THERMAL RATING

Rated Current (I_n)

It is the manufacturer's responsibility for stating the rated current of an assembly. This current must be carried without the temperature-rise of the assembly exceeding set limits. However, as assemblies contain switching devices of different origins all connected together to form a unique arrangement, the rated current is often difficult to establish. In theory it can be derived from the sum of all the various thermal ratings within an assembly and, providing the heat loss of all the devices and conductors is known, then the total heat loss and resultant temperature rise can be calculated. These calculations, which are complicated to say the least, should be based on actual test data established from tests previously conducted. Test results should prove the suitability of connections, not components. If the equipment being connected to is overheating then it is likely that the connections are undersized for the duty. However the major problem is that the rating data produced for switching devices is established under different conditions to that required for manufacturing or testing an assembly. Full details of the test requirements for switching devices will be found in BS EN 60947.

Deciding on a rating

During the initial engineering of an assembly several important factors need to be decided on, namely:-

a/ ***Base rating of the main conductors***
b/ ***Rating of switching devices***
c/ ***Enclosure design & ventilation***

Once these principle designs have been established it is then necessary to compare data and adjust accordingly, taking account of the following:-

d/ ***Temperature-rise limits set by the standard***
e/ ***Maximum operating temperature of insulating materials***
f/ ***Types of load and the affect of harmonic currents***

This is obviously a simplified approach. It ignores the fine tuning that may be necessary when testing, but enables ratings to be established with some accuracy.

Extract from Table 2 COPPER BAR RATINGS (UNENCLOSED)

IMPERIAL COPPER		STILL AIR RATING	
CONDUCTOR		NO. OF BARS/POLE	
IMPERIAL (Ins)	***METRIC EQUIVALENT***	***1***	***2***
1 x $^1/_4$	(25.4 x 6.35mm)	478	916
2 x $^1/_4$	(50.8 x 6.35mm)	849	1502
3 x $^1/_4$	(76.2 x 6.35mm)	1154	1973
4 x $^1/_4$	(101.6 x 6.35mm)	1445	2452

METRIC COPPER	STILL AIR RATING		
CONDUCTOR	NO. OF BARS/POLE		
METRIC (mm)	***1***	***2***	***3***
25 x 10	626	1133	
50 x 10	1077	1898	2460
75 x 10	1444	2551	3361
100 x 10	1870	2976	3890

All ratings allow for a 50°C rise over a maximum ambient of 40°C in still but unconfined air.
Copper installed vertically on edge at 65mm centres as illustrated in Fig.1
Ratings in RED, copper installed vertically on edge at 110mm centres.
Ratings for 2 or 3 bars allow for gap equal to bar thickness between conductors.
Copper emissivity 0.11 @ 19°C

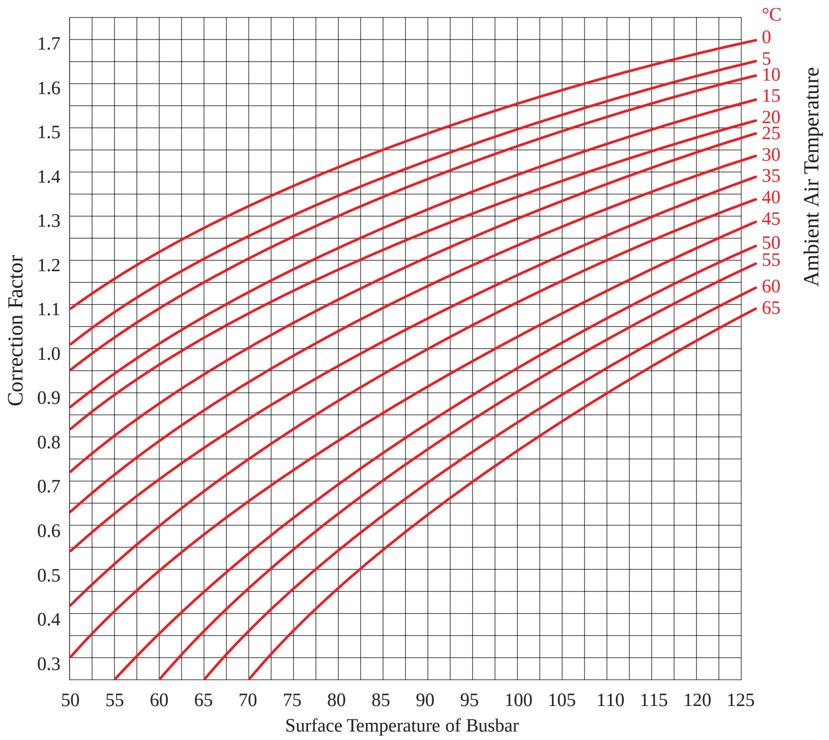
Ambient temperature

The maximum ambient temperature in service if this exceeds 40°C is to be specified by the user.

Note:Temperature magnitude is measured in degrees Celsius or Centigrade (°C). Temperature rise is measured in degrees Kelvin (K). 1°C = 1K in magnitude.

In service locations where the maximum ambient temperature can exceed 40°C the current ratings of the assembly must be derated accordingly. International standards do not permit uprating of low voltage assemblies in situations where the local maximum ambient temperature is less than 40°C, however such uprating may be acceptable by the end user.

Fig 2 RE-CALCULATION GRAPH
For varying busbar surface and ambient temperatures



USE THIS GRAPH TO ESTABLISH A RATING CORRECTION FACTOR WHERE:-
I/ AMBIENT TEMPERATURE IS ANYTHING OTHER THAN 40°C
OR
II/ SURFACE TEMPERATURE OF THE BUSBAR IS ANYTHING OTHER THAN 90°C.
NOTE: CORRECTION FACTOR = 1 WHEN AMBIENT = 40°C & BUSBAR SURFACE = 90°C

SHORT-CIRCUIT RATING

A three phase short circuit is, fortunately, a very rare event. Short circuit conditions usually arise from lightening strikes, human error or insulation failure. Possibly the most common, an earth fault short circuit, which results from cables being damaged downstream from the protective device, generally result in no more than a tripped device or blown fuse. A three phase short circuit caused by a link bolted across all three phases is near to impossible, to say the least.

So why does fault level figure so prominently in panel design & construction?

Principally, because the effect of a short circuit within a system having the capability to deliver a fault current is so damaging and the implications to personnel and plant safety so great, that the whole aspect has to be treated with great respect.

The effects of a short-circuit loosely falls within 3 categories:-

1 - The protective device clears the fault

No disturbance

2 - The protective device clears the fault

Disturbance through disruptive arc causes cover/door to open (see Photo 3)

Disturbance through disruptive arc causes internal arcing fault

Magnetic disturbance damages connection & causes internal arcing fault

3 - Mechanical failure of busbar joint, metal cover plate or insulation material

Internal arcing fault sustained until upstream protective device opens

It can be seen that the problems that arise when a short circuit is not properly controlled usually result in an internal arcing fault. However to test a switchboard solely by the application of such faults would, because of the exceptional damage caused, provides limited help to the designer. So as to provide more factual results a bolted short circuit is used during test which offers the manufacturer a better form of result and a more flexible time scale.

A well designed system minimises the risk of a short-circuit occuring in the first place and the “standard” documents the method to be adopted for short-circuit testing. Further explanation and details are given the complete guide under the section entitled “Short-circuit testing”

Photo 3 An MCCB on test at 50kA conditional. The breaker passed the test but the enclosure did not.