NHP

TECHNICAL NEWS

Issue 9

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Quarterly Technical Newsletter of Australia's leading supplier of low-voltage motor control and switchgear.

IN THIS ISSUE

UTILISATION CATEGORIES

The end of electrical life for a switch[1]) can be quite different. Some will fail to carry current, others will overheat and the most dramatic of them will go out in a blaze of sparks. Fortunately most applications of switches result in an electrical life far greater than the application requires.

When a switch does meet an untimely end it is time to reflect on why it occurred.

Was it caused by an unduly harsh life or was it the result of an oversight by its maker?

Mode of failure

Under normal operating conditions a switch will reach its electrical life when the contact material has been eroded to the point where the base contact material is exposed.

When this point is reached the contact resistance will increase and cause severe overheating. If the switch is not removed from service the overheating will cause failure to adjacent parts of the switch and an open circuit or a short circuit between phases or poles will occur.

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Star delta starter failure to reach near full speed before changing to delta connection greatly reduces life of star contactor.

Note [1])" Switch" refers to contactor and control switches

Utilisation Categories (continued from page 1)

Performance testing

To simulate service conditions the electrical standards have devised different test levels for different switching applications. Different types of loads place greatly varying stresses on the switch. With some loads the initial inrush current can be high but the switch would not normally be required to break this current.

The power factor of the load greatly influences the arc duration at switch off. With a resistive circuit the power factor is unity and this produces the most favourable conditions for the switch to interrupt the current as there is no energy stored in the load. As the inductance increases and the power factor drops, the stored energy increases and this energy causes the arc voltage to rise as the switch tries to interrupt the current. This results in longer arcing times and greater contact erosion.

In **Table 1** the test conditions for common utilisation categories are listed.

Test "A" represents the overload condition created at turn on. It is the breaking of this current that causes the major stress on the switch. As the inrush only lasts for a short time it is unusual for the switch to interrupt this current. The number of operations for the test is therefore very low.

Test "B" is the conventional operational performance test and represents in some categories a current higher than the switch would normally interrupt but it is only for a limited number of operations.

Test "C" defines the test conditions for verifying the electrical life of a switch. For AC 3 the test conditions are dramatically different to test "B", the conventional test. When switching off a motor during running the voltage across the switch is reduced by the back Electro Motive Force (EMF) of the motor. To allow for this the voltage for the test is only 0.17 times the rated voltage.

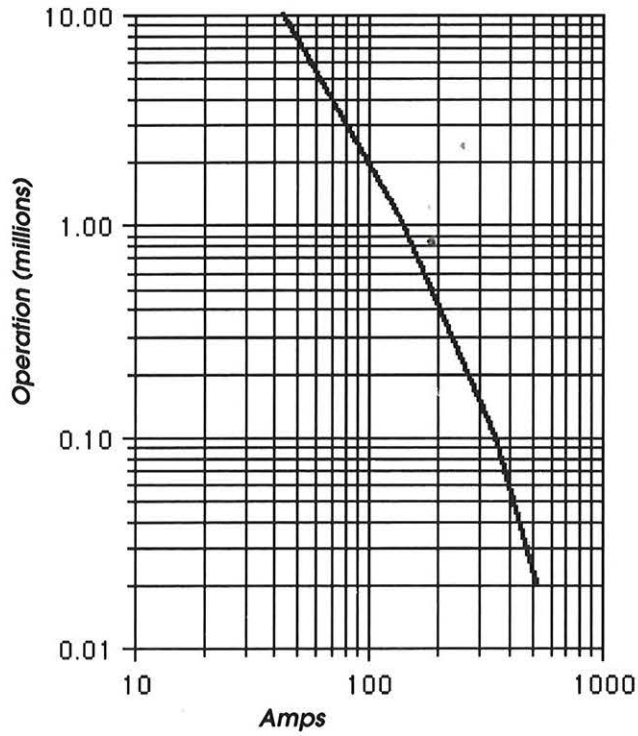
Normal service

To achieve in service the same electrical life as its rated life a switch must have circuit conditions no more arduous than the test conditions used to determine the rating.

With motor loads even only occasional switching off at less than full speed will greatly reduce contact life. While AC 4 ratings do provide for this type of duty it is normal that the AC 4 electrical life is less than the typical AC 3 life.

It is common for AC 4 applications such as inching of motors to be under manual control and the total number of operations would not normally be very high. **Fig. 1** represents the typical electrical life of a 100 amp rated contactor. It can be seen that the life is greatly influenced by the current interrupted. If the current is doubled the life is reduced by approximately a factor of four. It can be seen therefore, that if a contactor is required to interrupt the locked rotor current (typically 6 times the full load current) of a motor the contact life will be reduced dramatically.

Fig. 1



Utilisation categories and test conditions

Common AC categories

TYPE OF DEVICE	CAT.	TYPICAL APPLICATION	TEST	MAKE				BREAK		OPERATIONS
				I/Ie	U/Ue	COSØ	Ic/Ie	Ur/Ue	COSØ	
	AC-1	Non-inductive or slightly inductive loads,	A	1.5	1.05	0.8	1.5	1.05	0.8	50
		resistance furnaces.	B	1	1	0.95	1	1	0.95	6000
	AC-2	Slip-ring motors: starting, switching off.	A	4	1.05	0.65	4	1.05	0.65	50
			B	2	1.05	0.65	2	1.05	0.65	6000
	AC-3	Squirrel-cage motors: starting switching off	A	8	1.05	0.45	8	1.05	0.45	50
		motors during running.	B	2	1.05	0.45	2	1.05	0.45	6000
			C	6	1	0.45	1	0.17	0.45	
CONTACTORS	AC-4	Squirrel-cage motors: starting, plugging, inching.	A	10	1.05	0.45	10	1.05	0.45	50
			B	6	1.05	0.45	6	1.05	0.45	6000
			C	6	1	0.45	6	1	0.45	
	AC-5a	Switching of electric discharge lamp control.	A	3	1.05	0.45	3	1.05	0.45	50
			B	2	1.05	0.45	2	1.05	0.45	6000
	AC-5b	Switching of incandescent lamps.	A	1.5	1.05		1.5	1.05		50
		(tests made using lamps)	B	1	1.05		1	1.05		6000
	AC-6a	Switching of transformers.	A	Rating derived from AC-3 rating. (x 0.45)						
			B							
	AC-6b	Switching of capacitor banks.	A	Depends on circuit conditions of application.						
			B							
	AC-12	Control of resistive loads and solid state loads	A							
		with isolation by opto couplers.	B	1	1	0.9	1	1	0.9	6050
CONTROL	AC-13	Control of solid state loads with transformer	A	10	1.1	0.65	1.1	1.1	0.65	10
DEVICES		isolation.	B	2	1	0.65	1	1	0.65	6050
	AC-14	Control of small electromagnetic loads (≤ 72 VA)	A	6	1.1	0.7	6	1.1	0.7	10
			B	6	1	0.3	1	1	0.3	6050
	AC-15	Control of electromagnetic loads (≥ 72 VA)	A	10	1.1	0.3	10	1.1	0.3	10
			B	10	1	0.3	1	1	0.3	6050
	AC-20	Connecting and disconnecting under no-load	A	No testing required						
		conditions.	B							
SWITCHES	AC-21	Switching of resistive loads, including moderate	A	1.5	1.05	0.95	1.5	1.05	0.95	5
		overloads.	B	1	1	0.95	1	1	0.95	10000
	AC-22	Switching of mixed resistive and inductive	A	3	1.05	0.65	3	1.05	0.65	5
		loads, including moderate overloads.	B	1	1	0.8	1	1	0.8	10000
	AC-23	Switching of motor loads or other highly	A	10	1.05	0.45	8	1.05	0.45	5
		inductive loads.	B	1	1	0.65	1	1	0.65	10000

Notes: Tests A = Making and breaking capacity. B = Conventional operational performance. C = Verification of the number of on-load operating cycles. Some test values depend on the value of Ie and the values listed are indicative.

I = Current made
Ic = Current broken
Ie = Rated operational current
Ur = Recovery voltage
Ue = Rated operational voltage
cos ø = Power factor to test circuit

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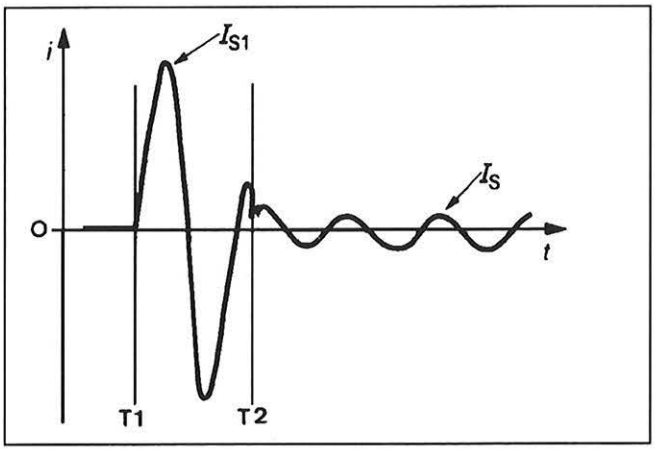
Utilisation Categories
(continued from page 2)

Selection

It is essential for applications which will subject any switch to high operational requirements that consideration is given to either selecting a larger device or introducing a maintenance programme that replaces the device before it fails. It must be remembered that the actual failure mode is not tested by the standards. The device is expected to still be operational at the end of any testing for contact performance. If the switch is left in service until it fails because contact life has been exceeded the failure can be quite dramatic and may cause damage to other components.

For further information refer to Sprecher + Schuh publication 2200T.



Typical electromagnet

I_s Steady state current

I_{sl} Closing current

T_1 Turn on

T_2 Magnet closed

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