SUPPAR files are designated with the acronym such as “sup” in the naming convention.
SUPPLIER	An entity delivering products or performing services being acquired. (2) An individual, partnership, company, corporation, association, or other service having an agreement (contract) with an acquirer for the design, development, manufacture, maintenance, modification, or supply of items under the terms of an agreement (contract).
SUPPLIER COMPANY SUB-DIVISION	A sub-division or location of the suppliers company that is not the directly contracted division or location to Boeing for providing products or services.
TAA	Technical Assistance Agreement - An agreement for the performance of a defense service(s) or the disclosure of technical data, as opposed to an agreement granting a right to manufacture defense articles. Assembly of defense articles is included under this section, provided production rights or manufacturing know-how are not conveyed. Should such rights be transferred, a Manufacturing License Agreement (MLA) is required.
TDI	Tooling Data Identifier - A TDI is used by Boeing for the development of tools used by outside suppliers.
TRANSLATION	Translations occur when a digital dataset is changed from its original CAD system format to another CAD, CAM, and CAI application format and require verification.

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 their Boeing Procurement Agent to request applicable documents.

BSS7120	Qualification of Equipment for Fabrication of Composite Structure
D33200	Boeing Supplier's Tooling Document
D6-56199	Hardware and Software Compatibility Requirements for Suppliers Use of BCA CATIA Native Datasets as Authority for Design, Manufacturing and Inspection
D6-81491	Usage of CATIA Native, CATIA IGES and PDM STEP Datasets
D6-82402	Define Products Distributed to Suppliers
D6-83402	Translation of Model Based Definition
D6-83754	Authoritative Model Based Definition
D6-84378	Supplier Product Data Management (SPDM)
D950-11059-1	BDS Seller Special Tooling Requirements
D950-11288-1	Product Definition Template (PDT) Requirements, Validation and Verification Processes, and Handling Instructions for Plot Centers and Supplier Use

The following Aerospace Standards are referenced.

ANSI/ASME Y14.5	Dimensioning and Tolerancing
B89.4.10	Methods for Performing Evaluation of Coordinate Measuring System Software
B89.6.2	Temperature and Humidity Environment for Dimensional Measurement

Revision Record

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