



General Requirements for Factory Floor Magnetic Particle Inspection Equipment

Global Common

SD-1044

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Table of Contents

1. Scope	3
2. Reference Specifications.....	3
3. General Requirements	3
4. Machine Error-Proofing	4
5. Machine Masters	4
6. Machine Runoff, Qualification and Acceptance.....	5
7. Traceability (MES) Requirements:.....	6
APPENDIX A: Error Proofing Checklist for MPI Machines.....	7

1. Scope

This document is a general specification defining requirements and guidelines for the design, construction and qualification of magnetic particle inspection equipment purchased by Nexteer for non-destructive evaluation of production components in routed 100% sort applications. This specification is written to supplement part or application-specific Manufacturing Equipment Purchase Specs (referred to hereafter as t-specs). This specification provides general rules and guidelines for NDT equipment; whereas the t-specs define requirements and information pertaining to:

- specific components and part families to be tested
- equipment cycle time and changeover
- program timing requirements
- equipment installation locations
- machine layout, footprint, and factory floor space requirements
- material handling
- specific error-proofing
- additional project-specific requirements not included within the text of this document

2. Reference Specifications

The following specifications universally apply to manufacturing equipment purchased by Nexteer; however, additional regulations and requirements may be applicable depending on the final equipment destination:

- An MQXXXXXX document (T-spec.) will be issued to detail the specific equipment requirements.
- SD-000 and other associated Nexteer Automotive General Manufacturing Equipment Specifications, can be found at the Nexteer Data Exchange (<https://nexteerdataexchange.com/>) under "Vendor Documents."
- Nexteer P4101 – Wet Magnetic Particle Inspection Calibration / Verification Specification.

3. General Requirements

Production MPI benches and associated equipment must be capable of consistently and reliably indicating flaws on all external part surfaces, in any direction, verifiable by placing QOI patches on representative part surfaces. The machine must provide error-proofing, 2-D bar-code reading and Nexteer traceability interface and data management functions while meeting all requirements detailed in this document, the reference specifications provided in Section 2, and any additional local and safety requirements applicable at the sight of installation. Equipment quotations and proposals must include all necessary light shielding, coils, platens, plumbing, etc. for a turn-key installation at the manufacturing site.

- 3.1 The machine shall include end-shot, coil shot and true combination field capabilities, as well as suitable part demagnetization capability.
- 3.2 The particle tank must have a graduated strip to indicate the fill level. A particle agitation system is required to prevent particles from settling at the bottom of the tank.

4. Machine Error-Proofing

The following error-proofing characteristics are required unless specifically waived within the T-Spec or stated in writing by the responsible Nexteer Engineer:

4.1 The MPI bench must have auto-wetting capability. Specific part programs or cycles are to be provided for each component listed in the T-Spec, with capabilities to recall and run 25 or more automatic wetting and magnetizing programs. Wetting motion and magnetizing feedback control and monitoring are required. The machine must illuminate an alarm light beacon and enunciate fault descriptions on the HMI in the event of a machine malfunction. Part-specific parameters must be password protected to prevent unauthorized editing or modification.

4.2 The following capabilities are to be quoted as options in all MPI equipment proposals:

4.2.1 Instrumentation with sensors to assure proper ultraviolet (black) and white light levels in the visual inspection area.

4.2.2 Instrumentation to require curtain closure for 1 minute prior to auto-cycling.

4.3 At the end of each cycle, an operator acknowledgement by bar code scanning is required to indicate the detection of no critical indications, or an instrumented lock box signal must be detected to indicate the rejection of a sample with indications.

4.4 The workpiece must be scanned and tracked through the machine for traceability purposes. The PLC or cell controller must immediately store part test information with the part serial number

5. Machine Masters

5.1 QQI masters for each part identified in the T-Spec must be designed and constructed for machine setup verification within the regions of interest for each part identified by the T-Spec. AS 5371 notched shims shall be used. If QQI application is not possible on the sample parts, QQI's may be applied to representative similar geometries with surfaces conducive to QQI adhesion.

5.2 Representative quality Indication samples (RQI's) may be provided by Nexteer for setup verification masters. These shall be documented and labeled in a manner similar to QQI samples, per 5.3-5.6, below.

5.3 QQI and RQI masters shall be labeled according to Nexteer Product Engineering Specification 34202569 with guidance from SD-1049 and SD-1062. The 20-character barcode requirements provide qty (2) user defined values that shall be "99" to indicate Part Master. The qty (5) digit serial number shall be replaced with the detail number with any unused leading digits being replaced with zero (0).

Example: 12345678213000007899 where:

12345678	Part Number
21300	Julian Date
00078	Detail Number
99	User Defined (Part Master)

- 5.4 QQI and RQI master parts shall be documented on Nexteer gage drawing format. Gage detail numbers shall be assigned for each master part. Manufactured flaws (where used) are to be dimensionally defined for each inspected part model on Nexteer drawing format.
- 5.5 All master part samples must be painted red and labelled in non-test areas by etching or engraving to display gage/detail number and fabrication date.
- 5.6 Where possible, master parts are to be error-proofed vs. building into finished assemblies by obscuring critical interface surfaces with welding, adhesive, feature mutilation or feature removal, etc.; these modifications shall not interfere with the machine & instrument mastering process.

6. Machine Runoff, Qualification and Acceptance

This section defines the additional requirements to the MQ1 and MQ2 Machine Qualification process as outlined in SD-002.

6.1 Run-off Readiness (MQ1):

The Machine Supplier shall complete all documentation as outlined in SD-002 and provide all results to the Engineer in Charge for preliminary review. Upon acceptable review, the Engineer in Charge is responsible for completing the following additional checklists:

- Error Proofing Checklist for MPI Benches (see Appendix "A")

In preparation for MQ1, the Machine Supplier is responsible for ensuring the machine is properly charged with MPI Solution and calibrated / verified in accordance with Nexteer Metallurgical Specification P4101, including:

- Notched Shim / Known Standard Checks
- Solution Concentration Checks
- AS 5282 / Ketos Ring verification
- Black Light Intensity Verification
- Ambient White Light Intensity Verification

The MPI Equipment Verification Check Sheet provided in P4101 shall be properly completed prior to machine runoff. In addition, the following shall be completed:

- All QQI and RQI masters must be complete and available.
- Machine programs for each component governing auto-wetting cycles and magnetism shall be installed and verified.
- All setup parameters shall be documented.

A trial evaluation of each test sample is strongly recommended prior to runoff.

A prescribed quantity (per the t-spec) of known good parts and several parts with known defects and/or manufactured flaws will be used for the run. These parts will be randomly tested over a minimum 4-hour period. The pass/fail status of each part will be recorded. A total run-time of 4 hours without part misidentifications or excessive downtime shall be required. After the completion of the run, the pass/fail results for each part tested shall be evaluated in terms of percent rejection (# of times rejected vs. # of times tested). These results will be evaluated prior to

machine acceptance. Certain part samples will be pre-identified as requiring 100% rejection and must be rejected every time tested. Multiple operators must evaluate the parts during the qualification run as prescribed by the T-Spec. Model changeovers and fixture set-up shall be demonstrated (if applicable). Additional MQ1 requirements may be defined in the t-spec.

Bar code scanning and traceability functions must be successfully demonstrated throughout the course of the 4-hour runoff and comply with all T-spec requirements.

6.2 Nexteer In-plant Machine Verification (MQ2):

A repeat of the vendor's runoff (per Section 6.1) will occur on-site at Nexteer immediately following installation. Final acceptance of the system will occur after successful completion of an acceptance test run at the Nexteer facility. This run will be done at the standard production rate and must comply with all specifications. The service personnel who assist with the on-site installation at Nexteer must be present at the runoff.

7. Traceability (MES) Requirements:

7.1 The following Nexteer Automotive Specifications shall be followed:

- SD-1020 – Human Machine Interface Application Specification – HMI Template shall be used
- SD-1032 – Programmable Logic Controller Application Specification – Traceability routines within the Logic Library shall be used.
- SD-1052 – Machine Controls Traceability Interface Studio 5000

7.2 The additional Traceability requirements shall be met by the machine supplier:

7.2.1 Operator identification.

Shall be provided in a format that can be communicated to Nexteer's Traceability System. Nexteer's project leader will define the appropriate data format and protocol for the specific application.

7.2.2 Periodic solution checks and other daily/weekly verifications.

The date, time and appropriate operator identification shall be associated with each part inspected prior to the next checks and adjustments.

7.2.3 Regular machine maintenance and calibrations.

This information shall include at a minimum:

- the last date of maintenance / calibration, and
- the identity of the maintenance technician/organization.

7.2.4 Items 7.2.1 thru 7.2.3 above shall be stored in Nexteer's Traceability system.

7.2.5 Machine faults are to be generated by the PLC when required solution checks and verifications, machine maintenance or calibrations are past due.

7.2.6 Alarms/warnings shall be annunciated on the HMI one month prior to required dates for yearly calibrations or critical machine maintenance activities.

APPENDIX A: Error Proofing Checklist for MPI Machines

Item	Ref Section	Description	Yes	No	N/A*
1	4.2	Have controls been implemented to require a 1-minute eye adjustment period prior to cycling the machine?			
2	4.2	Is there a functional photometer on the bench to detect low ultraviolet light intensity and excessive white light intensity?			
3	5	Are QQI and RQI samples complete, correct and documented?			
4	6.1	Have all auto-wetting programs been verified?			
5	6.1	Has the wetting solution been verified and documented?			
6	6.1	Are the machine settings documented for each part and password protected from unauthorized editing?			
7	4.1	Have alarms been verified for detecting and annunciating wetting cycle and magnetizing faults?			
8	3	Have had shot, coil shot and multidirectional field functions been verified (photos required) using QQI and RQI samples?			
9	4.3	Has an instrumented lock box been installed with part deposit feedback to the main processor?			
10	4.3	Do machine controls require a successful barcode scan or detection of scrapped part prior to resuming inspection in its production mode?			
11	6.1	Have barcode reading and traceability functions been verified versus T-Spec requirements?			
12	7.2.1	Does the PLC require and store operator identification information for traceability?			
13	7.2.2-7.2.5	Does the PLC verify daily solution and lighting checks; track periodic calibration and machine maintenance; and generate upcoming maintenance alarms/warning?			

* N/A responses must be justified in writing and approved by the responsible Nexteer Engineer.

RECORD OF REVISIONS

Revision No	Date	Section	Description
001	040C19	All	Initial publication.
002	18N021	All	Added section 7. All other changes are highlighted.
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