Standards:

IEC publications 60941-1, 60947-4-1 and 60947-5-1 should be referred to on an international level with respect to contactors, contactor relays and thermal O/L relays.

Utilization Categories:

A contactor's duty is characterised by the utilization category together with the rated operational voltage and current indicated.

Utilization Categories for Contactors According to IEC 60947-4-1:

Alternating current:	AC-1	Non-inductive or slightly inductive loads, resistance furnaces.
	AC-2	Slip-ring motors: starting, switching off.
	AC-3	Cage motors: starting, switching off running motors.
	AC-4	Cage motors: starting, plugging, inching.
	AC-5a	Discharge lamp switching.
	AC-5b	Incandescent lamp switching.
	AC-6a	Transformer switching.
	AC-6b	Capacitor bank switching.
	AC-8a	Hermetic refrigeration compressor motor control with manual resetting of overload releases.
	AC-8b	Hermetic refrigeration compressor motor control with automatic resetting of overload releases.
Direct current:	DC-1	Non inductive or slightly inductive loads, resistance furnaces.
	DC-3	Shunt motors: starting, plugging, inching, dynamic breaking of d.c. motors.
	DC-5	Series motors: starting, plugging, inching, dynamic breaking of d.c. motors.
	DC-6	Incandescent lamp switching.

Utilization Categories for Contactor Relays According to IEC 60947-5-1:

Alternating current:	AC-12	Control of resistive loads and static loads with opto-coupler isolation.
	AC-13	Control of static loads with transformer isolation.
	AC-14	Control of weak electromagnetic loads (≤ 72 VA).
	AC-15	Control of electromagnetic loads (> 72 VA).
Direct current:	DC-12	Control of resistive loads and static loads with opto-coupler isolation.
	DC-13	Control of d.c. electromagnets.
	DC-14	Control of d.c. electromagnets having economy resistors.

In fact some applications, and the specific criteria characterizing the various loads controlled by contactors, may modify the utilization characteristics of the contactors. The main applications concerned are:

Capacitor Bank Switching

Account must be taken of high peaks when the current is made and of harmonic currents during continuous duty. For this application, IEC publication 60947-4-1 stipulates utilization category AC-6b. The operational currents or powers acceptable for the contactors are determined by our electrical tests; IEC publication 60947-4-1 gives the calculating formula for determining the operational current (Table 7 b).

Transformer Switching

Account must be taken of the peaks due to magnetization phenomena when the current is made.

For this application, IEC publication 60947-4-1 stipulates utilization category AC-6a. The operational currents or powers acceptable for the contactors are determined using the values obtained for AC-3 or AC-4 category tests and the calculating formula given in IEC 60947-4-1 (Table 7 b).

Lighting Circuit Switching

The current peaks occurring on energization of the circuit and the power factor depend on the type of lamps, the connection mode and whether or not there is compensation.

For this application, IEC publication 60947-4-1 stipulates two standard utilization categories:

– AC-5a for discharge lamp switching.

– AC-5b for incandescent lamp switching.

Slip-ring Motor Switching

The contactors used for short-circuiting rotor resistors can be used for rotor voltages above their natural nominal operational voltage.

The conditions of use of rotor contactors depend on the connection mode of the main poles. IEC 60947-4-1 stipulates AC-2 utilization category.

The current values on circuit closing and the current and voltage values on circuit opening (as well as a generally low load factor) are easily withstood by the contactors.

Utilization Categories (cont.)

d.c. Power Circuit Switching
Arc suppression is more difficult in direct current than in alternating current. Higher the time constant and voltage, heavier the breaking conditions: consequently several poles have to be connected in series.

a.c. High Current Circuit Switching
Possibility of increasing performances by connecting poles in parallel.

Circuit Switching during Temporary and Intermittent Duty
In these cases higher operational currents are acceptable, the appropriate uprating factors are given in this catalogue (section 2).

Influence of the Length of the Conductors used in the Contactor Control Circuit
According to the operational voltages, the cross-sectional areas, the coil consumption and the control layout, difficulties due to line resistances and capacitances may appear during contactor closing and opening orders. The corresponding information is given in this catalogue (section 2).

Making and Breaking Conditions for Utilization Categories

Utilization category	Durability test conditions						Occasional operation Making and Breaking Capacities - 50 operating cycles					
	Making conditions			Breaking conditions			Making conditions			Breaking conditions		
	I/I_e	U/U_e	Cos. φ or L/R (ms)	I/I_e	U/U_e	Cos. φ or L/R (ms)	I_c/I_e	U_r/U_e	Cos. φ or L/R (ms)	I_c/I_e	U_r/U_e	Cos. φ or L/R (ms)
Contactors for a.c. circuit switching												
AC-1	1	1	0.95	1	1	0.95	1.5	1.05	0.8	1.5	1.05	0.8
AC-2	2.5	1	0.65	2.5	1	0.65	4	1.05	0.65	4	1.05	0.65
AC-3 $I_e \leq 17$ A	6	1	0.65	1	0.17	0.65	10	1.05	0.45	8	1.05	0.45
$17 < I_e < 100$ A	6	1	0.35	1	0.17	0.35	10	1.05	0.45	8	1.05	0.45
$I_e > 100$ A	6	1	0.35	1	0.17	0.35	10	1.05	0.35	8	1.05	0.35
AC-4 $I_e \leq 17$ A	6	1	0.65	6	1	0.65	12	1.05	0.45	10	1.05	0.45
$17 < I_e < 100$ A	6	1	0.35	6	1	0.35	12	1.05	0.45	10	1.05	0.45
$I_e > 100$ A	6	1	0.35	6	1	0.35	12	1.05	0.35	10	1.05	0.35
Contactors for d.c. circuit switching												
DC-1	1	1	1	1	1	1	1.5	1.05	1	1.5	1.05	1
DC-3	2.5	1	2	2.5	1	2	4	1.05	2.5	4	1.05	2.5
DC-5	2.5	1	7.5	2.5	1	7.5	4	1.05	15	4	1.05	15
Contactor relays for a.c. circuit switching												
AC-14 (≤ 72 VA)	–	–	–	–	–	–	6	1.1	0.7	6	1.1	0.7
AC-15 (> 72 VA)	10	1	0.7	1	1	0.4	10	1.1	0.3	10	1.1	0.3

Contactor relays for d.c. circuit switching

	Standard operation						Occasional operation Making and Breaking Capacities - 50 operating cycles					
	Making conditions			Breaking conditions			Making conditions			Breaking conditions		
	I/I_e	U/U_e	$T_{0.95}$	I/I_e	U/U_e	$T_{0.95}$	I/I_e	U/U_e	$T_{0.95}$	I/I_e	U/U_e	$T_{0.95}$
DC-13	1	1	6 P(1)	1	1	6 P(1)	1.1	1.1	6 P(1)	1.1	1.1	6 P(1)
DC-14	–	–	–	–	–	–	10	1.1	15 ms	10	1.1	15 ms

(1) The value "6 x P" is the result of an empirical relation which is estimated to represent most d.c. magnetic loads up to the highest limit of P = 50 W (6 x P = 300 ms). It is accepted that loads having drawn energy above 50 W are made up of weaker loads in parallel. As a consequence, the 300 ms value must form the highest limit whatever the value of the power drawn.

Key:

U (I) = applied voltage (current)
U_r = recovery voltage
L/R = test circuit time constant
U_e (I_e) = rated operational voltage (current)
I_c = making and breaking current expressed in d.c. or in a.c. like the r.m.s. value of the symmetrical components
$T_{0.95}$ = time required to reach 95% of the current in steady-state conditions, expressed in milliseconds