



**Manufacturing Equipment
Statistical Qualification Requirements**

Global Common

SD-002

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1.0 Scope

The intent of this specification is to assure that the productive equipment supplied to Nexteer Automotive will consistently produce products, which meet engineering requirements. Equipment qualification is not complete until the equipment has demonstrated acceptable Process Performance on Nexteer Automotive plant floor, under normal operating conditions. This specification defines the **minimum** requirements for machine qualification. Additional requirements may be necessary (i.e. longer runs, additional parts, etc.), for specific equipment. Any additions, clarifications, or exceptions shall be clearly identified in the Manufacturing Engineering Equipment Purchase Specification, which accompanies this document. The Chief Manufacturing Engineer shall have the final authority for any deviations to the MQ plan, length of runoff, and any other portion of SD-002.

Statistical Qualification Requirements have been developed consistent with the Automotive Industry Action Group (AIAG) “Statistical Process Control (SPC) Reference Manual” and “Measurement Systems Analysis MSA.”

Effective date for Revision 016 dated 31MR16 is for any equipment with MQ1 after 01JA17 or sooner if designated by the Chief Manufacturing Engineer.

2.0 Verification of Dimensions and Requirements

All print dimensions and requirements that apply to an operation shall be listed on a Machine Qualification (MQ) plan in an Electronic Run Off Book. Each dimension shall be verified during Machine Qualification (Dimensions verified by CMM, See Reference Publication MEP-001¹: How to Create a CMM Program to Inspect Part Features). The Engineer in Charge shall formally document the reason for anything not verified at MQ on the MQ plan. The MQ plan should be approved by the receiving plant’s Manufacturing Engineering Manager. All print dimensions and requirements shall be verified using one of the following methods:

Dimension Type

- 1) QCL/Std
- 2) Std
- 3) Std
- 4) Std

Verification Method

- Variable data*
- Attribute data**
- Single part dimensional/requirement inspection
- Dimension/requirement not verified
(must document reason on MQ plan)

* Except as noted in section 3.1

** Attribute gage design to follow G1331 Attachment D #7

It is preferred to complete a 30 pc variable data study to verify the process is centered and capable. This may not always be economical or feasible.

1: ME Reference Publications are located in RhodeS/Engineering/ME/Training catalog

3.0 Process Capability & Performance

Applies to all equipment except those listed in section 3.1

Minitab® and Stat Pack 1 (Nexteer developed statistical package) are the preferred statistical software. SPC5 or other software can be used if approved by the Engineer in Charge.

Please be aware that Nexteer approved and documented Customer requirements may supersede these requirements.

After January 1, 2017

Before January 1, 2017

Dimension Type		MQ1 and MQ2
CL1	Bilateral	Cpk or Ppk > 1.67
	One Sided	Cpk or Ppk > 1.67
CL2	Bilateral	Cpk or Ppk > 1.67
	One Sided	Cpk or Ppk > 1.33
CL3**	Bilateral	Cpk or Ppk > 1.33
	One Sided	Cpk > 1.33 or Ppk > 1.18
CL4	Bilateral	Cpk or Ppk > 1.67
	One Sided	Cpk or Ppk > 1.33
CL5 Yellow	Bilateral	Cpk or Ppk > 1.33
	One Sided	Cpk > 1.33 or Ppk > 1.18
CL5 Red	Bilateral	Cpk or Ppk > 1.67
	One Sided	Cpk or Ppk > 1.33
STD*	Bilateral	Cpk or Ppk > 1.33
	One Sided	Cpk > 1.33 or Ppk > 1.18

Dimension Type	Pre-qualification 30 Consecutive pieces	MQ1 or MQ2 The larger of: 125 pieces or 4 hours production (25 Subgroups of 5, with minimum 125 pieces)
Standard Zero Based	Ppk>1.18	Cpk>1.33* or Ppk>1.18
Standard Bilateral, Unilateral	Ppk>1.33	Cpk>1.33* or Ppk>1.33
KPC/QCI/QCL Zero Based	Ppk>1.33	Cpk>1.33* or Ppk>1.33
KPC/QCI/QCL Bilateral, Unilateral	Ppk>1.67	Cpk>1.67* or Ppk>1.67

Cpk valid for a stable process, see 3.0.1

*Refer to MQ plan for verification method. Not all STD dimensions will have capability data.

**Capability requirements for CL3's may be waived (see Policy Letter PL-0044)

For all situations where approval of alternate stability and/or capability acceptance criteria are warranted follow AIAG PPAP requirements for approval.

For CL3 and CL5, where process capability is not met, acceptable action plan would be a 100% inspection or approval using the Extreme Tolerance/Capability Approval form found in the run off book.

For CL1, CL2 and CL4, since 100% inspection is already required, if process capability is not met, approval is needed using the Extreme Tolerance/Capability approval form found in the run off book.

3.0.1 Stability

Stability defined by no points exceeding the control limits on the range chart or the chart of averages (\bar{x} bar). Cpk can be calculated when the process is stable. Trends, runs and the like which are known to be inherent and allowable in the process should be identified and documented with the MQ data. When such known and predictable special causes are present, Ppk shall be used

3.0.2 Extreme Tolerances

For processes with extremely tight tolerances, lower Cpk/Ppk may be acceptable with appropriate additional control plans. Use the Extreme Tolerance/Capability approval form found in the run off book.

3.0.3 True Position

True Position specifications should be analyzed using separate X and Y components and treat them independently.

3.1 Special Equipment

The following types of equipment may have special requirements with regard to Pre-qualification, and/or Qualification for Shipment Approval. These special requirements are caused by the type of equipment being verified or by the time and difficulty required to perform the measurement.

3.1.1 Assembly Equipment

If the assembly equipment incorporates measurement equipment such as functional test equipment the measurement devices should be qualified using a gage capability study. Attribute measurement devices should also be qualified using an attribute gage study.

3.1.2 Induction/Conduction Heating

3.1.2.1 Pre-qualification

The first ten (10) pieces off each spindle shall be collected. The 1st, 5th, and 10th piece from each spindle shall be cut and all case depth and hardness values shall be measured and recorded. The results shall be submitted to the Engineer in Charge for approval.

3.1.2.2 Qualification for Shipment Approval

The supplier shall collect five subgroups with subgroup size of three pieces per spindle sampled at equal intervals throughout the run. These samples shall be statistically analyzed by the supplier and shall meet the requirements defined in Section 3.0.

All surface hardness, case depth and runouts cannot all be statistically analyzed due to gage R&R issues per industry standard techniques. Refer to the MQ plan for dimensions to be statistically analyzed.

3.1.3 Furnace Heating

Furnace heating equipment cannot be completely run off at the supplier's facility since the support equipment required is generally not available. The following qualification requirements shall be performed at Nexteer Automotive facility. Since furnace heat treatments are normally a batch type process, control charting is not required and Process Capability does not apply. Process Performance studies are required, but the number of samples is reduced as follows. For batch type furnaces, eight (8) samples per load for three (3) loads for a total of twenty-four (24) pieces will be analyzed for the appropriate metallurgical properties. For pusher carburizers the samples will be one (1) part per tray, for twenty-five (25) trays for a total of twenty-five (25) pieces. Statistical analysis is not required for draw type furnaces.

3.1.4 Joining

Dimensional requirements produced in joining processes will be checked as described in Section 4.2, 4.3, and 4.4. Joint integrity checks used to determine joint strength shall utilize 25 samples equally spaced throughout the run. Joint Integrity checks shall consider industry standard integrity testing along with part print requirements when developing test methods. Checks requiring cut and etch procedures for analysis shall use 15 samples equally spaced throughout the run.

3.1.5 Test Machines, Gages

Test machines and gages should be qualified using the gage capability process.

3.1.6 Coatings and Painting

Statistical analysis is only required for those finishes that are defined by the part print. In process coatings do not require statistical analysis.

3.1.7 Material Handling, Washers

These types of equipment do not normally provide variables type data and therefore do not require statistical analysis.

4.0 Steps to complete Machine Qualification (MQ)

- *Verification of Machine Cycle (Dry Cycle)
- *Pre-qualification (30pc)
- *MQ1 (Machine Qualification 1) on Supplier Floor
- *MQ2 (Machine Qualification 2) on Nexteer Plant Floor

4.1 Verification of Machine Cycle (Dry Cycle)

The minimum intent of the Verification of Machine Cycle is to identify faulty switches, valves, and bearings, and confirm that the equipment can cycle over a minimum pre-determined period of time without malfunction and to insure that the equipment will function effectively once delivered. It is recognized that some equipment cannot effectively be tested in this manner. These types of equipment may use an appropriate substitute test, which meets the minimum intent of this section. Substitute tests require the approval of the Engineer in Charge.

The equipment will be cycled, at quoted cycle rate, in automatic mode and must, as far as possible, be configured as the final installation (panel doors closed, etc.). It is preferred that this run should be performed using parts to demonstrate the material handling capability only. When using production parts the equipment must be prevented from actually performing alterations to the parts. The equipment supplier shall maintain a log of this activity. Any malfunctions or deviations must be recorded along with the corrective action. The log shall be provided to the Engineer in Charge upon completion of the test. Major malfunctions may cause the test to be repeated. The Engineer in Charge will decide if the severity of the malfunction requires the test to be repeated. The Verification of Machine Cycle is as follows.

- A. Continuous for 10 hours.
- B. Overnight complete shutdown.
- C. Restart equipment and continue the run for 10 consecutive hours.

The supplier shall notify the Engineer in Charge prior to beginning this run. Attendance of Nexteer Automotive personnel will be at the discretion of Nexteer Automotive.

4.2 Pre-qualification (30pc)

After approval of the Verification of Machine Cycle and prior to the MQ1 run, the vendor will run a minimum of 30 consecutive pieces, with the equipment set to the print nominal, or the appropriate target value. In the case of multiple spindle devices, 30 consecutive pieces will be produced from each spindle. The 30 pieces will be produced with no unscheduled interruptions.

Attendance of Nexteer Automotive personnel will be at the discretion of Nexteer Automotive. The supplier must notify the Engineer in Charge when the equipment is ready for this Pre-qualification.

The 30-piece study will be performed using production tooling. All adjustments shall be performed prior to the run, and no adjustments will be allowed during the run, unless the process is known to require tool adjustments within the 30-piece time period. The 30-piece run shall be performed at quoted cycle rate.

Compliance to the Pre-qualification (see Section 3.0) is the responsibility of the supplier. Upon successful completion of this pre-qualification, the supplier will forward the data and related charts to the Engineer in Charge. These documents will be verified by the equipment supplier's inspection department, prior to transmission to Nexteer Automotive. The Engineer in Charge may require the actual parts produced, to be delivered to Nexteer Automotive for verification and/or further testing.

4.3 MQ1 (Machine Qualification 1) on Supplier Floor

When the Pre-qualification has been successfully completed and verified by Nexteer Automotive personnel, the MQ1 demonstration can be scheduled. Nexteer Automotive personnel must be present for this phase of the run off.

This qualification run may begin after all setup adjustments have been completed. Measurement devices shall be mastered prior to the run. No unscheduled adjustments to the machine shall be permitted. Any unscheduled interruptions that occur shall be documented, along with the corrective action taken to prevent a recurrence. The Engineer in Charge shall determine if the MQ1 must be restarted, for those features where the adjustment was required.

The MQ1 run shall be 125 pieces or 4 hours of production, whichever is greater, produced at quoted cycle rate. The production run must insure that sufficient parts are produced to perform the statistical analysis. The sample data used for statistical analysis shall be a minimum of 25 subgroups with a minimum of 125 pieces. The subgroup size is to be 5 pieces for all equipment except the Special Equipment described in Section 3.1. Subgroup data should be taken in consecutive order with no machine adjustments within a subgroup. In the case of multiple spindle devices, the sample will be a minimum of 25 subgroups with a minimum of 125 pieces per spindle. Shorter runoffs are permissible with the written authority of the Chief Manufacturing Engineer.

If the equipment incorporates automatic tool compensation devices, a sufficient sample shall be run with the compensation disabled. This run is intended to provide information as to the effectiveness of the compensation, and shall be monitored to avoid the generation of non-conforming material.

All measured parts are to be identified as to spindle, fixture or station. The pieces shall be measured and recorded in consecutive order on a control chart.

The resulting control chart will be analyzed to confirm that the process is statistically stable and the equipment conforms to the Process Capability and Process Performance requirements (see Section 3.0). If the equipment is found to be non-conforming this run must be repeated, after the appropriate corrective action. The control charts shall be documented to reflect any assignable causes, which have been identified during the run. Machine variables (e.g. speeds, feeds, etc.) shall be documented and included with the control charts.

MQ 1 Approval can only be considered complete when all the above requirements are met, and will be granted by the Engineer in Charge.

4.4 MQ2 (Machine Qualification 2) on Nexteer Plant Floor

The MQ2 shall include a Pre-qualification (30pc) and a final Qualification which are identical to the MQ1 Verification. These tests shall be done by Nexteer Automotive personnel. The receiving plant's Manufacturing Engineering Manager has the authority to modify the quantity of parts to be run during the MQ2.

5.0 Part Control during all steps of the Machine Qualification (MQ)

All parts used in the qualification process are to be identified to ensure traceability and may be used in subsequent qualification processes. This identification is the responsibility of the equipment supplier. Allowable locations for the identification will be determined by Nexteer Automotive. Measured parts produced during the qualification process that are used to develop statistical data are to be segregated, identified and retained to insure traceability. The order of

production of the measured parts must be preserved. All parts produced during the qualification process, which do not conform to process print dimensions, shall be identified and segregated by the equipment supplier, for disposition by Nexteer Automotive.

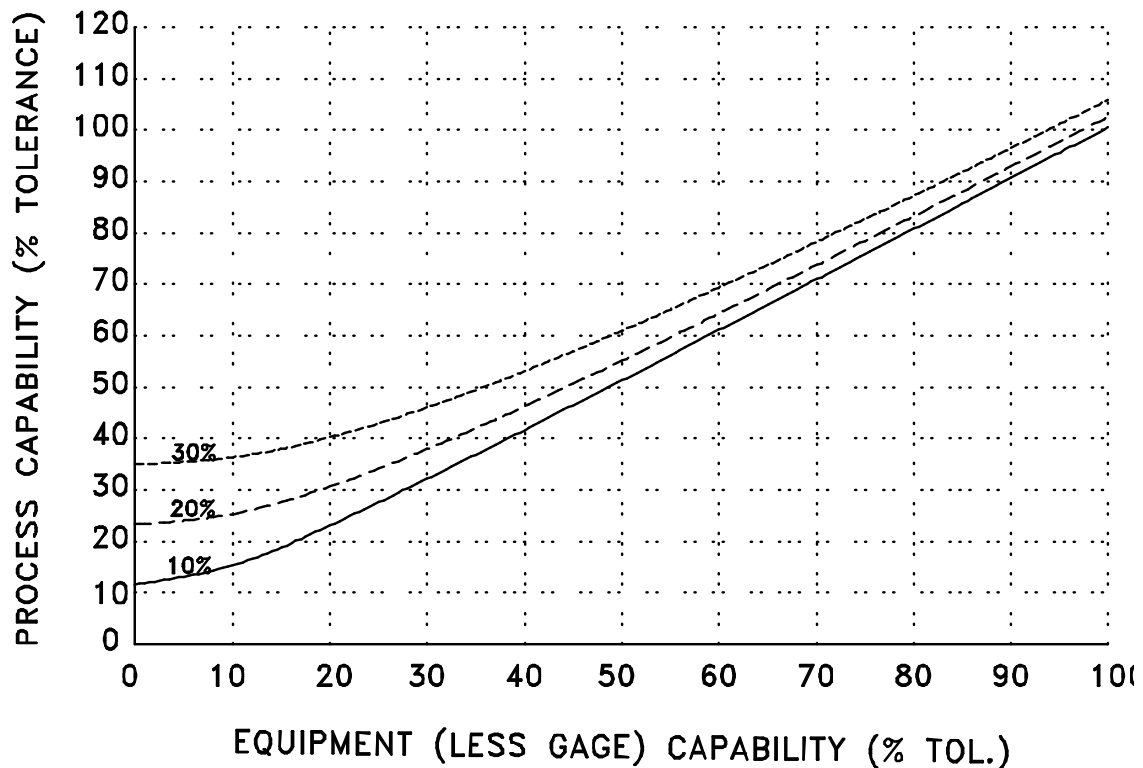
6.0 Measurement Systems

All measurement devices used during machine qualification, including standard tool room or inspection instruments, must be evaluated for Repeatability, Reproducibility, and Accuracy.

Any measurement devices that are produced as a part of this purchase order must be qualified by the supplier using the procedures described in SD-005.

Variability exists in every measurement system, and the purpose of this section is to identify the sources of this variation. Since it is allowable to statistically factor out the gage variability from process capability, the relationships involved are represented in the graph below.

GAGE ERROR EFFECT ON CAPABILITY



Note: Follow line that represents the % gage error. Read Process capability on Y-axis. Read equipment (less gage) capability on

Reference

G1331	Product and Process Characteristics
SD005	General Gage Specification
SPC5	Statistical Software Package
AIAG	Statistical Process Control (SPC) Manual
AIAG	Measurement System Analysis (MSA) Manual
Stats Pack 1	Statistical Software Package

Record of Revisions

Revision #	Date	Section	Description
001	01MAR93	ALL	ORIGINAL APPROVAL & ISSUE DATE
002	18OCT94	ALL	PPK INDICES INCREASED TO 1.67
003	01FEB95	ALL	CHANGED TO DELPHI SAGINAW STEERING SYSTEMS
004	10 SEPT 98	8.1	5-DAY RUNOFF CHANGED 2 DAYS.
005	01MAR99	8.1	5 DAY RUNOFF CHANGED TO 2 DAYS.
006	07 JAN 02	ALL	COMPLETELY REVISED AND REWRITTEN.
007	02 AUG 06	9.1 10.11	SECTIONS ADDED
008	16 JAN 08	ALL	CPK INDICES INCREASED TO 1.67
009	21 OCT 08	ALL	QCI REFERENCES ADDED AND KCC REFERENCES REMOVED
010	02 FEB 09	2.0	DOCUMENT ALL CHARACTERISTICS NOT VERIFIED AT MACHINE QUALIFICATION
011	06NO09	ALL	COMPANY NAME UPDATED. ALL SD DOCUMENTS ARE GLOBAL COMMON.
012	27NO12	ALL	COMPLETELY REVISED AND REWRITTEN
013	03JA14	3.1.4	ADDED: JOINT INTERGITY TESTING SHALL CONSIDER INDUSRTY STANDARD INTEGRITY TESTING.
014	03JA14	3.1.4	REFERENCE TO SECTION 6.0 AND 7.0 REVISED TO SECTION 4.2, 4.3, AND 4.4. MISTAKE WHEN DOCUMENT WAS REWRITTEN.
015	01JL15	2.0	ADDED: Dimensions verified by CMM, See Reference Publication MEP-001: How to Create a CMM Program to Inspect Part Features
016	31MR16	3.0	Updated Process capability to match G1741 update. Eliminated Economical Control Limits, Mirror Image Transformation, Positional Capability/Positional Ppk and Appendix A