Application Paper **AP083006EN**

Eaton medium-voltage circuit breakers reliability and availability for service

The medium-voltage circuit breaker reliability estimate on the following page is based on the independent findings of the Power Systems Support Committee, Industrial Power Systems Department, IEEE® Industry Applications Society. Data were taken from "IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems." IEEE STD 493-1980, IEEE Inc.

The above referenced reliability data is considered typical for the installed equipment base. Because Eaton cannot define or attempt to measure breaker reliability in specialized industry applications, we consider our reliability typical within the definition of IEEE's industry analysis. Eaton product constitutes a significant portion of the subject installed product base; therefore it is reasonable to use this data to describe our product's reliability, if only a worst-case estimate.

Our design experience indicates that the actual reliability of the vacuum circuit breaker is higher than that of the IEEE's estimate. Eaton's medium-voltage circuit breaker vacuum technology has improved reliability by providing the market with a product requiring less maintenance and a simplified high-energy mechanism. Both ease of maintenance and system simplicity are major factors in the reliability and availability equation.

Other factors further support the position that Eaton's vacuum circuit breaker is more reliable than the installed base of typical product. Vacuum interrupter reliability is described in a magnitude of several hundreds of years Mean Time Between Failure calculated on an installed base in excess of 40 million tube years (1 tube in service 1 year = 1 tube year). Estimating product life to be 40 years, vacuum interrupter integrity is certain.

Circuit breaker life and reliability are closely related to frequency of operation and load characteristics. While we cannot control load characteristics, we have concentrated on improving mechanical endurance. Through a program of periodic production life testing to the product's destruction, opportunities are reviewed and life extending changes are incorporated into the circuit breaker's design.

The surveyed product base has not been influenced by the above design features and aggressive quality assurance techniques. Therefore, the data presented is likely a worst-case description of our product's estimated reliability. It is Eaton's goal to become the world leader in the manufacture of power circuit breakers. Our attention to quality will assure we remain a leader in reliability and reliability improvement.

Reliability data taken and calculated from:

"Reliability Data — Metalclad Drawout Circuit Breakers, Table 24", page 83, from "IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems" IEEE STD 493-1980, IEEE Inc.

Description	Units
Failure rate per unit year (or 3.6 failures per year on an installed base of 1000 breakers)	0.0036
Sample size of installed base in unit years	16,280.0 units
Number of failures reported	58.0 failures
MTBF = Installed base in unit years / failures = 16,280 / 58	280.7 years
Hours of downtime per failure (repair failed unit)	83.1 hours
Hours of downtime per failure (replace failed unit)	2.1 hours
Forced hours of downtime per year (repair)	0.2992 hours
Forced hours of downtime per year (replace)	0.0076 hours
Total hours in a year (365 x 24)	8760.0 hours
Availability — Total time – downtime (repair) (8760 – 0.2992)	8759.7 hours
% Availability — Availability / total time x 100 (8759.7 / 8760 x 100)	99.9%
Actual availability in the event of a failure (repair) (8760 – 83.1)	8676.9 hours
Actual % availability in the event of a failure (repair) (8676.9 / 8760 x 100)	99.05%

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Printed in USA
Publication No. AP083006EN / Z21340
September 2018

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