Switchgear Selection for Greater Safety and Dependability with Proven Component Co-Ordination

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Abstract - Most of the industries are suffering with a common event that is failure of contactors, but often the reason for the failure is not understood. The modern contactor is the product of many years of refinement of basically the same technology. The performance of each contactor is well documented under test conditions. If the application only operates the contactor within its defined operating parameters, a life consistent with its published ratings can be expected. If the contactor is subject to a stress outside its ratings, rapid failure can sometimes be the result. An understanding of the possible causes of early failure in contactor is helpful in increasing productivity in industries.

Keywords: Welding of contacts, contact welding, short circuit coordination, coordination of contactors with SCPD, short circuit protection Device.

I. INTRODUCTION

One of the major applications of contactors is switching of motors. The contactor is protected by a short circuit is protected device (SCPD) - a circuit breaker and a fuse which also protects the motor including the Connecting wires against short circuits. All these devices must be carefully matched or coordinated with one another for the whole range of application. The project engineer must also be able to predict the level of damage, if any, occurring to the different components in the case of a fault, say short circuit.

II. WHAT IS WRONG WITH THE WAY SWITCHGEAR IS USUALLY SELECTED?

It is usually assumed that all is well if a component of switchgear is chosen on the basis of its KW or current rating and according to its utilization category. But, That’s not true, additional consideration of How will the component s work together under all possible situations? should be taken care of.

III. WHAT CAN GO WRONG?

To ascertain this, a comprehensive service of tests is necessary. It is not just a case of looking up tables.

Many uncontrollable effects can result from poor component Co-ordination.

For example:-

- Nuisance fuse blowing or circuit breaker tripping during starting.
- Uncontrollable arcing inside contactors which may even develop into a full blown arcing fault.
- Welded contacts.
- Distorted overloads falling to detect motor over loads.
- High repair and replacement costs.
- Production losses.
- Loss of profitability.

IV. AND WHY

During the motor run up the high inrush current during starting can blow an undersized fuse or trip the circuit breaker thereby preventing the drive from even starting effectively.

Even at relatively low fault the electromagnetic forces created by the fault current can cause the contacts of a contactor to lift. This cause heating or even mild arcing which melts the contacts material on the surface of the contact.

At the instant the short circuit protective Device (SCPD) interrupts the current, the pressure of the spring re close the contacts. Under these conditions contact welding can occur resulting in loss of control and possibly a single phase condition when the power is restored.

Furthermore the let-through current of the SCPD can also causes excessive distortion of the bimetal strip to its original configuration on cooling destroying its protection characteristics.

Such Damage is not readily evident and can consequently lead to nuisance tripping of the overload or motor failure at some time in the future, depending on the degree of the damage to the overload elements, Good component design can improve short circuit performance and provide reliable operation under abnormal conditions.

V. WHAT IS COORDINATION

The motor starter consist of a combination of contactor Overload relay and short circuit protection device (SCPD) being either fuse or circuit breakers.

During motor starting and at normal loading the overload relay protects both the motor and cables by tripping the contactor in a time inversely proportional to the current. however under short circuit condition the response time would be too long and the fuse or circuit breakers must take over to interrupt the fault current therefore limiting energy passed through the starter components when this is successfully achieved , the combination is said to be Coordinated.

It is a requirement of Standard that combination motor starters are capable of withstanding the effects of load side short Circuits. Some damage to the combination is permitted, but this must be confined and not present a risk to the operator, or damage equipment adjacent to the starter.

Contactors and thermal overload relays only have limited ability to withstand the high current associated with a fault such as an internal motor short. Their design is optimised for performance at much lower currents and to design in the ability to control or withstand high fault levels would add to costs and possibly reduce its performance at normal levels.

VI. THE STANDARDS

The requirement s of several standards can be applied to these combinations units. The wiring Rules, are concerned mainly with setting standards for the fixed wiring. In this regard the concern is the wiring between the protection device and the motor.

As Motor can experience short term overloading the current rating of a fuse can be up 4 times and a circuit breaker 2.5 times the full load rating of the motor. The wiring rules allow the overload protection and the short circuit protection to be provided by different devices .This allows magnetic only circuit breakers, or back up type fuse, to be used in conjunction with a contactor /Thermal overload relay configuration.

Isolating switches must also be provided in the motor or control circuit, these are to be in clear view of any person working on the motor or provided with a locking device.

Standard specifies testing requirements for the combinations of components required to perform the motor control and protection functions.

If the equipment has been mounted in a switchboard it is possible to meet the testing requirements of the IEC4-39.1. Short circuit withstand of the outgoing circuit at the same time as the tests to IEC 947.4.1 are performed.

Bothe standards look at the performance of the equipment when a fault occurs on the outgoing circuit. It is accepted in these standard that some damage may be sustained by the components of the starter when subjected to short circuit conditions.

IEC 439.1 requires that during the tests the equipment installed in the switchboard performs in accordance to its own standard. A selection by the customer of the performance required needs to be made as IEC947.4.1 allows for Type –‘’1’’ and Type- ‘’2’’ performance.

Type –‘’1’’ performance requires that under short circuit conditions the starter shall not causes a danger to person or the installation.

The starter itself may need repair. For Type-‘’2’’ after a short circuit the starter is to be suitable for further service , but contact welding is permitted .

Any weld must be easily separated for example, by a screwdriver, without significant deformation.

In all cases it is therefore essential that the coordination of the starter is checked if the short circuit protective device has operated .Type-‘’2’’ Coordination does not mean that the starter is suitable for normal operation without inspections /repair of the contacts. Refer above table for short circuit coordination with motor protection circuit breaker.

VII. SHORT LRCUIT CO-ORDINATION STARTING:DIRECT-ON-LINE(DOL)

Rated Operational Voltage Ue: 415V,50 HZ.

Test Voltage =415+5%: 436V, 50 HZ.

Rated Conditional S.C. Current Iq: 6 5 KA (rms Symmetrical)

Type of co-ordination : Type “2”

Nom. Motor # Rating/Current		Circuit Breaker		Contactor
#4-Pole 415v / 1500 Rpm Motors				
Rating (kW)	Current (A)	Thermal (A)	Magn. (A)	Iac-3 (A)
0.19	0.60	0.40-0.63	6.9	4.8
0.25	0.80	0.63-1.00	11.0	4.8
0.37	1.10	1.00-1.60	18.0	4.8
0.55	1.50	1.00-1.60	18.0	4.8

0.75	1.80	1.60-2.50	28.0	4.8
1.10	2.60	2.50-4.00	44.0	4.8
1.50	3.40	2.50-4.00	44.0	4.8
2.20	4.80	4.00-6.30	69.0	4.8
3.00	6.50	6.30-10.0	110.0	8.2
4.00	8.20	6.30-10.0	110.0	8.2
5.50	11.00	10.0-16.0	176.0	11
7.50	14.00	10.0-16.0	176.0	14
9.00	17.00	16.0-20.0	220.0	21
11.00	21.00	20.0-25.0	220.0	21
15.00	28.00	25.0-40.0	560.0	28
18.50	34.00	25.0-40.0	560.0	37
22.00	40.00	25.0-40.0	560.0	40
30.00	55.00	40.0-63.0	882.0	60
37.00	66.00	63.0-90.0	1260	66
45.00	80.00	80-100	1200	85
55.00	100.00	100-125	1500	105
75.00	135.00	125-160	1900	140
90.00	160.00	125-160	1900	170
110.00	200.00	160-200	2400	230
132.00	230.00	200-250	3000	230
160.00	270.00	250-320	3800	315
200.00	350.00	320-400	4800	425

VIII. CONCLUSION

The result of short circuit coordination tests with contactors tests with contactors and the characteristics of the short circuit protective of the short circuit protective devices (SCPD) are compared. This leads to the conclusion that certain definite relations exist between the cut-off current, total clearing time and joule-integral of the SCDP on one hand and the contactor characteristics like contact, mass of the contact bridge, contact spring force etc. on the other hand, which may lead to the welding of contacts. The influence of varying design parameters like the mass of the contact bridge and contact spring force of the contactor is demonstrated with simulated short circuit tests. By a proper choice of these parameters, the chances of welding of contacts with the specified SCPD reduce to a minimum.

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