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PPG Aerospace
Transparencies

TOOLING ADDENDUM TO PPG QC 22-001
(SUPPLIER QUALITY CONTROL REQUIREMENTS)

**Control and Use of Digital Datasets for the Purpose
of Tool Fabrication and Inspection**

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1. SCOPE

This document provides the PPG Aerospace Tooling requirements for Supplier's Computer Aided Design, Computer Aided Manufacturing, and Computer Aided Inspection Quality Assurance/Control System.

2. PURPOSE

This document establishes and defines the quality system requirements for tooling suppliers control and use of PPG Aerospace digital data.

This document is intended as a supplement to, not a replacement for, other Supplier Quality Requirement documents and the procurements governed by them.

Suppliers will be audited to the requirements in this document. Upon satisfactory completion of the audit, the supplier will be approved to receive and utilize Digital data for manufacturing and inspection purposes.

Suppliers shall be compliant and approved by PPG Aerospace to the requirements of this document prior to manufacturing and/or inspection when using released digital datasets.

3. ASSOCIATED DOCUMENTS

SUPPLIER QUALITY CONTROL REQUIREMENTS: PPG QC 22-001

4. DEFINITIONS

ACCOUNTABLE TOOLS – These tools are subject to the accountability requirements of the affected contract and will be accounted for, or called out, on the purchasing documents. These tools must be available for the return to the customer upon request or contract completion / termination.

CAD - Computer Aided Design - Any computer system or program that supports the computer graphic design process.

CAD/CAM/CAI – Computer Aided Design / Computer Aided Manufacturing / Computer Aided Inspection. The integration of CAD, CAM, and CAI through the common sharing of part geometry definitions and other data jointly used in design, engineering, manufacturing, and inspection.

CAI - Computer Aided Inspection - The use of computer data in the inspection of parts, assemblies, and installations.

CAM - Computer Aided Manufacturing - The use of computer data in the development and production of a part (product) including fabrication, assembly, and installation

CATIA - Computer-Aided Three-Dimensional Interactive Application

CMM – Coordinate Measuring Machine

CMS - Coordinate Measurement Systems - Measurement and test equipment used to support CAI activities. Including, but not limited to, Coordinate Measuring Machines, Theodolite, and Photogrammetry systems.

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

DLO – Daylight Opening

DMIS – Dimensional Measuring Interface Standard

DXF – A file extension that denotes an AutoCAD model.

EOP – End of Part

IGES - Initial Graphics Exchange Specification – The American National Standards Institute (ANSI) Data standard for the exchange of computer graphics generated product definition (text and geometry) between different manufacturer’s computer graphics systems.

INBOARD – Generally a directional reference moving from outside to inside the aircraft.

PDT –Product Development Team

2D DRAWING – A limited dimension drawing that depicts in AUTOCAD a representation in sufficient detail to enable downstream disciplines to analyze, inspect and fabricate the tool.

OUTBOARD - Generally a directional reference moving from inside to outside the aircraft.

REFERENCE DATA – Data used for information purposes only. This data is considered to be auxiliary information. This data shall not be used to produce inspection media for deliverable hardware (including accountable tooling and tooling used as a media of inspection).

SURFACE PATCH – An area within a part or tool that defines the mold line/surface definition of a part or tool. Several surface patches can exist to define tool mold line/surface or feature.

Vericut®, Valisys®, CATCMM® - software simulates NC machining to detect mistakes and inefficiency electronically. Compares “as machined” cut path with the original design model.

5. SPECIFIC REQUIREMENTS

A. CAD/CAM/CAI QUALITY ASSURANCE REQUIREMENTS

1. The Supplier shall maintain a documented CAD/CAM/CAI Quality Assurance Plan that illustrates how configuration control of digital data is maintained to an identifiable level throughout the Suppliers' CAD/CAM/CAI system, from receipt of PPG Aerospace data to end item acceptance. This QA Plan shall specifically address the processes and techniques unique to the Supplier's CAD/CAM/CAI mode of operation and bear acceptance by the appropriate level of management.
2. The QA Plan shall remain in effect throughout the life of the contract and shall define the CAD/CAM/CAI processes, systems and procedures to be used for software installation, data receipt, control, use for manufacture, in-process inspections, Supplier's subcontractor control, and end item inspections of products produced for PPG Aerospace.
3. The supplier shall provide a description of the process used to develop inspection data from PPG Aerospace provided digital datasets. The description shall include the steps required to translate, develop inspection points and criteria, and to program the inspection devices. It shall also include the hardware and software used, the data formats used for transport and processing. Use of data without translation is preferred. Figures 1 and 2 are provided as examples of inspection data flow.
4. PPG Aerospace reserves the right to periodically test portions of the Suppliers' CAD/CAM/CAI system to verify effectiveness of the Suppliers' Quality Assurance Plan.
5. The authority and responsibility for each element of the CAD/CAM/CAI Quality Assurance Plan shall be defined and documented to assure consistent implementation.
6. Elements of the CAD/CAM/CAI Quality Assurance Plan shall include but not be limited to the requirements as outlined in the balance of the document.
7. PPG Aerospace may authorize the outsourcing of data translation. The process and source shall be documented in the QA Plan.

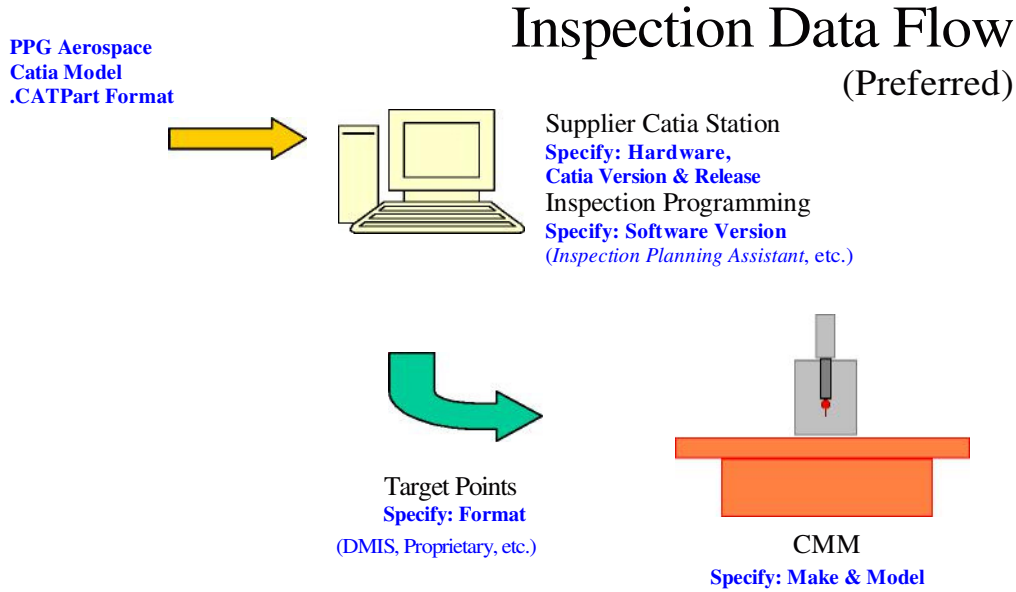


Figure 1

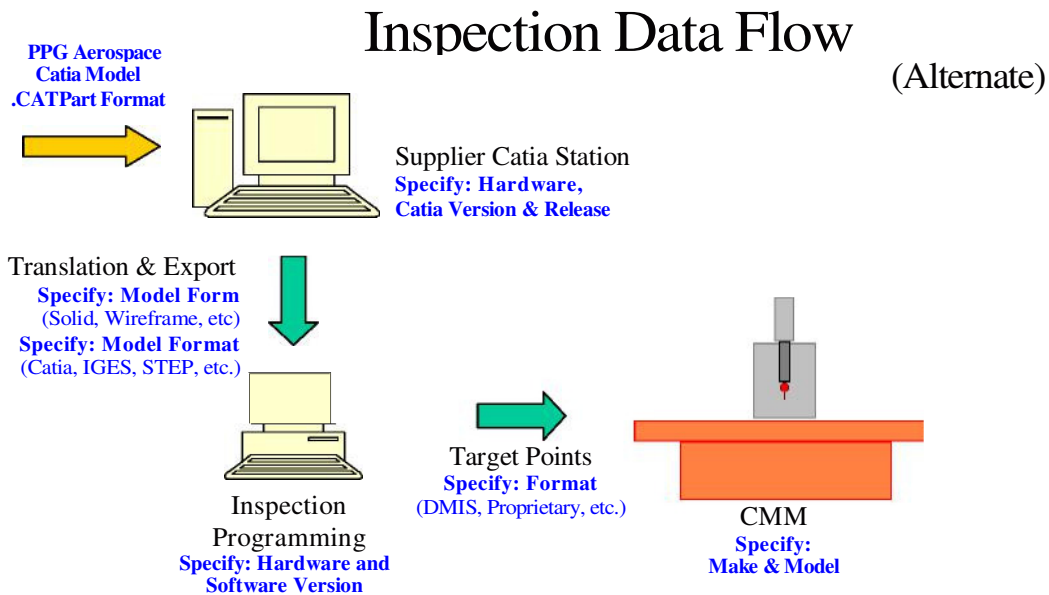


Figure 2

B. CONFIGURATION MANAGEMENT

1. All Digital Data must be received through PPG Aerospace as a controlled release. Any Digital Data received by other means shall be considered non-conforming.
2. The Supplier shall ensure that the configuration control of CAD/CAM/CAI systems, hardware, application software, product and data verification are identified, controlled and recorded.
3. A system for change accountability and traceability, for all datasets and dataset derivatives (including graphical/geometric electronic data), will be maintained by the Supplier.

C. REVIEW AND INTERNAL AUDIT

1. Reference Section 3.18 of QC 22-001.

D. PROBLEM REPORTING

1. The Supplier shall assure that non-conforming CAD/CAM/CAI datasets, graphics or extractions are identified as discrepant, segregated and reviewed for disposition.
2. The Supplier shall describe the practices and procedures to be followed for reporting, tracking, and resolving all transmission, hardware, software and dataset problems and deficiencies.
3. All problems should be reported to the PPG Tooling Engineer or PPG Tooling Coordinator.

E. MEDIA SECURITY

1. The Supplier shall describe the procedures and methods in place to ensure the integrity and security of PPG Aerospace supplied CAD/CAM/CAI data, Supplier extracted data and/or Supplier generated definition data. This shall include live storage of controlled data, read/write protection, passwords, access, and archiving. The Supplier shall include a procedure for a data backup system.

F. INSPECTION MEDIA

1. The Supplier shall describe the procedures established to provide CAD/CAM/CAI inspection media. This will include documented procedures and objective evidence showing data sources independent of manufacturing flows and assure that qualified personnel and required system/data access are available. The following paragraphs apply to datasets for inspection use.

2. Media that may be authorized for tool inspection will include, but is not limited to, 3D CAD model, DXF file, 2D Drawings, supplier generated dimensioned drawings, CMM with appropriate inspection planning software, and inspection checking fixtures.
3. Any data extracted from datasets used for product acceptance, must be traceable back to the original dataset.
4. Data or datasets identified as "REFERENCE"/"UNCONTROLLED DATA" may not be used for inspection purposes.
5. When PPG Aerospace supplied Datasets are translated for the purpose of CAI (CATIA, IGES, STEP, DXF, DWG, etc.), the supplier must provide a system that supports verification (through comparison) of the translated data to the original Model. The supplier may use an appropriate sampling plan to verify points. The CAI data shall be certified and approved by the Supplier's Quality Assurance process. Translations that deviate .0005 inches or less from the base geometry shall be deemed acceptable.
6. When using a sampling plan, any single point, which exceeds the specified acceptance criteria, contaminates the entire file rendering that file unacceptable for use.
7. Suppliers shall describe the procedure used to assure all part features have been inspected.
8. Supplier shall provide a "pictorial" of the matrix orientation (X, Y, Z origin) and data locations to be used as a mapping guide to note where the points are in relationship to the part. This pictorial map shall be supplied to PPG Aerospace with the required CMM report.

G. DATA EXCHANGE METHODS

1. All data exchange between PPG Aerospace and the Supplier shall be accomplished using a system with a version and release compatible with the design data as identified in contractual documents and/or engineering. If a discrepancy exists, the Supplier shall follow the steps in the Problem Reporting section of this document.
2. Suppliers are responsible for any translation of the PPG Aerospace file into other formats for use with their equipment. Defective hardware, caused by a translation error is the sole responsibility of the supplier.

H. TOOLING

1. The Supplier's CAD/CAM/CAI Quality Assurance Plan shall identify methods that assure accurate design, fabrication and inspection dataset identification used for Accountable Tooling and inspection tools.

I. CAD/CAM/CAI COMPUTING EQUIPMENT

1. Supplier shall have hardware & software or access to same with the appropriate version to support specific program requirements and inspection criteria & tolerances specified.
2. Dependent on part complexity, the Supplier should have access to a CMM or other automated measuring device. The supplier shall identify inspection data flow for each device within the QA Plan.
3. Supplier shall have and be able to demonstrate inspection programming software capable of the following:
 - a. Receiving 3D solid model.
 - b. Provide target points for inspection
4. A current Hardware/Software status document listing hardware model, software version, revision levels, addendums, etc. must be kept on file with PPG Aerospace Tooling Quality Department & updated annually.
5. Authorized PPG Aerospace representatives may periodically review the CAD/CAM/CAI Quality Assurance Plan for compliance to PPG Aerospace specifications.

J. SIMULATION SOFTWARE/PROGRAMS

1. Simulation programs such as Vericut®, Valisys®, CATCMM®, etc., can be used to validate cutter/probe path and verify inspection point locations and densities. The simulation software used shall be identified in the CAD/CAM/CAI QA Plan.

K. TOOL INSPECTION WITHIN A 3-D ENVIRONMENT

1. All part features shall be inspected and documented as part of the Tool Inspection in compliance with this document, the tool drawing and Purchase Order requirements. It is the responsibility of the Supplier to ensure product meets released engineering design, purchase order, and other applicable requirements that can be verified and validated via Tool Inspection Reports, CMM readouts, and process certifications. Verification of product nominal data within the 3-D model, and variable/actual data will be at the discretion of the PPG Aerospace Tooling Engineer and/or the PPG Aerospace Tooling Coordinator.
2. PPG Aerospace may request all applicable Inspection Data Media prior to, during, and after the Tool Inspection. This data may include the Tool Inspection Reports/documents, CMM inspection points and sketches, 2-D Drawings, and methodology documents.
3. The PPG Aerospace Tooling Coordinator may, at its discretion, request that re-inspection of the product take place in order to verify and corroborate report actuals with the presented Tool specimen.
4. Each product requires Tool Inspection documentation (records) as outlined in this document to ensure product meets or exceeds engineering specifications, drawing notes, parts list requirements, purchase order requirements, etc. In addition to the Tool Inspection requirements of this document, the supplier shall have, at a minimum, the following necessary documentation defining:
 - a. Inspection Methodology, including:
 - i. Features/Requirements Checked (Contoured surfaces, thickness, GD&T requirements, Key Characteristics, etc.).
 - ii. Inspection Equipment Used (CMM's, micrometers, hole/height gages, check fixtures, etc.)
 - iii. Tolerance Type (Surface profile, GD&T requirements, thickness, etc.).
 - iv. Part Restraining methods used for inspection.

- b. CMM Point Definitions and Locations & Verification.
 - i. Refer to Section L.
- c. 2 D Drawing Dimension Locations Coordinating with Bench Inspection Requirements.
 - i. For all other product features that cannot be verified by a CMM inspection program such as joggle breakouts, web transition areas, unique fillet radii, wall and web thickness, etc., a 2 D Drawing and point sketch or graphical map shall be created to show dimensional inspection points and corresponding position relative to the Tool Inspection Report.
- d. Solid Model Face Extraction Listing.
 - i. Each feature within a solid model has its own unique attribute and identification. These features or “faces” can be extracted and can be compiled as a listing. Solid model feature listings may be cross-referenced with the Tool Inspection Report to ensure all features of the product have been accounted for, verified, and documented.

L. INSPECTION POINT VERIFICATION

- 1) When CMM inspection is utilized as part of the Tool Inspection, CMM point sequences, theoretical values (X, Y, Z, I, J, K), their graphical location shall be depicted on a product point sketch or graphical map. CMM inspection datums, part datums, reference planes, tooling points, etc., should be depicted within this sketch or map showing relative position on tool.
- 2) The supplier shall create CMM inspection points to insure that features of the part have been verified as required in the Tool Inspection paragraph “K” and the tool drawing where applicable. Bench inspection methods shall be employed on the remaining features to substantiate that all engineering requirements have been verified.
- 3) The supplier shall create CMM inspection points using the definitions and the minimum number of points as described in the paragraphs below unless specified otherwise by the Tool drawing or PPG Tooling Engineer. When authorized by PPG Aerospace, the number of inspection points required on certain designated surfaces may be reduced. All GD&T engineering design callouts must be addressed and made available for review. All applicable paragraphs must be considered.
- 4) CMM inspection of all part critical surfaces, mating surfaces, index pin locations, part hole location bushings and other key characteristics as identified on the applicable drawing or in communications with PPG Tool Design shall be performed after final machining and prior to shipment of the tool to PPG.

- 5) General CMM inspection criteria are as follows and serve as a minimum guide. More detailed GD&T inspection requirements may be indicated on the drawing and take precedence:
- a) **Surface** tolerances must meet those specified by PPG technical data and drawings. The profile representing cross-sections of the critical surfaces should be inspected every 2 inches along their lengths (more often in corners and radii) per the supplied CAD model.
 - b) Surface inspection density should be according to the following general guidelines:
 - (i) Surfaces up to 100 in²: ½" x ½" grid.
 - (ii) Surfaces between 100 in² and 400 in²: 1" x 1" grid.
 - (iii) Surfaces greater than 400 in²: 2" x 2" grid.
 - (iv) Surfaces that are smaller than ½" in one direction should be measured at two levels along the length of the surface. Surfaces smaller than 1/8" in one direction should be measured as a curve (see section L. 5. e. of this document.)
 - (v) Areas of greater density may be required in order to adequately inspect the surface of the tool in order to adequately inspect the tool to insure that it meets all model and drawing requirements.
 - (vi) Points should be located within ¼" of the Edge of Part and at tangent points of transition, whenever possible
 - (vii) Surface inflection points should be measured.
 - c) **Holes** should be measured as cylinders using at least 4 points at 2 levels (8 points minimum) in order to capture accurate hole vector and centerline information. The measured hole vector angle should be compared to the nominal supplied hole vector angle and should be within +/- ½ degree.
 - d) The measured hole location (measured along the actual hole centerline vector) should be compared to the intersection of the nominal hole centerline and a nominal plane at the surface or the surface itself. The location tolerances must meet those specified by PPG technical data and drawings.
 - e) **Curves** must meet tolerances specified by PPG technical data and drawings. Scribe lines and vertical surfaces that are less than 1/8" deep should be considered curves.
 - f) Curve inspection point density should be according to the following guidelines.
 - (i) There will be a minimum of one point per inch (or any fraction) of curve for

curves shorter than (5) inches. (Three (3) points minimum)

- (ii) If the curve is longer than five (5) inches, a minimum of five points are to be verified. Point spacing on the curve is not to exceed ten (10) inches depending on complexity of the curve.
- 6) When possible, all points should be numbered starting from one end to form a continual chain to completely check one area (with like tolerances) with the least number of wasted moves before moving on to the next area or feature.

M. SUPPLIER QUALIFICATION

1. As part of the approval process, if requested by the PPG Aerospace, a sample solid model may be sent to the supplier for inspection per paragraph L. At which point, the supplier shall submit the results to PPG Aerospace for evaluation.
2. PPG Aerospace shall conduct a supplier survey, performed to this procedure, for all first tier suppliers to be qualified for use of digital data sets. Suppliers may be requested to provide their QAP prior to the onsite evaluation to facilitate the surveys/evaluations. Approval must be granted prior to issuance of data sets for the manufacture and/or inspection of deliverable hardware. Suppliers are responsible for subcontractor control for use and control of digital data and/or product acceptance.