Accreditation Audit Checklist (Version 4.1) With Criteria Explanations

(Based on EASA Std. AR100-2020 and applies for all audits completed after December 1, 2021)

Scope

The EASA Accreditation Program applies only to three-phase, squirrel-cage motors that are repaired in accredited service centers. As such, the scope of the program includes mechanical repairs as well as electrical rewinding.

Notes

- An EASA-approved third-party auditor will determine conformance to the criteria in each line item of the Accreditation Checklist by reviewing applicable service center documents and observing service center practices on site.
- The auditor will record the audit outcome ("score") for each item on the service center's Accreditation Checklist by marking the corresponding check box (first column to the right of "Criteria") as follows:

  S – Satisfactory **U** – Unsatisfactory*

  N – Not observed** **N/A** – Not applicable***

  * Description of any unacceptable condition(s) will be provided.

  ** Applicable mandatory criteria not observed in a prior audit must be observed at the next scheduled audit; the auditor's comments must also include the reason(s) that the criteria could not be observed.

  *** Criteria that do not apply to a specific service center.

- The auditor also will review the service center's calibration program and the calibration status of associated equipment. (See Annex A for list of equipment that must be calibrated.)
- For each criteria the service center must record all applicable tests and measurements made with calibrated equipment.
- **Audit criteria**

  All criteria on the EASA Accreditation Audit Checklist are mandatory. To obtain EASA Accreditation, a service center must submit to an external audit by an EASA-approved third-party auditor and receive a Satisfactory (S), Not Observed (N) or Not Applicable (N/A) score on each checklist item. The symbol Ø indicates a line item that is not audited or a check box that does not require an entry. Any checklist criterion marked "Unsatisfactory" will require Corrective Action (CA) that the auditor will specify and review before accreditation will be granted. Note: Corrective Actions (CA) are measures taken to rectify conditions adverse to motor efficiency and reliability, and where applicable, to prevent repetition.

Outsourcing

Outsourcing of some but not all repair activities is permitted. The outsource vendor must provide documentation to confirm that repairs meet the requirements of this program. If outsourced repair requires measurements or testing, proof that calibrated equipment was used is also required.

Exclusions

Excluded from the scope of the EASA Accreditation Program are specific requirements, certification, and inspection required for listed explosion proof, dust-ignition-proof, and other listed machines for hazardous locations. Also excluded are specific or additional requirements for hermetic motors, hydrogen-cooled machines, submersible motors, traction motors, or Class 1E nuclear service motors.

Service Center–General

A. Housekeeping

	Score	Checklist item
Criteria		Work areas and equipment are clean and orderly, by auditor observation.
Equipment	Ø	N/A

Audit criteria explanation

Criterion: Work areas and equipment are clean and orderly, by auditor observation.

Explanation: The criterion in this clause apply to the service center facility. The cleanliness and orderliness of work areas and equipment are indicators of professionalism and a controlled (and safe) repair environment.

Examples of indicators of conformance include but are not limited to: aisles clear, rotors blocked to prevent rolling Floors swept clean and dry, bake oven tray not overflowing with residual varnish from impregnation process, turnings from machining cleared from machines and floor in machine shop, parts on pallet racks containerized and/or blocked.

If applicable, safety compliance reporting documents to applicable authorities are to be current.

B. Training

	Score	Checklist item
Criteria		Internal training of technicians on technical topics is documented.
Equipment	Ø	N/A

Audit criteria explanation

Criterion: Internal training of technicians on technical topics is documented.

Explanation: Technicians are to receive ongoing technical training, whether formal or informal. Applicable technical training includes topics related to electric motor rewinding, machining, mechanical assembly or disassembly; and theory, principles applications, failure analysis and design/redesign. Applicable training also includes shop or group meetings.

Although not a requirement, external formal training of technicians can enhance internal training on the applicable topics mentioned for internal training. If technicians receive external training, it is to be documented.

Records of attendee names, date and time duration of training, and name(s) and title(s) of trainer(s) are to be recorded. If training is external, location of training venue and title of training program are also to be recorded.

C. Internal audits

	Score	Checklist item
Criteria		Annual internal audits are performed and documented.
		Annual internal audit reports are submitted to external auditor for review.
		If applicable, corrective actions for internal audit findings are taken and documented.
Equipment	Ø	N/A

Audit criteria explanation

Criterion: Annual internal audits are performed and documented.

Explanation: Internal audits are to be performed at least annually. The EASA Accreditation Checklist is to be used for the audits. The auditor(s) and the date(s) of the audit are to be documented.

Criterion: Annual internal audit reports are submitted to external auditor for review.

Explanation: The service center is to submit reports from each annual internal audit to an external audit firm. The external audit firm is to be the firm that will provide the next external audit of the service center. The external auditor will provide a report with any findings as a result of the review of each annual report.

Criterion: If applicable, corrective action for internal audit findings is taken and documented.

Explanation: Findings, if any, from internal audits are to be documented. Corrective actions in response to audit findings are to be documented.

Conformance to recommended practices and guidelines

Recommended Practice: *ANSI/EASA AR100-2020 [AR100]*

Guideline: *Good Practice Guide to Maintain Motor Efficiency [GPG]*

1. Identification and condition assessment

	Score	Checklist item
Criteria		Original nameplate data of repaired motors is documented; or document if nameplate is not present or illegible.
		Shop order number is permanently marked on motors received for repair.
		Records of each shop order are established and retained for at least 3 years after repair.
		The primary cause of failure is determined, if possible, and documented in the repair record.
		Job records document findings during incoming inspections, such as physical condition, mechanical damage, and evidence of overheating; and customer's reason for repair.
Equipment	Ø	N/A
Source references: AR100-1.3-1.5; GPG 1, 2.7-2.8		

Audit criteria explanation

Criterion: Original nameplate data of repaired motors is documented; or document if nameplate is not present or illegible.

Explanation: If the motor has a nameplate the minimum information to record is: manufacturer, power rating (hp or kW), speed, voltage, current, frequency and frame. If there is no nameplate, or the nameplate is not legible, that should be noted in the job record.

Note: In some cases the nameplate data includes multiple entries, such as for dual-voltage and current ratings; and not all nameplates indicate a frame.

Criterion: Shop order number is permanently marked on motors received for repair.

Explanation: When feasible, the exterior of incoming motors is to be permanently marked with the shop order number. Permanent marking is often not practical due to contamination, paint, and the physical construction of the motor; and permanent marking may deface the exterior of the motor.

An alternative to external marking following disassembly is to mark major components such as the stator, rotor and end brackets with the shop order number. Another alternative is that small parts and hardware can be placed in a bin marked with the shop order number.

Note: See Figure B.1 in Annex B for an illustration of terminology associated with the parts of an electric motor.

Criterion: Records of each shop order are established and retained for at least 3 years after repair.

Explanation: There is to be a documented service center policy for the retention period for shop order records. Also, the composition of what are deemed shop order documents should be described. For example, if there are temporary documents used to provide data to be transferred to the shop order records, the practice and procedure should be described such that the expected contents of the shop order record are clearly identified.

Note: Shop order records can be paper or electronic documents, or both; and may include digital photographs.

Criterion: The primary cause of failure is determined, if possible, and documented in the repair record.

Explanation: The primary cause of failure is typically of either electrical or mechanical origin. The purpose of the audit of this criterion is to confirm that the primary cause has been documented. If the primary cause was not identifiable, or not identifiable with certainty, that determination should be documented in the repair record.

Criterion: Job records document findings during incoming inspections, such as physical condition, mechanical damage, and evidence of overheating; and customer's reason for repair.

Explanation: Findings of faults or abnormal conditions are to be documented in the repair record. Satisfactory condition of components as a result of inspections may be noted; but that is not a requirement.

The customer's reason for repair is to be indicated in the repair record. Although there does not need to be specific documentation to indicate how the repairs addressed the customer's reason for repair, the service center should be able to explain to the auditor how this was accomplished. If the customer did not provide a reason for repair, a term such as "unknown" is to be noted in the repair record.

Note: Job records are to be legible, readily identifiable and readily retrievable.

2. Terminal leads, connectors and boxes

	Score	Checklist item
Criteria		Terminal leads of completed repairs are labeled.
		Terminal lugs, if so equipped, are properly crimped.
		Size and type of replacement lead wire are documented.
		Terminal box integrity (e.g., not damaged) is checked.
Equipment	Ø	Confirm calibration and functionality of associated equipment.
		Terminal crimpers function checked at least quarterly for wear and proper crimp by service center
Source references: AR100-1.6-1.8; GPG 2.1		

Audit criteria explanation

Criterion: Terminal leads of completed repairs are labeled.

Explanation: Terminal leads are typically found in the motor terminal box. Original manufacturer labeling consists of either numbers or a combination of numbers and letters on each lead. Motors manufactured in North America, or for use in North America, normally have numbered leads in accordance with NEMA (National Electrical Manufacturers Association) standards. Motors manufacturer in, or for use in, other locations normally have combination number and letter identification in accordance with IEC (International Electrotechnical Commission) standards. The labels are typically permanently marked (e.g., ink) on the leads, are on adhesive paper-like material, or are metallic strips that enwrap the lead.

Terminal leads of incoming repairs or in-process repairs may not have labels on some or all leads. Completed repair are to have terminal leads labeled.

Note: Terminal leads are motor power leads. Accessory leads are outside the scope of this criterion.

Criterion: Terminal lugs, if so equipped, are properly crimped.

Explanation: Terminal lugs at the ends of the motor leads are to be crimped tightly enough to hold the leads securely without fracturing lead wire strands. Tightness can be checked by pulling firmly on the lug with one hand while holding the lead wire adjacent to it with the other hand. Visual inspection can reveal broken strands of wire caused by too much compression of the terminal lug.

The crimp itself should be symmetric–i.e., not offset to one side. If the terminal lug has manufacturer identification, its applicability to the lead wire size can be verified by consulting the lug manufacturer's documentation. The service center is to have the appropriate terminal lug manufacturer's documents on file and available upon request for the auditor to review.

Note: This criterion does not apply to motors without terminal lugs.

Criterion: Size and type of replacement lead wire are documented.

Explanation: The size and type of replacement lead wire are to be recorded in the repair record. If the service center stocks only one type of lead wire, only the lead wire size needs to be documented.

Note: This criterion is not applicable if lead wire is not replaced. It is not typical nor expected that a service center

would record lead wire information if lead wire for a motor was not replaced.

Criterion: Terminal box integrity (e.g., not damaged) is checked.

Explanation: If visual inspection reveals damage to the terminal box, it is to be documented in the repair record. Corrective action taken to address a damaged terminal box is to be documented.

Note: This criterion does not apply to motors without terminal boxes.

3. Cooling system

	Score	Checklist item
Criteria		Fan and fan cover integrity (e.g., not damaged) are checked.
		Check is performed for evidence of damaged or missing cooling system parts.
		Locations of air baffles and end winding spacers to be documented if stator is to be rewound.
Equipment	Ø	N/A
Source references: AR100-1.9; GPG 5.5, 6		

Audit criteria explanation

Criterion: Fan and fan cover integrity (e.g., not damaged) are checked.

Explanation: This criterion most often applies to motors with external cooling fans. However, it also applies to motors with internal cooling fans that may be mounted on the shaft or rotor end rings.

If visual inspection reveals damage to a cooling fan or fan cover, it is to be documented in the repair record. Corrective action taken to address a defect in fan or fan cover integrity is to be documented.

Criterion: Check is performed for evidence of damaged or missing cooling system parts.

Explanation: If visual inspection reveals any evidence of damaged or missing cooling system parts (e.g. ventilation passages), it is to be documented in the repair record. Corrective action taken to address a damaged or missing cooling system part is to be documented.

Criterion: Locations of air baffles and end winding spacers to be documented if stator is to be rewound.

Explanation: This only applies to rewinds. The purpose is to allow duplication within a replacement winding.

4. Shafts

	Score	Checklist item
Criteria		Shaft integrity (e.g., not damaged or worn) is checked.
		Mounting position of the shaft in relation to the leads (e.g., F1 or F2) is noted.
		Initial and, if applicable, after repair shaft dimensions and runout are documented.
Equipment	Ø	Confirm calibration and functionality of associated equipment.
		Outside micrometers
		Dial indicators verified by service center
Source references: AR100-2.1; GPG 2.5, 5.2		

Audit criteria explanation

Criterion: Shaft integrity (e.g., not damaged or worn) is checked.

Explanation: If visual inspection reveals damage or wear to a shaft, it is to be documented in the repair record. Corrective action taken to address a defect in shaft integrity is to be documented.

Note: Bearing journal repair is addressed in Item 5, Bearings (ball, roller; sleeve).

Criterion: Mounting position of the shaft in relation to the leads (e.g., F1 or F2) is noted.

Explanation: If the shaft orientation is recorded with an incoming photo of the motor, that satisfies the requirements of this criterion. If there is no photo, or the shaft orientation is not shown in the photo, the F1 or F2 orientation (or the equivalent) is to be noted in the repair record.

If the terminal box is mounted on top of a horizontal motor, or if the motor is footless, this criterion does not apply.

Note: F1 indicates that the shaft extends to the right when viewing the terminal box; and conversely, F2 indicates that the shaft extends to the left when viewing the terminal box of a horizontal (floor mounted) motor.

Criterion: Initial and, if applicable, after repair shaft dimensions and runout are documented.

Explanation: The repair record is to indicate the initial and, if applicable, after repair shaft dimensions and runout. Although other shaft dimensions may be included in the repair record, only the dimensions of the repaired parts of the shaft must be documented.

Replacement of the shaft, whether by fabricating a replacement or purchasing new, is considered a repair. That is, this criterion also applies to fabricated or new shafts.

5. Bearings (ball, roller; sleeve)

	Score	Checklist item
Criteria		Visually inspect bearings for evidence of fretting, fluting, scoring or other damage.
		As-received, and if repaired, post-repair bearing fit dimensions are documented.
		If repaired, rolling bearing fits are rebuilt to applicable AR100 table size.
		Replacement bearings are equivalent to the original or are better suited to the application; and original and replacement bearing numbers are documented.
Equipment	Ø	Confirm calibration and functionality of associated equipment.
		Inside micrometers (including bore gauges)
		Outside micrometers
Source references: AR100-2.2; GPG 2.3		

Audit criteria explanation

Criterion: Visually inspect bearings for evidence of fretting, fluting, scoring or other damage.

Explanation: If visual inspection reveals evidence of damage to the bearings, it is to be recorded. It is not a requirement that ball and roller bearings be dissected to determine the apparent failure mode. However, the apparent mode of failure is to be recorded for sleeve bearings.

Criterion: As-received, and if repaired, post-repair bearing fit dimensions are documented.

Explanation: The as-received bearing fit dimensions for the journals and housings are to be recorded even if they do not require repair. If bearing journals or housings are repaired, the repair record is to indicate the before and after bearing fit dimensions for the applicable journal(s) and housing(s). These provisions apply to motors equipped with ball, roller or sleeve bearings.

If sleeve bearings are repaired (i.e., rebabbitted), the before and after inside and outside diameters of the repaired bearings are to be recorded.

Criterion: If repaired, rolling bearing fits are rebuilt to applicable AR100 table size.

Explanation: Ball or roller bearing journals, if rebuilt, are to conform to the fits of the applicable tables in AR100. The recorded values for repaired ball or roller bearing fits can be compared to the applicable AR100 fit to verify that this criterion is met.

Note: There are no standards for sleeve bearing fits, thus fits for sleeve bearings are not audited for conformance. However, if sleeve bearing journals or housings are repaired, the before and after measurements of the repaired fits are to be recorded.

Criterion: Replacement bearings are equivalent to the original or are better suited to the application; and original and replacement bearing numbers are documented.

Explanation: The repair record is to indicate the manufacturer and bearing number observed on each original bearing in the motor. Similarly, the repair record is to indicate the manufacturer and bearing number observed on each replacement bearing in the motor. If the replacement bearing identification does not match the original, the service center is to provide evidence to the auditor indicating that the replacement bearing is equivalent to the original or better suited to the application .

6. Lubrication

	Score	Checklist item
Criteria		Lubricant used is compatible with the customer's lubricant; and lubricant used by service center is documented.
		In the absence of the motor manufacturer's lubrication instructions, the grease reservoir is filled to approximately 1/3 capacity.
		If motor is oil-lubricated, there is a means to indicate proper oil level.
		If motor is oil-lubricated, check is performed for evidence of lubricant leakage.
Equipment	Ø	N/A
Source references: AR100-2.3; GPG (none)		

Audit criteria explanation

Criterion: Lubricant used is compatible with the customer's lubricant; and lubricant used by service center is documented.

Explanation: The service center is to have documentation indicating that the lubricant inserted in the motor is compatible with the customer's lubricant. Further, the service center is to identify, such as with a tag, the lubricant inserted in the motor.

Note: A lubrication tag attached to the shipped motor that indicates the lubricant used by the service center and states that lubricants are not to be mixed is an acceptable alternative to verifying lubricant compatibility.

Criterion: In the absence of the motor manufacturer's lubrication instructions, the grease reservoir is filled to approximately 1/3 capacity.

Explanation: Visual inspection of a bearing grease cavity at the time of assembly can indicate that the cavity is partially filled with grease. The amount of grease is to agree with the manufacturer's instructions, if available, or to the alternate 1/3 capacity level. It is not a requirement that the service center obtain the manufacturer's lubrication instructions.

Note: If sealed bearings are used, the cavity need not have any grease content; or there may be a film-coating of grease to help prevent corrosion of ferrous metal surfaces.

Criterion: If motor is oil-lubricated, there is a means to indicate proper oil level.

Explanation: Oil level indications typically are lines drawn across a sight glass, or a supplementary metal plate on the motor explains proper oil level.

Note: If the motor was not manufactured with an oil level indicator, the service center is to request authorization from the customer to retrofit the motor with an indicator. The outcome of the request is to be documented.

Criterion: If motor is oil-lubricated, check is performed for evidence of lubricant leakage.

Explanation: Oil-lubricated motors should be given an exterior inspection for evidence of any oil leakage. Corrective action taken to address lubricant leakage is to be documented.

7. Frame and bearing housings

	Score	Checklist item
Criteria		Frame and bearing housing integrity (e.g., not damaged) are checked.
		Check is performed for evidence of damaged or missing frame or bearing housing parts.
		Parts are match-marked in accordance with service center policy.
Equipment	Ø	Confirm calibration and functionality of associated equipment.
		Inside micrometers (including bore gauges)
		Outside micrometers
Source references: AR100-2.4; GPG 2.2, 5.3		

Audit criteria explanation

Criterion: Frame and bearing housing integrity (e.g., not damaged) are checked.

Explanation: If visual inspection reveals damage to the frame or a bearing housing, it is to be documented in the repair record. Corrective action taken to address a defect in frame or bearing housing integrity is to be documented.

Note: Bearing housing repair is addressed in Item 5, Bearings (ball, roller; sleeve)

Criterion: Check is performed for evidence of damaged or missing parts.

Explanation: If visual inspection reveals any evidence of damaged or missing frame or bearing housing parts, it is to be documented in the repair record. Corrective action taken to address a damaged or missing frame or bearing housing part is to be documented.

This is not a requirement because there may be damage to a component that is not visually obvious; likewise it may not be visually obvious that a component is missing. Corrective action taken to address damaged or missing parts is to be documented.

Criterion: Parts are match-marked in accordance with service center policy.

Explanation: The service center is to have a policy on match-marking parts. For example, the policy may be that the drive end components are match-marked with a single punch mark, and the opposite drive end parts are marked with two punch marks. There are no industry standards for match-marking; thus the service center can choose and must follow its own policy. This policy should also address parts match-marked by another facility where those marks are different than the ones specified in the service center's policy. Anyone in the repair operation of the service center interviewed by the auditor is to be able to describe the service center's policy on match-marking parts.

The major components are to have visual indication of match-marking. The applicable major components include: frame, end brackets, and bearing back caps (if applicable).

8. Squirrel cage rotors

	Score	Checklist item
Criteria		Check is performed for evidence of rotor damage.
		Rotor core is checked for tightness on shaft or spider.
		If repaired, original electrical and mechanical characteristics are maintained. Repair method used is documented.
		Rotor is tested for cage (bars and end rings) integrity. Test results are documented.
Equipment	Ø	Confirm calibration and functionality of associated equipment.
		Growler (functionality)
Source references: AR100-2.5.1, 3.8, 4.3.2; GPG 1.2, 2.6-2.7		

Audit criteria explanation

Criterion: Check is performed for evidence of rotor damage.

Explanation: If visual inspection reveals evidence of rotor damage such as cracked, broken or loose bars, or overheating, it is to be documented in the repair record. Corrective action taken to address rotor damage is to be documented.

Criterion: Rotor core is checked for tightness on shaft or spider.

Explanation: If visual inspection reveals any evidence of rotor core looseness, it is to be documented in the repair record. Corrective action taken to address a defect in rotor core tightness is to be documented.

Criterion: If repaired, original electrical and mechanical characteristics are maintained. Repair method used is documented.

Explanation: Repairs to the rotor that do not remove original material should not affect the electrical or mechanical characteristics. Such repairs include buffing over a rotor surface that has rubbed the stator, or brazing a cracked or open bar or end ring. If the rotor core is repaired, the method(s) used is to be documented.

Repairs that do remove original material from the rotor, such as a "rebar" or skim cut on the rotor surface can change the electrical and mechanical characteristics of the rotor. A rebar is a process of removing and replacing bars and end rings of a rotor. Unless the service center can provided documented design engineering evidence that a rebar or skim cut has not changed the electrical or mechanical characteristics of the rotor, the repair shall be deemed outside the scope of the accreditation program and the motor is not eligible for the program label.

Criterion: Rotor is tested for cage (bars and end rings) integrity. Test results are documented.

Explanation: One or more of the following tests is to be performed:

1. Growler test

2. Single phase test

3. Measurement and analysis of magnetic field

The growler is an electromagnetic device that is essentially the primary of a transformer, and the rotor is placed in contact with the growler to make the rotor the secondary of the transformer. The single-phase test utilizes a single phase power supply to the stator such that the stator is a transformer primary and the rotor is the secondary. The measurement and analysis of the magnetic field uses induction or direct electrical connection to the end rings to create a magnetic field around the periphery of the rotor.

These tests provide an indication of the electrical integrity of the rotor bars and end rings (the rotor "cage"). Information that is to be documented for a growler test includes the finding of any defects (e.g., open bars or bar to end ring joints). The growler test utilizes a strip of magnetic steel, typically a hacksaw blade, to audibly and visually indicate complete circuits (by vibrating) and incomplete circuits (weak or no vibration). The current (amps) to the growler can also be monitored as in the single-phase test (see paragraph below).

Similarly, information that is to be documented for a single-phase test is the finding of evidence of any open connections (e.g., open bars or bar to end ring joints). The single-phase test utilizes variation in current during manual rotation of the rotor to indicate a rotor defect. Therefore, the values of minimum and maximum current during the test are to be documented.

Information to be documented for the measurement and analysis test is the uniformity or lack of uniformity in the magnetic field around the periphery of the rotor. A core loss tester can be used with caution to energize the cage. The use of shaft clamps can result in stray current paths that reduce the effectiveness of the test.

Note: The growler and single phase rotor test utilize variation in current, not the measured currents, for assessment. The ammeter used with these tests does not need to be calibrated.

9. Balancing

	Score	Checklist item
Criteria		Dynamic balancing of the rotating element is to the level specified by the customer; or in the absence of a requested level, dynamic balance is to ISO quality grade G2.5 or better for machines rated 2500 rpm or slower, and to the level of grade G1.0 or better for machines rated above 2500 rpm. Original and final balance values are documented. Exception: Rotors of shaker (vibrator) motors do not need to be balanced.
		Balance weights are located so as not to interfere with other components.
Equipment	Ø	Confirm calibration and functionality of associated equipment.
		Balancing machine (calibration by service center or outsource firm)
Source references: AR100-2.6; GPG (none)		

Audit criteria explanation

Criterion: Dynamic balancing of the rotating element is to the level specified by the customer; or in the absence of a requested level, dynamic balance is to ISO quality grade G2.5 or better for machines rated 2500 rpm or slower, and to the level of grade G1.0 or better for machines rated above 2500 rpm. Original and final balance values are documented. Exception: Rotors of shaker (vibrator) motors do not need to be balanced.

Explanation: Dynamic balancing is performed in a commercial balancing machine. The rotor revolves at a fixed speed and an indication is obtained of the magnitude (mass/weight) and location (mechanical degrees from a reference point) of the unbalance in each (usually two) balancing plane.

The balancing machine may have software that indicates the ISO quality grade 2.5 or other more stringent tolerance and the level attained as a result of balancing. Alternately, the service center may use a formula or tabulated chart to indicate the acceptance values for the ISO quality grade 2.5 or other more stringent tolerance.

The original and final balance values (e.g., units of ounce-inches or gram-millimeters) are to be documented; and the balance tolerance is also to be noted.

If the balancing machine is calibrated by the service center, the calibration procedure is to be documented and referenced to a national/international standard, or comply with the machine manufacturer calibration procedure. The same requirements apply to calibration by an outsource firm.

Note: If the service center uses an external vendor (outsource) for dynamic balancing, the vendor is to provide the service center with documented evidence of machine calibration, original and final balance values, and balance tolerance for each completed service order.

Criterion: Balance weights are located so as not to interfere with other components.

Explanation: A visual inspection of balance weights is to be performed. Corrective action taken to address deficiencies in balance weight location is to be documented

Note: This criterion does not apply in the case of weight removal because interference could not result.

10. Accessories

	Score	Checklist item		
Criteria		Space heaters are tested for rated current or power at rated voltage and subjected to a ground insulation test.		
		Bearing and winding sensors or protectors are identical with or equivalent to the original devices in electrical and thermal characteristics; and replacement winding sensors or protectors placed at the same locations in the windings.		
		Check is performed for evidence of damaged or defective accessory components.		
Equipment	Ø	Confirm calibration and functionality of associated equipment.		
		Ammeter and voltmeter or		Wattmeter
		Megohmmeter or		High-potential tester
		Ohmmeter		
Source references: AR100-2.13, 3.1.2; GPG (none)				

Audit criteria explanation

Criterion: Space heaters are tested for rated current or power at rated voltage and subjected to a ground insulation test.

Explanation: This is not a requirement if the motor is not equipped with space heaters. The current and voltage are to be compared to the rated values, and all values recorded. If a wattmeter is used, the measured wattage is to be within +5%/-10% of the rated wattage of the space heaters, and both values recorded. If a wattmeter is not used, the measured voltage multiplied by the measured current is to be within +5%/-10% of the rated watts. If a wattmeter is not used, the calculated result are also to be documented.

The insulation resistance between space heater electrical element circuit and ground is to be measured and recorded. The motor winding is to be connected to ground during this test. The minimum insulation resistance value is 1 megohm.

Note: Rated current and power of space heaters is the value applicable to the heater circuit and not to the individual heaters. Individual heaters may be connected in series, parallel, or series-parallel.

Criterion: Bearing and winding sensors or protectors are identical with or equivalent to the original devices in electrical and thermal characteristics; and replacement winding sensors or protectors placed at the same locations in the windings.

Explanation: This is not a requirement if the motor is not equipped with bearing and or winding sensors or protectors. Bearing and winding sensors or protectors detect the temperature of the component with which they are in contact. Examples of bearing and winding sensors are resistance temperature detectors (RTDs), thermocouples, thermistors and thermostats. They are to be tested for the characteristics (e.g., resistance, continuity) described in the March 2005 and July 2012 issues of EASA *Currents*.

If a replacement sensor or protector is identical, the manufacturer part number will match the part number of the original; or the manufacturer will provide documentation that the replacement part is equivalent to the original. Similarly, non-identical replacement sensors or protectors are to have documentation to indicate that they are equivalent to the original in electrical and thermal characteristics.

Criterion: Check is performed for evidence of damaged or defective accessory components.

Explanation: A visual inspection of accessories is to be performed. Corrective action taken to address damaged or defective accessories is to be documented.

11. Winding removal and core integrity

	Score	Checklist item
Criteria		Core testing is performed before burnout or other equivalent process, and after winding removal, and the results are documented. Evaluation assessment of core acceptability (watts per lb or kg and temperature rise) is documented.
		Burnout oven has part temperature limited to 700°F (370°C) or less, analog or digital recorder; and water mist system is functional.
		If core test losses increase more than 20% between the before and after winding removal tests, the core is repaired or replaced.
		Parts are oriented and supported in oven so as to avoid distortion.
		Check is performed that core slots are clean and free of sharp edges or particles.
		Core teeth are not splayed (i.e., flared at ends of slots).
Equipment	Ø	Confirm calibration and functionality of associated equipment.
		Temperature meter
		Water mist system (functionality)
		Analog/digital recorder
		Core tester (wattmeter, ammeter and voltmeter integral with tester)
	Ø	or loop test with separate/standalone:
		Wattmeter
		Ammeter
		Voltmeter
Source references: AR100-2.5, 3.1.1, 3.3, 4.2.6; GPG 3.2-3.4, 5.1, 7		

Audit criteria explanation

Criterion: Core testing is performed before burnout or other equivalent process, and after winding removal, and the results are documented. Evaluation assessment of core acceptability (watts per lb or kg and temperature rise) is documented.

Explanation: The criteria in this clause apply to motors with windings that are to be rewound. Core testing of stators with windings that do not need to be rewound can be performed; however, that is not a requirement of this program.

Core testing can be performed by means of a commercial core tester or the loop test method. A core test is to be performed before the winding removal process and after completion of the burnout or winding removal process. Information that needs to be documented includes the amperes and turns of the test loop (1 turn if commercial core tester is used), the induced voltage (which is directly proportional to the magnetic flux in the core under test), the magnetic flux level, the watts loss per pound/kilogram of core back iron weight, and the core temperature rise.

The before and after winding removal core test results and assessments (acceptable or unacceptable) are to be documented in the repair record. The magnetic flux level for the after winding removal test should be within 5% of the before winding removal level. The wattmeter, ammeter and voltmeter of a commercial core tester are to have current calibration labels; and the wattmeter(s), ammeter(s) and voltmeter(s) used for any loop tests also are to have current calibration labels. The oven part temperature meter is to have a current calibration label. The analog or digital temperature recorder also is to have a current calibration label. If the oven part temperature sensor is integral with the recorder, only the recorder must have a current calibration label.

Corrective action should be documented in the repair records for stators with after winding removal test values that exceed the acceptable watts/lb (watts/kg) or temperature rise limits. The results of the acceptable core test following corrective action are to be documented.

Note: See Reference Information at the end of this checklist clause explanation for additional information about core testing.

Criterion: Burnout oven has part temperature limited to 700°F (370°C) or less, analog or digital recorder; and water

mist system is functional.

Explanation: Typically the oven part temperature thermocouple attaches to the stator core. Temperature sensing and recording of the part temperature is required. Although it is preferred that direct (contact) part temperature sensing be used to control part temperature, oven air temperature sensing is acceptable provided part temperatures remain within the prescribed limits. If multiple parts are processed, sensing and recording temperature of each part is required. The reason is that without temperature sensing and recording the actual temperature of any given part(s) would be unknown and may attain a higher temperature outside of prescribed limits.

The water mist system is usually activated by the oven temperature controller. The system can be function tested with the oven at room temperature to confirm that water sprays from it by momentarily manually activating and observing the water spray. The temperature recordings should be archived after each oven operating cycle to provide evidence that the temperature recorder is functional. The stator(s) processed during each cycle should be marked on the applicable recording, or there should be a log that correlates the recordings to the stators processed.

Criterion: If core test losses increase more than 20% between the before and after winding removal tests, the core is repaired or replaced.

Explanation: The watts/lb (watts/kg) values from the before and after winding removal core tests for a stator are to be compared and evaluated. If the "after" value divided by the "before" value is greater than 1.20 (+20%), the core should be repaired or replaced. The corrective action taken when the value exceeds 20% should be documented in the repair records. If the core is repaired the final core test value is to be documented in the repair records. It is suggested that the auditor check at least one active or historical repair before and after core test assessment to verify that the ratio was correctly calculated and interpreted.

Criterion: Parts are oriented and supported in oven so as to avoid distortion.

Explanation: This good practice reduces the possibility of any frame distortion or collateral damage to other stators when multiple stators are processed in the same burnout oven cycle. The feet of the stator should be flat on the oven rack or other support structure. Keeping the feet on the same plane avoids stresses in the frame that could result in distortion. Arranging stators such that core bores do not axially align avoids the tendency of creating a "chimney" effect, which could increase the temperature of the air moving through the stators.

Criterion: Check is performed that core slots are clean and free of sharp edges or particles.

Explanation: Core slots that are not clean can reduce slot space available for the winding, and reduce heat transfer from winding to core. The slots should not have visual evidence of any foreign material. Sharp edges can abrade the magnet wire insulation, which could cause an electrical short. Similarly, small particles could also abrade magnet wire insulation; and large and sharp particles could puncture coil to ground insulation such as slot cells. Corrective action taken to address core slots that are not clean and free of sharp edges or particles is to be documented.

Criterion: Core teeth are not splayed (i.e., flared at ends of slots).

Explanation: This is not a requirement because the evaluation of splayed teeth and their potential deleterious effect on performance is subjective and based on experiential knowledge. Core lamination teeth that are splayed (flared out) at the ends of the core will increase the motor stray load losses. If that condition is found, the teeth should be tamped back in place. Although repair records need not indicate that this condition existed or was repaired, inspection of active stator rewind work in process should not indicate any flared laminations. Note that inactive rewind repairs such as those awaiting customer authorizations to proceed and those in the rewind queue are outside the scope of this inspection. Corrective action taken to address splayed teeth is to be documented.

Reference information

Assessing a stator core integrity and condition is done by a core test. The core test can be performed with a commercial core tester or by using the loop test method. This reference information provides background about the core test and methods of performing it.

The commercial core tester is a standalone machine that applies a high current to a single turn wrapped around a stator core. The loop test method utilizes multiple turns wrapped around the core so as to obtain the required magnetization. The principle of the magnetization is that magnetic strength is a function of amperes multiplied by turns. Thus for a specific core the commercial core tester would use many amperes and one turn, and the loop test would use many turns at a much lower current (ampere) level.

The ampere-turn value of a core test is reference information and is not used for core evaluation. The typical magnetic

flux level of the test is 85 kilolines per sq.in. (1.32 Tesla). The induced voltage level that is equivalent to this flux density value is calculated as part of the test routine. The watts per pound/kilogram limit for a satisfactory core is typically 4.0 watts/lb (8.8 w/kg). The core temperature rise is the difference between the hottest spot in the core at the end of the test period versus the initial core temperature, which should be equal to the room (ambient) temperature. The typical limit for core temperature hot spot rise is 27°F (15°C).

12. Rewind data (specification)

	Score	Checklist item
Criteria		Details of old winding are documented (e.g., EASA Polyphase Winding Data Card).
		Winding data is verified for accuracy.
		Winding changes made to maintain or improve efficiency of a rewound motor are documented.
Equipment	Ø	N/A
Source references: AR100-3.2; GPG 3.1, 4.2		

Audit criteria explanation

Criterion: Details (e.g., EASA Polyphase Winding Data Card) of old winding are documented.

Explanation: The winding detail that is to be recorded includes connection (wye or delta), number of circuits, number of poles, turns and turn sequence if unequal, pitch or pitches, wire sizes and quantity of each, grouping and grouping sequence if unequal, and jumpers. Also, the coil extension from the core at the connection end and the opposite connection end of the winding.

Core dimensions that are to be recorded include core length, inside diameter, back iron, and average tooth width; and number and width of vent ducts, if applicable. Further, the number of slots and total number of coils are to be recorded.

Nameplate data that is to be recorded includes rated power (hp or kW), voltage(s), current (amps), speed and frequency.

Note: The winding data card (or equivalent record) is to include entry locations for each of the above mentioned data entries. The audit evaluation is based on completing the data card (or equivalent record) completely, with the exception of data that is not applicable; for example, vent data for a core without vents would not be recorded.

Criterion: Winding data is verified for accuracy.

Explanation: The winding data can be verified by one or more of three methods. The first is to obtain original factory data from the manufacturer. This is not always practical because of reasons such as: manufacturer unknown or out of business, data is proprietary, data not available in a timely manner, and data uneconomical to purchase.

The second method is to compare the as-found data to comparable data in the EASA Motor Rewind database. If the air gap magnetic flux density and wire area per amp of both windings are within 2% of each other, the windings are functionally equivalent. Note: the core length and bore are to be equal within 2% respectively, and the voltage and current ratings also are to be equal within 1% respectively.

The third method is to calculate the air gap, tooth and back iron magnetic flux densities, and the wire area per amp. The results are then compared to industry norms, such as by using the EASA AC Motor Verification and Redesign program. This program, or an equivalent method, compares calculated values to industry norms based on many thousands of motor data entries. Use of any one or more of the three methods fulfills the requirement of this criterion.

Note: Magnetic flux density values are usually given in kilolines per square inch or Tesla (1 T = 10,000 gauss). Wire area per amp is typically given one of two ways. It can be expressed as circular mils per amp (CMA), which uses the wire diameter in thousandths (mils) of an inch squared to obtain the circular mils. It can also be inversely expressed as amperes per square inch (A/in^2) or square millimeters (A/mm^2) of actual wire area.

Criterion: Winding changes made to maintain or improve efficiency of a rewound motor are documented.

Explanation: Maintenance of efficiency of a winding change is indicated by magnetic flux densities and wire area per amp values that do not change more than 2% from the original as-found winding values. An increase of more than 2% in the wire area per amp value is acceptable since that would indicate a reduction in winding losses and therefore an increase in efficiency.

The most common method to improve motor energy efficiency during rewinding is to increase the wire area per amp. If this is done, the original and as-wound wire area per amp values are to be documented. Any other changes that are done to improve motor efficiency are to have documented objective evidence of the magnitude of the improvement.

13. Stator windings, insulation system, conductors and coils

	Score	Checklist item
Criteria		Voltage rating and insulation class of winding system are equal to or greater than the original, unless redesigned by agreement with, or at the instruction of, the customer.
		Coil extension lengths are not to exceed original.
		Winding wire cross-sectional area per amp is equal to or greater than original.
		Random coils are wedged with full-length top sticks, and phase insulation is used.
		Form coils are wedged and fit securely in slots; and wedges are tight in wedge grooves.
		Magnetic wedges are replaced with equivalent magnetic wedges.
Equipment	Ø	Confirm calibration and functionality of associated equipment.
		Outside micrometer
		Coil winding machine turns counter (accuracy verified by service center)
Source references: AR100-3.4-3.6, 3.9-3.11; GPG 4.2, 4.4		

Audit criteria explanation

Criterion: Voltage rating and insulation class of winding system are equal to or greater than the original, unless redesigned by agreement with, or at the instruction of, the customer.

Explanation: Low-voltage systems are typically rated 600 volts; and medium-voltage systems are usually rated above 1000 volts. The 600-volt systems can be used for motor ratings up to 1000 volts if the winding is wye (not delta) connected. A winding system voltage rating that equals or exceeds the highest nameplate voltage rating of the motor meets this requirement. There is to be documentation of the voltage ratings of the winding systems in use at the service center; and the voltage rating of the winding system need not be documented in the repair record.

The original insulation class is usually indicated on the motor nameplate. The insulation class ratings are: A (or 105°C), B (or 130°C), F (or 155°C) and H (or 180°C). Thus either an alphabet letter that is equal to or further into the alphabet than the original meets this requirement; as does a temperature rating that is equal to or greater than the original. There is to be documentation of the insulation class ratings of the winding systems in use at the service center. Typical insulation system class ratings for service centers are class F for form (rectangular or square wire) coil and class H for random (round wire) windings. If the system insulation class rating used by the service center meets or exceeds the rating on the motor nameplate, this criterion has been met; and the insulation class rating of the winding system need not be documented in the repair record. If the insulation class rating is not provided on the motor nameplate this criterion does not apply.

A winding can be redesigned to a higher voltage rating, such as from a 600 to a 5000 volt system, by agreement with, or at the instruction of, the customer. The winding ground insulation thickness will have to increase (see EASA Tech Note 44, Table 1); and the wire area per amp needs to be equal to or greater than the original. The original and as-wound ground voltage ratings and insulation thickness are to be recorded; and the original and as-wound wire area per amp values also recorded. Conversely, a winding can be redesigned to a lower voltage rating, such as from a 5000 to a 600 volt system, by agreement with, or at the instruction of, the customer. The winding ground insulation thickness can decrease (see EASA Tech Note 44, Table 1); and the wire area per amp needs to be equal to or greater than the original. The original and as-wound ground voltage ratings and insulation thickness are to be recorded; and the original and as-wound wire area per amp values also recorded.

Note: Lead wire voltage rating is to equal or exceed system voltage rating.

Criterion: Coil extension lengths are not to exceed original.

Explanation: The coil extension length measured when obtaining the original winding data is not to be exceeded by the new winding. The coil extension length is the axial distance from the end of the stator core laminations to the

outermost part of the coils. The coil extension on the winding connection end may not be the same as on the opposite connection end. Therefore the coil extension distance is to be measured and recorded for both ends of the winding. If the coil extension length is increased, the winding resistance will increase and thus increase winding copper losses. Winding copper losses are proportional to the rated current squared multiplied by the winding lead-to-lead resistance. The original and as-wound coil extension dimensions are to be measured and recorded.

Criterion: Winding wire cross-sectional area per amp is equal to or greater than original.

Explanation: The original and as-wound wire cross-sectional area per amp values are to be calculated and recorded. The as-wound wire cross-sectional area per amp is to be equal to or greater than the original.

Note: See last criterion of Item 12, Rewind data (specification), for explanation of tolerance applicable to "equal to".

Criterion: Random coils are wedged with full-length top sticks and phase insulation is used.

Explanation: Random coils, also termed mush coils, use round magnet wire. Visual inspection can determine that the random coils are wedged with full-length top sticks and that phase insulation was used. The top stick wedges are made of stiff insulation material and are inserted over the coils at the top of the slot.

Phase insulation is made of flexible insulation material and inserted the full length of the coil extensions between adjacent coils of different phases. The adjacent coils of different phases will have leads (lead wire) or insulated jumpers (magnet wire covered with insulated sleeving material) connected to them.

Note: See Annex B, Figure B.1, for an illustration of terminology associated with random coil windings.

Criterion: Form coils are wedged and fit securely in slots; and wedges are tight in wedge grooves.

Explanation: Form coils use rectangular (or infrequently square) magnet wire. A sampling of individual coils can be manually grasped at the slot exit point and an attempt made to move the coils side to side (circumferentially) and vertically. No evidence of coil looseness should be detected.

The top stick wedge can be visually inspected and physically tapped to confirm tightness. The physical tapping can be performed with a small hammer and a rectangular fiber wedge. The hammer is used to lightly tap the fiber wedge, and the fiber wedge taps the coil top stick vertically and axially with respect to the slot. No evidence of top stick looseness should be detected.

Service center personnel should be able to demonstrate the above looseness checks.

Note: See Annex B, Figure B.2, for an illustration of terminology associated with form coil windings.

Criterion: Magnetic wedges are replaced with equivalent magnetic wedges.

Explanation: Although not common, magnetic top stick wedges are used in some form coil windings. If magnetic wedges are detected in the original winding, they are to be replaced with equivalent magnetic wedges, that is, of the same dimensions. To confirm that magnetic wedges have been used in the new winding, a magnet can be placed in contact with a sampling of the top sticks if the rotor has not been inserted into the stator. If the magnet adheres to the top sticks, the top stick wedges are magnetic and compliance is indicated. Service center personnel should be able to demonstrate this if an applicable stator is available.

14. Winding impregnation

	Score	Checklist item
Criteria		Windings of rewound motors are preheated, varnish/resin treated and cured in accordance with varnish/resin manufacturer's instructions.
		Bake oven temperature control set in accordance with varnish/resin manufacturer's instructions.
		Varnish is maintenance tested in accordance with manufacturer's instructions. Test results and any maintenance actions are documented.
Equipment	Ø	Confirm calibration and functionality of associated equipment.
		Temperature meter
	Ø	Vacuum pressure impregnation (VPI) process (if applicable):
		Vacuum gauge
		Pressure gauge
Source references: AR100-3.13; GPG 4.6		

Audit criteria explanation

Criterion: Windings of rewound motors are preheated, varnish/resin treated and cured in accordance with varnish/resin manufacturer's instructions.

Explanation: Preheating of windings is performed by placing the rewound stator in a bake oven and removing it after the winding has reached or exceeded the preheat temperature range recommended by the varnish/resin manufacturer. With the winding at the recommended preheat temperature range it is removed from the oven and impregnated in the varnish/resin. Following the impregnation the rewound stator is oven baked to cure the varnish/resin in accordance with the manufacturer instructions, including but not limited to time and temperature. The service center is to have documentation of the varnish/resin manufacturer preheat and curing instructions. Service center personnel should be able to demonstrate that the preheat, impregnation, and curing processes follow the varnish/resin manufacturer instructions.

Note: An acceptable alternate method of winding impregnation is the trickle process. The trickle varnish is exothermic and self-cures. The stator is oriented vertically, and the winding is heated by applying power to the winding leads. The trickle varnish is poured on the top of the winding and flows through to the coil extensions at the bottom. If applicable, the service center is to have documentation of the trickle varnish manufacturer process instructions. Service center personnel should be able to demonstrate that the trickle varnish process follows the varnish/resin manufacturer's instructions.

Criterion: Bake oven temperature control set in accordance with varnish/resin manufacturer's instructions.

Explanation: The bake oven temperature control is to be set to a temperature within the range indicated in the varnish/resin manufacturer's instructions. The baking cure time duration is to be at least as long as the minimum given in the varnish/resin manufacturer's instructions for the curing temperature that is used. Winding cure time at a lower temperature will be longer than the cure time at a higher temperature within the manufacturer's ranges. The bake oven temperature and bake cycle duration can be determined by observation of the oven control settings.

Note: Cure time begins when the part reaches the oven setpoint temperature.

Criterion: Varnish is maintenance tested in accordance with manufacturer's instructions. Test results and any maintenance actions are documented.

Explanation: Varnish should be periodically tested in accordance with the manufacturer's instructions. The varnish/resin manufacturer typically tests samples sent to them by the service center. The service center should have documentation indicating that the time periods between testing are within the manufacturer's recommended intervals; and documentation of the manufacturer test results. If the manufacturer makes corrective action recommendations as a result of varnish testing, the service center should have documentation indicating that the recommendations were followed.

Note: This criterion is not a requirement in its entirety. The service center may, at its discretion, use longer time intervals between tests; and may modify varnish/resin manufacturer's corrective action recommendations. For example,

the service center may choose to extend the time periods between tests for a varnish that has indicated stability–i.e., has required no corrective action for 3 or more sample test results.

15. Winding insulation and coil tests

	Score	Checklist item
Criteria		Stator winding insulation resistance is measured, and results are documented.
		Stator winding resistance is measured, and results are documented.
		Stator winding surge comparison test is performed, and results are documented.
Equipment	Ø	Confirm calibration and functionality of associated equipment.
		Megohmmeter
		Ohmmeter or milli-ohmmeter (as applicable)
		Surge tester
Source references: AR100-4.2-4.3; GPG 4.5, 7		

Audit criteria explanation

Criterion: Stator winding insulation resistance is measured, and results are documented.

Explanation: The insulation resistance (IR) measurement is a winding to ground electrical test using a megohmmeter. The test voltage and the minimum IR values are given in AR100. The IR test voltage and megohm values are to be recorded. If the IR value for a test does not meet or exceed the minimum, corrective action is to be taken. Following corrective action the satisfactory IR test value is to be recorded.

Criterion: Stator winding resistance is measured, and results are documented.

Explanation: The stator winding resistance can be measured with either an ohmmeter or a milli-ohmmeter. If the lead-to-lead winding resistance is less than 5 ohms, it usually requires a milli-ohmmeter to provide a test value of sufficient precision (at least 3 significant digits) to compare test readings. Typically there will be 3 test values for the lead-to-lead resistance of a winding. If original manufacturer or prior repair winding resistance values are available, the measured resistance should be compared to them. The stator winding resistance test values and the calculated variation in lead-to-lead resistances are to be recorded. If an unacceptable test result is found, it is to be noted in the repair record, and corrective action taken and documented.

Criterion: Stator winding surge comparison test is performed, and results are documented.

Explanation: The stator winding is surge tested using a commercial surge tester. The tester applies a decaying sine wave voltage (multiple pulses), and the waveform is typically displayed on an oscilloscope. The actual oscilloscope display is of two separate tests across two different sets of winding leads. One result is superimposed on the other and a satisfactory result is indicated by the appearance of a single waveform. If two separate waveforms are present, a winding fault or anomaly is indicated. The surge test outcome of pass or fail (or words to that effect) is to be indicated in the repair record. If an unacceptable test result is found, corrective action is to be taken and documented.

16. High-potential tests

	Score	Checklist item
Criteria		High-potential test new windings and document results.
		High-potential test reconditioned windings if approved by the customer and document results.
		High-potential test accessories of new and reconditioned (if applicable) windings and document results.
		Windings and accessories of windings not reconditioned are insulation resistance tested, and results are documented.
Equipment	Ø	Confirm calibration and functionality of associated equipment.
		High-potential tester
		Megohmmeter
Source references: AR100-4.4; GPG 4.5.3		

Audit criteria explanation

Criterion: High-potential test new windings and document results.

Explanation: The high-potential (also termed hipot) test applies an above rated AC or DC voltage (i.e., overpotential) between the winding and ground (e.g., the motor frame). The test voltage used for high-potential tests of new windings is to be recorded. The test values are to be those given in AR100. If a winding fails a high-potential test, that is to be noted in the repair record; and corrective action is to be taken. Following corrective action the satisfactory high-potential test result is to be noted in the repair record. If a winding passes the high-potential test and there are no additional comments in the repair record, that indicates that the test result was satisfactory.

Criterion: High-potential test reconditioned windings if approved by the customer and document results.

Explanation: This test is performed if the customer approves of it. The high-potential (also termed hipot) test applies an above rated AC or DC voltage (i.e., overpotential) between the winding and ground (e.g., the motor frame). The test voltage used for high-potential tests of reconditioned windings is to be recorded. The test values are to be those given in AR100. If a winding fails a high-potential test, that is to be noted in the repair record; and corrective action is to be taken. Following corrective action the satisfactory high-potential test result is to be noted in the repair record. If a winding passes the high-potential test and there are no additional comments in the repair record, that indicates that the test result was satisfactory

Criterion: High-potential test accessories of new and reconditioned (if applicable) windings and document results.

Explanation: The high-potential test applies an above rated AC or DC voltage between the accessory and ground. The test voltage used for high-potential tests of accessories of both new and reconditioned windings is to be recorded. The test values are to be those given in AR100. If an accessory fails a high-potential test, that is to be noted in the repair record; corrective action is to be taken. Following corrective action the satisfactory high-potential test result is to be noted in the repair record.

Note: This test applies to reconditioned windings if it is approved by the customer.

Criterion: Windings and accessories of windings not reconditioned are insulation resistance tested, and results are documented.

Explanation: The insulation resistance (IR) test is a winding or accessory to ground electrical test using a megohmmeter. The test voltage and the minimum IR values are given in AR100. The IR test voltage and megohm values are to be recorded. If the IR value for a test does not meet or exceed the minimum, corrective action is to be taken. Following corrective action the satisfactory IR test value is to be recorded.

Note: The typical test voltage for an accessory is 500 volts, and the minimum insulation resistance is 1 megohm.

17. Bearing insulation

	Score	Checklist item
Criteria		If applicable, bearing insulation is insulation resistance tested, and results are documented.
Equipment	Ø	Confirm calibration and functionality of associated equipment.
		Megohmmeter
Source references: AR100-4.2.7; GPG (none)		

Audit citeria explanation

Criterion: If applicable, bearing insulation is insulation resistance tested, and results are documented.

Explanation: This test only applies if the motor has one or more insulated bearings.

A megohmmeter is used to test the resistance between bearing insulation and ground. The test voltage and the minimum IR values are given in AR100. The IR test voltage and megohm values are to be recorded. If the IR value for a test does not meet or exceed the minimum, corrective action is to be taken. Following corrective action, the satisfactory IR test value is to be recorded. If the bearing insulation passes the IR test and there are no additional comments in the repair record, that indicates that the test result was satisfactory.

18. No-load tests

	Score	Checklist item
Criteria		No-load running test using test panel is performed at rated voltage.
		Speed is measured and compared with nameplate speed.
		No-load currents and voltages are measured and documented.
		Vibration levels are measured and documented.
		Evaluation assessment of acceptability is documented (e.g., “OK to ship”).
Equipment	Ø	Confirm calibration and functionality of associated equipment.
		Test panel (functionality; instruments calibrated if applicable)
		Voltmeter
		Ammeter
		Digital tachometer (functionality)
		Vibration meter
Source references: AR100-4.5; GPG (none)		

Audit criteria explanation

Criterion: No-load running test using test panel is performed at rated voltage.

Explanation: The no-load test is a functional test of the motor. That is, power from a test panel source is applied to the stator windings, and the rotor revolves. The test panel is to have the capability to apply rated voltage to the motor. The applied voltage is to be within 10% of the motor rated voltage. Service center personnel should be able to demonstrate the highest output voltage that the test panel can achieve. A motor with a winding rated above that voltage shall be deemed outside the scope of the EASA Accreditation program, and the motor is not eligible for the program label.

Criterion: Speed is measured and compared with nameplate speed.

Explanation: The test can indicate that the motor’s actual speed does not match the nameplate rating; thus it is a potential diagnostic tool.

If this test is performed, a digital tachometer is used to measure the rpm of the shaft, and the result are recorded. The speed of a motor rotor during a no-load test will be above rated speed and less than synchronous speed. For example, a motor rated 1750 rpm at 60Hz would have a synchronous speed of 1800 rpm; and at no load the expected speed would

be about 1795-1799 rpm. The formula for synchronous speed is given in the EASA *Electrical Engineering Pocket Handbook*.

Note: The degree of accuracy for the speed measurement does not require a calibrated instrument.

Criterion: No-load currents and voltages are measured and documented.

Explanation: The no-load currents and voltages are to be measured for all three phases and documented. If the test panel does not have metering to display voltage, current, or both, a clamp-on ammeter and portable voltmeter are to be used for the current and voltage measurements. The currents can be compared to prior results of the same motor, if available, or to the range of typical values given in the no-load current article in the February 2005 issue of *Currents*. Further, the auditor can review the repair record of a finished motor to determine if the no-load current was within the guideline tolerance and that the motor was tested at rated voltage.

Criterion: Vibration levels are measured and documented.

Explanation: A commercial vibration test instrument is used to perform this test, and the results are recorded. Vibration is to be measured in all 3 planes of the drive end and both radial planes of the opposite drive end of the motor. The vibration levels are to be within the limiting values given in AR100.

Criterion: Evaluation assessment of acceptability is documented (e.g., "OK to ship").

Explanation: If the motor is deemed to have passed all required tests, the repair record is to have the indication of acceptability (e.g., "OK to ship") entered in the repair record. The service center policy for those authorized to make this determination must be understood within the repair ("shop") operation. Anyone in the repair operation of the service center interviewed by the auditor is to be able to identify the individuals who are authorized to make this acceptability determination.

19. Finish and handling

	Score	Checklist item
Criteria		Motor is externally clean and painted (if applicable).
		Shaft extensions are treated to prevent corrosion.
		Motor is packed/packaged suitably for the form of transportation to be used.
		Oil-lubricated motors are shipped without oil, and the need for lubricant is clearly identified.
Equipment	Ø	N/A
Source references: AR100-1.10-1.11; GPG 6		

Audit criteria explanation

Criterion: Motor is externally clean and painted (if applicable).

Explanation: The motor being externally clean is a requirement. However, exterior painting is not always a requirement. In some cases the customer does not want the motor painted; for example, food industry motors require a special paint, or no paint at all (stainless steel). Visual inspection of the exterior of the finished motor should not indicate evidence of dirt, debris or other contaminant.

If the motor is painted, the paint coating should be uniform and completely cover all visible surfaces except for the shaft, exposed rabbets (e.g., C-face or D-flange), and the mounting feet. The service center is to be able to explain to the auditor the reason(s) for not painting a specific motor.

Criterion: Shaft extensions are treated to prevent corrosion.

Explanation: This is not always a requirement because customers may not want a protective coating; and the motor may be going into immediate or near term operation following delivery. The service center is to be able to explain to the auditor the reason(s) for not treating shafts to prevent corrosion. Visual inspection of the output shaft can indicate the presence or lack of a corrosion preventive coating.

Criterion: Motor is packed/packaged suitably for the form of transportation to be used.

Explanation: Most repaired motors are shipped on service center vehicles. Unless the motor was received with packaging, or the customer requests packaging, the motor is not shipped with any packaging. The repair record is to have an incoming photo of the motor. The auditor can compare the incoming photo of a finished motor to the actual finished motor as an indication that this criterion has been met. Further, the auditor can review the repair record of a finished motor to determine if packaging was specified.

Motors equipped with sleeve bearings are to have their output shafts blocked to prevent axial movement. Visual inspection of a sleeve bearing motor can indicate the presence of shaft blocking.

Criterion: Oil-lubricated motors are shipped without oil, and the need for lubricant is clearly identified.

Explanation: Oil-lubricated motors typically have oil fill ports and pipe plugs for draining oil. Those components, versus grease fittings or no provisions for lubrication, are indicators that the motor is oil-lubricated. Oil in the reservoir(s) of a motor can leak during transportation; therefore oil is to be drained prior to transportation. The identification of the need to fill with oil to the appropriate level prior to operating the motor is typically achieved by the use of tags. The auditor can visibly observe "oil tags" on a finished oil-lubricated motor.

20. Calibration

	Score	Checklist item
Criteria		Proof of current (at least annual) calibration to applicable national standard is available for all applicable instruments.
		Proof of current (at least every 3 years) certification for standards and gauge blocks (if applicable) used for micrometer calibration is available.
Equipment	Ø	All applicable instruments on Equipment List (Note: All applicable are included above)
Source references: AR100-4.7; GPG (none)		

Audit criteria explanation

Criterion: Proof of current (at least annual) calibration to applicable national standard is available for all applicable instruments.

Explanation: Each instrument that must be calibrated is to have an indication of calibration affixed to it. The service center is to provide documentation to indicate that the calibration of each of these instruments is current (at least annual) and was performed in accordance with the applicable national standard. This requirement applies to both in-house and outsourced instrument calibration.

For equipment that is only function checked (i.e., not also calibrated), the service center is to demonstrate to the auditor that there is a formal process for performing the function checks. Examples include terminal lug crimpers and burnout oven water mist systems.

Criterion: Proof of current (at least every 3 years) certification for standards and gauge blocks (if applicable) used for micrometer calibration is available.

Explanation: If the service center uses gauge blocks for an internal calibration program for micrometers, the gauge blocks, or if applicable, set(s) of gauge blocks are to have an indication of calibration affixed to the packaging/container for them. The service center is to provide documentation that shows the certification of each of these gauge blocks or set(s) of gauge blocks is current (at least every 3 years) and was performed in accordance with the applicable national standard.

If the service center does not use gauge blocks to calibrate micrometers, it is to have documented evidence of gauge block certification from the applicable outsource vendor.

Annex A (normative)

Equipment

- Unless noted otherwise, all equipment listed must be on site and functional.
- Except for gauge blocks, all instruments must be calibrated at least annually to applicable national standards. After initial accreditation is achieved, the service center must retain calibration records for a 3-year period, or until the next external audit is performed.
- Verification: Confirming, through the use of objective evidence, that specified requirements have been fulfilled.

Electrical

Milli-ohmmeter
Ohmmeter
Voltmeter (AC)
Ammeter (AC)
Wattmeter (AC)
Megohmmeter
High-potential tester
Surge tester
Core tester [1]
Loop test [1]
Growler (functional)
Test panel (to motor rated voltage; individual instruments calibrated)

Mechanical

Inside micrometers
Outside micrometers
Dial indicators (verification by service center)
Digital tachometer (verification by service center)
Terminal crimpers (verification by service center)
Vibration meter
Balancing machine [2]
Gauge blocks (if applicable) [3]

Physical

Temperature meters
Burnout oven part temperature control
Burnout oven analog or digital recorder
Burnout oven water mist system (verification by service center)
Bake oven temperature control
Winding machine with turns counter (verification by service center)
VPI system vacuum gauge [4]
VPI system pressure gauge [4]

Notes
[1] Must have either one or both of these items
[2] Outsourcing permissible
[3] Periodic verification by gauge block manufacturer or other qualified external source.
[4] Only applies if service center has VPI system (VPI process outsourcing permissible)

Annex B (informative)

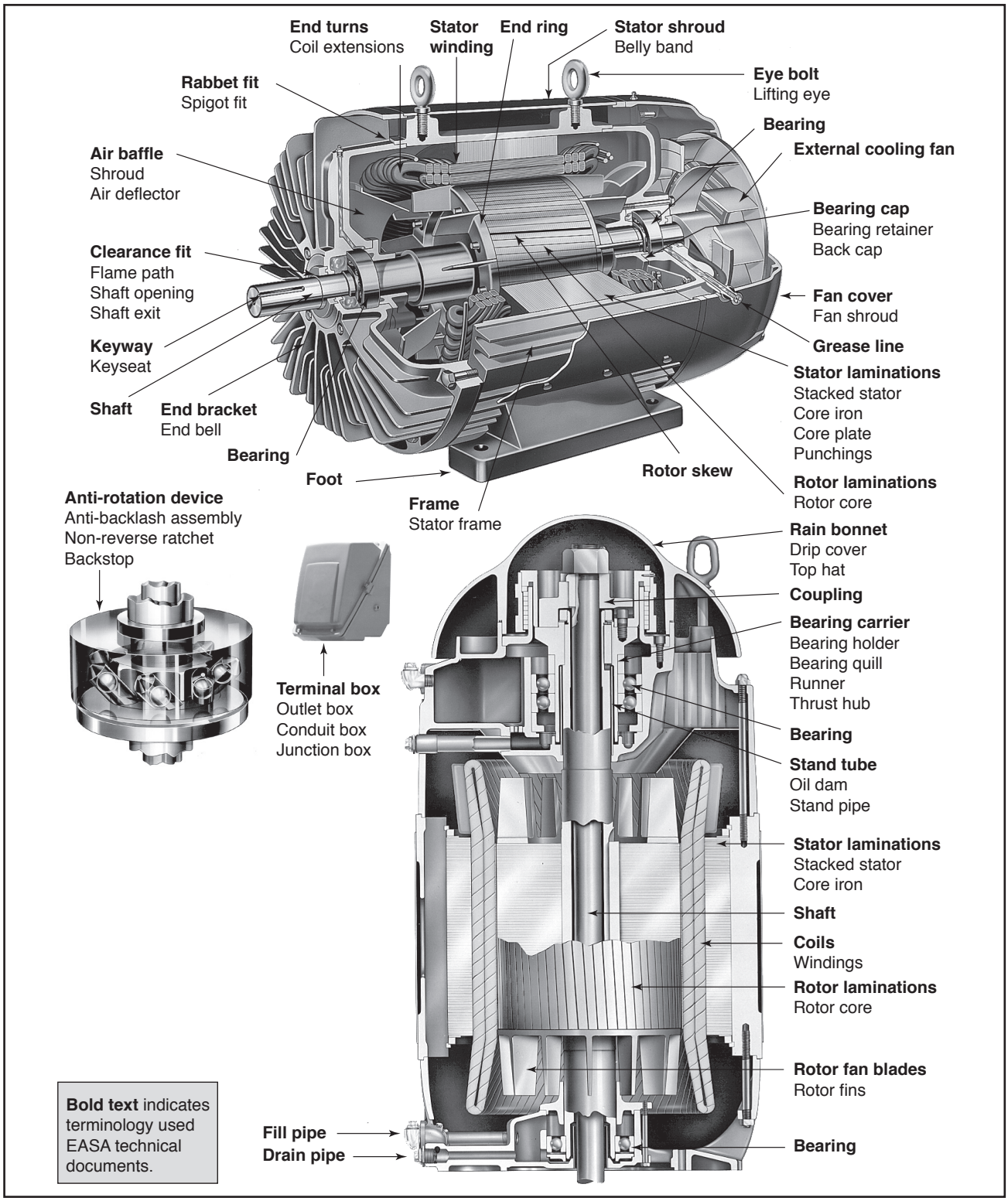

Figure B.1: Terminology associated with the parts of a motor.

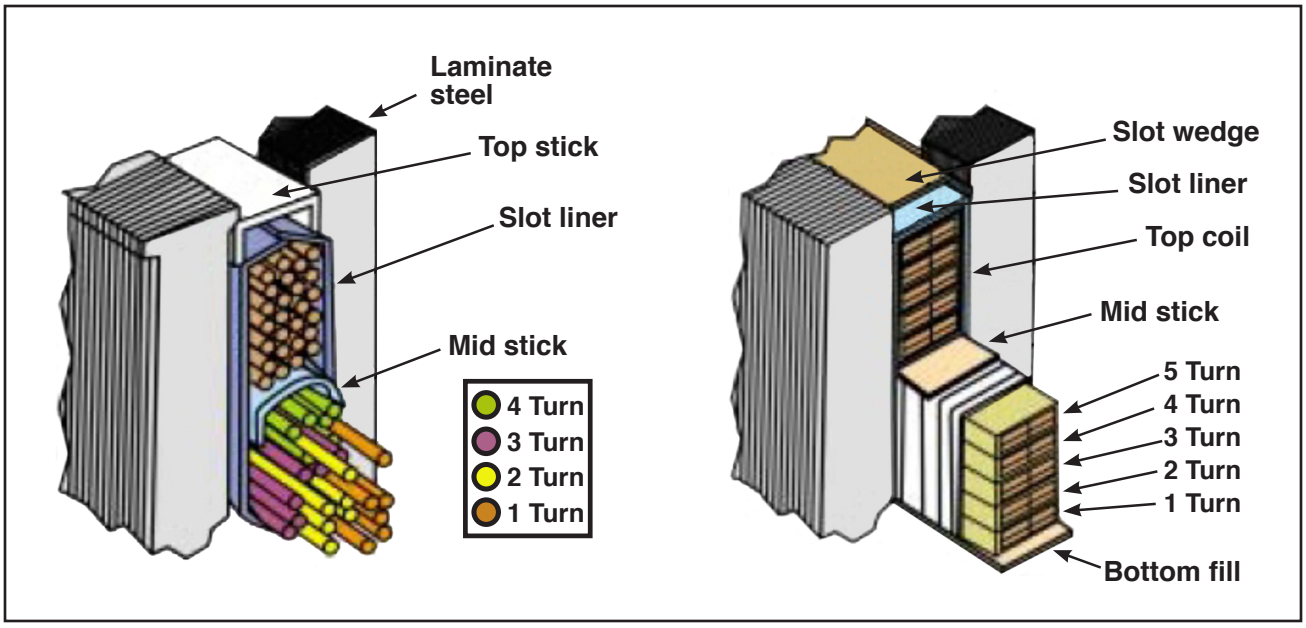

Figure B.2: Terminology associated with random (top) and form coil (bottom) windings.

Annex C (normative)

Referenced EASA *Currents* articles [documents will be provided as PDFs]:

C.1 March 2005
Temperature Detectors: Choosing the Correct Device to Fit the Application, by Thomas H. Bishop, P.E., Senior Technical Support Specialist, EASA.

C.2 July 2012
Identifying Different Types of Temperature Detectors, by Tony Sieracki, Spina Electric, Warren, MI

C.3 February 2005
No-load Current Basics: Practical Guidelines for Assessment, by Chuck Yung, Senior Technical Support Specialist, EASA.