

SPG01

Special Processes Guidebook

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1. Introduction

1.1. Intent

The intent of this document is to increase knowledge and understanding of special processes throughout the supply chain. The most up to date version of this document is maintained online at <https://www.lockheedmartin.com/en-gb/suppliers/mfc-uk.html>. This document may be copied by Lockheed Martin suppliers and subcontractors (at any tier of subcontracting) for use in support of Lockheed Martin contracts provided that it is not modified in any way and that this and all other copyright statements are retained.

1.2. Scope

The term special processes within this document refers to processes undertaken in aerospace, space and defence production processes.

2. What Are Special Processes?

2.1. ISO9000 Fundamentals and Vocabulary

In accordance with ISO9000:2015(E) 3.4.1 Process, Note 5: A process where the conformity of the resulting output cannot be readily or economically validated is frequently referred to as a “special process”.

2.2. ISO9001 Requirements

Special Processes are reference in ISO9001 8.5.1 f “the validation, and periodic revalidation, of the ability to achieve planned results of the processes for production and service provision, where the resulting output cannot be verified by subsequent monitoring or measurement”

2.3. AS9100 Requirements for Aviation, Space and Defence

Specific requirements are listed in AS9100 8.5.1.2 Validation and Control of Special Processes as; For processes where the resulting output cannot be verified by subsequent monitoring or measurement, the organization shall establish arrangements for these processes including, as applicable:

- a. definition of criteria for the review and approval of the processes;
- b. determination of conditions to maintain the approval;
- c. approval of facilities and equipment;
- d. qualification of persons;
- e. use of specific methods and procedures for implementation and monitoring the processes;
- f. requirements for documented information to be retained.

2.4. Summary

So, a special process is when the output of a process cannot be verified without destruction of the product. Generally, if you cannot measure or confirm the output of a process (the resulting product or service) with calibrated tools or instruments and know whether it conforms to specifications, the process is likely a special process that requires validation and revalidation (periodic testing).

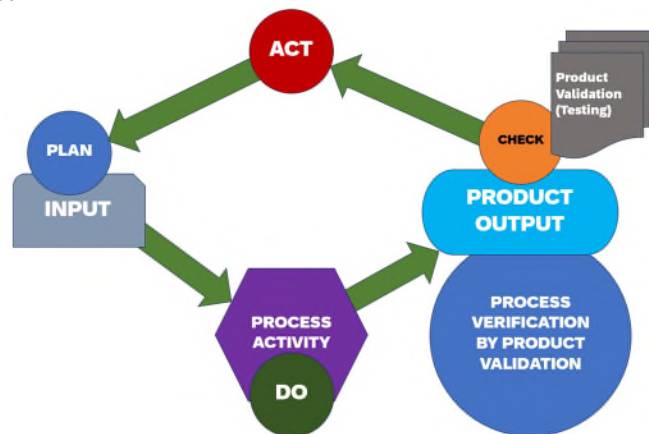
3. Production Process Verification

3.1. Verifiable (Non Special) Process

To further understand, an output of a process that can be verified is usually done during the production process verification or inspection. For example, where a machined part is manufactured to design data that includes dimensional tolerances is inspected. In this case, the output can be verified or tested (validated) by the use of a calibrated tool or measuring instrumentation. The ‘inspection’ or production process verification activity ensures the production process is able to produce product that meet requirements. This activity can be referred to as first article inspection. In other words, the product (output) inspection or test can verify the process.

3.2. Process Verification By Product Validation PDCA Cycle

The below Plan Do Check Act diagram demonstrates typically how process output (product) is validated which directly verifies the process is sufficient to produce consistent and conforming output.



4. Special Process Validation

4.1. Process Control

Special processes require a different approach to control. Instead of the output being directly measured for conformity, the process itself is 'measured' (validated). This validation process takes the form of periodic testing and qualification of the process and / or operators performing the process against criteria detailed in specifications.

One or more of the following activities are used to validate a special process: -

- Test pieces processed and destructively tested and results evaluated on a periodic basis
- Qualified Operators are periodically evaluated or re-qualified
- Periodic monitoring, testing and system accuracy tests are performed on the process, equipment and measurement instrumentation

4.2. Periodic Testing (Re-Validation)

All special processes must be validated and re-validated (periodically tested) to verify that the process is capable of producing product that repeatedly meets requirements. Usually validation consists of processing a test piece or test standard made of the same material with known properties through the special process and then destructively testing the test piece. For example for surface treatment such as chemical conversion coating, electroplating, anodising or application of paint the validation includes the periodic adhesion testing and salt spray (corrosion) testing of test coupons that are processed on a monthly or batch basis etc.

4.3. Qualification

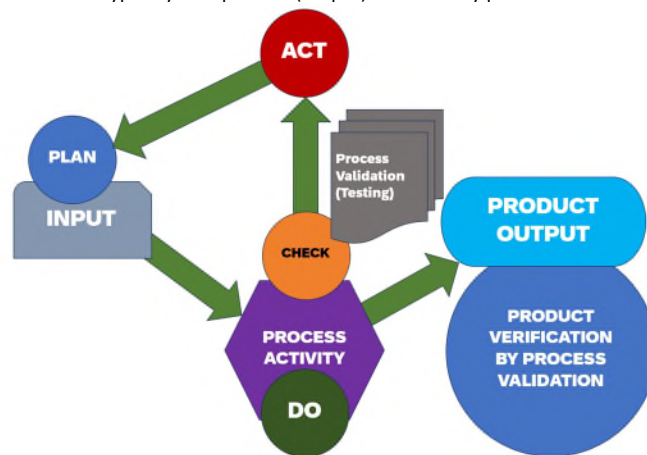
Some special processes require processing staff to be formally qualified and periodically re-qualified as part of the validation process. For Example, coded welder and weld inspection, Non-destructive Testing (NDT) Level II & III qualification etc.

4.4. Monitoring & System Accuracy Testing

Some special processes require periodic monitoring of the system accuracy. For example, heat treatment system accuracy test and temperature uniformity survey (AMS2750 Pyrometry SAT & TUS) or NDT penetrant flaw detect TAM panel processing and evaluation to verify the NDT system is functioning correctly etc.

4.5. Product Verification By Process Validation PDCA Cycle

The below Plan Do Check Act diagram demonstrates typically how product (output) is verified by process validation and revalidation (periodic testing).



5. Risks

If special processes are not validated or periodically tested (re-validated) then, as a consequence, deficiencies can become apparent only after the product is in use or the service has been delivered. For example where parts are coated (plated or painted), lack of process control can result in poor adhesion and the coating may crack, blister, flake or peel after delivery or in service etc.

5.1. Process Failure Mode Effect Analysis (PFMEA)

All processes including special processes can benefit from a failure mode effect analysis activity to anticipate risks and the output of the PFMEA should input into process control documentation. For further guidance see AS13004 Process Failure Mode and Effects Analysis and Control Plans.

6. Aerospace, Space & Defence Special Processes

6.1. Special Processes Reference Table

The below table contains special process categories and specific processes within each category. Each of the below specific processes will have or produce one or more characteristic that can only be tested or verified by destructive methods.

Aerospace, Space & Defence Special Processes Incorporated in Manufacturing		
Welding	Surface Engineering & Chemical Processing	Electronics
Rotational Friction / Inertia Welding, Torch / Induction Brazing, Flash Welding & Laser Welding, Electron Beam Welding, Resistance Welding, Fusion Welding & Evaluation of Welds	Electroplating, Electroforming, Electroless Plating, Anodising, Chemical Conversion Coatings, Passivation, Painting & Dry-Film, Surface Enhancement, Etching & Chemical Cleaning	Printed Circuit Board (PCB) Manufacture, PCB Assembly (Incl. Soldering), Cable and Harness Assemblies, Conformal Coating, Battery Cell Manufacture & Array Assemblies
Composites	Elastomer Seals	Heat Treatment
Prepreg, Adhesive Bonding, Resin Film Infusion (RFI), Metal Bonding, Core Processing, Liquid Resin Processing & Compression Moulding	Plate Seals, Fabric / Textile Reinforced Seals, O-Rings & Moulded Shapes	Brazing, Aluminium Heat Treating, Carburizing, Nitriding, Hot Isostatic Pressing, Induction Hardening & Sintering
Materials Testing & Inspection	Nonconventional Machining	Non-destructive Testing
Chemical Analysis, Mechanical Testing, Metallography, Micro Indentation Hardness Testing, Corrosion Testing, Fastener Testing, Physical Testing, Thermal Testing & Coordinate Measuring Machines	Electrochemical Machining, Electrochemical Grinding, Electrical Discharge Machining, Laser Beam Machining, Laser Part Marking & Spark Erosion Grinding	Penetrant Flaw Detect, Anodise Flaw Detect, Magnetic Particle Inspection, Ultrasonic Testing, Radiographic Inspection Testing & Eddy Current Inspection Testing
Additive Manufacturing		
Directed Energy Deposition (DED)	Powder Bed Fusion (PBF)	Sheet Lamination (SHL)
Laser Engineered Net Shaping (LENS), Electron Beam Additive Manufacturing (EBAM), Wire Arc Additive Manufacturing (WAAM)	Selective laser sintering (SLS), Selective laser melting (SLM), Direct metal laser sintering (DMLS), Electron beam melting (EBM), Selective heat sintering (SHS) & High-speed sintering (HSS)	Laminated object manufacturing (LOM), Selective lamination composite object manufacturing (SLCOM), Plastic sheet lamination (PSL), Selective deposition lamination (SDL)
Material Extrusion (MEX)	Material Jetting (MJT) & Binder Jetting (BJT)	Vat Photopolymerization (VPP)
Fused deposition modelling (FDM) & Fused filament fabrication (FFF)	PolyJet, Nanoparticle jetting (NPJ), Drop on demand (DOD)	Stereolithography (SLA), Digital light processing (DLP) & Continuous digital light processing (CLIP)

6.2. Standards & Specifications

All special processes have a related standard or specification that defines the validation method, frequency and criteria to be applied. For example see the below table of standards and specifications relating to special processes. Please note that this list is not comprehensive.

Examples of Special Process Standards & Specifications		
Welding	Chemical Processing	Electronics
ISO 24394, Def Stan 03-34, Def Stan 08-39, ISO 10042, ISO 3834, ISO 2553, AWS D17, AWS B5.2	MIL-PRF-8625, MIL-DTL-5541, AMS 2700, AMS-QQ-N-290, ASTM B545, ISO 2081, ISO 4042, AMS 03-11, AMS 2454, Def Stan 03-32	IPC J-STD-001, IPC-A-600, IPC-A-610, IPC-A-620, IPC-A-630, IPC-CC-830
Composites	Elastomer Seals	Heat Treatment
ASTM E2981, ASTM D6856 ASTM D7745, AMS 3914, AMS 6885, AMS 3961, ISO 21368	ISO 27996, AS4716, AS3569	AMS 2750, AMS 2759, AMS 2769, AMS 2770, AMS 2771, AMS 2772, AMS 2773, AWS A5.31, AWS C3.7, ISO 13585
Materials Testing & Inspection	Nonconventional Machining	Non-destructive Testing
ISO 22826, ASTM E103, ASTM E1842, ISO 6892, ASTM E1004, AMS2658, ASTM B-117, ISO 15530-3, ASME B89, ISO 898-1, ISO 3506-1, ASTM F606	AMS2548, ASTM DL MNL56, VDI 3400, BS 2634-2	ASTM E1417, ISO 3452, ISO 5579, EN 4179, ISO 9712, ISO TS 11774, ASTM E3166, ASTM E165, ASTM E1209, ASTM E709
Additive Manufacturing		
DNV-CG-0197, ISO/ASTM 52904, ASTM 52927, ISO 17295, ASTM 52950, ASTM 52919, ASTM 52930, ASTM 52910, ASTM 52900, ASTM F3635, AWS D20.1, ASTM DL STP1631, NACE AMPP TR21522, ASTM F3554, AMS7005, ASTM F3413		

6.3. External Sources of Special Processes

When outsourcing special processes to external providers, it is essential to include the relevant standard or specification in the design data or purchase order. This should encompass specific requirements for process control, validation methods and any other criteria that ensure the process meets the necessary quality standards.

6.4. Auditing Special Processes

Both internal and externally provided special processes should be regularly audited to gather objective evidence that the required process validation is being conducted in full compliance with the relevant specifications and standards. These audits are critical to ensure that processes are being executed correctly and that the final output meets all necessary quality requirements.

To ensure a thorough and consistent evaluation, checklists should be derived directly from the specifications or standards, providing a structured framework for the audit. This approach helps auditors systematically assess each component of the process and confirm that all validation steps are being followed appropriately. Regular surveillance audits also help identify any potential nonconformities or areas for improvement, allowing corrective actions to be taken promptly to maintain process integrity and product quality.

Surveillance audits and other quality verification activities are essential for monitoring and ensuring ongoing compliance, but they should never be considered a substitute for the validation and revalidation criteria outlined in the relevant standards or specifications.

6.5. Nadcap

[Nadcap](#) is an industry-managed approach to conformity assessment that brings together technical experts from both Industry and Government to establish requirements for accreditation, accredit Suppliers and define operational program requirements for special processes. Organisations that hold Nadcap accreditation for a particular special process can demonstrate that validation and re-validation activities are performed to industry best practices.

SPG01 Issue Control

Date	Iss	Clause	Changes	By
5 Sep 2022	1	All	Special Processes Guidebook established	Konrad Burgoyne
26 Feb 2025	2	3 4 6 6 6	Added PDCA for product validation and process verification Added PDCA for process validation and product verification Addition of additive manufacturing Addition of standard and specification examples Addition of special processes auditing information	Konrad Burgoyne

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