This edition completely replaces all previous editions.

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P0	1 Jan. 2007	Initial issue	TAG	JPP
P1	1 Jan. 2010	New revision	TAG	JPP
P2	1 March. 2015	New revision	TAG	JPP
P3	22 Feb 2019	New revision Procedure completed taking account some specific work on the aircraft	TAG	JPP
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0 INTRODUCTION

0.1 Purpose

This procedure establishes the requirements for conducting eddy current examinations/inspections to detect surface and sub-surface discontinuities on parts made for example of aluminium alloys, titanium, magnesium, steel and Inconel 718. Composite materials cannot be inspected with this method.

Parts can either be on the aircraft or removed from the aircraft.
This inspection method can be applied to bare surfaces and to painted surfaces, provided the paint layer is regular without any interruption.

0.2 Applicability

This procedure is applicable to **DABS** certified NDT staff in ET-method in accordance with EN 4179/ NAS 410 and DA-0114.

The process of Eddy Current examinations/inspections permit to identify cracks, corrosion, material conductivity and layer thickness.

Paint thickness measurements and conductivity tests are physically based on the electromagnetic testing principle and are included in § 2.5.

All Eddy Current examinations/inspections are carried out in accordance with the appropriate approved procedures. Where no detailed approved procedures exist, specific technical instruction must be written and approved by the method Level 3 staff, prior the inspection is performed. Refer §1.4.

0.3 References

All documents at the latest revision unless otherwise stated.

0.3.1 Standards/Specifications

NAS 410/ EN 4179	Certification and Qualification of Non-destructive Test Personnel
Manufacturer/Authorities relevant document/	AMM, CMM/ NDT MANUAL/ AD /SRM
SAE-ARP 4402	Eddy Current Inspection of open Fastener Holes in Aluminium aircraft structures

0.3.2 Internal Documents

DA-0100	Maintenance Organisation Exposition
DA-0114	Procedure for Training, Qualification and Certification of NDT-Personnel
DA-0113_NDT	NDT Examination Report
DA-0114_ET_INST-xx	NDT Specific Technical instruction. *This document may also be named Technique Sheet.*

0.4 Abbreviations and definitions

0.4.1 Abbreviations

- **AMO** **Approved Maintenance Organisation**
- **CMTS** **Computerised Maintenance Tracking System** - software used by **DABS** 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.**
- **CMM** Component maintenance manual
- **SRM** Structure Repair Manual
- **EDM** Electrical Discharge Machining- Metal removed by electrical spark in a dielectric fluid. Commonly used to create artificial discontinuities
- **HFEC** High frequency Eddy current
- **LFEC** Low frequency Eddy current
- **RTEC** Rotating Test Eddy current

0.4.2 Definitions

The following definitions shall apply to terms which are unknown or have special meaning as used in this standard. Definitions of terms included herein are in addition to terms defined in referencing specifications and are associated primarily with procedure.

- **Bolt Hole Clean-Up** Use of clean-up ream in bolt hole to improve surface for eddy current examination/inspection.
- **Electrical Conductivity** An intrinsic property of a particular material which refers to the ability to carry electric current. Commonly expressed in units of percent IACS (International Annealed Copper Standard) or Mega Siemens/meter (MS/m).
- **NDT instruction** A detailed written instruction for conducting a Non-Destructive examination. It may be broken into the following document:
  - A general procedure which has the basic instructions on performing ET inspection method, and
  - A specific Technique Sheet or a Technical instruction which has the detailed instructions for specific parts.
- **Technique** A category within a method.
- **Technique Sheet** A detailed, written technical instruction (may be in the form of a sheet, card or other documentation form) that supplements the instructions of a general procedure.

1 GENERAL

1.1 Requirements

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

All examinations performed are carried out in accordance with in order of preference, the present ET internal procedure, the appropriate procedures from manufacturer AMM / NDT / CMM, or other approved documents, such SB or specific procedures, approved by the method Level 3 staff; generally the manufacturer's documents give areas to be tested and acceptance criteria.

Where no detailed procedure exists, a specific technical instruction must be written, and approved by the method Level 3 staff, prior the inspection is performed.

1.2 Responsibilities

The individual performing the actual Eddy Current 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 method Level 3 staff).

This procedure and its contents are to be approved by the method Level 3 staff.

1.3 Personnel Qualification

Personnel should have appropriate level qualification and certification in this method and hold an internal certificate with relevant privileges.

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 and approved by the method Level 3 staff.

1.5 Materials and Equipment

1.5.1 Eddy Current Test System

The eddy current test system shall consist of the following components, at a minimum:

- Eddy current instrument
- Test probe(s) including cable(s)
- Reference standard(s)

Test system may be semiautomatic or manual.

DABS has no automatic system installed. All inspections are performed manually.

The sensitivity of the eddy current system shall be such that a repeatable change in signal response of the magnitude specified herein can be detected, when the appropriate test coil encounters a known specified natural or artificial discontinuity in a reference standard.

The response to the appropriate size notch in the reference standard shall not be less than 20 percent of the full scale of any display.

The response to the appropriate size notch shall have minimum of a 5:1 signal-to-noise ratio when compared to an area on the reference standard that is not notched.

1.5.2 Eddy current instruments

Eddy current test instruments shall be capable of inducing an eddy current in a conductor and detecting the change in the induced eddy current produced by a discontinuity.

Eddy current instruments shall be capable of lift-off compensation or identification.

Eddy current instruments may be meter, impedance plane, or time-based. Use of impedance plane instruments is recommended for most applications.

All NDT-equipment (or instruments if they are part of a NDT system), are registered in Quantum data base. Each Instrument must be labeled with a Label sticker i.a.w DA-0126 after the annual calibration check is performed.

The following Instrument is available.

- Nortec 500,
- Nortec 600
- GE Phasec 3D or equivalent

The following Instrument is available for Paint thickness measurements.

- Elcometer with digital read-out and a permanent attached spring-loaded probe with cable.

Together with the unit case several calibration foils from 23.4 µm to 1029 µm are available to cover the thickness range for **DABS** applications.

Before paint thickness readings are taken, the instrument must be checked with the above-mentioned calibration foils. The tolerance should not be greater then the values given on each foil, otherwise recalibrate the instrument with the calibration foils.

1.5.3 Eddy current probes

Due to the wide range of eddy current equipment and probes availability on the market, it is the responsibility of the qualified Level 2 certified personnel, to check, if the requirements for the appropriate procedure can be achieved with the equipment and probes, available at **DABS**.

For some inspection areas, special geometrically formed probes are required. If they do not already exist at **DABS**, they must be rented for the inspection as required.

All probes have a Part-number and are listed in an internal **DABS** tools store inventory list for traceability. They are stored in appropriate drawers in the Shop to prevent any damage.

Probe tip and reference standard wear can be reduced by placing a thin layer of Teflon tape over the probe tip prior to use and replaced as needed during inspection. The calibration and adjustment of equipment must be checked after replacement of tape.

When new spares or replacement probes are received from the manufacturer, calibration certificate shall be checked for their proper performance and sensitivity compared to that of existing probes or data recorded from previous probes.

The following probes to measure the required parameters are available.
The lists shown below are not exhaustive lists of probes
These probes can be substituted by other ones as long as the result is acceptable:

GVA

- Olympus HF probe 1-6MHz 90°
- Olympus HF probe 1-6MHz 45°
- Olympus HF probe 1-6 MHz 0°
- Olympus HF Probe 1-3MHz 0°
- Olympus HF Probe 100KHz -1MHz 0°
- Olympus HF probe 100-500 KHz 90°
- Olympus HF probe 100-500 KHz 0°
- Olympus BF probe 1-50KHz 0°
- Olympus BF probe 300Hz-40KHz 0°
- Olympus BF probe 100Hz-1KHz 0°
- Olympus Specific Conductivity probe 60KHz
- Rotating Probes Kit SPO-5965
- Sonde Elcometer (only paint thickness measurement)

FAB

- GE HF probe 50-500KHz 15° crank 90° Tip.
- GE HF probe 2MHz NFe 15° crank 90° Tip.
- GE HF probe 500Hz NFe. crank 90° Tip.
- GE HF probe 2MHz NFe. crank 90° Tip.
- GE HF probe 2MHz NFe Straight.
- GE HF probe 500KHz NFe Straight.
- Rohman UK LFEC KAS95-5E Spot Probe
- GE Conductivity Probe 47P001 60KHz-500KHz.
- Techna NDT HF Probe 50-500KHz 125mm Shaf, 90° angle 0.3mm Drop tip.
- Techna NDT HF Probe 50-500KHz 125mm Shaf, 90° angle 12mm Drop tip.

1.5.4 Reference standards

For each eddy current inspection, a reference standard is required, to set up the instrument sensitivity correctly in accordance with procedure instructions.

The reference standard contains artificial defects on which the eddy current system has to be set up in that manner, that a known defect will have a corresponding signal on the eddy current unit. These signal requirements are given in the inspection procedure, supplied by the aircraft or engine manufacturer.

If the reference standard for an inspection is not available in the NDT-department at the time when an inspection is due, it must be either ordered or rented from the appropriate company. The reference standard should be qualified for work to be performed.

The inspection must not be performed without calibration standard.

The surface roughness of the reference standard shall be comparable to that of the test per a 5 to 1 signal-to-noise ratio between the reference notch signal and noise signal be obtained.

Each reference standard must be identified by a Part-number and shall be supported by a calibration certificate stored in safe and clean areas, so that environmental condition cannot reduce the performance of the standard.

Unless otherwise specified, Eddy Current reference standards require an initial certification only. The usable surfaces of the reference standard shall be inspected by the Eddy Current certified personnel before each use for damage such as gouges, dents, deep scratches, corrosion, visible wear and so forth that could change the size of the discontinuity. All visible damage on the usable surfaces shall be assessed by the method Level 3 staff and if needed, the reference standard shall be removed from use for further inspections.

The following reference standards are available.
These standards can be substituted by other ones as long as the result is acceptable.

Reference standards for eddy current inspection:

- Hight frequency standard, 3 notches depth 0.2mm/0.5mm/1.00mm, standard for aluminium alloys, Titanium, magnesium, steel, Inconel 718.
- Low frequency step standard
- Electrical conductivity standard
- Rototest Aluminium Standard.

1.6 Accept / Reject criteria

Criteria are described in appropriate instruction given by the component manufacturer or procedure approved by the method level 3 staff.

1.7 Area to be inspected

As per the document (instruction, procedure) requesting and describing the inspection.

1.8 Records

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

- Reference to the material & equipment
- Reference to the documents.
- Location, classification and disposition of relevant indications.
- Staff's stamp, certification Level and signature.
- Date of inspection.

2 PROCESS

2.1 Safety and precautions

The various materials may contain chemicals, which if improperly used, could be hazardous to the health and safety of operators. Protective clothing, including eye shields, suitable cloves, and aprons, must be worn when filling tanks when there is a possibility of splashing or overspray.

Necessary precautionary measures should be taken to ensure the health and safety of all personnel and prevent damage to equipment.

2.2 Work requirements

Eddy Current 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 checks outside **DABS**.

2.3 Approved Data

- This procedures, and
- Specific Technical Instructions, approved by the method Level 3 staff 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, extend of inspection and accept/ reject criteria are given to perform the set-up for a specific inspection and the inspection itself.
If accept/reject criteria are missing, the method Level 3 staff should describe it.

2.4 Examination process

- Examination process for HFEC inspection: Refer to paragraph 2.4.1
- Examination process for LFEC inspection Refer to paragraph 2.4.1
- Examination process for RTEC inspection: Refer to paragraph 2.4.2.2
- Examination process for Paint thicknesses measurements : Refer to paragraph 2.4.2.3
- Examination process for Conductivity measurements: Refer to paragraph 2.4.2.4

2.4.1 Preparation

2.4.1.1 Job set-up:

A. Read the relevant documents
B. Remove the applicable parts to gain access to the area to be inspected
C. Clean the area to be inspected in accordance with AMM, CMM procedure etc..
D. Inspect the area with a white light (minimum 1000 Lux)
E. if you find visual defect, identify location before inspection.
F. Measure layer thickness and electrical conductivity to compare with reference standard

   Thickness shall be compensated by equal tape thickness on reference standard and electrical conductivity of part shall be within ±10% IACS of reference standard.
G. Select the appropriate probe in accordance with AMM, CMM procedure, the area geometry/ dimension, and the accessibility.

2.4.1.2 Preparation of the instrument

A. Connect the cable and probe to the instrument
B. Switch on the eddy current instrument
C. Adjust the frequency and make sure that values are properly set with CMM or AMM procedure, etc.. (Type, frequency range, shielding, core)
D. Select the appropriate reference standard.
E. Place the probe on a sound area of the reference standard that is unaffected by either an Edge effect, or part assembly or artificial discontinuities
F. Hold the probe perpendicular to the surface
G. Balance the probe using the balancing control of the instrument
H. Hold the probe steady until the point reappears at the null point.

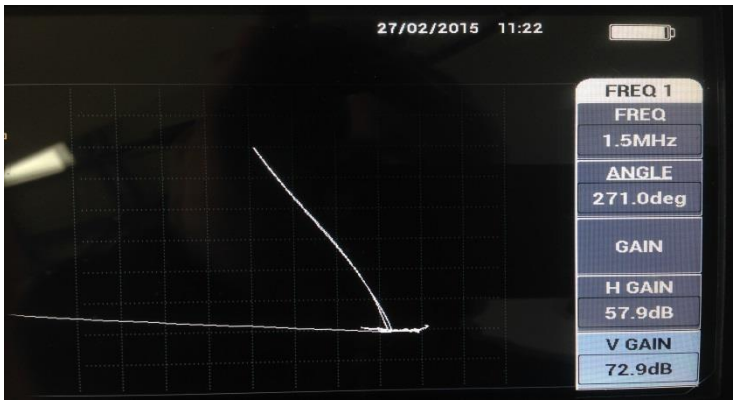
2.4.1.3 Set the phase angle

Note: *This adjustment is used to direct the lift-off effect of the probe on a preferred angle to facilitate interpretation by the operator.*

A. Raise the probe vertically from the reference standard, the signal obtained on the screen is the lift-off signal.
B. Adjust the phase angle to Horizontal position on the screen with the deviation from null point to air point to the left of he screen
C. The null point shall be located as requested by the document.

2.4.1.4 Set the sensitivity

A. Move the probe on the relevant notch on the reference standard as requested by the documents.
Note: A signal appears on the screen when the probe goes over the defect



Typical signal generated over EDM notch 0.50 mm with horizontal lift off

B. Make sure the signal has a correct angle (well separated from the lift off).

C. Adjust the gain to get a signal equivalent to the requested screen hight.

D. Repeat C) several times.

Important note: For inspection on a painted surface, standardization shall be carried out on the standard painted identically as the part, or covered with the corresponding thickness of adhesive tape.
The probe is protected with adhesive tape.

2.4.1.5 Signal Analysis

The presence of a discontinuity is indicated by the sudden appearance of a non-horizontal signal towards the left of the screen (see figure paragraph 2.4.1.4).

Lift-off variations are indicated by the horizontal displacement of the signal; this signal should always find its origin **close to the null point used for sensitivity setting.**

A. Identify and compare the signal shown on the screen to the reference signal obtained with the standardization block.

B. Make sure the signal is due to a discontinuity and not to another parameter.

C. Check the AMM, CMM or any other approved data for the specific accept/reject criteria and make your decision.

D. Check the standardization at the start of work, at the end of it and at 15 minutes interval or whenever a doubt is suspected; if the deviation is greater than 2 dB, all parts tested since the last valid standardization shall be re-checked.

2.4.2 Examination

2.4.2.1 Inspection on aircraft parts and components

The area to be inspected should be clean of dirt and grease.

Remove loose paint over inspection area.

When inspecting a painted part, if the paint coat is not consistent in terms of thickness or adhesion, or if the surface is rough, it may be necessary to strip with SCOTCH BRITE the scanned area.

Do the inspection at the specified locations following the procedures and/or technique sheets.

Keep probe perpendicular to surface while moving the probe over the inspection area and concentrate to eddy current unit for signal indication. The use of a plastic straight edge or a draftsman circle template is recommended whenever possible.

The probe scan speed used during instrument standardization will be the maximum used during inspection.

Response from defect indications shall be compared with response from the reference standard. Edge effect interference on the test part shall not reduce the signal sensitivity.

2.4.2.2 Hole/Bore Inspection (RTEC)

When conducting hole/bore inspection the scan increment shall be such that the reference notch on the applicable reference standard is scanned at least two times.

When conducting manual hole/bore inspection, a 360-degree scan is required at each depth increment.

When conducting automatic or semi-automatic hole/bore inspection, the scanning speed shall be such that the alarm is reliably triggered when scanning the applicable reference notch.

The probe play within the bore either on reference standard or during inspection shall be no more than 0.1mm (0.005-inch).

Probes that can be expanded must be set that there is no interference.

Probes that cannot be expanded must not be smaller than 0.1mm (0.005-inch) below the hole diameter.

The lift off shall be settled to minimize the vertical indication on the time base representation with the rotating probe revolving flat on the reference standard and to have the Lissajous' figure on the horizontal axis for the impedance plane representation. Both indications created by a) the radial notch through the chosen hole and b) the angle notch at the entry of the hole shall be seen

2.4.2.3 Paint thickness measurements

Measurement of nonconductive coating thickness on conductive material is made possible by utilizing the lift-off variable of the eddy current method. Variation in coating thickness cause corresponding changes in the distance between the eddy current probe and the conductive material. The resultant changes in eddy current response are registered on the instrument display and can be adjusted to represent coating thickness.

The unit used at **DABS** is an Elcometer with digital read-out and a permanent attached spring-loaded probe with cable as described in chapter 1.5.2.

Note: Special care must be taken, that the readings are taken on the same base material as the parts to be measured.

2.4.2.4 Conductivity measurements

The electrical conductivity of material is influenced by its chemistry and heat treat condition.

Mixed lots of materials or part subjected to fire or excessive heat damage can quickly and easily be separated.

Electrical conductivity is usually expressed as a percentage of the conductivity of the International Annealed Cooper Standard (IACS) and is defined to be 58 MS/m (100% IACS) at 20°C.

For exact readings in the range of Aluminium alloys, additional calibration standards are stored in the NDT-Shop with following conductivity figures:

GVA	FAB
S/N 1193: σ = (25.88% IACS) S/N 1193: σ = (37.44% IACS) S/N 1193: σ = (53.49% IACS)	S/N 33A136: σ = (8.60% IACS) S/N 33A136: σ = (58.17% IACS)

Note: These calibration standards must be sent for re-calibration every-year.

2.4.3 Evaluation and recording

Acceptance criteria shall be as specified on applicable specification.

If no flaw signal appears on the eddy current unit, the inspected part can be considered as serviceable with no defect.

If a flaw signal appears on the eddy current unit similar to that received from the reference standard, the inspected part must be considered as unserviceable and must be rejected.

Reject parts that contain indications in excess of the acceptance limits.

Reject all parts having crack-like indications and contact the requesting aircraft manufacturer.

In certain cases, it is helpful to use the store function of the instrument and have a print out of the screen with the flaw signals for further discussions.

2.5 Report

After each examination a NDT-Report (Form DA-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 two possibilities for examination results:

- The inspected Component has no defect 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.

3 QUALITY ASSURANCE

The following rules need to be adhered to:

3.1 Equipment/ accessories

What: check condition of equipment (generator, cable, probe, standardization block, validity of certificates)
Who: NDT Certified personnel
When: each use
Reference: comparison to the normal situation (new material)
Results: in case of any technical problem, the NDT method level 3 needs to be contacted.

3.2 Generators

What: calibration of generator
Who: external laboratory
When: yearly
Reference: EN
Results: on certificate

3.3 Standardization blocks

What: check condition of standard (degradation, corrosion, cracks, electrical conductivity and protective layer thickness)
Who: NDT Certified personnel
When: each use
Reference: comparison to the normal situation (new material)
Result: in case of any technical problem, the NDT method level 3 needs to be contacted.

Any deviation or suspected malfunction of equipment shall be reported to the ET method Level 3.

End of procedure