

Magnetic Particle Examination (MT)

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Prepared by TMS

Approved by TAG MT Level 3 J-P. POLLIEN Revision's approved only for new logo

0 INTRODUCTION

0.1 <u>Purpose</u>

This procedure establishes the minimum requirements and parameters for conducting fluorescent magnetic particle test within **TMS**. As a minimum, this procedure complies with Standard ASTM E-1444.

The fluorescent magnetic particle testing consists of applying a magnetic field to the area to be examined together with petroleum distillate loaded with suitable magnetic fluorescent magnetic particles and subsequently interpreting and evaluating any resulting particle accumulations.

0.2 <u>Applicability</u>

This procedure is applicable by **TMS** certified NDT staff in MT method in accordance with EN 4179/ NAS 410. Refer to TAG 0114.

The fluorescent magnetic particle test method is used to detect cracks, laps, seams, inclusions and other discontinuities on or near the surface of ferromagnetic material.

Acceptance criteria are not addressed by this procedure and shall be sought from the relevant documentation used, although most of the acceptance criteria for in service parts reject what has been identified as cracks and/ or corrosion.

0.3 <u>References</u>

All documents at the latest revision unless otherwise stated.

0.3.1 Standards/Specifications

AMS 2641	Magnetic Particle Inspection Vehicle	
AMS 3044	Magnetic Particles, Fluorescent, wet method	
AMS 3046B	Magnetic Particles, Fluorescent, wet method, Aerosol packaged	
ASTM E-1444	Standard Practice for Magnetic Particle Examination	
ASTM E-709	Standard Guide for Magnetic Particle Examination	
NAS 410/ EN 4179	Certification and Qualification of Non-destructive Test Personnel	
Manufactures/ Authorities	AMM, NDT/ CMM/ relevant documents/ AD	

0.3.2 Internal Documents

DA-0100	Maintenance Organisation Exposition	
DA-0114	Procedure for Training, Qualification and Certification of NDT-Personnel	
DA-0114_MT log	Log sheet for magnetic particle bench unit records	
DA-0113_NDT	NDT Examination Report	
DA-0114_MT_INST-xx	NDT Specific Technique Form	

0.4 Abbreviations and definitions

0.4.1 Abbreviations

- > AMO Approved Maintenance Organisation
- CMTS Computerised Maintenance Tracking System software used by TAG to monitor operational and continuing airworthiness control of the aircraft. Could be CAMP.
- PO Purchase Order Official request to perform specific maintenance tasks that may include instructions, a list of tasks or a combination of both
- QTM Quantum Software used in maintenance to record, to issue and to track all maintenance works performed in DABS

> WO Work Order

> SRM Structure Repair Manual

0.4.2 Definitions

For the purpose of this procedure, the following definitions apply:

8	Reference Standard	A representation of a part or structure used to adjust NDT equipment sensitivity and/or resolution. A reference standard may contain artificial or naturally occurring defects based on acceptance criteria stated in the process specification.		
۶	Ambient visible light:	the ambient visible light level, measured at the specimen surface		
۶	UV visible light:	the amount of visible light emitted by the UV bulb		
۶	Indication:	the visible presence on the part of a built up of magnetic particles		
•	No relevant indication	1 : indication due to magnetic writing, finger tips, over magnetization, difference of permeability (Heat affected zone), close fit, abrupt changes of section		
۶	Relevant indication:	all indication other than those determined to be nonrelevant		
۶	Linear indication:	any indication with length to width ratio of 3 to 1 or greater		
>	Excessive background : fluorescence Background that interferes with the interpretation and evaluation of indications			
>	Reprocess:	to repeat the entire magnetic inspection process including necessary Precleaning		
۶	Defect:	Discontinuity unacceptable compared to the applicable acceptance criteria.		
۶	CF:	Current Flow (between heads); circular magnetization		
۶	TB:	Threading Bar (between heads); circular magnetization		
۶	HC:	Helicoil (in coil); longitudinal magnetization.		

1 GENERAL

The magnetic particle examination is the preferred method for inspecting ferromagnetic components.

1.1 <u>Requirements</u>

This process requires certified personnel in accordance with EN 4179/ NAS 410 (TAG 0114).

All magnetic particle examinations performed at **DABS**, are carried out in accordance with in order of preference, the present MT internal procedure, the appropriate manufacturer AMM / NDT / CMM, or other approved documents, such SB or specific procedures.

If examinations are necessary, where no detailed procedure exists, a specific technical instruction must be written, and approved by the **DABS** MT Level 3, prior the inspection is performed.

1.2 <u>Responsibilities</u>

The individual performing the actual magnetic particle examination task is fully responsible for his work task for which he is certified.

Personnel performing the processing steps described in this procedure shall be qualified and certified to at least level 1.

Personnel making accept/ reject decision shall be qualified and certified at least to level 2 (unless written delegation made by the **DABS** MT Level 3).

This document and its contents are to be approved by the **DABS** MT Level 3 in this method.

1.3 <u>Personnel Qualification</u>

See paragraphs 1.1 and 1.2.

1.4 Specific technical instruction

If no detailed procedure exists, a specific technical instruction shall be written for each component or part of component to be tested.

The following information together with the general procedure, as a minimum, shall be described:

- Identification of the component to which the procedure applies (P/N, material, alloy)
- Identification of the technical instruction with **DABS** MT Level 3 approval and dates
- Areas of component to be examined (include sketch)
- Component preparation (pre cleaning) required before testing
- Identification of system performance verification
- Directions of current, magnetic field and locations with positions of magnetic field verification
- Directions for positioning the component with respect to the magnetizing equipment
- Order of shots, number and demagnetization between shots if necessary
- Pulse duration
- Type of magnetizing current
- The current level in amperes [A], the magnetic field in amperes x tours [A x t or A.t]
- Acceptance criteria
- Method of marking
- Special inspection tools
- Post cleaning and protection
- Records

1.5 Materials and Equipment

1.5.1 Materials

Fluorescent, dry Particles

Magnalo 14A from Magnaflux Co or equivalent and conforming to AMS 3044 E.

Vehicle

Petroleum base liquid conforming to AMS 2641 (type 1 or 2) or equivalent.

Aerosol

Product shall conform to AMS 3046B.

1.5.2 Equipment

Magnetic Bench Unit

	GVA	FAB
Make:	Magnaflux Model: DR 523	Johnson & Allen
Туре:	I as per MIL STD 6867	SBS2000
Electrical capacities:	Circular ~4200 A	AC/HWDC/FWDC/MF
	Longitudinal in coil: ~2'700 A	100-1000 AMPS
Amperage control:	by steps/ 8 plots	By Steps / 10 Plots
Ammeters:	digital	digital
Coil:	5 turns, Ø 12''	5 turns, 6 inches Dia
Form of current:	3 phases AC	20 Inches
Head opening length:	50 inches	6 Inches Fan
Ventilation:	NA	

Demagnetizer

Make:	Magnaflux Model: DR 523
Maximum magnetic field:	> 30 kA/m at the center of the coil
Form of current:	AC step down

Yoke (portable equipment)

Make:	Magnaflux Model: Y6	Magnaflux Model: JAY
Form of current:	AC	AC

Field Strength Meters and Indicators

FW Bell:	5070 or equivalent	
Indicators:	Annis Model 25 or equivalent	
	Pie gage (Berthold)	
	Laminated strip (Burmah-Castrol strip Aerospace type) or equivalent	
	IQI Shim 230 as per ASTM E-1444 and AS 5371	
Ketos Ring:	Ketos ring for system performance made with AISI 01, AS5282, S/N 213008	
Others:	Test block for longitudinal magnetization system performance TP4	

Light Meters

Un	it a)			
	Display:	Spectroline DSE-2000 or equivalent		
	UV sensor:	DIX-365 or equivalent	Units:	μW/cm²
	Visible sensor:	DIX-555 A or equivalent	Units:	fc (Foot-Candle)

Unit b)

Display:	Spectroline DSE-2000A or equivalent		
UV sensor:	DIX-365A or equivalent	Units:	μW/cm ²
Visible sensor:	DIX-555 A/L or equivalent	Units:	Lux

1.5.3 Consumables

Only consumables in conformance with AMS 2641, AMS 3044 and AMS 3046B shall be used. Other consumables can be used after evaluation for conformance to AMS by the **DABS** MT Level 3.

1.6 Acceptance criteria

Applicable drawings or other contract documents shall specify the acceptable size and concentration of the discontinuities, with zoning if applicable.

The acceptance criteria shall be incorporated to the specific technique or be shown, by reference, on the appropriate manufacturer's instructions.

1.7 Area to be inspected

By default, magnetic particle inspection performed under this procedure requires the inspection of 100 % of the component (internal and external) as well as 100% of the number of the parts.

The inspection requires:

- adequate visual access, meaning that angles shall be maximum 45° from the perpendicular to the surface to be inspected
- ability to confirm that indications are relevant
- ability to measure size of discontinuities
- ability to apply and remove magnetic particle material.

A valid magnetic particle inspection cannot be performed on some features and they are therefore excluded:

- honeycomb surfaces
- surfaces in closed volumes already inspected
- through any openings smaller than 0.25 inch in any direction
- blade and vane internal passages/ cavities

In areas where the maximum angle of inspection is greater than 45°, special equipment may be necessary.

Any area considered as non-inspectable shall be identified on the specific technique and submitted to the customer, if required.

Inspection of threaded holes shall be performed transverse to the thread profile, unless required by the drawing or other documents, transverse indications extending over more than one thread are rejectable. All other indications are considered non-relevant.

When specifications call for thread inspection in the root of the threads, then residual magnetization shall be performed in addition to continuous magnetization and inspection shall be aided using 3 to 10 X magnification, if possible.

1.8 <u>Records</u>

The results of all magnetic particle examination, including control checks, shall be recorded.

The records shall provide for traceability and shall contain as a minimum the following information:

- Reference to the data used
- Location, classification and disposition of relevant indications
- Staff's stamp, certification Level and signature
- Date of inspection.

2 PROCESS

2.1 Safety

Extreme care must be observed with the use of black lights.

Do not use units with cracked, damaged or incorrectly fitted filters as unfiltered ultraviolet light can be very dangerous to the skin and eyes.

Do not look into black lights.

When using solvents or aerosols always ensure there is adequate ventilation.

2.2 Work requirements

Magnetic particle examinations are carried out by specialized staff i.a.w § 0.2 at the following possible locations:

- In the shop; on components which are fitted on the aircraft or which have been dismantled from the aircraft
- During NDT examinations outside **DABS**.

2.3 Approved Data

All Magnetic particle examinations are performed in accordance with the appropriate document:

- This procedures, and
- Specific Technical Instructions, approved by the DABS MT level 3 and/ or
- Procedures supplied by aircraft, engine, component manufacturer or customer such as:
 - NDT- Manuals
 - Maintenance Manual
 - Maintenance task cards
 - Services Bulletins.

In each of these procedures, the equipment, reference standards and accept/ reject criteria's are given to perform the set-up for a specific inspection and the inspection itself.

2.4 Examination process

Magnetic Particle inspection shall be performed as per specific requirements; in any case, after the component has been fully heat treated, welded, transformed and machined and before subsequent operation which could close or mask discontinuities. When, on drawing, Fluorescent penetrant test is called for, it shall precede Magnetic Particle Inspection.

In all cases, the customer's requirements are considered as valid.

2.4.1 General

The following points reflect a normal work sequence, which should be followed as a minimum, if a Magnetic Particle examination is performed:



2.4.2 Preparation

2.4.2.1 Pre-Inspection Demagnetization

The component shall be demagnetized if a residual magnetic field higher than 240 A/m (3.0 Gauss) is measured.

2.4.2.2 Surface Cleanliness and finish

The surface of the component to be inspected shall be smooth, clean, dry and free of oil, scale, machining marks or other contaminants or conditions which can interfere with the inspection. Cleaning method shall be consistent with the contaminants to remove and not be detrimental to the component or its intended use. For the parts inspected in Quality Control's laboratory, solvent or oil based vehicle is considered acceptable.

2.4.2.3 Platings & Coatings

Magnetic particle inspection shall not be performed with coatings in place that could prevent the detection of surface defects in a ferromagnetic substrate.

- Electroplated surfaces with a final plating not exceeding 0.020 mm (0.0008 inch) shall be inspected either before or after plating.
- Electroplated surfaces with a final plating thickness of between 0.020 to 0.13 mm (0.0008 to 0.0050 inch) shall be inspected before and after plating.
- Electroplated surfaces with a final plating thickness of **0.13 mm (0.0050 inch)** or greater shall be inspected **before plating**.

Thin non-ferromagnetic coatings and ferromagnetic coatings not exceeding **0.020 mm (0.0008 inch)** in thickness may be left on in-service components during inspection. If the coating is non-conductive, it shall be removed before inspection. Inspect when the current is on, using repeated hit technique until the entire ground area has been inspected.

If Production components are to be magnetic inspected, it shall be performed as per requirements of drawing or engineering notes.

2.4.2.4 Plugging and masking

If required, small openings and oil holes leading to obscure passages or cavities shall be plugged with a non abrasive material which is, for engine parts, soluble in oil.

2.4.3 Examination - Magnetizing Methods

To assure complete coverage of the component to be inspected, magnetization shall be applied to the component from at least 2 perpendicular directions.

The magnetic fields shall be created by using circular magnetization in two or more directions, both circular and longitudinal, or longitudinal magnetization in two or more directions.

Combined magnetization is not allowed except with prior approval of the purchaser.

For all positions, suspension shall be applied to the component until all surfaces requiring inspection are thoroughly covered. The component shall be magnetized at the appropriate amperage with three current pulses (CF, TB, HC) of **0.5 to 1.5 seconds** duration. Ink diversion for the first 2 shots shall be just before the current is switched off.

The third shoot can be voided if the component heats too much.

Allow *30 minutes agitation* of the container before sample is taken for the concentration and contamination tests (maximum 30% contaminant).

The pear shaped tube and its content shall be demagnetized; settling time shall be a minimum of 60 minutes and particles shall be *0.1 ml to 0.4 ml/ 100ml*.

2.4.3.1 Direct Magnetization (CF= Current Flow)

The component is located between the 2 poles of the stationary equipment, allowing the current, when switched on, to flow through the component. Precautions shall be taken to prevent arcing between poles and component. Contact pads shall be maintained in a good condition.

If arcing occurs, it shall be reported to the **DABS** MT Level 3.

2.4.3.2 Indirect Magnetization

It shall use pre-formed coils, cable wraps or a central conductor (Threading Bar = TB) to produce a magnetic field of suitable strength and direction to magnetize the component under test. Central conductor shall be in good condition, straight with smooth surfaces and ends. It shall preferably be covered with a non-conductive coating (e.g. teflon paint, tape, insulated thermo-retractable sleeve).

2.4.3.3 Longitudinal Magnetization (HC= Helicoil)

Longitudinal magnetic field can be induced with a coil (HC) and the component located inside it.

A yoke is also considered acceptable; its use requires **DABS** MT Level 3 approval.

2.4.4 Evaluation of currents

In all cases, the magnetic field strength shall give a *minimum value of 2400 A/m (30 Gauss)* in the area to be tested or as per specific request.

The proper magnetization level shall be checked by one or a combination of the following 4 methods while preparing the specific technique:

- Testing component having known defects of the type, size and location specified in the acceptance criteria
- Using a Hall-effect probe field meter capable of measuring the peak value of the tangential field (set on "max" to read peak value as described in ASTM).
- Using field indicators located in the areas of interest
- Using the formulas given hereafter. In this case, this shall be checked by one of the 3 other methods.

For production use, the way to check the correct magnetization level for the 1st part of one uninterrupted series is the use of the appropriate IQI.

2.4.4.1 Direct Circular Magnetization

When magnetizing by passing currents directly through the component (head shots), depending on the permeability of the material, the current shall be from **80** A/cm (200 A/inch) to 160 A/cm (400 A/inch) of component diameter; the diameter shall be taken as the largest distance between any two points on the outside circumference of the component.

2.4.4.2 Central Conductor (Circular) Magnetization

Circular magnetization may be provided by passing current through a non-ferrous conductor which passes through the inside of the component (AI, brass, bronze, Cu are acceptable). AC current may be used only if the sole purpose is the inspection of the inside surface of the component.

2.4.4.2.1 Centrally located Conductor

When the axis of the central conductor is located close to the central axis of the component, the same current levels as shown in 2.4.4.1 shall be used.

2.4.4.2.2 Offset Central Conductor

When the conductor is placed against an inside wall of the component, the current levels shown in 2.4.4.1 shall apply except that the diameter shall be considered the sum of the diameter of the central conductor and twice the wall thickness. The distance along the component circumference (interior and exterior) which is magnetized shall be taken as 4 times the diameter of the central conductor. Rotation of the component may be necessary.



2.4.4.3 Longitudinal Magnetization

Longitudinal magnetization shall be used for those parts which are at least three times as long as they are wide (i.e. $L/D \ge 3$).

Ampere x turns for longitudinal inspection shall be calculated as follows:

• For component positioned at the bottom of the low fill factor coil:

• For component positioned at the center of the low fill factor coil

* **Note:** If a component is longer than 18 inches (450 mm), L/D shall be calculated using a value of L = 18, and D = Actual Diameter. If the resulting value of L/D is between 3 and 15, that calculated value will be used in the equations located before. If the resulting value of L/D is greater than 15, a value of 15 shall be used in the same equations.

If the resulting value of L/D is less than 3, the component will be inspected with ferromagnetic material extenders of same diameter(s) as the part or using an alternate approach; the L/D ratio shall not be obtained with parts stacked or nested together, unless precautions are taken.

When calculating the L/D ratio for a hollow component, D shall be replaced with an effective diameter, D_{eff} , calculated using:

$$D_{eff} = 2 \sqrt{\frac{(A_t - A_h)}{\pi}}$$

where:

where:

 A_t = the total cross-sectional area of the component.

 A_h = the cross sectional area of the hollow portion of the component.

For cylindrical parts, Deff is equivalent to:

$$D_{eff} = \sqrt{(OD)^2 - (ID)^2}$$

where:

OD = the outside diameter of the cylinder. ID = the inside diameter of the cylinder.

The effect distance of magnetic field for low fill factor coils is approximately one coil radius, on either side of the coil center; in any case, magnetic filed strength shall be checked with an appropriate means and if necessary, the entire length inspected by repositioning the component within the coil.

Separate magnetizing operations shall be used for both circular and longitudinal magnetization; when parts contain changes in transverse dimension that differ by more than a ratio of 2/1. In such cases, the sequence of magnetizations shall begin with the lowest current level and proceed in the direction of higher currents.

For circular magnetization, the field strength of each section shall be maintained at a *minimum of 30 Gauss (2400 A/m)*.

Proper care shall be taken to avoid damage to smaller sections from overheating.

2.4.4.4 Residual Magnetization

Residual magnetization shall be used when required by the Engineering Drawing or program documents (e.g. interpretation of indication, threads), or when areas are obscured by excess particles build up (threads, radii, splines). Use of residual magnetization shall be approved by the **DABS** MT Level 3.

2.4.5 Evaluation and Result

The viewing area shall meet the appropriate requirements of 3.2.1 and 3.2.2. The operators' eyes shall be dark adapted for a minimum of *1 minute*. Light sensitive glasses or lenses are prohibited.

2.4.5.1 Interpretation, Measurement

The necessary inspection aids, such as mirrors and borescopes, magnification and measuring devices shall be provided to assist interpretation of indications.

Size of indication shall be determined through the use of appropriate calibrated measurement devices.

2.4.5.2 Evaluation and result

Relevant indications that exceed the specific acceptance criteria for the component shall be cause for rejection. The inspector performing the magnetic process shall determine if indications are caused by flaws or are false indications caused by component geometry excessive field strength effects, surface finish or differential permeability effects such as heat affected zone of welds.

He shall evaluate all indications i.a.w relevant acceptance criteria, use up to x10 magnification and white light as required to assist with evaluation.

Reprocess the component with excessive background and false or non-relevant indications which interfere with the detection of relevant indication.

The following techniques may be used to help the evaluation of uncertain indications:

- Test uncertain indications with the residual method
- Demagnetize, clean the inspection area and repeat the magnetization and inspection process
- Demagnetize the component and re-inspect at lower amperage

If indications are still uncertain, contact the **DABS** MT Level 3 and check if another NDT method can help.

Processing for final acceptance shall comply with the requirements of the applicable technique.

Use the actual measured discontinuity size when evaluating relevant indications in accordance with applicable acceptance criteria.

Component containing linear indications caused by such discontinuities as cracks, laps, laminations, seams, and tears, etc. shall be rejected; unless otherwise stated, rejectable indications can be removed within the acceptable tolerances of drawing or applicable documentation (CMM/ NDT/ AMM).

Component with finished machined surfaces that have been subjected to arc burns shall be rejected.

Two systems for evaluation of materials when it is needed to know whether or not a discontinuity is open to the surface are:

- Residual technique; if the indication shows after it has been cleaned and the ink reapplied, the indication is open to the surface; if it does not show, the indication is subsurface
- Penetrant inspection as per relevant requirement.

2.4.6 Record

2.4.6.1 Record of indication

When required by the specifications, the location of all the rejectable indications shall be marked on the component and on a permanent record (location, direction, numbers). Permanent records can be either with a sketch, a written description or a photography.

2.4.6.2 Marking

Unless otherwise specified in contract documents, each component which has been magnetic particles inspected and found conform to the requirements of this procedure and the acceptance requirements of the relevant documents, shall be marked as specified herein. Marking shall be applied in a manner and location that is harmless to the component, or its intended function, and to preclude removal, smearing or obliteration by subsequent handling.

When subsequent processing would remove such identification, the records accompanying the component shall be marked. If quality records provide traceability from router to hardware, then component marking may be replaced by marking the router.

The summary of check is reported on Excel sheet "DIRECTORY of NDT Inspection" for the relevant year.

2.4.7 Post examination

2.4.7.1 Demagnetization

All parts shall be demagnetized at start of work and between circular and longitudinal magnetization, if the residual field is higher than **3** Gauss (240 A/m).

For final demagnetization, all parts shall be demagnetized to a maximum of \pm 3 Gauss (240 A/m), or less if required.

The component shall be held about one foot (30 cm) in front of the AC demagnetizing coil and then moved slowly through the coil to a point three feet (1 meter) beyond it when the current will be stopped. Parts of complex configuration shall be rotated and tumbled while passing through the coil.

This process shall be repeated as necessary, until the Gauss meter shows a field on parts of < 3 Gauss following the inspection.

2.4.7.2 Post cleaning and Preservation

Components shall be cleaned in clear inspection oil after inspection to remove inspection material residues, if they are detrimental to subsequent operations or the components intended function or as required by AMM aircraft or CMM manufacturer to remove residual oxides.

After cleaning and before storage, parts shall be applied a protective coating not detrimental to the material to preserve the component from corrosion until installation or repainting as applicable.

2.5 <u>Report</u>

Maintain records for all items inspected.

After each examination a NDT-Report (Form TAG 0113_NDT) must be filled out and filed as electronic copy in the NDT server, one copy shall be supplied to the customer for A/C documentation.

The NDT-report shall indicate the extent of inspection, either by reference to the documents, or by incorporation of sketches, drawings or digital pictures into the NDT-Report.

There are normally two possibilities for examination results:

- The inspected Component has no defects and is in serviceable condition.
- The inspected Component has a clear defect or a suspect indication and needs further investigations with different methods or with manufacturer support.

a. IN Case OF "NO_DEFECTS" ;

Fill out the NDT report as following:

- State in the "Work Description" field and "Maintenance Data used" field that the inspection has been performed and give exact reference to the procedure documents used for this examination.
- Indicate within "Inspection Results" field a statement like: "No defects found" or "Found satisfactory".
- Complete Form 1 or Release to service document if applicable. Refer to the NDT-Report Number.

b. IN CASE OF "DEFECT":

Fill out the NDT report as following:

- State in the "Work Description" field and "Maintenance Data used" field that the inspection has been performed and give exact reference to the procedure documents used for this examination.
- Make a statement like: "Defect found" and describe the defect and area where the defect has been found.
- Make a statement indicating: "Defect out of tolerance" if appropriate.
- Inform the Supervisor of the aircraft that defects have been found and corrective actions are necessary for planning purposes.

All the rules described in this procedure are to be adhered to if the yoke described in paragraph 1.5.2 with product of paragraph 1.5.1 are used.

3 QUALITY ASSURANCE

3.1 **Quality Assurance provisions**

This section provides the controls necessary to assure that the particle magnetic materials and equipment give an acceptable level of performance. The frequency of the required checks is based upon a facility operating for a full, one-shift-operation daily. For facilities operating less frequently, the frequency of daily and weekly checks may be reduced, but must be performed prior to inspections. Other checks should be performed at the same frequency as for full time operations. The NDT facility may perform these process control operations or contract for their performance with an independent laboratory.

Results of all required checks shall be documented; Appendix lists the frequency and values for the checks.

3.2 Calibration/ Certification of Equipment

The following equipment shall be calibrated/ checked at the frequency and within the tolerances shown in this procedure.

- ammeters
- light meters
- dimension measuring devices
- timers
- magnetic field meters
- magnetic flux indicator.

3.2.1 Black lights

UV-light wavelength shall be comprised between 320 – 380 nm.

All black lights shall be checked shiftly, and after bulb replacement, for output.

Minimum acceptable intensity is **1500** µW/cm2 measured at a distance of at least **15 inches (38** cm) from the front of the bulb or filter.

For posted black lights, the intensity shall be **1500** μ *W/cm***2** at the part surface. Black light reflectors and filters shall be checked shiftly for cleanliness and integrity. Damaged or dirty reflectors or filters shall be replaced or corrected as appropriate.

Allow 30 minutes warm up time before use of UV lights. Operators' eyes dark adaptation shall be **1 minute minimum.**

3.2.2 Visible light intensities

Fluorescent particles inspection shall be performed in a darkened area with a maximum ambient visible light level at the surface of the component of **2-foot candles (20 lux)**.

Additionally, the white light emission from ultraviolet lights, used for inspection, shall be measured at **15'' (38 cm)** from the front of the black light bulb or filter, with the black light on. The measured emission shall not exceed **2-foot candles (20 lux)**.

White light emission for confirmation of indication, shall be a minimum of **100 foot candles (1100** *lux)* at the surface of the component.

3.2.3 System performance

Allow 30 minutes vehicle circulation before starting any test.

3.2.3.1 Circular magnetization

The magnetic particle equipment shall be checked and documented at the beginning of each shift the system is in use. The check shall be performed by processing the AS 5282 ring through the system using appropriate processing parameters and comparing the indications to those obtained previously; when the performance of the equipment falls below the expected performance, the system shall be evaluated and corrected prior to conducting any magnetic inspection in accordance with this procedure (see table 2 and compare with pictures) for the minimum required indications when using the AS 5282 ring. The operator shall assure demagnetization of the standard before and after use.

Table 2 Particles used Maximum amperage with Minimum of holes central conductor* [A] indicated Up to 980 A 0 Wet Suspension Fluorescent 980 1 slightly 1480 1 2280 2 slightly Up to 4070 A 2

*= the central conductor will be a copper bar with a diameter comprised between 1 and 11/4 inch (25 and 32 mm) and a length greater than 16 inches (400 mm).

Check the performance with the maximum fixed settings shown in table 2. Results shall be reported on control check form as shown in Appendix.

3.2.3.2 Longitudinal magnetization

The magnetic particle equipment shall be checked and documented at the beginning of each shift that the system is in use. The check shall be made with certified Test Block TP4.

Helicoil (HC)

Put the TP4 flat into the coil. Apply settings corresponding to the number of visible holes, as defined by the established baseline (see parameters in table 3). If results show a lower number of visible holes with the appropriate Amps settings, the system shall be evaluated by the **DABS** MT Level 3 or his designee before performing any inspection.

i di	
Nb of visible holes	HC [A]
0 =>	510
1	730
2	1080
3	1580
4	2390
4 =>	2630

Table 3

Check the performance with all maximum settings shown in table 3. Results shall be reported on form shown in Appendix.

3.2.4 Materials

The conformance of materials to the requirements of AMS 2641, AMS 3044 and AMS 3046B shall be verified.

Use of materials not conforming to above standards shall be approved by the **DABS** MT Level 3; this approval shall be supported by documentation.

Staff shall be alert to any changes in performance, brightness, odor, consistency or appearance materials in use and shall conduct the appropriate checks and tests if they have reasons to believe the quality may have deteriorated.

3.2.5 Magnetic Vehicle

Check the following parameters:

- level of liquor shall be above pump
- concentration shall be comprised between 0.1 to 0.4 ml/ 100 ml
- volume of contaminants shall be < 30% of volume of fluorescent particles
- brightness of in-use vehicle shall be compared with a sample of the same unused vehicle serving as the reference and kept in a dark area, with the batch n° and date of fill.

Any of the above parameters which are out of the stated tolerance need correction or replacement of the vehicle.

3.2.6 Inspection Areas

The inspection area for stationary systems shall be checked weekly for cleanliness, freedom from undesirable fluorescent or visible contamination. Result shall be recorded.

The lighting requirements of 3.2.1 and 3.2.2 apply.

3.2.7 Connections

Check for loose connections.

4 APPENDIX

4.1 Equipment Monitoring

4.1.1 Control checks

All required control checks must be successfully completed before inspection of components commences and information must be entered in the magnetic particle system control check form.

CALIBRATION/ DAILY CONTROLS		Shift / each use	6 Months	yearly	Requirements		
					Values	§	Form
Magnetic particles materials	х				AMS 2641 & 3044 & 3046B	3.2.4	
Equipment calibrations (current)	х	х			all are current	3.2	Refer 4.1.2
Magnetic Ink Concentration (Settlement)		x			0.1 to 0.4 ml / 100 ml	3.2.5	Refer 4.1.2
Magnetic Ink Contamination		х			max 30% of above	3.2.5	Refer 4.1.2
Susp Suspension Fluorescence/Brilliance		х			no noticeable reduction	3.2.5	Refer 4.1.2
UV Light Intensity & Maintenance		х	X min 1500 μW/cm ² at		min 1500 $\mu W/cm^2$ at 38 cm	3.2.1	Refer 4.1.2
UV Bulb White Light Intensity		х			max 20 lux at 38 cm / at part surface for fixed lamps	3.2.2	Refer 4.1.2
Background White Light Intensity		х			max 20 lux	3.2.2	Refer 4.1.2
White Light Intensity for evaluation		x			min 1100 lux	3.2.2	Refer 4.1.2
System Performance with Ketos Ring/ AS 5282		х			see table 2	3.2.3.1	Refer 4.1.2
System Performance for Longitudinal magnetization TP4		х			see table 3	3.2.3.2	Refer 4.1.2
Tank Level		х			above pump	3.2.5	Refer 4.1.2
All Connections		х			no loose, safe	3.2.7	Refer 4.1.2
Installation Maintenance and Cleanliness		х			free of undesirable fluorescence	3.2.6	Refer 4.1.2
							Tools ref.
Demagnetising Coil Field at Centre							
Equipment: Bench test			х		min 6.76 KA/m at center	External	2032
Ammeter Accuracy Equipment: Bench test			х		±10% or 50 A of calibrated reference equipment	External	2032
Timer control Faujoment: Bench test			х		± 0.1 second	External	2032
Electrical Capacity (heads) Equipment: Bench test			x		± 10% of last 3 valid calibrations	External	2032
Electrical Capacity (coil) Equipment: Bench test			х		± 10%of last 3 valid calibrations	External	2032
Internal Shorting Equipment: Bench test			х		> 1000 A	External	2032
UV Radiometer Calibration Equipment: Radiometer Spectroline			х		± 5%, 5 points, 500 to 4000 μW/cm ²	External	2059/2060 2061/2063
White Light Photometer Calibration Equipment: Radiometer Spectroline			х		± 5%,5 points, 0 to 1999 lux	External	2059/2060 2061/2063
Field Strength Meter Calibration Equipment: Teslameter			х		± 5%, 5 points, 0 to + and - 12800 A/m	External	2026
Yoke dead weight check Equipment: Magnaflux Y6 Yok			x		AC: min 4.5 kg / DC: min 13.5 kg	Internal	2027
Magnetic field indicator Equipment: Magnetic flow tester			x	<u></u>	± 1 Division, 0 to + or – full scale (Gauss)	External	2003
Length measurement devices control				х	Within 1% of full scale	External	2031

4.1.2 Records form

RECORD SHEET MT Bench Unit Control Checks & Process Maintenance Control Chart										
Equipment: Unit: Magnaflux Type / SN: DR 523/ SN 770229 Ketos Ring (AS5282) SN: 213008 Known defect component: N/A		Suspension: Particle Carrier Initial u Total o			IS: Magnalo 14A fluid: Carreer II tilisation date: perating days:		Batch n°: Batch n°:			
SHIFT	SHIFT / EACH USE CHECKS (Use DA-0114_MT for detailed description)									ription)
§ Ref.	Description			Sticker? YES NO			Calibration valid? YES NO		Dec	Comments
3.2	6 monthly calibrations / checks	Bench unit (Paragraph DA-011 UV/visible lignt me (Paragraph DA-011 Magnetic field mete	3.2) 3.2)							
		(Paragraph DA-011	4_MT § 3	3.2)						
§ Ref.		Description		Tolerances ASTM E-1444		Hour of check	Results	Dec	Comments	
3.2.5	Magnetic Ink Con (settlement test)	centration		0.10 to 0.40 ml per 100 ml						
3.2.5	Magnetic Ink Contamination (UV + White light)			max 30% of above						
	Suspension Fluorescence			as samples						
3.2.1	UV Light Intensity			min 1500 µW/cm ² (38 cm)						
	UV Light - Maintenance (filters / connects.)		ts.)	clean and safe						
3.2.2	UV bulb White Light Intensity			max 20 lux (38 cm)						
3 2 2	2 Background White Light Intensity White Light Intensity for VT Insp.		max 20 lux (part surface)							
			min 1100 lux (part surface)							
3.2.3.1	a) Circular magnetization System performance with Ring AS5282 Shim shall appear at 1000A ALL 4 MAX SETTINGS TO BE TESTED!			Up to 980 A, 0 holes						
				980A, min 1 holes						
				1480A, min 1 holes						
				Up to 4070 A, min 2 holes					1	
3.2.3.2	b) Longitudinal magnetization System performance with TP4 block, with established baseline ALL MAX SETTINGS TO BE TESTED!		Holes		HC [A]		нс	HC	HC	
			0	510 730 1080						
			1							
			2							
			4	239	90 => (max) 2630					
3.2.5	Tank Level			above pump level						
3.2.7	All Electrical Connections			no loose, safe						
3.2.6	Installation Maintenance & Cleaniiness			Check all equipment. No detrimental fluorescence background						
Inspector:							DEC = Decision:			
Visa / stamp:.						1 = conform to specifications 2 = conform after corrections				
Date:							3 = non (conform		