Ideal Air Circuit Breaker

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Preference for an Air Circuit Breaker (ACB) can be assessed based on several parameters. With diverse applications and system configurations, the features offered by the ACB have to be really exhaustive. This article attempts to cover most of the major industrial requirements, by classifying them into ten categories. They are:

1. Safety:

‘Safety First’ has always been the principle of every industrial application where a human is expected to interact with machine.

In case of ACB, degree of interaction has always been higher – be it normal operation, routine maintenance or life cycle enhancement. Therefore, operational safety is a very crucial parameter for an ACB.

While ACBs have ensured safe operation and maintenance over the past decades, industry feedback highlights some more aspects where user’s safety needs to be ensured.

With increasing preference to control room concept, use of electrically operated ACBs is also increasing. When a breaker is remote controlled, there is always a risk of remote command closing the breaker when the maintenance person is racking it in/out. To prevent such a harmful situation, breakers should have a safety interlock, whereby the remote closing command will be blocked during ACB racking.

It is quite possible that after maintenance, the operator forgets to install the arc chutes or secure them properly. If the breaker clears a fault in this condition, it would cause severe damage. Hence, the breaker should not close if all the arc chutes are not secured properly.

The breakers should be equipped with safety shutters, with independent padlocking of top or bottom side, to ensure safety during maintenance.

2. Panel design:

When ACBs of different frame sizes are mounted in one panel, uniformity in breaker design across the frame sizes plays an important role. If the breakers have common depth and height for all the frame sizes, it would make easy the link work design and avoid wastage of valuable panel space.

Also, uniform location and common dimensions of panel cut-out for the ACBs in various frame sizes will add to the aesthetic value of the panel. However, attention to aesthetics should not result in wastage of panel space. This is only possible with right or left aligned breaker facia, a feature grossly overlooked.

Given the constraints on panel space in most of the industry premises, there is an increased pressure on making compact panels. By virtue of being the biggest LV switchgear equipment, ACB plays an important role in arriving at the panel dimensions. Therefore, a compact ACB is a welcome improvement.

However, compactness should not be at the cost of functional parameters such as breaking capacity and temperature rise. A compact ACB should also be operable at the ambient temperatures in tropical countries without derating. Inside the panel, temperature (micro ambient) is always higher than outside (macro ambient) by around 12-15 degrees C. Hence, when the manufacturers specify breaker technical data for inside ambient, it should be compared with equivalent outside ambient while working out ACB derating.

Making a breaker compact generally sacrifices the size of the terminals. In India, panels are designed with aluminium termination, which requires wider terminal size and the ACB should be able to support it without adapters.

No terminal design can directly be used for terminating all the possible link configurations. Some terminal designs are easier to manufacture but call for higher effort from the user. Typical example being horizontal terminals. Our experience reveals flat terminals as the best configuration, though it calls for higher efforts from the manufacturer. Flat terminals can be, in fact, aptly called ‘Universal terminals’.

It is important that ACB manufacturer provides flexibility of on-site adaptation, without the need for dismantling the existing terminals.

While most manufacturers claim suitability of terminating two wires on
control terminals, the unspecified desire is actually for ‘independent’ termination of 2:2.5 mm² wires.

In most cases, industrial environments call for higher degree of ingress protection. As front facia is the only part to project out of the panel door, it should have higher ‘intrinsic’ IP level.

3. Performance:

Needless to mention, the breaker should comply with the latest applicable standards.

ACB holds the ultimate responsibility for clearing the fault and protecting the circuit. It should trip only when the downstream devices fail to operate so that healthy feeders elsewhere in the system are not isolated unless there is an emergency. Therefore, the breaker should have adequate ‘short time withstand capacity (Iₕ)’.

The previous issue of L&T Current Trends talked about the advantages of Fully Rated System, which also reflects on ACB having adequate withstand capacity. Ideally, withstand capacity should be equal to Iₕ (rated ultimate short circuit breaking capacity) and Iₕ (rated service short circuit breaking capacity) though the standards permit Iₕ to be lower than Iₕ. At times, Iₕ and Iₕ are specified by the manufacturer with no vague reference to Iₕ. Users must be careful in making the selection.

4. Protection:

Circuit protection is the main function of the ACB. Breaker releases offer a very simple, cost effective and reliable protection. Since release operates directly on the trip mechanism of the ACB, it trips the breaker irrespective of availability of control supply or healthiness of trip circuit.

Initially releases were electromechanical. They provided the basic overload and short circuit protection efficiently and offered a very economical solution. They provided effective protection even to cables by using bimetal thermal memory.

Then came the static release. They offered better reliability and accuracy as compared to the conventional electromagnetic releases and still gave a cost effective solution. Hence, they became very popular all across the user industry.

Next evolution was micro-computer based releases. They offered versatility and higher accuracy in protection settings. All these releases offered the necessary basic protections essential in the ACB. But today’s complex control circuits require releases:

- that can be remotely programmed and monitored.
- that offer additional current protections like undercurrent, current unbalance, etc.
- that take voltage inputs, widening the scope of protection to include voltage, frequency and power related protections.
- that carry out measurements of current, voltage, power and several derived parameters for energy management thus reducing several metering equipment.
- that offer communication so as to capture all the metering, fault parameters, etc., at a remote location.
- that also monitor total harmonic distortion and amplitude of harmonics.

Owing to extensive usage of electronics and the release being a very sensitive part in the breaker, wherever required, EMI/EMC tests on the release are a pre-requisite.

Today, there are specific requirements for higher neutral rating with increasing usage of computers/UPS, etc. With considerable zero sequence currents adding up in the neutral, the required neutral rating goes well beyond the phase current, as high as 200%. Special versions of breaker should be available for such requirements (without 50% derating of higher ratings). Also, releases should be able to protect 200% neutral currents. For normal circuits, a release should be able to protect 50% and 100% neutral ratings.

There could be numerous other system-specific requirements, which the releases will have to cater to and the list of desirables features can be really long. But with electronics at your service, nothing is unachievable.

In current market, it is necessary to have a range of such relays and releases available to select from, depending on the system requirements and economics.

5. Maintenance:

At the end of electrical life, maintenance man should be able to replace the breaker poles in the shortest possible time and in the ‘Fix it right the first time’ way to reduce plant downtime and production loss. This convenience generally remains restricted to lower ratings of ACBs.

During ACB maintenance, whenever required, replacement of cradle terminals is done from the rear side. However, with the breaker mounted inside a panel, access from the rear side is restricted. Even if one has the access, he will have to dismantle the entire cable and link work for replacing cradle terminals. Therefore, it should be possible to carry out replacement of cradle terminals from the front side, preferably in a phase by phase manner. May be at the cost of much higher effort in ACB design, but this feature will certainly make the ACB maintenance much easier for the users.

Arc chutes have to be routinely opened by the maintenance man for contact inspection. To facilitate the above, it should be possible to remove and re-fix the arc chutes without using any tool. This feature becomes all the more important in case of a fixed breaker. It must be remembered here that the ‘easy-to-remove’ arc chutes must also withstand severe stresses encountered while clearing a major short circuit.
6. Security:

ACB needs to be secured for prevention of unauthorized access and inadvertent operation.

Operations susceptible to unauthorized access are ACB racking and opening/closing. ACB trips during rack-out operation, resulting in disruption of supply and hence, racking operation must be protected against unauthorised access. Similarly, ON and OFF buttons must also be guarded against foul play.

Protection settings on the release are extremely important for safety of the equipment downstream. Once set, they should not be touched unless a change is called for. Therefore, access to release settings must be secured to prevent tampering.

During a typical maintenance shutdown, several breakers are removed from the cradles. While replacing the breakers, one should not be able to inadvertently load a breaker of the same frame size in a wrong cradle.

7. Modular and User-friendly:

Though breaker configurations are normally ordered as per the system requirements, there are several instances where users have to add/delete accessories, where modularity plays a vital role.

Though modularity is a commonly used concept today, its extent of utilisation is varying. If an accessory can be fitted at site, but takes hours of assembly time and special skills, is it truly modular?

Therefore, one should be able to fit ACB accessories on-site, without using any special tools in minimum time. For a drawout ACB, this should even be possible without removing the ACB from the panel. The control wiring should also be easy to fix, without the need for calling a specialised person. It would be extremely beneficial if no control termination is required to be handled while replacing accessories. Though draw-out breakers are very popular today, there is still a large population of fixed breakers in the industry. In a plant where a combination of both types exist, it would be preferable if a fixed breaker and a draw-out ACB (breaker portion) are interchangeable.

In a PCC where a large number of ACBs are installed, it is essential that each ACB identifies itself clearly to the maintenance man, without even opening the panel door. The front of the ACB, which projects through the door cut-out should give as much information as possible about the accessories installed (and not installed!). Even for finding out the control voltage of various accessories, the operating personnel have to refer to the drawings, as they cannot open the breaker every time. Should the breaker front display this information, it would be quite convenient.

8. Complete range:

A maintenance man always prefers fewer variations in the equipment installed in his plant as standardization helps him in product familiarity and lower spares requirement. Therefore, the breaker manufacturer should be able to provide complete range in terms of ratings, 3/4-pole versions and fixed and draw-out models.

9. Environment friendly:

Implementation of environment friendly policies (ISO 14000) in most of the industries necessitates use of every equipment including switchgear, which is environment friendly in manufacturing and in service. Environment consciousness of the manufacturer can be seen right from the ACB packing made with disposable material to avoiding use of harmful heavy metals. It is lesser known that even paint pigments can be made environment friendly by avoiding lead content.

Another effort towards environment conservation can also be seen in life cycle enhancement of the product. Life cycle can be enhanced through a combination of higher basic life as per the product design and subsequent parts replacement.


ACB caters to a wide variety of applications – from one stand-alone ACB to hundreds of ACBs integrated in a modern plant. Extent of intelligence to be packed in the protection release also varies from one application to the other.

As a result, ACB manufacturer has to offer a wide spectrum of products – from high technology to economy. Standardization in ACB specifications helps the manufacturer manage the complexities and expedite deliveries in this wide spectrum of products. However, this style of feature packaging confuses the user.

Therefore, the users must be able to select the very features that they need and pay for them.

Conclusion:

Any breaker, which meets the above expectations will certainly keep the operation and maintenance personnel happy. But, for achieving this, the breaker must be designed for the USERS, designed to surpass world benchmarks!!!