CONSULTANTS MANUAL

Principles and Engineering Application

Causes of Motor Failure

50 - 70% of the motors on board ship are idle most of the time - and *whilst they are idle* they fail from insulation degradation caused by the aggressive environment and the cracking of the insulation from the thermal stresses of intermittent start/stop cycles.

This problem – the *major cause* of motor failures in the marine industry – can only be addressed by *monitoring the insulation resistance of idle motors,* as conventional motor protection for online problems of energized motors completely ignores idle motors.

FailSafe Insulation Monitors operate automatically and continuously to give ***early warning*** when motor insulation degrades in an idle motor, eliminating the need for costly and inefficient periodic Megger testing. In the FailSafe "early warning" range of 10 megohms and below, the insulation has lost most of its dielectric strength and the 24 volts that most FailSafe units use for monitoring gives safe, reliable readings. The diagram below shows the effect of age and aggressive environments on motor insulation levels.

DEGRADATION SPECTRUM OF MOTOR INSULATION

	FailSafe MONITORING RANGE			**FailSafe** ALARM RANGE	
DIELECTRIC	NEW MOTOR	EXCELLENT	GOOD	INADEQUATE	DANGER
INSULATION	<< 1000 MΩ	1000 – 100 MΩ	100 – 10 MΩ	10 – 1 MΩ	>> 1 MΩ

MOTOR AGE INCREASING →

How FailSafe Insulation Monitoring Works

Electric motors provide power because the magnetic field generated by the electric current flowing through its copper winding interacts with the electric currents induced in the rotor. To confine the electric current to the winding, the copper is coated with insulation, which resists the leakage of current to the motor frame. FailSafe Insulation Monitors compare the resistance of the insulation to a standard resistance built into the monitor, to monitor the insulation resistance. Connecting the FailSafe monitor to the motor winding joins the standard resistance in series with the insulation resistance and the monitor uses a fixed DC voltage to pass the same electric current through them both. By comparing the voltage across the two resistances it determines whether the insulation resistance is greater than, equal to or smaller than the standard resistance.

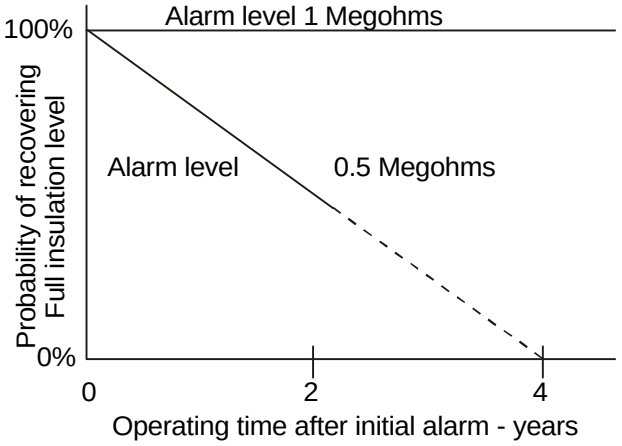

Fig.1 Alarm Setting v. Probability of Recovery - Low Voltage Motors

If it is equal to or smaller than the standard resistance, the FailSafe unit goes into alarm. Practical experience has shown that an alarm level of 1 Megohm gives the best chance of recovering the motor insulation resistance and its dielectric strength by the preventative maintenance measures of drying and re-varnishing the insulation but operating the motor after its insulation resistance has fallen to 0.5 Megohms reduces the probability of recovery significantly. (See Figure 1)

Figure 2 illustrates that, at about the 10 Megohm level the failure risk zone begins and it widens rapidly below 1 Megohm, creating a finite risk of immediate failure at 0.5 Megohms and below. For this reason the factory preset alarm levels are usually 1 Megohm or higher, although other alarm levels are available by request.

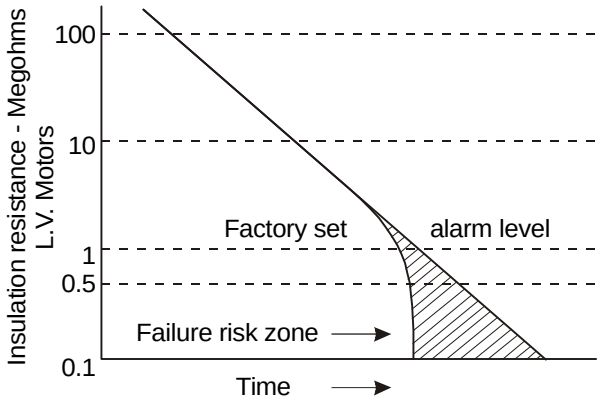

Fig.2 Alarm Setting v. Probable Time to Failure - Low Voltage Motors

Practical Matters

Fig. 3 shows a FailSafe Model MGM600D Monitor connected to a direct-on-line motor.

Terminals 1, 2 & 3 are used for control power input, 1 & 2 for 120 volts AC and 1 & 3 for 220 volts AC. An internal isolating transformer feeds a circuit, which produces a stabilized 24 volts DC for monitoring motor insulation resistance.

Note: Units are available for other AC and DC control power by special request.

Terminals 4 & 5 provide connection to N.O contacts rated at 5 amps, 250 volts AC, resistive, on the alarm relay.

Terminals 6 & 8 are connected to any two phases of the motor windings to sense if the motor is energized. If it is, the monitor opens its internal isolation relay, effectively disconnecting itself from the motor. The voltage appearing at these terminals is called “the isolation voltage”.

Terminals 6 & 7 are used for monitoring the motor insulation resistance. # 6 makes the connection to the motor winding and # 7 to the ground (the motor frame).

Terminal 9 & 10 provide connection to N.C contacts, rated at 5 amps, 250 volts AC, resistive, on the alarm relay

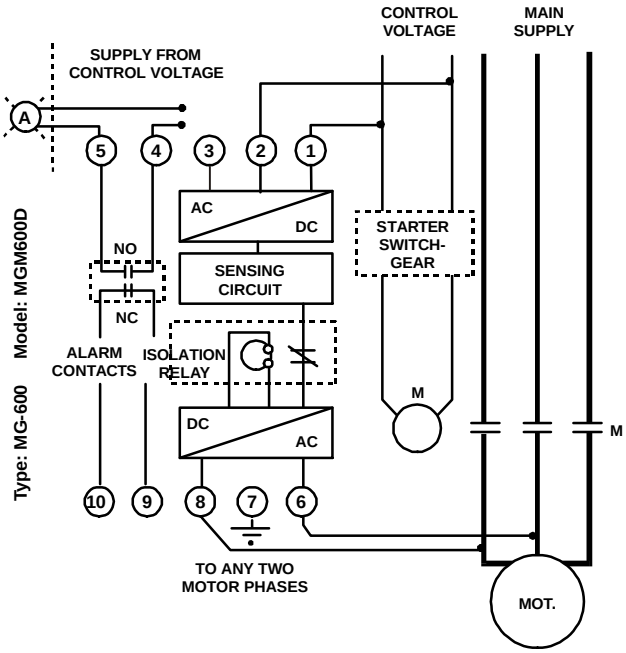

Fig. 3 Connection diagram - direct on line motor

An Alarm Level Switch allows levels of 3, 1 and 0.5 MΩ to be selected. Set it at 3 MΩ initially, then move down when an alarm occurs. Schedule immediate preventative maintenance at 0.5 MΩ.
Routine testing of the energized monitor can be done using the clearly labeled **“ON/TEST”** and **“ALARM/RESET”** push buttons on the FailSafe Insulation Monitor. Push and hold (up to 10 seconds) The **“TEST”** button until the **“ALARM”** button lights to test the monitor. Reset with **“RESET”** button.

Motors may meggered (to 1,000 volts DC) with the FailSafe Insulation Monitor connected, by switching off the control power to the monitor.

Basic application principles – motors to 600 volts

FailSafe Insulation Monitors automatically sense insulation resistance when the motor is de-energized, i.e. the condition in which insulation degradation occurs. The following rules must be applied.

Rule 1. The motor must be completely isolated from the supply; if a solid state starter is used, an isolation contactor must be installed between the starter and the supply.

Rule 2. The isolation circuit must sense the voltage applied to the motor when it is energized – connected as shown in the diagrams.

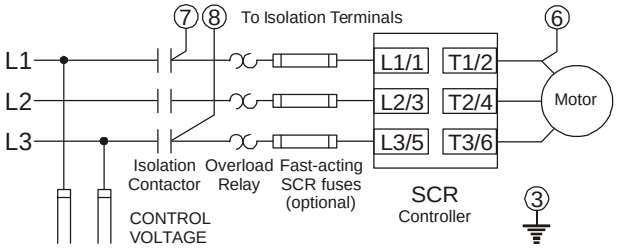

Fig 4. Solid State Starter with Isolation contactor - M603INDS Connection

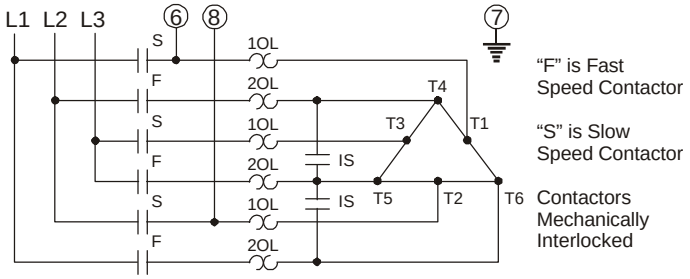

Fig 5. Multi-speed, same winding - connect 6 and 8 to any two phases on the load side of the final running state contactor

For **reversing motors,** connect to any two phases on the load side of either contactor**; multispeed separate windings,** connect a FailSafe monitor as direct on line, to each winding; **slip ring motors,** connect to any two phases of the stator and connect terminal 6 of a second monitor, via a NC contact on the main contactor, to any slip ring; **DC motors** should be treated as AC motors with solid state starters. (Fig. 4).

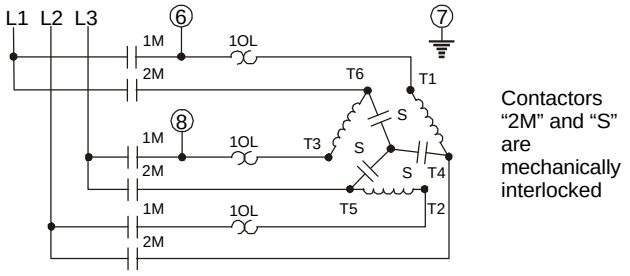

Fig 6. Star-Delta starter - connect to any two phases on the load side of the main contactor

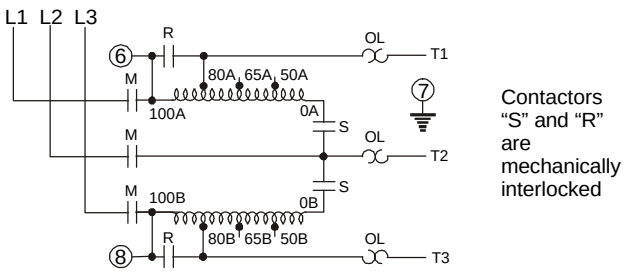

Fig 7. Autotransformer starter - connect 6 and 8 to any two phases on the load side of the final running state contactor

Basic application principles – marine generators

As the neutral of **AC generators** is isolated from ground in normal practice, they can be treated as direct-on-line motors (Fig. 3), except that monitor control power must be obtained from a separate source. Ungrounded **DC motors** can be treated the same way.

Multiple motor installation

It is recommended that the FailSafe Insulation Monitor for each motor be installed in the motor enclosure and the NO alarm relay contact (terminal 4 & 5) be used to control a remote alarm indicator (Fig. 8)

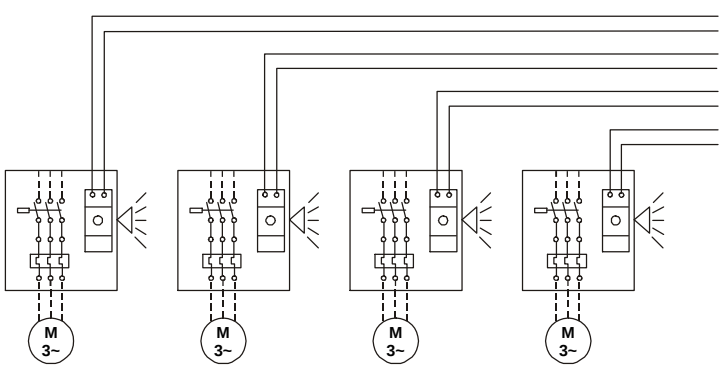

Fig. 8 Multiple Motor Installation – Typical Method

General Notes

In the unlikely event of a component failure, the FailSafe Insulation Monitor design is such that the normal operation of the monitor control is not affected.
The enclosure is made of self-extinguishing plastic and all terminals are completely shrouded, for safety DIN rail mounting is standard. When installed correctly, the unit meets the US Navy MIL Spec S901C requirements.
After completing the external wiring to the FailSafe Insulation Monitor the installation can be checked by grounding the motor winding temporarily with the 100 kΩ Test Resistor from the Installation Kit, to simulate a low resistance ground. If the unit alarms, the installation is correct.
A visual alarm unit, using a neon lamp, is provided and long life is ensured as the lamp flashes only when an alarm occurs. The unit is drip proof and may be used where regulations permit.

Installation Kit

Installation Instructions and an ”instruction” label (to be affixed near the monitor) are shipped with each unit. An Installation Kit, containing the following items, may be ordered if required

- Installation Instruction
- Self tapping mounting screws
- Hook up wire
- Cable ties
- Self adhesive “Warning “ and “Instruction” labels
- DIN rail mounting bracket
- Visual alarm unit
- Crimp on wire termination
- Test Resistor

Recommendations

FailSafe Insulation Monitors, correctly installed, will eliminate the two major electrical problems of the marine industry:

1) motor burn-out on starting and
2) the resultant grounds on ship’s power system.

This can be achieved by installing FailSafe Insulation Monitor on all motors and generators essential for the ship operation – deck machinery motors, lower platform motors, generators, i.e. wherever essential electrical insulation may be idle for extended periods.