TechTopics Topic:Circuit Breakers or Contactors – Application Considerations

We are often asked to discuss the application considerations that favor the use of medium voltage circuit breakers, and those that favor the use of medium voltage NEMA Class E2 controllers (fused contactors). This is one of those recurring questions, so this issue of TechTopics addresses it.

To compare the application of medium voltage circuit breakers and of fused contactors, we must understand the basic characteristics of each switching technology.

The table on the next page shows the major characteristics of medium voltage circuit breakers and medium voltage fused contactors that influence the application. Of course, the table entries are generalized, and the information varies by the voltage and current ratings of the equipment. However, the table is valid for an overall understanding.

From the data in the table, we make these observations:

- Medium voltage circuit breakers are favored when
  - Typical loads: transformers, capacitors, larger motors, generators, distribution feeders
  - Ratings required exceed those of contactors (360A or 720A at up to 5kV, 360A at up to 7.2kV)
  - Continuous load current is high (i.e., larger transformers, larger motors)
  - Switching is not very frequent (i.e., weekly or monthly); high endurance (1000's of operations) is satisfactory
  - Process continuity is critical (i.e., no time for fuse replacement)
  - Reduced voltage starting is not needed (RV starting complicates switchgear bus arrangements)

- Medium voltage NEMA Class E2 controllers (fused contactors) are favored when
  - Typical loads: motors, smaller transformers
  - Continuous load current is low or moderate (i.e., smaller motors or transformers)
  - Switching is very frequent (i.e., daily or several times per day); very high endurance (100,000s of operations) is needed
  - Process continuity compatible with fuse replacement time
  - Reduced voltage starting is needed to reduce starting duty (and voltage fluctuation) on system

Historically, circuit breakers have been used for medium voltage motors in certain industries, especially in utility generating stations. As these stations have aged, and station operation has changed from base-load to peaking service, many of these motor-starting circuit breakers have experienced total operations well in excess of the endurance required by the ANSI standards. As a result, these applications have had higher maintenance costs than if medium voltage fused contactors had been used originally. In contrast, users in the process industries have long favored the use of fused contactors for such applications, and have enjoyed long service with lower maintenance costs.

When applied properly, both medium voltage circuit breakers and medium voltage fused contactors should provide decades of reliable service. Applied incorrectly, either can lead to major headaches.

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Characteristic	Circuit Breaker	Contactor (NEMA E2 with fuses)
Continuous current	High (1200A, 2000A, 3000A, or 4000A)	Moderate (360A enclosed – NEMA size H3, or 720A enclosed – NEMA size H6)
Switching capability	Switch currents from very low (magnetizing) values to full system short-circuit current	• Switch currents from very low (magnetizing) values to interrupting capability of contactor without fuses (at least 10 X continuous rating). • Fuses operate for currents higher than the interrupting capability of the contactor alone, up to the interrupting capacity of the fuse
Endurance - mechanical	High (typically 10,000 operations) (see ANSI C37.06)	Very high (1,000,000 operations for 97H3 (360A) or 96H6 (720A)
Endurance - electrical	High • For vacuum, typically 10,000 operations at rated continuous current. • For vacuum, typically 30-100 operations at full short-circuit rating.	Very high • Switching continuous current, 250K operations for 97H3 (360A) or 200K operations for 96H6 (720A) • Switching short-circuit current, endurance data not established in NEMA or UL standards. Short-circuit current interruption requires replacement of current-limiting fuses
Application limitations	Not appropriate for very high endurance applications	Well suited for very frequent switching operations
Operation	Electrically operated (manual operation for maintenance or emergency).	Electrically operated only
Control scheme	Mechanically latched – circuit breaker remains closed on loss of system voltage	• (Usually) magnetically held – contactor opens on loss of system voltage. Contactor will close automatically on system voltage return with 2-wire control. Manual restart required on system voltage return with 3-wire control. • Latched contactors are available
Overcurrent / Short-Circuit protection	Requires protective relays	Requires protective relays for overload protection and current-limiting fuses for short-circuit protection
Short-circuit Let-through energy	High (3-5 cycles or more of short-circuit current)	Low (current-limiting fuses interrupt in 1/4 cycle for highest short-circuit currents, and peak magnitude is limited
Remote operation	Well suited	Well suited
Control power	Control power needed for relays, breaker operation, and heaters (if present).	Control power usually provided by CPT incorporated in the controller
Construction	• Drawout, if metal-clad (C37.20.2) • Stationary, if metal-enclosed (C37.20.3)	Drawout or stationary
Space requirements	• Larger enclosure • NEC required workspace equal	• Smaller enclosure • NEC required workspace equal • Rear access not required
Purchase cost	Relatively high	Moderate
Maintenance	Medium (long maintenance intervals, need to clean insulation)	Low (simple mechanism, need to clean insulation, replace fuses)