IPM Integrated Protection Relay: Compliance with AS/NZS2081

Earth Fault Limited Systems

AS/NZS4871.1 sets out the general requirements for mobile or re-locatable electrical equipment used in mines and quarries. This type of equipment should be fed from an earth fault limited system (or IT distribution network).

Most electricians and engineers will be familiar with the multiple earthed neutral (MEN) system, which is the most common electrical distribution network in Australia.

An earth fault limited system is fundamentally different to an MEN network and many electrical personnel may not be familiar with its topology or characteristics of the protection devices suitable for that type of electrical network.

AS/NZS2081

AS/NZS2081 sets out the design, performance, manufacturing, and testing requirements for electrical protection devices for use in surface and underground mines and quarries, where earth fault limited supply networks are utilised, and provides information on the general principles of:

- Earth fault current limitation
- Earth continuity protection
- Earth fault protection
- Earth fault lockout protection
- NER integrity protection
- Frozen contact protection

Under fault conditions there are substantial differences in voltage and current flows in an earth fault limited system over an MEN system.

Not all protection devices are suitable for use in both an MEN and earth fault limited system, and it is common to look for protection elements claiming compliance to AS/NZS2081 to ensure they are suitable for use.

Compliance - What Does It Really Mean?

Strict technical compliance with a nominated Standard is not mandatory unless that Standard is explicitly referenced in legislation.

Although not necessary mandatory, compliance to the key objectives of standards such AS/NZS4871.1 and AS/NZS2081 is expected by most if not all Australian regulatory bodies.

In order to utilise non-AS/NZS2081 compliant protection devices on an earth fault limited system, the user must ensure the key objectives of the resulting protection system are equivalent or better than that achieved using an AS/NZS2081 compliant device.

It should be recognised that :

- Selection of an AS/NZS2081 compliant protection relay, does not ensure that the installation or system will be safe or inherently compliant; and,
- Non- AS.NZS2081 compliant protection devices can be used provided they function correctly in an earth fault limited network.

The key objectives of AS/NZS2081 are:

- To maintain touch and step voltage levels against time within acceptable limits
- To ensure reliable performance of protection elements under predetermined operating conditions

The following examines the Ampcontrol IPM relay and it's technical non-compliances with AS/NZS2081, to establish that it is acceptable for use in an earth fault limited system.

AS/NZS2081 Clause 2.10

'The Maximum VA rating assigned to the protection device switching contacts shall have a factor of safety of five (5) applied to the rating nominated by the manufacturer of the output relay.'

Ampcontrol claims a rating of 5A, 190VAC, 100VA for the IPM output contacts. This does not meet the factor of five derating requested in clause 2.10.

Use of an interposing relay to switch a power contactor or circuit breaker will meet the requirements of clause 2.10.

AS/NZS2081 Clause 2.14

'The protection device shall be designed so that its normal operation remains unaffected while the control power supply voltage is varied within the range of 75% to 120% of the nominated supply voltage.'

The IPM power supply is specified at 24 VDC ± 20%, <10W

Control power for the protection relays is typically derived from a transformer supplied from the line side of the contactor or circuit breaker, and then an industrial 24VDC electronically regulated power supply. Selecting a 24VDC power supply with an AC input range +20% - 25% will enable compliance to clause 2.14

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AS/NZS2081 Clause 6.3

'This device shall initiate a trip of the circuit interruption device within the operating time setting when the earth fault current exceeds the nominated trip current for the duration of the nominated time delay.'

Earth Leakage operating time resembles an RCD characteristic whereas the AS/NZS 2081 requirements are for a definite time operation. The IPM characteristic is outlined in AS/NZS 3190.

High impedance faults that sustain in a high impedance state are much less common than faults that quickly evolve to low impedance or bolted faults. Also, high impedance faults generate significantly lower touch potentials than a low impedance fault. As a result the trip time for a high impedance fault can be longer.

During a bolted fault (low impedance fault) the trip characteristic of the IPM is actually faster than that required by AS/NZS 2081 (30mS compared to 50mS).

AS/NZS2081 Clause 7.3

'Extra low voltage earth fault lockout test.'

The standard calls for a low voltage lockout test to be completed before the HV test. This is desirable in hazardous area applications to limit the energy applied to a hard fault. The low voltage test does not reveal all faults. The IPM only completes an HV insulation test.

AS/NZS2081 Clause 9.2.1

'The protection device shall be designed to initiate a trip of an upstream circuit interrupting device if a voltage exceeding 25 V A.C. or 60 V D.C. is detected on any phase on the load side of the circuit interrupting device when it is expected to be in the open position.'

The IPM Frozen Contactor electrical trip point is fixed at 10% of the line voltage.

Note: 10% of line voltage is to provide noise margin, and will unambiguously identify a frozen contactor. The higher trip point provides greater immunity to noise and avoids nuisance trips due to induction.

Procedural controls must be in place to approach or touch a high voltage conductor. It is not sufficient to use the frozen contactor trip of a protection relay to guarantee the line is de-energised (below ELV). Earth switches and visible disconnection are typically necessary controls.

AS/NZS2081 Clause 9.3 (b) (Clause 9.2.2)

'For Clause 9.2.2, not exceed 1 s.

(The protection device shall be designed to initiate a trip of an upstream circuit interrupting device if the mechanical state of the circuit interruption device is different to that expected: for example, if the auxiliary interlocks have not changed state although the interruption device has been signalled to energize or de-energize.)'

The IPM's Fail To Close (FTC) trip occurs after a 5sec timeout.

The External Open (ExtOpen), Fail to Open (FTO), Under voltage and Under current detection trips all operate in less than 1sec.

This satisfies the AS/NZS2081 objectives by successfully tripping the outlet under dangerous faults (ExtOpen or FTO).

However in the circumstance of a FTC trip, which is a safe detected fault, the trip time has been increased to 5sec affording greater noise margin, so less susceptibility to nuisance trips.

Conclusion

The IPM is suitable for use in an earth fault limited system as described in AS/NZS4871.1.

It is an integrated protection relay that contains all of the protection functions required by mining and quarrying applications where equipment is mobile or re-locatable.