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Guidance on Auditing Magnetic Particle Inspection (MPI)

This document is a guidance for API Monogram/APIQR auditors conducting API audits. This document does not prescribe any requirements that must be complied with by Licensed and/or Registered organizations. Actual requirements are listed in API product specifications and quality management system standards. Specifically, auditors are expected to ensure that the facility is conforming to (1) applicable product specification requirements for this activity, and (2) quality management system requirements, such as conformance with the company's own procedures, regulatory requirements, or contract requirements.

Auditors should familiarize themselves with standards referenced in the applicable API product specification. In the case of Magnetic Particle Inspection, such referenced standards may include ASME BPVC Section V, ASTM E709, and ASTM E3024. Auditors may review the following areas of emphasis:

Procedures:

Auditors may review the Magnetic Particle Inspection procedure(s) and consider whether the procedure(s) or other documentation include any or all of the following:

- Competence requirements (NDE qualification and certification level) of personnel performing and/or interpreting inspections
- Areas of the part to be examined (entire part or specific area)
- Type of magnetic particle material and system (dry or wet, visible or fluorescent)
- Magnetic particle equipment
- Part surface preparation requirements
- Magnetizing process (continuous, residual)[1]
- Magnetizing current (AC, half wave, full wave, DC)
- Means of establishing part magnetization (direct-prods, head/tailstock contact or cable wrap, indirect-coil/cable wrap yoke, central conductor, etc.)
- Direction of magnetic field (circular or longitudinal)
- Magnetic field strength verification[2]
- Application of particles/examination media[3]
- Interpretation and evaluation of indications[4]
- Viewing conditions (white light intensity, UV light intensity at the defined distance to the surface)
- Acceptance criteria (if procedure does not contain the acceptance criteria, where is it documented and made available to the NDE technician?)
- Type of records/reports to be maintained
- Demagnetization techniques, if applicable, and the associated minimum gauss level.
- Post-inspection cleaning, if applicable
- Identification of personnel approving the procedure and evidence of their required competence[4]
- System verification/process and equipment validation

Process validation/System verification:

Auditors should consider whether the process/methods defined in the procedure have been verified via a system performance check in accordance with a written procedure so that verification of the system is performed in the same manner each time to achieve the intended results. For example:

- Is the correct type of magnetic particle material, magnetizing process, magnetizing current, etc used?
- Equipment calibration/check at the required frequency
- UV intensity, ambient light and visible light intensity, verified at the required frequency
- Wet particle concentration, wet particle contamination, water break check, fluorescence of the solution (for fluorescent MPI), verified at the required frequency
- Has the testing been validated using a testing samples/standards with known defects?
- Has the validation shown capability to identify defects that are the same size or smaller than the acceptance criteria?

If possible, auditors can observe facility personnel performing Magnetic Particle Inspection on a production part. If doing so, consider the following:

Examination area:

- Is the light intensity at the examination area in accordance with the procedure?
    - For non-fluorescent MPI, visible light intensity is above minimum defined by procedure?
    - For fluorescent MPI, visible light intensity is below maximum defined by procedure?
- For fluorescent MPI, does the UV light intensity meet the minimum defined by the procedure at the specified distance?
- How long must an inspector adapt to darkness in the booth for fluorescent inspection?

Part preparation:

- Is the part ferromagnetic?
- Has the part been prepared (clean, dry, etc.) for inspection?
- Is the part free of coatings (such as paint)? If coating is allowed by the procedure, is the thickness of the coating within tolerance?
- Has the organization identified inaccessible areas, part surface roughness, or areas that could potentially give non relevant or false indications?
- Is visual inspection required per the specification/code and is it performed prior to performing MT (if required)?

Performance of test:

- Identify the type of magnetic particle material used (dry or wet, visible or fluorescent) and confirm procedures being used.
- For dry, continuous magnetization, is the magnetic field applied before the dry powder?
- Is the facility using the correct current type specified by the procedure (AC, half-wave AC, full-wave AC, DC)?
- Is the facility determining initial amperage settings?
- Is the part magnetized in the required directions[5,6]?

- Does the MT technique utilized assure full contact of the magnetizing yoke?
- Are all required surfaces inspected with some overlap to ensure full coverage? Does the drawing of the part identify critical areas for NDE?
- Magnetic field intensity – is the organization using the equipment required by the relevant standard and is the intensity within range defined in procedure?
- Magnetic field direction – when required, is the organization verifying the direction using equipment required by the relevant standard?
- Are personnel evaluating and recording indications in accordance with the procedure?
- Is demagnetization performed if required by facility's procedures/drawings?

Check equipment calibration/verification:

- Visible light meter for inspection of defects
- Visible light meter for use in the darkened inspection booth
- UV light meter
- Wet particle concentration
- Ammeter
- Yoke dead weight
- Gaussmeter or field meter
- Timer control

Magnetic Particles:

- How are they maintained and stored? Is there an expiration date?
- Are the magnetic particles conforming with the specification and/or procedure?
- Review requirements related to particle color contrasts with part, size applicable to defects, and part and particle temperature, as applicable.
- For wet MPI where the liquid is reused, how is the organization verifying continued suitability of the wet particle bath[7]?

Acceptance standards

- Verify that the inspector is aware of and conforms to the acceptance criteria. Acceptance criteria is sometimes defined in the API product specification.

Personnel Qualifications

- Are the inspector's competence records available[4]?
    - This may include testing scores, practical hours of inspection, continuance log, when required.
- Are the eye examination/vision test records available?

Reports

- Do the contents of the reports meet the requirements of the specification or code?

Notes:

Notes provide additional guidance regarding some items identified above. Any findings raised during audits must reference specific requirements from normative documents and cannot be raised based on this document.

1. Note that automatic MPI inspection generally uses residual magnetization.

2. In certain instances, a gauss meter may be necessary. Some indicators (e.g. Castrol strips) may not be suitable for measuring magnetic field strength.

3. For continuous magnetization, the particles are applied during the application of the current.

4. There are usually competence requirements associated with performing these tasks. (e.g. Level III approves the procedure, Level II or higher interprets indications, Level I or higher performs the process). Review the specific requirements in the relevant Standards/Specifications.

5. It is often required to magnetize the part in two (2) directions, roughly 90 degrees apart.

6. If the organization is using cables, a central conductor may be required to achieve both longitudinal and transverse inspections.

7. It is generally necessary to have a recirculation system to keep particles in suspension.