FRANKLIN AID

Franklin Electric

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Franklin Application/Installation Data (AID)... For The Professional Pump Installer and Driller

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LIGHTNING – Submersible Motor Nemesis?

The question often arises whether or not a submersible motor failure has been caused by lightning, particularly in evaluating insurance claims.

Information in answer to this – based on experience at Franklin Electric – is as follows.

High voltage surges induced in electrical systems by a lightning strike on nearby power lines can cause failure of equipment and appliances - including submersible pump motors.

Depending on the severity of the surge and the available line current which momentarily follows it, the damage to wiring and electrical equipment may or may not be readily apparent. In some cases the surge may damage equipment by weakening its insulation, but failure does not occur until later when additional damage or stress leads to a destructive fault.

It is possible, and in fact quite common, for a lightning-induced surge to cause failure of submersible pumps and other equipment with no visible evidence to prove it. Examination of a failed motor can often give a strong indication of whether the failure was or was not the immediate result of a lightning surge, but there is usually no conclusive proof. The best evidence to support lightning failure of a submersible pump is:

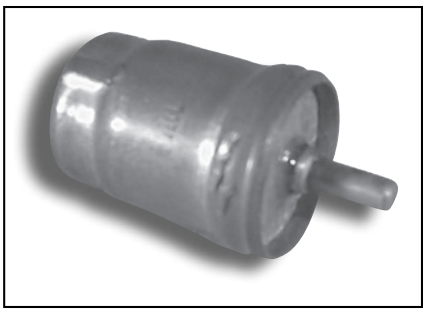
1. **The failure occurred during or at the first usage after an electrical storm.**
2. **Other electrical equipment in the area failed at the same time.**

A hole blown in the motor shell is not proof of lightning failure, nor is the absence of a hole proof that lightning did not cause the failure.

A motor that has been damaged by lightning could exhibit zero resistance to earth, infinite resistance to earth, or even a multi-thousand ohm resistance reading to earth – this type of reading could well be due to “carbon tracking” effects.

A carbon track is a carbonisation of the motor winding insulation (a small “hole” thru the winding insulation) caused by a high voltage surge. If the motor is running

at the time of the surge, the normal running current of the motor will follow thru the hole and continue to arc, increasing the damage to the insulation and immediately disabling the motor. If the motor is not running, the very small hole punched thru the motor insulation will at once weaken the strength of the insulation, then may gradually enlarge as later, smaller, more frequent surges strike. Eventually the build-up of the carbon track thru the hold in the insulation forms an electrical conduction path to the outside motor frame, and motor failure occurs.



Franklin Electric’s exclusive built-in lightning arrestor protects against lightning induced surge damage.

Submersible pump motors are particularly vulnerable to surge damage unless protected by surge arrestors. Reason: the motor shell, when submerged in ground water, is an excellent ground path for the surge, exposing the motor insulation to maximum voltage stress. For this reason, most Franklin domestic submersible pump motors contain internal surge arrestors.

These arrestors momentarily arc over to short potentially damaging surges to the shell at voltage level below that which would damage a normal motor. They then return to an open circuit after the surge is gone. Many years of experience show that these arrestors greatly reduce failures from voltage surges. However, it is still possible for motor failures to result from direct lightning strokes on secondary lines or severe repeated surges.

External three phase arrestor

The use of properly earthed above ground arrestors also greatly reduces the possibility of submersible motor damage from lightning surges. IMPROPERLY GROUNDED ARRESTORS OFFER LITTLE OR NO PROTECTION.

For an above ground arrestor to be most effective in protecting a submersible motor, it is absolutely essential to ground it to “Water Strata Ground” i.e. ground the arrestor to the motor shell (which is sitting in the water). Little or no protection is achieved when the arrestor is grounded to a grounding rod.

Earth wires should be stranded copper wire equal in size or larger than the drop cable used. The above ground arrestor should be connected to the submerged motor shell by means of the metallic drop pipe, or the metallic well casing (provided the casing extends into the well water to within 6 metres of the motor). Still better is to connect the arrestor to the power supply ground and also the metallic shell of the submerged motor via the earth wire, or the metallic drop pipe or the metallic casing. If PVC drop pipe or casing is used, a separate ground wire must be run to either the motor shell or to the motor lead (if it has a ground conductor).

Procedures to aid in determining if a motor has been damaged by lightning

A. Motor in the well

Use an ohmeter to check the winding resistances of the motor per data on pages 13, 16-17 of the Franklin AIM Manual dated 2008.

Then, using a MEGGER, check the insulation resistance between all leads and earth per data on page 33 of the AIM manual. Be sure to check for insulation resistance damage to any lateral (buried) leads.

B. Motor out of the well

Visually check the motor for signs of damage such as burned or charred leads, lead connector, insulation etc. (Also inspect the interior of the control box for same types of damage). Look for holes burned thru the stator shell, particularly in the area of the lead connector socket. Grasp the rotor shaft and try to turn it. If it will not turn, the stator liner is probably bulged due to heating from a lightning induced high voltage surge. Check for discoloration (bluing) of the stator shell (caused by heating from a very large voltage surge). Re-check the resistance readings according to the data in the AIM manual, (Note: The pump itself is very seldom if ever damaged by lightning).

C. Circumstantial Evidence

Was there any damage to TV’s, other electronic equipment and appliances, motor control boxes, switches, wiring?

Were other submersible motors in the area damaged in the same time period?

Is the residence where the motor was damaged out on the end of a power line? Is it on a rise of ground with respect to surrounding terrain? This type of location is like a magnet for lightning.

Hopefully, all of the preceding information will help our Franklin AID readers to be better equipped to prevent and identify lightning damage when it happens “In Their Territory”.