Common recommendations for stored motors

By Chuck Yung
EASA Senior Technical Support Specialist

When an electric motor is expected to be stored for an appreciable time before it is placed into service, certain steps should be taken to ensure that it will be suitable for operation when it is needed. The practical limitation we need to recognize is that much of what we do when putting a motor into long-term storage has to be undone when the same motor is moved into operation. This article addresses common recommendations for stored motors.

The suggested time periods are not absolute; a number of practical considerations might call for a different schedule. While factors such as heat, humidity and vibration affect motors both large and small, it may not be practical to protect smaller motors as diligently as a larger machine.

If you expect to place the motor into service within a few weeks, the only necessary precaution is to protect the motor from weather. Store it indoors, if possible. If an indoor storage location is not possible, cover the motor allowing for a breathing space at the bottom of the cover. If the motor is tightly wrapped in plastic and placed in the sun, the result is a solar still – temperature extremes plus humidity result in condensation inside the motor. For motors that have space heaters, the heaters should be energized to maintain the winding temperature 5-10º C (10-20º F) above the ambient temperature.

For larger (above-NEMA sized) machines, and those expected to be in storage for an extended period of time (several months or years), additional precautions are recommended to protect the windings, bearings, and machined surfaces.

Suitable storage area

Motors should be stored indoors in a clean, dry area with minimal ambient vibration. Motors should be stored in accordance with their intended use: Store horizontal motors in a horizontal position and vertical motors in a stable vertical position.

Precautions should be taken to prevent rodents, snakes, birds, or other small animals from nesting inside the motor. They can damage the winding insulation.

In areas where insects are prevalent, precautions should be taken to prevent them from blocking ventilation or drain openings; loosely wrap the motor, covering openings.

Prepare motor surfaces

There should be some sort of rust preventative coating on the exposed machined surfaces of the motor. A viscous corrosion inhibitor (e.g., LPS2, Techtyl 502C or RustVeto) should remain in place for the duration of the storage period. In humid and rainy/snowy environments, it is a good idea to routinely paint as much of the interior surface as practical. If sleeve bearing surfaces are coated, it will be necessary to dismantle and clean the coating before the machine can be placed into service. For motors in tropical environments, use a topical fungicide to coat the windings.

Bearing damage possible

Even when a motor is not rotating, it may still be subject to vibration. Proximity to rail lines, busy roads, and/or production floors will all contribute to the ambient vibration. Even low-magnitude vibration, over time, can cause bearing damage such as false brinelling. This occurs when the machine bearings are stationary but subjected to repeated vibration. Such damage may not be visible to the naked eye until the machine has been placed into operation, when it quickly worsens. I know of one mill where all stored motors are placed on old conveyor belting, to dampen the ambient vibration from nearby machinery.

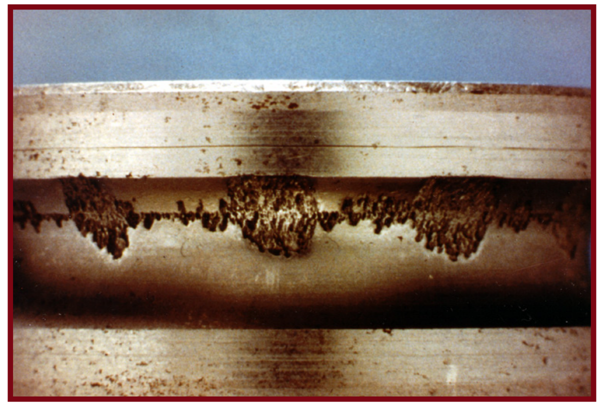

Figure 1. The damage shown here corresponds to the spacing of the rolling elements. The damage started as non-rotating vibration during shipping or storage.

The damage from false brinelling is easily recognized by the uniform spacing (see **Figure 1**) of damage – it matches the spacing of the rolling elements. Corrosion staining can also result, as moisture collects between the balls and races.

Motors placed into long-term storage should have the shaft rotated at regular intervals, both to prevent false brinelling and to redistribute lubricant on the metal surfaces to prevent corrosion. The recommended minimum time interval is monthly, depending on the size of the machine. Larger, 2-pole machines require more frequent attention than smaller (NEMA-frame) machines. In the case of machines with heavy rotors and long frames, regular rotation of the shaft is critical

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to prevent the shaft distortion caused by rotor sag. This is a consideration for machines rated approximately 1500 hp (1000 kW) and larger. Such machines may need to be rotated weekly. As an extreme example, very large generators are kept rotating slowly at all times to prevent sag. While uncommon, for critical, very large machines, the rotor can be removed and suspended vertically to prevent sagging.

Tip: ***Stop the keyway in a different o'clock position each month.*** By designating "5- hour increments," with all shafts following the same rule, you can easily tell if a motor was missed. For example, if the keyway position for September is 12:00, October will be 5:00, November is 10:00, December 3:00, and so on.

This puts the rolling elements in a different orientation each time and avoids rocking the rotor back and forth between just two positions.

If you know that the motor has been subject to vibration while in storage, inspect the bearings visually for damage before installing the motor. If the bearings are damaged, they should be replaced. From a practical standpoint, it makes sense to obtain baseline vibration readings when the motor is placed into service and to check a motor again within a week or two afterwards.

The bearing cavities of grease-lubricated motors should be filled completely *if long-term storage is expected.* If moisture is found in the grease, it is likely that the bearings have sustained rust damage and should be replaced. When the motor is put in service, purge the excess grease by running the motor without a load for at least 10-20 minutes with the drain plug removed. If the motor was stored for several years, the grease has probably hardened and the drain pipe is plugged with dried grease. If so, the best course of action is to dismantle the motor, clean out the old grease, and repack it with fresh grease.

Bearings that are oil-lubricated are shipped without oil and should be filled to the maximum capacity as soon as possible after they have been situated into storage. If at all possible, add enough oil to cover the bearings completely, without overflowing the stand tube or labyrinth seal. The oil should contain a rust and corrosion inhibitor. Water is heavier than oil, so at 3-month intervals draw an oil sample from the drain to check for moisture.

A motor should never be moved with oil in the reservoir. If oil is sloshed over the stand tube, capillary action may continue to siphon oil from the chamber. Before putting the motor into service, the oil should be drained and replaced as well. (Drain it, move it, then refill it.)

Table 1. Dielectric Absorption Ratio recommendation.

Form coil windings:	10 minute insulation resistance / 1 minute insulation resistance should be greater than 2.0
Random windings:	1 minute insulation resistance / 30 second insulation resistance should exceed 1.25.

Special care for windings

Motor windings must be kept clean and dry to prevent insulation degradation while the motor is in storage. If the storage area is not climate controlled, heating should be used to prevent condensation inside the motor. The winding temperature must be kept above the dewpoint (this is usually accomplished by maintaining the winding temperature at 5-10º C (10-20º F) above ambient). Space heaters should be energized if they are supplied (or added if they are not supplied) while the motor is in storage. Another option is to supply low voltage DC to use the windings as a resistance heater (See the July 2013 *Currents* article, "Space Heating to Prevent Motor Damage from Condensation.") Single-phase AC voltage approximately 8-12% of rated voltage can be used instead of DC. A third alternative is to use a dehumidifier to lower the dewpoint of the room in which the motors are stored.

Insulation resistance measurements of the winding(s) should be taken before the motor is put into storage. Even if it is to be idle for a very short period of time, at the very least, test it before it is stored and just before it is put into service. That way, any decrease in the insulation resistance can be addressed before the motor is installed. Hint: attach a card to each motor and record the insulation resistance, temperature and date each time it is checked.

If the motor is in storage for an extended time, insulation resistance (IR) readings should be taken annually, and corrected to a standard temperature.

For form coil windings, a polarization index (PI) test should be conducted in addition to the insulation resistance test. Because the variables that influence a PI test skew results for windings with an appreciable amount of exposed conductor surface area, a dielectric absorption ratio (DA) is used for random windings and DC armatures. See **Table 1**. (Also see the September 2000 *Currents* article, "Use Polariziation Index Test to Determine Condition / Health of Insulation.")

If the windings need to be cleaned and dried, take IR and PI readings again before putting the motor back into storage. According to IEEE 43: If the IR is greater than 5000 megohms, then the PI ratio can be disregarded.

Carbon brushes

DC machines, wound rotor motors, and some synchronous machines are fitted with carbon brushes. For long-term storage, the brushes should be lifted away from the commutator / slip rings to prevent a chemical reaction.

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The springs should be in the relaxed state, when practical, to avoid slow weakening of the springs.

Placing motor into service

Once a motor is taken out of storage, there are a number of things to check before installing it. First, use a megohmmeter to measure the insulation resistance. Next inspect the motor and clean off any dust or dirt. Drain oil-filled motors before moving them to where they will be installed.

After installing and aligning the motor, but before coupling it to the load, record vibration levels. For motors with rolling element bearings, evaluate the spectra for indications of bearing fault frequencies.

For large machines where shaft sag is a consideration, vibration analysis during startup is a critical step in avoiding catastrophic damage. Be sure to document uncoupled baseline vibration levels. Following these guidelines, a motor that was in storage for any length of time is much more likely to perform as expected.

It seems obvious that a high-cost machine justifies more precautions than a readily available, inexpensive machine. Not so obvious: Encourage your customer to factor in the consequence of failure. That small, inexpensive motor might have enormous consequence if it fails during a critical part of their production process.

I'll close with a light-hearted tip from an end user who claimed to have solved his shaft rotation issues easily. All stored motors were placed along the walkway to the break room, with the shafts pointed towards the walkway, and a sign that read "DO NOT TURN SHAFTS!" He said the shafts were all frequently spun, almost daily. ■

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