may be as great as 100% of the circuit breaker interrupting rating as long as the *X/R* ratio does not exceed *X/R*=15 for 5- and 3-cycle circuit breakers and 10 for 8-cycle circuit breakers. But if the *X/R* ratio is greater than these limits, multipliers from curves in ANSI/IEEE C37.010-1979 [5] should be applied. These evaluations require calculating or conservatively estimating the system *X/R* ratio at point of fault.

A satisfactory, safe *X/R* ratio can be obtained from vector analysis of the short-circuit currents and *X/R* ratios of the various sources. One way is to factor the various source short-circuit currents into effective reactance and resistance components by considering: reactance component = short-circuit current · sin (arctan *X/R* ratio); the resistance component = reactance component divided by *X/R* ratio. The arithmetic total of reactance components divided by the arithmetic total of resistance components will produce an acceptable *X/R* ratio for use with the total short-circuit current. Simplifying estimates tending toward a higher *X/R* ratio will be on the safe side in the medium-voltage circuit breaker applications.

In some cases circuit breakers with adequate interrupting capacity may have inadequate close and latch ratings. ANSI/IEEE C37.010-1979 [5] discusses this case. In essence, the calculated first-cycle short-circuit symmetrical rms current should be multiplied by a factor of 1.6 to obtain an asymmetrical rms current value to be compared with the close and latch rating of the circuit breaker expressed in asymmetrical rms amperes. If the circuit breaker close and latch rating is inadequate, a second evaluation can be made by reducing the induction motor short-circuit contribution, as shown in Table 13.

2.3.5 Calculating Short-Circuit Currents Through Impedances. After the short-circuit currents produced by the various sources throughout the system have been determined, short-circuit values at various locations can be calculated. This involves considering the impedance of each circuit segment (from start at one bus to finish at another bus) until every pertinent bus or eschelon of the system has been considered. The procedure is detailed in the following Figs 13–16. Note that since resistance, reactance, and impedance values are very small they are usually expressed in milliohms and a factor of 1000 appears in the ohms law equations.

2.3.6 Current-Limiting Protective Devices. In industrial and commercial power systems, it is common practice to use current-limiting devices to protect other devices against high values of short-circuit current, which exceed their short-circuit ratings. Short-circuit calculations should be made without considering the effects of current-limiting devices to determine the "prospective" short-circuit current, or that which would flow if no current-limiting device were present. This "prospective" short-circuit current is used in applying the devices. The manufacturer of the device to be protected should be consulted to determine the suitability of the application for the level of short-circuit current available at the line-side terminals of the protected device. At this time the best practice is to determine the suitability of various applications by performance testing in accordance with recognized test procedures of qualifying organizations, such as Underwriters Laboratories. No general agreement has yet been reached on how