

A-2 Process Dependency Table

	Points to Consider When the Process is Dependent Upon:								
	A. Set-Up	B. Machine	C. Fixture/Pallet	D1. Tooling	D2. Tooling	E. Operator	F. Material or Component	G. Preventive Maintenance	H. Climate
Description of the example Process dependency, including:	Automotive grills are produced on plastic injection molding machines.	A supplier manufactures a circuit board with electronic components soldered on the board, and wire bonded connections to a chip.	Metal castings are loaded on a seven-stage rotary machine with several fixtures which rotate machine rotates under a cutting head.	A sheet metal stamping die is used to form a steel bracket that has several angles and a pierced hole.	A broach is used to form the internal spline teeth on a steel prop shaft yoke.	Headlamp aim is one of the final operations during car and truck assembly. An aiming device, which contains two bubble levels, attaches to the headlamp. The operator adjusts the headlamps by turning aiming screws until the bubbles center in the level.	An automobile hood is made of SMC. SMC is a molding compound that is temperature sensitive, has a specific shelf life, and for which mixing is critical. The parts produced from this material can become brittle when the material is improperly mixed, handled, or rotated.	A painting operation for decorative parts requires clean equipment and a dirt-free work area.	Semiconductor chip production is carried out in "clean room" and ESD-controlled setting.
Part Characteristics), including special and/or "critical characteristics"	After set-up of the mold, the machine must be adjusted to produce a dimensionally-correct part. Parts must also be free of blemishes, flow lines and sink marks on the surface.	The special product characteristic is electrical continuity of the soldered joints.	Each part has a machined surface on which perpendicularity and depth of cut are critical.	The pierced hole diameter will not vary significantly, therefore it is not marked as a Special Characteristic. The presence of the hole is critical to the part. The angles on the part are critical and two angles are marked as Special Characteristics.	The pitch diameter of internal spline is the Special Product Characteristic.	Proper headlamp aim is an FMVSS requirement and therefore a Special Product Characteristic	A force specification on one end of the bracket is a Special Product Characteristic.	Dirt-free paint is a Special Product Characteristics.	Chip function is the part characteristic, as measured by functional, electrical and mechanical testing of samples.
Process Characteristics), including special and/or "critical characteristics"	A set-up card provides specifications for setting Two major process characteristics for the wave all controls on the machine. After setting the machine to the specifications a sample part is produced. This part is checked for the key control dimensions for mounting holes and perimeter fit, and visually inspected.	The major process characteristics for the wave solder machine, are solder level and flux concentration. An automated feeder controls the solder level by sensing the level of solder and feeding in additional solder as the level is reduced. The flux must be sampled and tested for the concentration level. An automated Wire Bonding machine feeds the wire, bonds the wire to heated connections, and checks the bond strength.	Location of part in fixture/pallet, location of fixture/pallet in machine or cell.	Condition of tooling, placement and movement of tool parts.	Pitch diameter and relief angle (sharpness) of the broach tool.	Operator knowledge and control, ensuring the two bubble levels center during aiming.	The Special Process Characteristics are the proper formulation, storage, and use of material date control (shelf-life).	The process characteristic is a scheduled routine cleaning, repair and replacement.	Temperature and humidity need to be controlled to prevent electrostatic discharge; humidity impacts adhesion of coating processes used to create circuits, encapsulate components in protective coatings, etc. Debris in air can result in short term and/or long term functional failure due to contamination.
Rationale for the Process and Part Controls described below, such as: • Capability of Process based on studies • Inspection frequency • Use error-proofing devices or methods • Factors influencing variation or defect	Capability studies on the product characteristics show that when properly set-up, the operation is highly capable and stable.	The Special Product Characteristic is measured 100% by checking electrically for continuity, which is built in to the automated control of the process (Manufacturing Execution System).	Besides the cutting tool, the removal of debris and proper placement of the fixtures/pallet can significantly affect the special product characteristic.	Historically, broken hole punches are a problem with this type tooling. Further, moving parts in the tool can vary when forming the angles in the bracket.	Studies have correlated spline pitch diameter and sharpness of tool to pitch diameter.	Skill, knack or knowledge of the operator may directly influence variation of part characteristics and the ability to correctly judge "good or no good" process or part characteristics.	The organization requires a laboratory report from the material supplier on each lot of compound. Lots of material are dated for proper rotation (inventory FIFO).	Periodic cleaning of the paint equipment and paint room prevents the problem of dirt in the paint.	Temperature, humidity and air cleanliness can negatively impact product characteristics of electronic components, such as semiconductors, PCBs, sensors and more complex electronic assemblies using such components.
Typical Process Characteristic for this type process.	The set-up is the critical variable in this type process.	Machine settings are the variables that have the major effect on the output for this type process.	Part location on fixture/pallet and proper placement of the fixture or pallet into a machine tooling and the location/movement of moving or cell.	The process characteristic is the condition of parts.	The process characteristic is the condition of the tooling.	Operator control/adjustment of tools, materials, conditions to achieve desired process characteristic.	The materials or components are the process characteristics for this process.	Periodic maintenance is the process characteristic.	The proper functioning of the "clean room" climate controls are the process characteristics to be controlled, and resulting conditions confirmed.
Comments giving rationale supporting the control methods.	The set-up specifications become the process characteristics that affect the product characteristic.	In highly automated systems, the controls and measures may be automated, such as in a Manufacturing System that specifies, monitors and controls hundreds or thousands of variables with no human interaction.	The dimensional differences between fixtures or pallets and part location contribute to product variation. In addition, debris accumulated on the fixture can cause fixture-to-incorrectly. The product characteristics are fixture variation of part location.	Tools can have details that break or moving parts that intermittently/permanently fall to move. Tools can also wear or be repaired incorrectly. The product characteristics are affected by these tooling problems.	Tools can have details that break or moving parts that intermittently/permanently fail to move. Tools can also wear or be repaired incorrectly. The product characteristics are affected by these tooling problems.		The variation found in the materials or components will affect the output of the process.	Where input variables exist, replacing worn out parts, cleaning, calibration, tool adjustments, and other maintenance activities have an effect on the product characteristics, and must be controlled.	
Types of Process Characteristics controls for this type process:	Types of controls for the process characteristic include "first piece check" procedures, and verifications that machine settings are correct to authorized set up cards.	Types of controls include self-adjusting devices on the parameters and statistical measurements taken on the process parameters and recorded on control charts and automatically managed via the automated control (Manufacturing Execution System). Reaction Plans may also be automated into the MES, such as the link to Out of Control Action Plan (OCAP) in this example.	Types of controls for fixture/pallet process characteristics are driven by loading procedures, fixture/pallet placement sensors, and fixture/pallet adjustments and maintenance (e., cleaning).	Types of controls for tooling dominant processes are mainly seen in the product. First piece check can verify that the tool has been properly repaired.	The sharpened tool is checked on a visual comparator for correct pitch diameter and relief angle prior to being approved for production. First piece check can verify that the tool has been properly repaired.		Types of controls for the process characteristics include the various ways of testing and controlling the specification on the material or component being used (i.e., control charts, lab reports and error proofing). Shelf life confirmation checks (operator checks, date code scanning etc.).	Product characteristics are checked after each maintenance to verify the process is properly performed.	Type of control for this process characteristic is continuously or periodically monitored temperature and humidity, and periodic checks with an air particle counter.
Product Characteristics control methods, including if lot control is appropriate/required.	Product characteristics are measured to ensure the set-up is correct and that no unusual special cause has occurred. In some cases, lot control may be appropriate between checks.	Product characteristics are measured using error proofing methods or statistical sampling to ensure that all products meet the customer's requirements. In this example, 100% sampling of the part critical characteristic is built-in to the MES	Product characteristics are often difficult to measure in fixture/pallet dominant processes. Therefore, frequent statistical product sampling performance. Sampling frequency should may be required for Special Product Characteristics.	Product characteristics trends are a very important measure of proper tool life reflect expected tool wear. When in operation a important measure of proper tool life tool failure may go unnoticed except in the part, performance. Sampling frequency should therefore lot control is appropriate and error proofing for Special Characteristics should be used.	First piece of a production run is checked for sharpness of cut and correct pitch diameter. Product characteristics trend are a very reflect expected tool wear. When in operation a tool failure may go unnoticed except in the part, therefore lot control is appropriate.	Operator judgment of product characteristic (100% inspection). Periodic audits of operator judgment (precision measuring, expert auditors, etc.) to confirm consistency of correct judgment, with lot control based on frequency of the audit.	Periodic testing of the product characteristic based on material or component lot/container changes. If product testing is infrequent (such as in destructive testing or testing which takes a long time), lot control of the product is advisable. Lot release is tied to acceptable result of test.	Periodic testing of related product characteristic (dirt in paint, etc.) between Preventive Maintenance events.	Product characteristics are checked by visual examination during first piece check and by subsequent periodic checks, or may have automated inspection checks built into an automated control system (Manufacturing Execution System). Reaction Plan related to automated controls may be automated into the MES, such as the link to Out of Control Action Plan (OCAP) in this example.