**Date:** **NVLAP Lab Code:** Click or tap here to enter text.

**NIST HANDBOOK 150-10 CHECKLIST (ISO/IEC 17025:2017)**

**(Efficiency of Electric Motors)**

**Instructions to the Assessor:** This checklist addresses specific accreditation criteria prescribed in NIST Handbook 150-10, Efficiency of Electric Motors. These criteria do not supersede the *Criteria for Accreditation* based on ISO/IEC 17025:2017, which are addressed in the NVLAP General Criteria Checklist.

Place an "X" beside each checklist item that represents a nonconformity. Place a "C" beside each item on which you are commenting for other reasons. Record the nonconformity explanation and/or comment in assessment report created in the assessor portal under the laboratory’s assessment record. Place "OK" beside all other items you observed or verified as compliant at the laboratory. Place “NA” beside any requirement that is not applicable.

| **Requirement** | | | **(OK, X, or C)** | **Management System Reference** | **Objective Evidence** |
| --- | --- | --- | --- | --- | --- |
| **6** | **Resource requirements** | | | | |
|  | **6.2** | **Personnel** |  |  |  |
|  | **6.2.1** | The laboratory’s technical director (or an appropriate supervisor) shall be experienced in efficiency of electric motors testing and shall have the technical competence and the supervisory capability to direct the work of professionals and technicians in efficiency of electric motors testing. | Choose an item. |  |  |
|  | **6.2.2** | Staff responsible for conducting the testing shall have technical competence in the following areas as a minimum: |  |  |  |
|  | **a)** | general requirements of the electric motor test methods; | Choose an item. |  |  |

|  | **b)** | testing laboratory system capabilities (electrical, mechanical, and environmental); | Choose an item. |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **c)** | electric motor specimen preparation and/or mounting techniques; | Choose an item. |  |  |
|  | **d)** | connection and operation of the test equipment; | Choose an item. |  |  |
|  | **e)** | electric motor pre-test temperature procedures; | Choose an item. |  |  |
|  | **f)** | techniques for measuring ambient thermal conditions; | Choose an item. |  |  |
|  | **g)** | use of equipment for measuring: |  |  |  |
|  | **1)** | temperature, | Choose an item. |  |  |
|  | **2)** | resistance, | Choose an item. |  |  |
|  | **3)** | torque, | Choose an item. |  |  |
|  | **4)** | power | Choose an item. |  |  |
|  | **5)** | speed (rpm) and slip, | Choose an item. |  |  |
|  | **6)** | voltage, | Choose an item. |  |  |
|  | **7)** | current, | Choose an item. |  |  |
|  | **8)** | and frequency; | Choose an item. |  |  |
|  | **h)** | equipment calibration techniques, when applicable, for labs that perform in-house calibrations; | Choose an item. |  |  |
|  | **i)** | data collection, calculation, and analysis. | Choose an item. |  |  |
|  | **6.2.3** | For each staff member, the staff member’s immediate supervisor, or a designee appointed by the laboratory director, shall conduct annually an assessment and an observation of performance competency. | Choose an item. |  |  |
|  | **6.2.4** | These reviews shall be planned to cover all authorized testing procedures over a defined period. This period is not necessarily one year and may vary depending upon the experience and previous performance of the staff member. | Choose an item. |  |  |
|  | **6.2.5** | These annual performance competency reviews shall be documented, dated, signed by the supervisor and the employee, retained in the personnel file, and be available for review by the assessor. | Choose an item. |  |  |
|  | **6.3** | **Facilities and environmental conditions** | |  |  |
|  | **6.3.1** | Specific environmental requirements for laboratories follow: |  |  |  |
|  | **a)** | For testing of polyphase electric motors (1 hp to 500 hp using IEEE 112 method B or CSA C390 method 1) or three-phase small electric motors (under 1 hp using IEEE 112 method A), the laboratory shall be able to control the ambient air temperature within the temperature range of 10 °C to 40 °C. | Choose an item. |  |  |
|  | **b)** | For testing of single-phase small electric motors (using standards IEEE 114 or CSA C747), the laboratory shall be able to control the ambient air temperature within the temperature range of 20 °C to 30 °C. | Choose an item. |  |  |
|  | **c)** | The motor shall be protected from movement of the air resulting from sources other than the motor. Drafts and air currents shall be minimized to achieve required stable temperature rise during testing. | Choose an item. |  |  |
|  | **d)** | There shall be sufficient open space around the motor during testing so as not to restrict the normal air flow around or through the motor during testing. | Choose an item. |  |  |
|  | **e)** | The ambient temperature shall be relatively stable during the test. | Choose an item. |  |  |
|  | **f)** | The method for securing the motor to restrict movement during testing shall not interfere with the cooling of the motor. | Choose an item. |  |  |
|  | **6.4** | **Equipment** |  |  |  |
|  | **6.4.1** | Provisions shall be available to properly ground the motor and test equipment as may be necessary during testing. | Choose an item. |  |  |
|  | **6.4.2** | Power supply: |  |  |  |
|  | **a)** | The power supply shall be at rated voltage for the motor being tested. If the motor being tested is a small electric motor rated for dual voltage service or service over a range of voltages, it shall be tested at the voltage specified by the motor manufacturer. | Choose an item. |  |  |
|  | **b)** | Polyphase motors shall be tested using a power source with balanced voltages. | Choose an item. |  |  |
|  | **c)** | The line voltages shall be balanced within 0.5 %. | Choose an item. |  |  |
|  | **d)** | The voltages should be sinusoidal and shall not have a total harmonic distortion (THD) exceeding 5 %. | Choose an item. |  |  |
|  | **e)** | The average frequency shall be within ± 0.1 % of the specified test value. | Choose an item. |  |  |
|  | **f)** | The frequency variation during the tests shall not exceed 0.33 % of the average frequency. | Choose an item. |  |  |
|  | **g)** | Any deviation of frequency from the rated frequency shall be taken into consideration when calculating slip. | Choose an item. |  |  |
|  | **6.4.3** | Other equipment requirements: |  |  |  |
|  | **a)** | Test instrumentation shall be properly selected and installed to minimize errors introduced by:  • loading of the signal source;  • lead calibration;  • range, condition, and calibration of the instrument;  • inductive or electrostatic coupling of signal leads to power systems;  • common impedance coupling or ground loops;  • inadequate common mode rejection; and  • conducted interference from the power line. | Choose an item. |  |  |
|  | **b)** | The loading device, such as a dynamometer, shall be appropriate for the size of the motor. The coupling, friction and windage loss of the dynamometer measured at rated speed should not be greater than 15 % of the rated output of the motor being tested. | Choose an item. |  |  |
|  | **c)** | The motor shall be aligned correctly with the loading device (dynamometer). | Choose an item. |  |  |
|  | **d)** | When determining the cold winding resistance, a double bridge shall be used, or other means of equivalent accuracy, and checked by a second instrument, if possible.  *Note: This requirement does not apply to efficiency testing of small electric motors unless temperature is being determined by the rise of resistance.* | Choose an item. |  |  |
|  | **e)** | If thermocouples are used to monitor temperature, they shall be installed correctly. | Choose an item. |  |  |
|  | **f)** | Multiple thermocouples shall be cross-checked at ambient temperature for accuracy and agreement. | Choose an item. |  |  |
|  | **6.4.4** | Accuracy of the test equipment |  |  |  |
|  | **a)** | Instrumentation for measuring voltage, current, and power shall have an accuracy of ± 0.2 % of reading. | Choose an item. |  |  |
|  | **b)** | Instrument transformers shall have an accuracy of ± 0.3 %. | Choose an item. |  |  |
|  | **c)** | When the above instrumentation is calibrated as a system, the accuracy shall be ± 0.2 % of reading. | Choose an item. |  |  |
|  | **d)** | Instrumentation used to measure speed shall have an accuracy within ± 1 rpm. | Choose an item. |  |  |
|  | **e)** | Instrumentation used to measure the output torque of the motor shall have an accuracy of ± 0.2 % of reading.  Dynamometers used for testing of small electric motors shall be sensitive to a change in torque of 0.1 % of the rated torque of the motor under test. | Choose an item. |  |  |
|  | **f)** | The range of each instrument chosen shall be as low as practical for the motor being tested such that readings are in the upper region of the scale. | Choose an item. |  |  |
|  | **6.5** | **Metrological traceability** |  |  |  |
|  |  | The laboratory shall maintain calibration intervals in accordance with appendix A. | Choose an item. |  |  |
| **7** | **Process requirements** | | | | |
|  | **7.2.1** | **Selection and verification of methods** | |  |  |
|  | **7.2.1.1** | **DOE Requirements** |  |  |  |
|  | **a)** | For compliance with the DOE requirements in the NVLAP EEM LAP, laboratories shall use the test procedures described under “Energy Conservation Program: Test Procedures for Electric Motors and Small Electric Motors, Final Rule,” Federal Register 77: 87 (4 May 2012), pp. 26608-26640 (to be codified at 10 CFR Part 431). | Choose an item. |  |  |
|  | **b)** | For testing of polyphase electric motors (1 hp to 500 hp) in compliance with U.S. DOE requirements in the NVLAP EEM LAP, the laboratories shall determine efficiency and losses in accordance with NEMA MG1-2011 paragraph 12.58.1 and the test procedures described in IEEE Standard 112-2004 Method B or CSA International (or Canadian Standards Association) Standard C390-10 Test Method (1). | Choose an item. |  |  |
|  | **c)** | For testing of single-phase small electric motors in compliance with U.S. DOE requirements in the NVLAP EEM LAP, the laboratories shall use the test procedures described in IEEE Standard 114-2010, or CSA International (or Canadian Standards Association) Standard C747-09.  Polyphase small electric motors (power output less than 1 horsepower) shall be tested using IEEE Standard 112-2004 Method A or CSA International or CSA Standard C747-09. | Choose an item. |  |  |
|  | **7.2.2** | **Requirements related to testing equipment** | | |  |
|  | **7.2.2.1** | **Heat Run** |  |  |  |
|  | **a)** | For polyphase electric motors (1 hp to 500 hp) the initial winding resistance measurement shall be taken after the motor is exposed to the ambient temperature for a sufficient time for the windings to reach a stable reference temperature. | Choose an item. |  |  |
|  | **b)** | For small electric motors the initial winding resistance may be measured as above if temperature is to be determined using rise of resistance. | Choose an item. |  |  |
|  | **c)** | For small electric motors the ambient temperature in the test lab shall be not less than 20 °C or greater than 30 °C unless temperature correction of motor losses is calculated as described in IEEE 114-2010. | Choose an item. |  |  |
|  | **d)** | If a heat run is to be performed, it shall be performed first in the test sequence. | Choose an item. |  |  |
|  | **e)** | The heat run shall be performed at rated voltage, rated frequency, and rated load (1.0 service factor). | Choose an item. |  |  |
|  | **f)** | If the motor being tested is a small electric motor rated for dual voltage service or service over a range of voltages, it shall be tested at the voltage specified by the motor manufacturer. | Choose an item. |  |  |
|  | **g)** | If the motor is overloaded at the start of the test to shorten the total test time, the overload shall be kept under 150 % of rated load. | Choose an item. |  |  |
|  | **h)** | The motor shall be operated at rated load, voltage, and frequency for a sufficient period of time for the temperatures to stabilize with not more than a 1 °C change in temperature rise between two successive readings taken at thirty-minute intervals. | Choose an item. |  |  |
|  | **i)** | For polyphase electric motors (1 hp to 500 hp) at the conclusion of the test, the resistance between two lines shall be measured:  • Within 30 seconds of shutdown for motors rated 50 hp or less,  • Within 90 seconds of shutdown for motors rated 51 hp to 200 hp, or  • Within 120 seconds of shutdown for motors rated above 200 hp. | Choose an item. |  |  |
|  | **j)** | If the time limits above are exceeded, then resistance shall be measured as a function of time after shutdown, and the results plotted and extrapolated back to the appropriate time delay to determine the resistance at shutdown. | Choose an item. |  |  |
|  | **k)** | For small electric motors the final winding resistance may be measured as above if temperature is to be determined using rise of resistance. | Choose an item. |  |  |
|  | **7.2.2.2** | **Load performance test** |  |  |  |
|  | **a)** | The load test shall be performed following a heat run. If performed at another time, the motor temperature shall be adjusted by operating the motor at rated load or some overload condition. | Choose an item. |  |  |
|  | **b)** | The temperature of the stator winding shall be within 10 °C of the hottest thermosensor temperature reading during the heat run at rated operating conditions on a machine under test or on a duplicate machine for the rated full load operating temperature prior to beginning the test. | Choose an item. |  |  |
|  | **c)** | The temperature shall be stable at the start of a test. The test should be performed as quickly as possible to minimize temperature changes in the motor during the test. | Choose an item. |  |  |
|  | **d)** | The motor shall be loaded in decreasing order from the highest to the lowest load. | Choose an item. |  |  |
|  | **e)** | The load readings shall be taken at two points suitably chosen above 100 % but not exceeding 150 % of rated load, and at four points including 100 % of rated load and approximately equally spaced between 100 % and 25 % of rated load. | Choose an item. |  |  |
|  | **f)** | The load shall be steady during the time the data at each load are recorded. | Choose an item. |  |  |
|  | **g)** | The dynamometer correction test shall be performed properly in accordance with the applicable procedure in the test standard used. | Choose an item. |  |  |
|  | **h)** | The dynamometer correction test shall be performed after the load test is completed. | Choose an item. |  |  |
|  | **7.2.2.3** | **No-load test** |  |  |  |
|  | **a)** | The motor shall be operated at no-load until the input power at rated voltage and frequency does not vary by more than 3 % between two successive readings over a half hour time interval before starting the test.  This test is not required for the determination of efficiency of a small electric motor. | Choose an item. |  |  |
|  | **b)** | The test shall begin at the highest voltage level and the voltage reduced in steps from that level to the lowest test value.  This test is not required for the determination of efficiency of a small electric motor. | Choose an item. |  |  |
|  | **c)** | The readings shall be taken at voltages from approximately 125 % of rated voltage down to the point where further voltage reduction increases the current or the motor becomes unstable.  This test is not required for the determination of efficiency of a small electric motor. | Choose an item. |  |  |
|  | **7.6** | **Evaluation of measurement uncertainty** | | |  |
|  |  | The uncertainty shall be determined and reported when required by the test method, the regulator, or the customer. | Choose an item. |  |  |
|  | **7.7** | **Ensuring the validity of results** | | |  |
|  | **7.7.1** | The laboratory shall have satisfactorily participated in all required proficiency testing (PT) during its previous accreditation period or prior to accreditation if initial accreditation.  Note: Required PT will be identified on the program page on the NVLAP website. | Choose an item. |  |  |
|  | **7.7.2** | If the laboratory performs unsatisfactorily in any proficiency test, the laboratory shall take corrective action to investigate and resolve nonconformities in a timely manner, according to the requirements of ISO/IEC 17025 for the control of nonconforming work. | Choose an item. |  |  |
|  | **7.8** | **Reporting** |  |  |  |
|  | **7.8.1** | The correlation factor for smoothing stray-load loss shall be equal to or greater than the minimum value prescribed by the applicable standard with no more than one of the six points omitted from the analysis.  For efficiency testing using IEEE 112-2004 Method B, the minimum value is 0.90.  For efficiency testing using CSA C390-10 Method 1, the minimum value is 0.95.  **Note:** This requirement does not apply to efficiency testing of small electric motors. | Choose an item. |  |  |
|  | **7.8.2** | When necessary to repeat the test to obtain a correlation factor equal to or greater than the minimum values listed above, the source of error shall be investigated and corrected prior to rerunning the test.  **Note:** This requirement does not apply to efficiency testing of small electric motors. | Choose an item. |  |  |
|  | 7.8.3 | Data analysis and report generation | |  |  |
|  | **7.8.3.1** | In some cases, raw data collected electronically are collated, reduced, analyzed, or otherwise treated for direct incorporation in the test report. Such treatment involving transmission of the data, writing, and generation of the test report is generally performed at the laboratory or at an area close to the facility and under the control of laboratory personnel. In such cases, the laboratory personnel responsible for the report writing and generation shall be available during the laboratory’s onsite assessment to be interviewed by the assessor for evaluation of the laboratory’s compliance with the NVLAP criteria for test reports. The assessor shall perform an independent calculation of the efficiency based on laboratory test results and compare the independently-calculated efficiency with that calculated by the laboratory. | Choose an item. |  |  |
|  | **7.8.3.2** | At times, the final report may be written and generated at an offsite facility that is located some distance from the testing laboratory such that the assessor cannot interview the offsite personnel. In such a case, the laboratory shall have in place for assessor review appropriate written descriptions in its management system documentation of procedures and documentation for assuring the accuracy and validity of the data transmission, the incorporation and accurate analysis of the data in the test report, and the compliance of the test report with NVLAP criteria. Depending on the onsite laboratory evaluations of these written descriptions, a visit to the offsite facility may be required. When warranted, an assessor will visit the offsite facility at additional cost to the laboratory before accreditation is granted or renewed. | Choose an item. |  |  |
|  | **7.8.3.3** | When a test report is written at an offsite facility such that the assessor cannot interview the offsite personnel, the report shall include the names and addresses of both those responsible for conducting the laboratory tests and for writing and generating the test report. Copies of typical reports written at an offsite facility shall be available at the laboratory at the time of the onsite assessment and these typical reports shall be reviewed by the assessor for compliance with NVLAP requirements. The assessor shall perform an independent calculation of efficiency and compare it to that calculated at the offsite facility as required in 5.10.2.1. | Choose an item. |  |  |
| **8** | **Management system requirements** | | | | |
|  | **8.4** | **Control of records** |  |  |  |
|  |  | To allow for objective evidence during NVLAP assessments, the laboratory shall maintain all records at least three (3) years. | Choose an item. |  |  |
|  | **8.8** | **Internal audits** |  |  |  |
|  | **8.8.1** | An applicant laboratory shall conduct at least one complete internal audit prior to the first onsite assessment. The records will be reviewed by the NVLAP assessor before or during the onsite assessment visit. | Choose an item. |  |  |
|  | **8.8.2** | Internal audits are separate and distinct from both management reviews (see 8.9) and NVLAP onsite assessments. | Choose an item. |  |  |
|  | **8.9** | **Management reviews** |  |  |  |
|  |  | An applicant laboratory shall perform at least one complete management review prior to the first onsite assessment. The records will be reviewed by the NVLAP assessor before or during the onsite assessment visit. | Choose an item. |  |  |

Annex A

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| --- | --- |
| To account for the effects on traceability of the calibration of measurement and test equipment, the laboratory shall determine equipment calibration, verification, and maintenance intervals based on the equipment’s frequency of use and the environment in which it is used, and also in accordance with standard test methods, manufacturer’s recommendations, or as specified in the following table, whichever results in a shorter time between calibrations.  Extension of the time interval between calibrations is acceptable if the laboratory can provide justification for increasing the interval. | |
| ***Apparatus/Instrumentation*** | ***Calibration or Verification Frequency*** |
| ammeters, voltmeters and wattmeters | Annually |
| current transformers (CTs) | Every 5 years |
| potential transformers (PTs) | Every 5 years |
| shunts | Every 2 years |
| data acquisition systems | Annually |
| electronic transducers | Annually |
| frequency meters | Annually |
| resistance measurement equipment | Annually |
| speed sensors | Annually |
| temperature measuring equipment | Annually |
| torque measuring equipment | Annually or more frequently.\* See note below for requirements for the calibration interval for torque measurement equipment. |
| calibration weights and torque arm | 1 to 3 years \* |
| \* With regard to torque measurement, the frequency of recalibration of torque transducers, masses (weights) and arm length needs to be determined by the laboratory.  Torque transducers may need to be recalibrated more often if laboratory calibration records show that the instrument is subject to drifting out of tolerance with time. It is the responsibility of the lab to ensure that torque transducers always meet NVLAP accuracy requirements even if this means more frequent calibrations.  Depending on how often the masses and torque arm are used, their care and storage, and records that the laboratory develops and maintains to see if any change has occurred, the laboratory may determine that the masses and arm length need to be recalibrated relatively infrequently; that is with sufficient documentation for masses and arm length, the laboratory may determine to extend the calibration frequency interval of one year to an interval not exceeding three years. | |