CHAPTER 6 — NONDESTRUCTIVE INSPECTION

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT)

TABLES

NONDESTRUCTIVE INSPECTION

6-1. GENERAL

Nondestructive inspections included in this chapter are fluorescent penetrant, magnetic particle and Eddy Current.

6-2. FLUORESCENT PENETRANT INSPECTION METHOD (ASTM E1417)

6-3. INTRODUCTION

Penetrant inspection is a nondestructive test for discontinuities open to the surface in parts made of nonporous materials. This is done by applying penetrant to the surface of the part which then penetrates the surface discontinuity. Excess penetrant is removed from the part surface with penetrant remaining in the discontinuities. Developer is then applied to the part surface to provide a blotting action which allows the penetrant to emerge from the discontinuities. Indications become visible by the fluorescence of the penetrant under ultraviolet light.

6-4. SAFETY PRECAUTIONS

1. Make sure safety requirements for using electrical equipment near aircraft fuel cells, oxygen systems, and stores have been met.

2. Use only low sulfur and low halogen content penetrant materials. Penetrant containing excessive sulfur or halogens may cause stress corrosion cracking in titanium parts.

3. Black lights generate considerable heat during use. Be sure to grasp the black light only by the handle.

4. To prevent injury to the eyes, do not look directly into the black light as unfiltered black lights or a damaged filter on a black light may damage eyes.

5. Prolonged or repeated inhalation of vapors or powders may result in irritation of mucous membrane areas of the body. Provide adequate ventilation when handling cleaner, emulsifier, penetrants, or developers.

6. Continual exposure to penetrant inspection materials may cause skin irritation. Avoid contact with penetrant inspection materials by wearing gloves. Wash exposed areas of body with soap and water.

7. Temperatures in excess of 120°F (48.8°C) may cause bursting of pressurized spray cans and injury to personnel. Store all pressurized spray cans in a cool, dry area protected from direct sunlight. Avoid exposure of pressurized spray cans to open flame.

8. Exercise extreme caution when handling penetrants which have been heated to a point where some lighter constituents are driven off. Volatile fumes may occur, creating both a fire and health hazard.

6-5. PERSONNEL QUALIFICATION/ CERTIFICATION

All personnel performing NDI shall be certified to meet or exceed Level II requirements as established in the latest revision of NAS 410 or alternate approved document. Personnel that have successfully completed the level I Special NDI training course at Bell Helicopter are qualified to perform fluorescent penetrant inspections in accordance with the applicable maintenance and overhaul manuals, or as specifically authorized in an ASB or other Bell Helicopter approved written directive. The ASB or other Bell Helicopter approved written directive must indicate in the document that a Bell Helicopter trained Level 1 Special individual is qualified to perform such task and may be responsible for product acceptance. The employer of NDI Level I Special personnel must have an established written practice which meets the requirements of ATA 105 for qualification and training of NDT personnel as described in the Bell Helicopter Customer Training Academy (CTA) NDI training course.

Individuals who have successfully completed and passed the Level I Special Bell Helicopter training course may perform routine inspections for acceptance on components as listed in the Chapter 4 Airworthiness Limitations Schedule for retirement life parts and as listed in Chapter 5 Component Overhaul Schedule for components requiring an overhaul interval providing the applicable MM and or the CR&O provides the detailed instructions to perform the inspection.

Individuals who have successfully completed and passed the Level I Special Bell Helicopter training

course may only perform evaluations on components if the MM or CR&O do not provide the required detailed instructions. An evaluation is performed for information purposes only, and is not intended as a final means of acceptance or rejection. Examples include assessment of a damaged bare metallic skin for evidence of cracking, and to characterize indications found visually (crack, vs. scratch). Actual inspection of such parts needs to be supported by a certified Level II in the method employed. If during the course of the evaluation an indication is found, a person certified to meet or exceed a Level II requirement will be responsible for the acceptance or rejection of that indicated part.

6-6. EQUIPMENT REQUIREMENTS

1. General. Fluorescent penetrant inspection (FPI) equipment shall be designed specifically for the purpose intended and constructed from materials compatible with the chemicals used. The equipment shall be arranged to facilitate part flow through the process and be capable of providing a repeatable operation. All tanks shall be provided with covers to avoid contamination of the materials when not in use. Penetrant, emulsifier, and aqueous developer tanks shall have drain racks. Adequate ventilation and personal protective devices shall be provided as instructed by the penetrant materials manufacturer. Portable kits (Method C) may be employed for inspection of localized areas of components and parts installed on aircraft.

a. Penetrant/Emulsifier Application Equipment. Penetrant application equipment shall provide a means of application by immersion, brushing, flowing, conventional or electrostatic spraying so that the entire part is covered with penetrant. Prior to electrostatic spray application refer to the manufacturer's product data to determine if the penetrant is compatible with this method of application.

b. Equipment for applying lipophilic emulsifiers shall provide complete part coverage by immersion or flowing. Brush application is prohibited.

c. Equipment for applying hydrophilic emulsifiers shall provide complete part coverage by immersion or spraying. If application is by immersion, the bath or parts shall be agitated during immersion. If application is by spraying, the spray unit shall be capable of dispensing the concentration recommended by the manufacturer. Hydro-air nozzles may be used with a maximum of 20 PSI added air pressure.

d. Rinsing/Wash Apparatus. Excess penetrant and penetrant/emulsifier mixtures shall be removed by manual spraying. Water temperature shall be between 50 – 100°F (10 – 37.7°C). The rinsing apparatus shall deliver a coarse spray of water having a maximum pressure of 40 PSI (276 kPa). Hydro-air nozzles may be used with a maximum of 20 PSI (138 kPa) added air pressure. The rinsing area shall be provided with a black light to monitor the progress of penetrant removal and to prevent over-washing/under-washing.

Temperature/pressure indicators and controls shall be calibrated at six month maximum intervals in accordance with ISO 10012-1, NCSL Z540-1, or a calibration system approved by Bell Helicopter.

6-7. DEVELOPER APPLICATION EQUIPMENT

1. Aqueous Type Developers. The equipment shall provide a means of application by immersion, flowing, or spraying so that the entire part is completely covered. Equipment used to apply suspension type developers shall be capable of agitating the mixture to maintain a uniform suspension.

2. Non-Aqueous Type Developers. The preferred application of non-aqueous developers is by commercially available aerosol containers. Air pressure type spray units equipped with a means to continuously agitate the developer mixture during use may be used so that a thin, uniform coating can be applied.

3. Dry Type Developers. Developer shall be applied in an enclosed cabinet, which disperses the powder in a manner resulting in a uniform coating being applied to the entire surface of the part. The cabinet shall be equipped with a viewing window to allow for visual verification of cloud formation.

6-8. STANDARD EQUIPMENT

1. Drying Ovens. Drying equipment shall be recirculating hot air ovens, electrically heated and thermostatically controlled. Drying oven temperatures shall be at least 120°F (48.8°C) and shall not exceed 160°F (71.1°C). The temperature controller shall be capable of maintaining the oven temperature at ±15°F (±8.3°C) from set point and the temperature indicator shall be accurate to ±10°F (±5.5°C) of the oven temperature. The drying oven shall be equipped with a safety shut off, visible alarm, or audible alarm which operates should the oven temperature exceed 160°F

(71.1°C). The oven shelves (if so equipped) shall allow free air circulation.

2. Inspection Viewing Area. The area where parts are inspected shall be kept clean at all times and free from excessive fluorescent contamination. Stationary inspection areas shall be shielded adequately to assure the white light background does not exceed 2 foot-candles at the examination surface.

3. When portable inspection is required, the inspection area shall be darkened adequately with dark canvas, photographer's black cloth, or other methods to provide satisfactory viewing of indications.

4. Black Light Source. Black light sources shall be filtered to pass a wave band of 3200 to 4000 Angstrom units.

a. Portable Black Light Units. Portable black light units shall be of the spot bulb type. They shall provide a black light intensity level of not less than 1000 microwatts per square centimeter ($\mu W/cm^2$) when tested at a distance of 15 inches (38.1 cm).

b. Fixed Black Light Sources. Fixed black lights shall provide a black light intensity level of not less than 1000 $\mu W/cm^2$ at the surface of the inspection work table.

5. Black Light Meter. The black light meter shall be capable of measuring black light intensity in μW/cm2 within the spectral range of 3200 – 4000 Angstroms. The DSE-100X Light Meter (Spectronics Co., Westbury, NY) or equivalent is acceptable.

6. Visible Light Meter. The visible light meter for measuring white light background in the inspection area shall be capable of measuring a light level of at least one foot-candle. The DSE-100X Light Meter (Spectronics Co., Westbury, NY) or equivalent is acceptable.

7. System Performance Test Panels. Panels used for testing system performance shall be Chrome, NiCr, or those conforming to Pratt & Whitney Aircraft drawing number TAM 146040.

6-9. INSPECTION MATERIAL REQUIREMENTS

NOTE

All penetrant materials shall conform to MIL-I-25135.

Penetrant Systems. FPI systems covered by this document shall be of the following types, methods and sensitivity levels.

1. Penetrants:

NOTE

Method B (Lipophilic Emulsifier) may be substituted in place of Method D (Hydrophilic Emulsifier) provided Sensitivity Level 4 penetrant is used.

Type I — Fluorescent Dye

Method B — Post Emulsified, Lipophilic

Method C — Solvent Removable

Method D — Post Emulsified, Hydrophilic

Sensitivity Level 3 — High

Sensitivity Level 4 — Ultrahigh

2. Developers:

NOTE

Developers shall be of the following forms.

Form a — Dry Powder

Form b — Water Soluble

Form c — Water Suspendable

Form d — Non-aqueous

3. Solvent Removers:

NOTE

Solvent removers shall be of the following classes.

Class 1 — Halogenated

Class 2 — Non-halogenated

CAUTION

WHEN PORTABLE INSPECTION KITS ARE USED ON TITANIUM OR NICKEL BASE ALLOYS, THE USE OF A HALOGENATED SOLVENT REMOVER (CLASS 1) OR A HALOGENATED NON-AQUEOUS DEVELOPER IS PROHIBITED.

6-10. PREINSPECTION CLEANING

The inspection surface shall be clean, dry, and free of contaminants such as grease, oil, etc. Organic coatings such as paint may be removed by hand sanding, plastic media blast and/or liquid strippers to reveal the bare metal for inspection. After contaminants are removed, the inspection area shall be precleaned using solvent and a clean, dry cloth (refer to Chapter 5). Allow the inspection area to dry completely before applying penetrant.

6-11. PENETRANT INSPECTION

CAUTION

DO NOT PERFORM PENETRANT INSPECTION AT TEMPERATURES BELOW 40°F (4.4°C).

CAUTION

DUE TO EXCESSIVE BACKGROUND RELATED TO HIGH SENSITIVITY PENETRANT MATERIALS WHEN USED FOR INSPECTION OF COMPONENTS MANUFACTURED FROM SAND CASTINGS, SENSITIVITY LEVELS IN EXCESS OF LEVEL 2 SHOULD NOT BE USED, (EXAMPLE: MAGNESIUM TRANSMISSION CASES).

1. Minimum penetrant sensitivity levels for inspection shall be level 2 or greater. For components identified in Chapters 4 and 5 (Airworthiness Limitations/Inspections and Component Overhaul Schedule), minimum penetrant sensitivity levels for inspection shall be level 3 or greater, except as stated in the above caution.

2. Penetrant may be applied to the inspection surface by dipping, flow-on, brushing, or spraying. For localized inspections on assemblies, the preferred method of application is brushing. After the penetrant is applied, check the inspection area for adequate coverage and to assure that the penetrant is not contaminating non-inspection areas.

3. The penetrant dwell time shall be a minimum of 30 minutes, unless otherwise specified. Dwell time shall be doubled when the part temperature is between 40 and 60°F (4.4 and 15.5°C). For specific components which have been identified in Bell Helicopter manuals as having potential for stress corrosion cracking, dwell times shall be a minimum of 120 minutes.

4. Lipophilic post emulsified penetrant systems (Method B) shall be removed by water immersion or with a water spray rinse after application of an emulsifier and an appropriate emulsifier dwell time. Lipophilic emulsifiers shall be applied by immersion or flowing. Lipophilic emulsifiers shall not be applied by spray or brush and shall not be agitated while on the surface of the part. Maximum dwell times, unless otherwise specified, shall be 3 minutes. Actual dwell times shall be the minimum necessary to produce an acceptable background. After the emulsifier dwell time, emulsification shall be stopped by agitated immersion rinse or water spray. Parts that have excessive background or appear to be over-emulsified must be cleaned and reprocessed.

CAUTION

THE INSPECTION AREA SHALL NOT BE FLUSHED WITH SOLVENT OR WIPED WITH SOLVENT-SATURATED CLOTH WHEN PERFORMING PENETRANT REMOVAL.

5. Solvent removable penetrant systems (Method C) shall be removed by using a clean, dry cloth followed by a cloth moistened with solvent. Rewipe with a dry cloth to remove any solvent residue. Check the inspection area with a black light for adequate

penetrant removal. If over-removal is suspected, the area shall be cleaned and reprocessed.

6. Hydrophilic post emulsified penetrant systems (Method D) shall be removed with a water prerinse, application of the hydrophilic emulsifier and then a postrinse. The prerinse shall be applied for the minimum amount of time to achieve removal of the bulk surface penetrant. The hydrophilic emulsifier shall be applied by immersion or spray. For immersion applications, the concentration shall not exceed 35% by volume. For immersion applications, the emulsifier or part shall be mildly agitated. Dwell time shall be the minimum required for adequate penetrant removal, but unless otherwise specified, shall not exceed 2 minutes. For spray applications, the concentration shall not exceed 5%. After the application and dwell of the emulsifier, the part shall be rinsed with water. Evidence of over-removal shall require the part to be cleaned and reprocessed. Excessive background may be removed by additional (touch up) application of the emulsifier provided the maximum dwell time is not exceeded, followed by a rinse. If touch up application of the emulsifier does not produce an acceptable background, the part shall be cleaned and reprocessed.

7. The parts shall be dried prior to the application of dry or nonaqueous developer. Parts shall be air dried or dried in an oven. The oven temperature shall not exceed 160°F (70°C) and drying time shall not exceed that necessary to adequately dry the part.

8. Dry developer shall be applied by lightly dusting the areas to be inspected. Developer dwell time shall be a minimum of 10 minutes and a maximum of 4 hours. Parts that are not inspected before the maximum dwell time shall be cleaned and reprocessed.

CAUTION

A HEAVY COATING OF DEVELOPER WILL MASK INDICATIONS. DO NOT OVER APPLY DEVELOPER.

9. Nonaqueous developer shall be applied by lightly spraying. If excessive application of developer has occurred, then the part shall be cleaned and reprocessed. Developer dwell time shall be a minimum of 10 minutes and a maximum of 1 hour. Parts that are not inspected before the maximum dwell time shall be cleaned and reprocessed.

CAUTION

DO NOT WEAR PHOTOSENSITIVE, OR PERMANENTLY SHADED LENSES WHEN PERFORMING INSPECTION.

10. Perform inspection under black light. Observe any obvious bleed-out as the developer dwells. Complete inspection after developer dwell time is complete.

6-12. EVALUATION

Penetrant indications may be evaluated by wiping once with a solvent moistened cotton swab followed by re-development. Mark relevant indications of concern for further evaluation and/or disposition.

6-13. ACCEPTANCE CRITERIA

Unless allowed by a specific procedure, indications of cracks shall be cause for rejection.

6-14. POSTINSPECTION CLEANING

Remove developer residues as soon as practical after completion of inspection. Nonaqueous or dry developer residues may be removed by wiping with a clean cloth, or brush (with soft, nonmetallic bristles), and water as necessary. If determined to be detrimental to the service of a component, other penetrant residues shall be removed from the inspection area using solvent or other approved methods.

6-15. PROCESS CONTROL REQUIREMENTS

1. Specific Process Controls. The following specific process control tests shall be accomplished according to the minimum frequency indicated in Table 6-1. FPI materials dispensed from closed containers and discarded after one use are exempt from the testing requirements of step 4 through step 10. FPI materials used in open containers (tanks) and/or materials that are reused shall be tested as required.

Inspectors shall be continually alert to any changes in performance, color, odor, consistency, or appearance

of all penetrant materials being used. Appropriate tests shall be conducted if their quality is believed to have deteriorated.

2. Black Light Intensity. Black lights used for inspection shall be checked using a black light meter conforming to paragraph 6-8, step 5. The test shall be conducted in the inspection booth/area in which the black light is normally used. All black lights shall be checked after bulb replacement. Black light reflectors and filters shall be checked for cleanliness and integrity. Damaged or dirty reflectors or filters shall be replaced or cleaned as appropriate.

a. Portable Light Sources. Portable light sources shall be tested with the meter fifteen inches from the face of the filter.

b. Fixed Light Sources. For fixed light sources, the black light intensity shall be measured at the surface of the work table.

3. Visible Light Intensity. The intensity of the spurious visible light in the inspection area shall be measured at the surface of the work table with a visible light meter conforming to paragraph 6-8, step 6.

4. System Performance Test. The system performance shall be checked by processing a test panel conforming to paragraph 6-8, step 7 through each inspection line in use. A comparison test is made by processing a similar test panel through exactly the same processing steps and times using unused materials of the same designation. After developing, a comparison is made between the panels. Alternately, comparison may be made between a panel processed through the in-use material and a photograph of the same panel previously processed through unused material. The comparison test may also be made by dividing a panel (if using NiCr or chrome panels) into two equal sections by means of a wax line or narrow vinyl tape.

The comparison shall reveal no appreciable difference in background fluorescence, brilliance of indications, or extent to which the defects are shown. If a difference exists, inspection shall be stopped and all of the solutions and procedures shall be checked to determine which of the used solutions or the procedures are discrepant, and the discrepancy shall be corrected before resuming inspection.

Immediately after each use, the test panels shall be cleaned according to the following Instructions as the minimum requirement:

a. Soak in alkaline cleaner for 1/2 to 1 hour.

b. Rinse.

c. Vapor degrease, ultrasonic clean for 5 minutes, or solvent soak for 1 hour.

d. Store panel(s) immersed in solvent or dry at 120 – 160°F (48.8 – 71.1°C) for 10 minutes.

5. Water Content of Lipophilic Emulsifier. The water content of in-use emulsifier shall be determined in accordance with the test procedures in ASTM-D-95 or ASTM-D-1744.

6. Hydrophilic Emulsifier Concentration. The concentration of hydrophilic emulsifiers (applied by immersion or spraying) shall be checked using a calibrated refractometer. Spray concentrations shall be within the manufacturer's recommended limits and emulsifier concentration shall not exceed 5%. For immersion applications, the emulsifier concentration shall be no higher than specified by the penetrant system supplier and shall not exceed 35% by volume. Variation of immersion solution concentrations shall not be greater than 3 percentage points from the initial, unused concentration.

7. Penetrant Fluorescence Tests. The brightness of the in-use penetrant shall be determined according to ASTM E1135 with a sample of the unused penetrant serving as the reference.

8. Developer Contamination. Aqueous developers shall be checked for fluorescence by immersing a clean aluminum panel approximately 3 x 10 inches (7.6 x 25.4 cm) into the bath, drying, and observing the panel under black light. Additionally, failure of aqueous developers to uniformly wet part surfaces shall be cause for FPI to cease until the problem is corrected.

Dry developers shall be checked for fluorescence by spreading a thin layer on a flat, 4 inch (10.2 cm) diameter circular area and observing under a black light. Dry developers shall not contain more than 10 fluorescent specks. Dry developers shall be fluffy and not caked. Caked dry developer shall be discarded.

9. Penetrant Contamination. The penetrant shall be examined visually and shall be discarded if there is any evidence of precipitates, separation of constituents, surface scum, waxy deposits, white coloration or any other evidence of contamination or breakdown.

10. Drying Oven Temperature. The temperature of the drying oven shall be verified daily and shall be within the range of 120°F (48.8°C) and 160°F (71.1°C). The oven temperature indicator (refer to paragraph 6-8, step 1) may be used for this check. The oven temperature indicator shall be calibrated against an ASTM calibrated thermometer or a thermocouple traceable to the N.I.S.T.

11. Light Meter Certification. Black and visible light meters shall be certified every six months using standards traceable to the N.I.S.T.

Table 6-1. Fluorescent Penetrant Process Control Tests — Frequency and Requirements

TEST	FREQUENCY	REQUIREMENTS
Rinse Water Pressure/ Temperature	Each Shift	Per paragraph 6-6, step d
Black Light Intensity	Daily	1000 μW/cm^2@15 inches
Black Light Reflectors and Filters	Daily	Per paragraph 6-15, step 2
Visible Light Intensity (Background)	Daily	≧ 2 foot-candles
System Performance	Daily	Per paragraph 6-15, step 4
Developer Contamination	Daily	Per paragraph 6-15, step 8
Penetrant Contamination	Daily	Per paragraph 6-15, step 9
Drying Oven Temperature Verification	Daily	Per paragraph 6-15, step 10
Inspection Viewing Area Cleanliness	Daily	Per paragraph 6-8, step 2
Hydrophilic Emulsifier Concentration	Weekly	Per paragraph 6-15, step 6
Aqueous Developer Concentration	Weekly	Per paragraph 6-15, step 8
Water Content of Lipophilic Emulsifier	Monthly	5%
Drying Oven Temperature Indicator Calibration	Six Months	Per paragraph 6-15, step 10
Light Meter Certification	Six Months	Per paragraph 6-15, step 11
Drying Oven Controller Calibration	Six Months	Per paragraph 6-8, step 1 and paragraph 6-15, step 10

6-16. RECORDS

1. Process Control Test Records. Records shall be maintained showing the dates and results of all tests required. Records shall be maintained for a length of time prescribed by Bell Helicopter. When inspection is performed by an independent facility, an inspection report with information similar to that specified for the inspection log must be prepared.

2. Inspection Records. An inspection log shall be maintained for all parts inspected showing the part number, lot identification or traveler number, quantity in lot, date of inspection, the number of parts accepted or rejected, reference to any rejection documents and the identity of the inspector.

3. Personnel Certification Records. Records shall be maintained on each inspector showing experience, formal training, examination results, vision tests results, performance evaluations and inspection stamp identification.

6-17. FLUORESCENT MAGNETIC PARTICLE INSPECTION METHOD (ASTM E1444)

6-18. INTRODUCTION

Magnetic particle inspection is effective in detecting surface and near surface discontinuities in ferromagnetic parts. Inspection is accomplished by inducing a magnetic field into the part and applying a liquid suspension of fluorescent iron oxide particles to the surface to be inspected. By controlling the direction of the magnetizing current, the lines of magnetic force can be induced at right angles to the discontinuity. Direction of the magnetic field should be at right angles to the discontinuity to obtain the best inspection results. During magnetization of the part, the fluorescent magnetic particles are aligned along the flaw or discontinuity due to a leakage field and are visible under ultraviolet or black light. Unless otherwise directed, components shall be subjected to magnetization in at least two directions, 90° apart, to insure 100% inspection of the part. All inspections shall be of the wet continuous method using fluorescent magnetic particles. Types of defects that can be detected are cracks, laps, seams, folds, and nonmetallic inclusions that are either surface or slightly subsurface.

6-19. SAFETY PRECAUTIONS

1. Make sure safety requirements for using electrical equipment near aircraft fuel cells, oxygen systems, and stores have been met.

2. Black lights generate considerable heat during use. Be sure to grasp the black light only by the handle.

3. To prevent injury to the eyes, do not look directly into the black light as unfiltered black lights or a damaged filter on a black light may damage eyes.

4. Prolonged or repeated inhalation of vapors may result in irritation of mucous membrane areas of the body. Provide adequate ventilation when handling cleaner, and magnetic particle materials.

5. Continual exposure to magnetic particle inspection materials may cause skin irritation. Avoid contact with magnetic particle inspection materials by wearing gloves. Wash exposed areas of body with soap and water.

6. Temperatures in excess of 120°F (48.8°C). may cause bursting of pressurized spray cans and injury to personnel. Store all pressurized spray cans in a cool, dry area protected from direct sunlight. Avoid exposure of pressurized spray cans to open flame.

7. Magnetizing equipment shall be maintained properly to prevent personnel hazards from electrical short circuits.

6-20. PERSONNEL QUALIFICATION/ CERTIFICATION

All personnel performing NDI shall be certified to meet or exceed Level II requirements as established in the latest revision of NAS 410 or alternate approved document. Personnel that have successfully completed the level I Special NDI training course at Bell Helicopter are qualified to perform magnetic particle inspections in accordance with the applicable maintenance and overhaul manuals, or as specifically authorized in an ASB or other Bell Helicopter approved written directive. The ASB or other Bell Helicopter approved written directive must indicate in the document that an individual is qualified to perform such task and may be responsible for product acceptance. The employer of NDI Level I Special personnel must have an established written practice

which meets the requirements of ATA 105 for qualification and training of NDT personnel as described in the Bell Helicopter Customer Training Academy (CTA) NDI training course.

Individuals who have successfully completed and passed the Level I Special Bell Helicopter training course may perform routine inspections for acceptance on components as listed in the Chapter 4 Airworthiness Limitations Schedule for retirement life parts and as listed in Chapter 5 Component Overhaul Schedule for components requiring an overhaul interval providing the applicable MM and or the CR&O provides the detailed instructions to perform the inspection.

Individuals who have successfully completed and passed the Level I Special Bell Helicopter training course may only perform evaluations on components if the MM or CR&O do not provide the required detailed instructions. An evaluation is performed for information purposes only, and is not intended as a final means of acceptance or rejection. Examples include assessment of damaged ferromagnetic components for evidence of cracking, and to characterize indications found visually (crack, vs. scratch). Actual inspection of such parts needs to be supported by a certified Level II in the method employed. If during the course of the evaluation an indication is found, a person certified to meet or exceed a Level II requirement will be responsible for the acceptance or rejection of that indicated part.

6-21. EQUIPMENT REQUIREMENTS

1. Cleaning Apparatus. Suitable solvents shall be available for degreasing parts prior to and after magnetic particle inspection (MPI).

2. Magnetizing Current. The magnetizing apparatus shall be of Wet Horizontal DC or AC Type. All equipment shall contain quick break circuitry. The equipment shall be capable of inducing a magnetic flux into the part being inspected by means of a low voltage, high amperage current passed through the part or through a conductor which passes through a hole in the part. The equipment shall also be capable of inducing a magnetic flux in the part being inspected by placing the part in a current carrying coil. Equipment other than Wet Horizontal DC or AC shall not be used without prior Bell Helicopter approval.

3. Inspection Area. The inspection area shall be equipped with a means of shielding the area from spurious visible light so as to provide a darkened area. The ambient visible light level shall not exceed two foot-candles. The area shall be provided with a black light source for inspection as required.

4. Black Light Source. The black light source shall be filtered to pass a wave band of 3200 to 4000 Angstrom units.

a. Portable Black Light Sources. Portable black light sources shall be of the spot bulb type. The black light source shall be filtered to pass a wave band of 3200 to 4000 Angstrom units. Black light intensity shall not be less than 1000 microwatts per square centimeter ($\mu W/cm^2$) when tested at a distance of 15 inches (38.1 cm).

b. Fixed Black Light Sources. Fixed black lights shall provide a black light intensity level of not less than 1000 $\mu W/cm^2$ at the surface of the work (15" minimum light to surface distance).

5. Black Light Meter. The black light meter for monitoring black light intensity shall be available. This meter shall be capable of measuring intensity in $\mu W/cm^2$. A model DSE-100X (Spectronics Corporation) or equivalent is acceptable.

6. Visible Light Meter. A visible light meter for measuring visible light at the surface of the work being inspected shall be available. This meter shall be capable of measuring an ambient light level of at least one foot-candle. A model DSE-100X (Spectronics Corp.) meter or equivalent is acceptable.

7. Test Sensitivity (Ketos) Ring. A test sensitivity ring in accordance with ASTM-E1444 shall be available.

8. Magnetic Field Strength Indicator. In order to insure the direction and magnitude of the magnetic field in the part being inspected, a field strength indicator in accordance with ASTM-E1444 shall be available. A Hall effect gauss meter (F. W. Bell Model 4048) will satisfy this requirement, as will commercially available etched shims.

9. Field Indicator. A field indicator capable of detecting a magnetic field of at least three oersteds or gauss shall be available for checking demagnetization.

10. Demagnetizing Apparatus. Demagnetizing equipment shall be available. The equipment shall be of the open coil, box or DC step decay type and shall be capable of demagnetizing all inspected parts to a level of three oersteds or gauss maximum. Demagnetization apparatus should be oriented with the axis of the coil in the East-West Direction.

11. Centrifuge Tube. A 100 ml, pear shaped centrifuge tube graduated in 0.05 ml increments for checking suspension concentrations shall be available.

6-22. INSPECTION MATERIAL REQUIREMENTS

Fluorescent wet inspection material shall be used unless otherwise specified. Fluorescent particle concentration shall be maintained in the range of 0.1 to 0.4 milliliters per 100 milliliters of suspension fluid. All suspension fluid shall conform to AMS 3045 and/or AMS 3046.

6-23. PREINSPECTION CLEANING

NOTE

Ferrous parts may be inspected through a coating of epoxy primer or epoxy polyamide primer. Normal magnetic particle inspection procedure should be followed.

The surface of the component to be inspected shall be clean and dry, and free of oil, scale, or other contaminants that might interfere with the efficiency of the inspection. Magnetic particle examination shall not be performed with coatings in place that could prevent the detection of surface defects in the ferromagnetic substrate. When such coatings are nonconductive, they must be removed where electrical contact is to be made.

6-24. MAGNETIZING CURRENT APPLICATION

1. Alternating and/or rectified alternating current (referred herein as DC) is used for the detection of surface and near surface defects.

6-25. MAGNETIC FIELD STRENGTH

The applied magnetic field shall have sufficient strength to produce satisfactory indications, but it must not be so strong that it causes the masking of relevant indications by nonrelevant accumulations of magnetic particles. Adequate magnetic field strength may be determined by one or a combination of four methods:

(1) By testing parts having known or artificial defects. This includes the use of shims with artificial defects (per ASTM E1444) placed on the part.

(2) By using a Hall effect probe gaussmeter capable of measuring the peak values of the tangent field.

(3) By using the formulas given in paragraph 6-28, step 6 (the current values given are peak current values and are applied directly to full-wave rectified current); and by using values as specified for part number specific components in applicable sections of the manual. When formulas are used, at least one additional stated method, such as the Hall effect probe gaussmeter specified in item (2), must be used in conjunction.

(4) The use of etched shims per Aerospace Standard 5371 (AS 5371) may be utilized to determine adequate field strength and direction.

NOTE

When using AC, values shall not be less than 65% of the calculated DC values.

When using a Hall effect probe gaussmeter, tangential field strengths, measured on the part surface, in the range of 30 to 60 Gauss (2.4 to 4.8 kA/m) peak values are normally adequate magnetization levels for magnetic particle examination. It is important to ensure that field strengths in this range are present in all areas to be inspected on the part.

6-26. MAGNETIC FIELD DIRECTION

Unless otherwise specified, each part must be magnetized in at least two directions 90° apart. Depending on part geometry, this may consist of circular magnetization in two or more directions, of both circular and longitudinal magnetization, or of longitudinal magnetization in two or more directions.

6-27. CIRCULAR MAGNETIZATION

CAUTION

CARE MUST BE TAKEN TO REDUCE ARCING.

1. When magnetizing by passing current directly through the part, the current shall be from 300 to 800 A/inch of part diameter (12 to 32 A/mm). The diameter of the part shall be taken as the greatest distance between any two points on the outside circumference of the part.

2. Circular magnetization may be provided by passing current through a conductor that passes through the inside of the part. When the axis of the central conductor is located near the central axis of the part, the same current levels as given in paragraph 6-27, step 1 shall apply. When the conductor passing through the inside of the part is placed against an inside wall of the part, the current levels as given in paragraph 6-27, step 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 around the part circumference (interior) that is effectively magnetized shall be taken as four times the diameter of the central conductor. The entire circumference shall be inspected by rotating the part on the conductor, allowing for approximately a 10% magnetic field overlap.

3. Prods shall not be used.

6-28. LONGITUDINAL MAGNETIZATION USING COILS

1. Longitudinal magnetization is often accomplished by passing current through a coil encircling the part or section of the part. This produces a magnetic field parallel to the axis of the coil. For low or intermediate fill factor coils, the effective field extends a distance on either side of the coil center approximately equal to the radius of the coil. For high fill factor coils, the effective distance of magnetization is 9 inches (22.8 cm) on either side of the coil center. For parts longer than the effective distance, the entire length shall be inspected by repositioning the part within the coil, allowing for approximately 10% effective magnetic field overlap.

2. Longitudinal Magnetization With Low Fill Factor Coils. When the cross-sectional area of the coil is ten or more times the cross-sectional area of the part being inspected, the product of the number of coil turns, N, and the current in amperes through the coil, I, shall be as follows:

a. For parts positioned to the side of the coil:

$NI = [K/(L/D)]$ (±10%)

where:

K = 45,000 A turns,

L = length of part, and

D = diameter of the part (measured in the same units as the length).

b. For parts positioned in the center of the coil:

$NI = [KR/((6L/D)-5)]$ (±10%)

where:

R = radius of the coil, inch (or mm),

K = 43,000 A turns per inch if R is measured in inches (1690 A turns per mm),

L = length of the part, and

D = diameter of the part (measured in the same units as the length).

3. If the part has hollow portions, replace D with Deff as given in paragraph 6-28, step 6. These formulas hold only if L/D is greater than 2 and less than 15. If L/D is less than 2, pole pieces (pieces of ferromagnetic material with the same diameter as the part being tested) shall be placed on each end of the part to effectively increase the L/D to 2 or greater. If the L/D is greater than 15, the value of 15 shall be substituted for L/D.

4. Longitudinal magnetization with high fill factor coils. When the cross sectional area of the coil is less than twice the cross sectional area (including hollow portions) of the part under testing, the product of the number of coil turns, N, and the current in amperes through the coil, I, shall be as follows:

$$NI = [K/((L/D)+2)] (\pm 10\%)$$

where:

K = 35,000 A turns,

L = length of the part, and

D = diameter of the part (measured in the same units as the length)

5. If the part has hollow portions, replace D with Deff as given in paragraph 6-28, step 6. These formulas hold only if L/D is greater than 2 and less than 15. If L/D is less than 2, pole pieces (pieces of ferromagnetic material with the same diameter as the part being tested) shall be placed on each end of the part to effectively increase the L/D to 2 or greater. If the L/D is greater than 15, the value of 15 shall be substituted for L/D.

6. Calculating the L/D ratio for a hollow or cylindrical part. D shall be replaced with an effective diameter, Deff, calculated using the following:

$$Deff = 2[(At - Ah)/p]^{1/2}$$

where:

At = total cross sectional area of the part, and

Ah = cross sectional area of the hollow portions of the part.

For cylindrical parts, this is equal to the following:

$$Deff = [(OD)^2 - (ID)^2]^{1/2}$$

where:

OD = outside diameter of the cylinder, and

ID = inside diameter of the cylinder.

6-29. LONGITUDINAL MAGNETIZATION USING AN ELECTROMAGNETIC PROBE

CAUTION

DUTY CYCLE FOR AN ELECTROMAGNETIC PROBE IS USUALLY 2 MINUTES ON, 2 MINUTES OFF. COIL COVER HEATING IS AN INDICATION OF EXCESSIVE ON TIME.

FALSE INDICATIONS MAY OCCUR IF PROBE LEGS ARE POSITIONED WITHIN 2 1/2 INCHES OF EACH OTHER.

DO NOT SWITCH THE PROBE FROM DC TO AC OR FROM AC TO DC WHEN THE PROBE IS TURNED ON.

1. For magnetization using the electromagnetic probe, direct current (DC) is required for all magnetic particle inspections. Adjust magnetization intensity control to maximum.

2. Position probe legs on the part. Decreasing the spacing between the legs will increase the magnetic field strength.

3. Apply inspection material to the inspection surface and immediately press ON to magnetize the part.

4. Allow a short amount of time for particle dwell and drainage.

5. Perform inspection under black light in a darkened area.

6. Reposition probe legs 90° from original position and repeat step 3 through step 6.

6-30. PARTICLE APPLICATION

1. In the fluorescent wet continuous method, the magnetizing current shall be applied simultaneously with or immediately after applying the suspension. Fluorescent particles suspended in a liquid vehicle shall be applied by flowing over the area to be inspected. Proper sequencing and timing of part magnetization and application of particle suspension are required to obtain the proper formation and

retention of indications. This generally requires that the flow of suspension be stopped simultaneously with or slightly before energizing the magnetic circuit. The magnetizing current shall be applied for a duration of at least 1/2 second, with a minimum of two shots being used. The second shot shall follow the first in rapid succession.

6-31. EVALUATION

CAUTION

DO NOT WEAR PHOTOSENSITIVE OR PERMANENTLY SHADED LENSES WHEN PERFORMING INSPECTION.

1. Following magnetization and particle application, the parts shall be examined for indications under black light in a darkened area. The black light shall be capable of a minimum intensity of 1000 microwatts per square centimeter measured 15 inches (38.1 cm) from the face of the filter or bulb. Inspection booths of stationary equipment shall not exceed 2 foot-candles of white or ambient light during inspection when measured with a white light meter. When performing portable inspections, an opaque cloth or plastic tarp shall be used to darken the inspection area to the lowest possible ambient light level. All indications will be identified as relevant or nonrelevant. Unless allowed by a specific procedure, indications of cracks shall be cause for rejection.

2. Polar effects as a result of design factors, for example; keyways, drilled holes, and abrupt changes in section, may cause indications which are nonrelevant. Adjusting the amperage (decreasing) or electromagnetic probe leg spacing (increasing) can minimize these effects by reducing the magnetic field strength.

3. Some metallurgical discontinuities and magnetic permeability variations may also cause indications which are nonrelevant.

4. When an indication is not believed to be relevant, it should be evaluated as "not acceptable" until the indication is either removed by surface conditioning or reinspected by the same or other nondestructive inspection method and shown to be nonrelevant.

6-32. ACCEPTANCE CRITERIA

Rejectable Defects. Any indication of a crack shall be cause for rejection.

6-33. DEMAGNETIZATION

1. When using AC demagnetization, the part shall be subjected to a field with a peak value greater than and in nearly the same direction as, the field used during examination. This field is then decreased gradually to zero. Hold the part approximately 1 foot (30.5 cm) in front of the coil and then move slowly through the coil and at least 3 feet (91.4 cm) beyond the coil. Repeat this process as necessary. Rotate and tumble parts of complex configuration while passing through the field of the coil.

2. When using DC demagnetization, the initial field shall be higher than and in nearly the same direction as, the field used during examination. The field shall then be reversed, decreased in magnitude, and the process repeated until an acceptably low value of residual field is reached.

3. Whenever possible, parts that have been magnetized circularly shall be magnetized in the longitudinal direction before being demagnetized. After demagnetization, a magnetic field indicator shall be used. Readings obtained equal to or greater than 3 oersteds/gauss anywhere on the part is not acceptable.

4. Demagnetization using an electromagnetic probe. For small parts, apply AC magnetization. Pass parts through area between poles of probe and withdraw parts to a minimum distance of 3 feet (91.4 cm) from probe before turning probe off. For large parts, demagnetize parts in same position as they were magnetized. Apply AC magnetization, keep magnetization switch on and slowly move probe away a minimum of 3 feet (91.4 cm), then turn probe off.

6-34. POST INSPECTION CLEANING

Clean the inspected area with solvent and wipe dry with a clean cloth to remove any magnetic particle residue that could have an adverse effect in the use of the part. Parts shall be corrosion protected to prevent the occurrence of corrosion after final inspection.

6-35. PROCESS CONTROL REQUIREMENTS

1. Specific Process Controls. The following specific process control tests shall be accomplished periodically. The frequency of testing shall be as specified in Table 6-2.

2. Black Light Intensity. The intensity of illumination of each black light source shall be measured. The measured intensity shall not be less than 1000 μW/cm^2 at 15 inches (38.1 cm).

3. Visible Light Intensity. The visible light intensity shall be determined. The measured intensity shall not exceed two foot-candles in the darkened inspection area for inspection of fluorescent magnetic particles.

4. System Sensitivity. The effectiveness of the MPI materials and procedure shall be determined.

A Ketos ring or AS 5282 ring may be used for system test sensitivity.

	AMPERAGE	MINIMUM HOLES DETECTED
△1 Ketos Ring	1400	3
	2500	5
	3400	6
△2 AS 5282 Ring	1500	6
	2500	7
	3500	9

△1 The Ketos ring at amperages of 1400, 2500 and 3400 should reveal 3, 5 and 6 holes respectively.

△2 The AS 5282 ring at amperages of 1500, 2500 and 3500 should reveal 6, 7 and 9 holes respectively.

After test, the Ketos ring or AS 5282 ring shall be demagnetized, cleaned and checked under black light to ensure residual indications do not exist.

Examples:

- When using a Ketos ring or AS 5282 ring all amperages shall be achieved with Full Wave Rectified Alternating Current (FWDC) or Half Wave Rectified Alternating Current (HWDC).
- If using a Magnaflux Magnetic Test Bar #189838 or Continuous Method Test Bar 75130, refer to manufacturers directions.

5. Suspension Concentration. The suspension concentration shall be tested. The settled volume of magnetic particles shall be from 0.10 to 0.40 ml. The high limit (0.40 ml) may be adjusted lower when using accelerated settling tests to give results equivalent to the one hour settling test.

6. Suspension Contamination. The suspension contamination shall be evaluated on the settled suspension. When examined in black light, the liquid shall not show objectionable fluorescence. If the settled particles appear as loose agglomerates a second sample shall be taken. If second sample reveals the same, the bath shall be replaced. If examination of the precipitates reveals two distinct layers, the top layer (contamination) shall not exceed 30% of the bottom layer volume nor shall the contamination layer fluoresce objectionably.

7. Current Flow. The current flow shall be between 0.5 to 1.0 second.

8. Current Output. The current output shall be within ±10% of the indicated current.

9. Internal Shorting. When the current is actuated, there shall be no deflection of the ammeter.

10. Magnetic Field Quick Break. The current decay as measured using a suitable oscilloscope or other applicable method as specified by the manufacturer shall be within the manufacturer's definition of quick break.

11. Black Light Meter. The black light meter shall be certified every six months using an illuminate standard traceable to NIST.

12. Visible Light Meter. The visible light meter shall be certified every six months using an illuminate standard traceable to NIST.

Table 6-2. Fluorescent Magnetic Particle Process Control Tests — Frequency and Requirements

TEST	FREQUENCY	REQUIREMENT
Suspension Concentration	Each Shift	0.10 – 0.40 ml*
Black Light Intensity	Daily	1000 µW/cm^2 @ 15 inches
System Sensitivity	Each Shift	paragraph 6-35, step 4
Suspension Contamination	Weekly	paragraph 6-35, step 6
Visible Light Intensity	Daily	2 foot-candles maximum
Quick Break	Six Months	Per Manufacturer
Black Light Meter	Six Months	DSE-100x or equivalent
Current Flow	Six Months	0.5 – 1.0 second
Current Output	Six Months	±10%
Internal Shorting	Six Months	No Deflection
Visible Light Meter	Six Months	DSE-100x or equivalent
Gauss Meter	Six Months	30 – 60 gauss

6-36. RECORDS

1. Process Control Test Records. Records shall be maintained showing the dates and results of all tests required. When inspection is performed by an independent facility, an inspection report, with information similar to that specified for the inspection log, must be prepared.

2. Inspection Records. An inspection log shall be maintained for all parts inspected showing the part number, lot identification or traveler number, quantity in lot, date of inspection, the number of parts accepted or rejected, reference to any rejection documents and the identity of the inspector.

3. Personnel Certification Records. Records shall be maintained on each inspector showing experience, formal training, examination results, vision tests results, performance evaluations and inspection stamp identification.

6-37. NONDESTRUCTIVE INSPECTION EDDY CURRENT METHOD

6-38. SCOPE

It is not the intent of this NDI method to provide a substitution for penetrant inspection. When the overhaul manual specifies penetrant, and/or for components off aircraft requiring inspection over 100% of the surface area, penetrant inspection (level 3 sensitivity or greater) shall be used (eddy current may not be used as a substitution). Eddy current and penetrant are somewhat complimentary methods of inspection.

Cases may arise when one or the other can be employed to provide additional NDI for evaluation of indications. In some cases, particularly for localized areas on the aircraft, eddy current is recognized as a sensitive method for the detection of fatigue cracks. When eddy current is specified in the overhaul manual, by ASB or other Bell Helicopter approved written directive, written inspection procedures shall be developed by Level III personnel per paragraph 6-47.

6-39. INTRODUCTION

Eddy currents are electrical currents induced in a conductive material by an alternating magnetic field. The eddy currents induced in a metallic part vary in magnitude and distribution in relation to the following specimen properties: electrical conductivity, magnetic permeability, geometry, and homogeneity. Therefore, by measuring the magnitude and/or distribution of eddy currents generated in a conductor, changes in one or more of these variables can be determined. During inspection with eddy currents, care must be exercised to isolate the specimen property of interest, either by eliminating the variation in the specimen properties for which inspection is not performed or by electronically suppressing or differentiating the other variables.

6-40. SAFETY PRECAUTIONS

Make sure safety precautions have been met for electrical grounding when using electrical equipment near aircraft fuel cells, oxygen systems, electronic systems, and stores.

6-41. PERSONNEL QUALIFICATION/ CERTIFICATION

1. All personnel performing NDI shall be certified to meet or exceed Level II requirements as established in the latest revision of NAS 410 or alternate approved document. Personnel that have successfully completed the level I Special NDI training course at Bell Helicopter are qualified to perform eddy current inspections in accordance with the applicable maintenance and overhaul manuals, or as specifically authorized in an ASB or other Bell Helicopter approved written directive. The ASB or other Bell Helicopter approved written directive must indicate in the document that an individual is qualified to perform such task and may be responsible for product acceptance. The employer of NDI Level I Special personnel must have an established written practice which meets the requirements of ATA 105 for qualification and training of NDT personnel as described in the Bell Helicopter Customer Training Academy (CTA) NDI training course.

Individuals who have successfully completed and passed the Level I Special Bell Helicopter training course may perform routine inspections for acceptance on components as listed in the Chapter 4 Airworthiness Limitations Schedule for retirement life parts and as listed in Chapter 5 Component Overhaul Schedule for components requiring an overhaul interval providing the applicable MM and or the CR&O provides the detailed instructions to perform the inspection.

Individuals who have successfully completed and passed the Level I Special Bell Helicopter training course may only perform evaluations on components if the MM or CR&O do not provide the required detailed instructions. An evaluation is performed for information purposes only, and is not intended as a final means of acceptance or rejection. Examples include assessment of a damaged bare metallic skin for evidence of cracking, and to characterize indications found visually (crack, vs. scratch). Actual inspection of such parts needs to be supported by a certified Level II in the method employed. If during the course of the evaluation an indication is found, a person certified to meet or exceed a Level II requirement will be responsible for the acceptance or rejection of that indicated part.

2. Personnel responsible for the development of written eddy current inspection procedures shall be certified to meet or exceed Level III requirements as established in the latest revision of NAS-410, or alternate approved document.

6-42. EQUIPMENT REQUIREMENTS

1. Flaw Detectors. All flaw detector instrumentation shall be capable of detecting surface and/or near surface discontinuities in electrically conductive materials. The operating frequency range of the instrument shall be suitable to collect the desired information from the material under test. Instrumentation shall possess the capability of detecting impedance changes introduced by variations in material properties as well as metallurgically and mechanically induced discontinuities. Equipment shall contain a means to display detected impedance changes. Displays may include CRT's, Meters and/or LCD's.

2. Probes. Optimization of defect detection is the primary objective in the selection of probes. Defect type, size and orientation along with part geometrical and metallurgical characteristics shall be considered. All probes shall be compatible with the detection instrumentation and be identified as to type and frequency. Table 6-3 shall be used as a guideline for selection of probe frequency. When using small diameter surface probes, the use of shoes and/or

collars to prevent undesirable lift-off effects is highly recommended. When using bolthole probes, fill factor ratios shall be as close to 1:1 as possible and allow for full coverage of the hole under test. Fill factor ratios shall be within ± 10% of reference standard ratios. For eddy current inspection of magnetic materials, saturation probes are recommended.

6-43. REFERENCE STANDARDS

1. All inspections require the use of reference standards. Reference standards shall be representative of the material, and in cases where part geometry effects lift-off, geometry of the test material. Each standard shall be constructed of the same base material and have approximate conductivity values of the material under test (refer to Table 6-4 and Table 6-5). These standards may be actual parts, manufactured specimens to simulate parts, or general purpose flawed material containing natural or artificially induced flaws. All standards shall be identified and have documentation on file defining, as a minimum, base material type, condition and flaw pedigree.

2. Defects. Reference standard defects may be naturally occurring or artificially induced. For naturally occurring flaws, at least one other inspection method shall be implemented for the determination of flaw pedigree. Artificially induced flaws may be introduced through machining, drilling, etc. Electrical Discharge Machining (EMD) is the recommended method for crack simulation. Recommended crack depths are 0.010 inch (0.254 mm), 0.020 inch (0.408 mm) and 0.040 inch (1.016 mm).

3. Reference Standard Material. All eddy current instrumentation shall be capable of detecting discontinuities in the materials listed in Table 6-4 and Table 6-5.

4. Surface Preparation/Cleanliness. Reference standards shall have a surface finish representative of the component under inspection. Oxides, scale, paint or other foreign surface material which when present, prevents the inspection to be performed to its required efficiency shall be removed prior to inspection. Any surface finish which impedes reference standard defect responses greater than 10% deflection/ amplitude shall be removed (refer to Chapter 4).

5. Surface Roughness. Surface roughness of reference standards and components/material to be inspected shall be such that at least a 3:1 defect signal to noise ratio is maintained. For components listed in Chapters 4 and 5 (Airworthiness Limitations/ Inspections and Component Overhaul Schedule), eddy current inspections shall not be performed on surfaces which exceed 125 RHR. For all other components, eddy current inspections shall not be performed on surfaces which exceed 250 RHR.

6-44. INSPECTION

1. Calibration Requirements. Unless otherwise specified by overhaul manual, ASB or other Bell Helicopter approved written directive, the inspection system shall be calibrated as follows prior to inspection. Connect applicable surface probe (geometry and frequency range). Nonconductive shims shall be used to represent paint thickness when calibrating for inspection of painted surfaces. Null/ balance on a defect-free area of the appropriate reference standard. Lift-off shall be compensated for (for phase analysis displays, lift-off shall be oriented along the horizontal axis and deflections obtained from simulated cracks shall be oriented vertically). Gain shall be adjusted to provide a crack deflection (0.020 inch (0.408 mm) crack depth) with a minimum of 30% full scale from the null point.

2. Calibration shall be checked prior to inspection, after inspection and periodically within every fifteen minutes of continuous inspection. If the system is found to be out of calibration, the cause shall be determined and corrected, and all inspections performed after the last successful calibrated repeated.

3. Scanning Requirements. Areas of inspection shall be scanned 100%. Scanning may be manual or automated, when automated scanning is incorporated, alarms shall be employed. Scanning shall be accomplished in two axes. Scan indexing shall not exceed one-half of the probe diameter. Scan speeds shall not exceed calibration scan speeds. Nonconductive guides, i.e., straightedges, hole templates, etc. may be used to enhance scanning. A thin protective layer of teflon tape may be used on probe faces to reduce friction and reduce probe wear.

6-45. EVALUATION

1. All indications shall be verified after recalibration per paragraph 6-43. Penetrant, high magnification

visual and/or additional NDI methods may be employed to aid in verification process.

6-46. ACCEPTANCE CRITERIA

1. All verified indications of cracks shall be cause for rejection.

6-47. INSPECTION PROCEDURES

1. When inspection per overhaul manual, ASB or other Bell Helicopter approved directive is required, written inspection procedures shall be prepared. This specification along with the applicable inspection procedures, as a unit, govern the inspection requirements. These procedures shall be sufficiently detailed in the following areas:

a. Area to be Inspected. A description of area, cross section, surface, etc., to be inspected, as indicated from the applicable callout shall be given.

b. Equipment. All equipment, probes, recorders, etc. required to perform the inspection shall be documented.

c. Reference/Calibration Standards. List calibration/reference standards required to perform the inspection.

d. Calibration. List initial equipment control settings necessary to establish a starting point from where final calibration can be obtained.

e. Preinspection. Described steps to be performed before inspection can begin, i.e., cleaning, fixturing, etc.

f. Inspection. Describe the sequence of steps required to perform this inspection. This section shall be written in sufficient detail to assure repeatability of the inspection.

g. Evaluation. Describe techniques used to verify indications detected.

h. Accept/Reject Criteria. Identify the document and/or location of acceptance criteria applicable to this inspection.

i. Post Inspection. When applicable, describe operations necessary for clean-up/handling of part after inspection.

j. Records. Describe steps necessary for the recording and maintenance of inspection results.

k. Additional NDI. Reference other NDI methods and/or procedures, when applicable, used to provide additional evaluation of detected indications.

6-48. PROCESS CONTROL REQUIREMENTS

1. Personnel

a. All personnel performing inspections shall be certified in accordance with paragraph 6-41.

2. Equipment

3. All inspection instrumentation used to perform eddy current inspection shall have valid calibration certification traceable to procedures and/or standards required by the National Institute of Standards (NIST).

Table 6-3. Probe Frequency Selection

TEST MATERIAL	OPERATING FREQUENCY
Aluminum	100 – 500 kHz
Steel	300 – 1.0 MHz
Titanium	500 – 1.0 MHz

Table 6-4. Reference Standard Materials Non-Critical Components

TEST MATERIAL	REFERENCE STANDARD MATERIAL
All conductive nonferromagnetic alloys with conductivity's between 15% and 60% IACS.	Nonferromagnetic alloy with a conductivity that does not exceed 15% IACS of test material.
All conductive nonferromagnetic alloys with conductivity's between 0.8% and 15% IACS.	Nonferromagnetic alloy with a conductivity that does not exceed +0.5% or -0.8% IACS of test material.
High permeability steel and stainless steel alloys.	4130, 4330, 4340 or similar high permeability alloys in any heat treat condition.
Low permeablity alloys.	17-7 PH annealed.

Table 6-5. Reference Standard Materials for Components Listed in Chapter 4 and Chapter 5 (Airworthiness Limitations/Inspections and Component Overhaul Schedule)

TEST MATERIAL	MAGNETIC PROPERTIES	REFERENCE STANDARD MATERIAL	SURFACE FINISH
All Aluminum Alloys	Nonmagnetic	Same as Table 6-4	< 125 RHR
All Titanium Alloys	Nonmagnetic	Ti-6A1-4V	< 125 RHR
All 300 Stainless Steel, Nickel Alloys, A286, N155, MP35, Inconel 625 and 718 Hasteloy X	Nonmagnetic (1)	304 and 321 annealed	< 125 RHR
Precipitation Hardening Stainless Steels			
17-4 PH, 15-5 PH, PH13-8 Mo, Custom 455	Moderately Magnetic	17-4 PHH1025 condition|	< 125 RHR
17-7 PH Annealed	Slightly Magnetic	17-7PH annealed	< 125 RHR
17-7 Heat Treated	Moderately Magnetic	17-07 PHTH1050 condition	< 125 RHR
All AISI-SAE low alloy steels: i.e. 4130, 4340, 8620, 9310, 1095; H-11, H-12, M-50, 300M, 52100, 4330V, Nitralloy N, Nitralloy 135, X-53, 18 Ni Maraging grades, Aermet 100	Highly Magnetic	4340 Heat Treat to 125 KSI minimum	< 125 RHR

6-49. ULTRASONIC INSPECTION METHOD

6-50. INTRODUCTION

Ultrasonic inspection is a method of inspection using sound waves with frequencies that are above the audible range. These sound waves provide information as to the state of various materials. The inspection is accomplished by inducing the ultrasound into the part by coupling the transducer which generates high frequency ultrasonic energy. The transducer picks up the reflected sound from within the part. The detected ultrasonic reflections are electronically displayed and interpreted for indications of defects. Correct selection of transducer, sensitivity, angle and so forth, will enable inspection of surface, subsurface, and back surface of part.

6-51. SAFETY PRECAUTION

Make sure safety requirements for electrical (static) grounding have been met when using ultrasonic equipment near aircraft fuel cells, oxygen systems, electrical systems, and stores.

6-52. PERSONNEL QUALIFICATIONS/ CERTIFICATIONS

1. All personnel performing NDI shall be certified to meet or exceed Level II requirements as established in the latest revision of NAS 410 or alternate approved document. Personnel that have successfully completed the level I Special NDI training course at Bell Helicopter are qualified to perform ultrasonic inspections in accordance with the applicable maintenance and overhaul manuals, or as specifically authorized in an ASB or other Bell Helicopter approved written directive. The ASB or other Bell Helicopter approved written directive must indicate in the document that an individual is qualified to perform such task and may be responsible for product acceptance. The employer of NDI Level I Special personnel must have an established written practice which meets the requirements of ATA 105 for qualification and training of NDT personnel as described in the Bell Helicopter Customer Training Academy (CTA) NDI training course.

Individuals who have successfully completed and passed the Level I Special Bell Helicopter training course may perform routine inspections for acceptance on components as listed in the Chapter 4 Airworthiness Limitations Schedule for retirement life parts and as listed in Chapter 5 Component Overhaul Schedule for components requiring an overhaul interval providing the applicable MM and or the CR&O provides the detailed instructions to perform the inspection.

Individuals who have successfully completed and passed the Level I Special Bell Helicopter training course may only perform evaluations on components if the MM or CR&O do not provide the required detailed instructions. An evaluation is performed for information purposes only, and is not intended as a final means of acceptance or rejection. Examples include assessment of bare metallic skin to determine thickness, or to assess suspect damage of composite laminates or honeycomb composite structures. Actual inspection of such parts needs to be supported by a certified Level II in the method employed. If during the course of the evaluation an indication is found, a person certified to meet or exceed a Level II requirement will be responsible for the acceptance or rejection of that indicated part.

6-53. EQUIPMENT REQUIREMENTS

An ultrasonic instrument having a capability for both the through transmission and the pulse-echo techniques is required. The instrument shall be capable of transmitting and receiving ultrasound of the frequency specified for the inspection. Ultrasonic instruments required for contact inspection may be specific to pulse-echo, through transmission, shear wave, contact impedance, or resonant frequency, The instruments shall have audio and/or visual flaw indicators and be commercially available. Battery operated units shall have low voltage warning.

Ultrasonic equipment shall be calibrated as recommended by the manufacturer, or as defined by the maintenance organizations quality control guidelines.

Ultrasonic transducers may be of the broadband or narrow band frequency type. Typical inspection frequencies shall be 1.0MHz, 2.25MHz, 5.0MHz, and 10.0MHz. The specific transducer frequency used for an inspection/evaluation shall be determined by the Level III individual, or as directed by the MM, CR&O, ASB, or other approved Bell Helicopter directive.

The ultrasonic couplant utilized should be water based. The grade of the couplant should be appropriate for the conditions encountered when performing routine inspection. The use of petroleum

based couplants should not be used on composite parts, but may be utilized on metallic components. Care should be taken to avoid the use of non-compatible materials.

6-54. REFERENCE STANDARDS

Reference standards representative of the part being inspected are required. The reference standard(s) shall be of known quality and shall represent all relevant characteristics of the component it is intended for. The reference standard shall be used to establish acceptable or rejectable thresholds during equipment calibration and/or setup.

6-55. INSPECTION

Unless otherwise specified by MM, CR&O, ASB or other BHTI approved written directive, the ultrasonic inspection unit shall be utilized and calibrated following the applicable written inspection procedure which outlines:

1. Area to be inspected. A description of area, cross section, surface, etc., to be inspected, as indicated from the applicable callout shall be given.

2. Equipment. All specific equipment requirements, probes, recorders, etc. required to perform the inspection shall be documented.

3. Reference/Calibration Standards. List calibration / reference standards required to perform the inspection.

4. Calibration. List initial equipment control settings necessary to establish a starting point from where final calibration can be obtained.

5. Pre-inspection. Described steps to be performed before inspection can begin, i.e., cleaning, fixturing, etc.

6. Inspection. Describe the sequence of steps required to perform this inspection. This section shall be written in sufficient detail to assure repeatability of the inspection.

7. Evaluation. Describe techniques used to verify indications detected.

8. Accept/Reject Criteria. Identify the document and/ or location of acceptance criteria applicable to this inspection.

9. Post Inspection. When applicable, describe operations necessary.

6-56. EVALUATION

All indications shall be verified after recalibration per inspection procedure. Additional NDI methods may be employed for positive defect affirmation.

6-57. ACCEPTANCE CRITERIA

Any indication found using this method should be verified, when it is possible, using another NDE method such as by visual or mechanical means. Acceptance criteria will be as stated in the MM, CR&O, or as stated on applicable safety bulletin or other approved Bell Helicopter directive.