Circuit Breaker Timing Tests

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By definition, a circuit breaker timing test is the process of measuring the mechanical operating times with the goal of verifying, analyzing, and validating the correct function of the circuit breaker. Timing tests are particularly important in maintaining the reliability of the transport and distribution network and also in ensuring the safety of the personnel employed to maintain and operate the network protection apparatus. Using test execution, experience acquired in the field, and analysis tools, such as a circuit breaker timer, it is possible to determine with remarkable accuracy the nature of the problems that affect circuit breaker performance even before disassembling the apparatus.

However, timing tests are not limited to tests conducted after a circuit breaker has failed (corrective maintenance). In the preventive maintenance strategy, the breaker is subject to regular timing tests to detect trends in the degradation and aging of the equipment so that corrective action may be applied before the problems become a danger to the network or personnel.

Timing tests are also useful in the factory to check production quality standards, in reliability testing to determine the reference parameters, and in field testing after the installation of a new circuit breaker.

The potential for damage that a circuit breaker, essentially a protective device, can inflict on a network if its operations are not within specifications should not be ignored. The economic repercussions can be severe, including the cost of repairs, the cost of the failure, and the interruption of service to customers. If the operation time during a trip is too long, the short-circuit current being interrupted will persist for a much longer amount of time and could damage transformation, transmission, and distribution installations. Reducing the interrupting time may also bring the added benefit of increasing the transportable power because the stable power limit increases in inverse proportion with the tripping time. In addition, the contacts are subject to the arc for longer periods, which reduces their useful lifespan.

It is also important for all contacts to be synchronized within a certain tolerance limit. In three-phase systems, all poles (phases) and contacts must operate at the same time. If the contacts in one pole do not operate in synch, then the slowest contact to close and the quickest to open will absorb the greater part of the load, causing premature wear to the contacts in question.

The difference between phases can generate voltage spikes because of the very nature of the transportation system. These systems can consist of long transmission lines with extremities whose state can not always be predicted, such as open-ended, loaded, capacitive, inductive, etc. These factors may cause huge voltage spikes that could potentially damage the network and its equipment.

Inoperative insertion resistors will cause premature wear on the main contacts since they will be subjected to the strongest breaking currents and the accompanying arc will be so much more powerful. Voltage surges will also be present, which can damage the breaker and surrounding equipment.

Troubleshooting breakers

The first prerequisite for diagnosing breaker troubles is to know the breaker being analyzed. By knowing the configuration of the suspect appartus' innards, it is possible to figure out the nature of the problem by visualizing the mechanical process of the operation. This should be kept in perspective with the data of the timing test. The same is true of an experienced mechanic who at a glance can determine the source of the mechanical problem in a car. They not only know automobile mechanics as a general subject but know the peculiarities of the model.

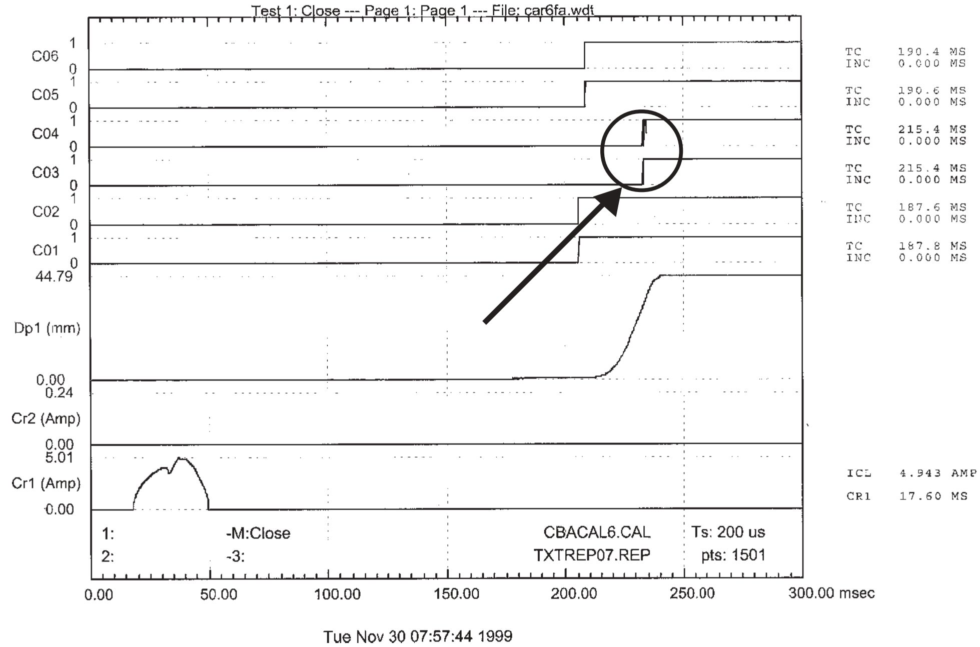
One also needs precise timing test data after a timing test has been conducted

The following examples — the curves generated by the faulty apparatus and the analysis, the description of the actions and corrections applied, and the curves generated by the repaired equipment — all illustrate how the principles previously explained can be applied in a real-world situation.

In conclusion, the role played by the high-voltage circuit breaker has always been one of the determining factors of high-voltage network reliability. Its main role is to protect the network and the installed electrical equipment from destructive short-circuit currents. A high-voltage circuit breaker can stay in the closed position for years but is still expected to interrupt a powerful short-circuit current of many thousands of amperes in a fraction of a second. The nature of its operation possibly places it among the most unpredictable equipment on the electrical network.

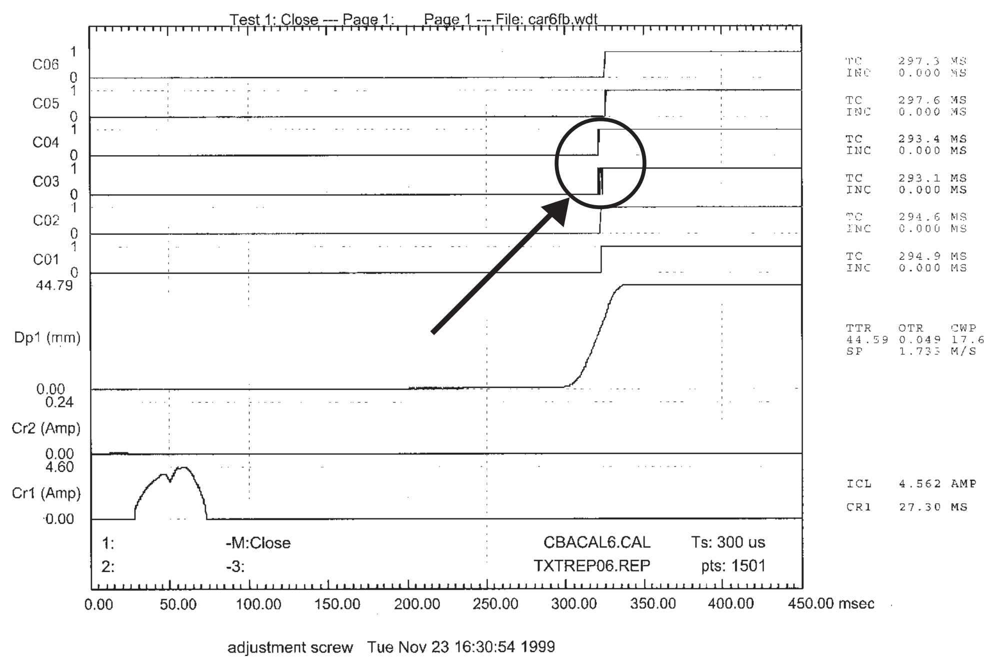
SF_6 Breaker with Hydraulic Commands — Adjustment Screw Incorrectly Set

An adjustment screw on the breaker is incorrectly set, crating a 25 millisecond difference on one phase. This problem may produce similar results to those produced by an incorrectly positioned control valve.



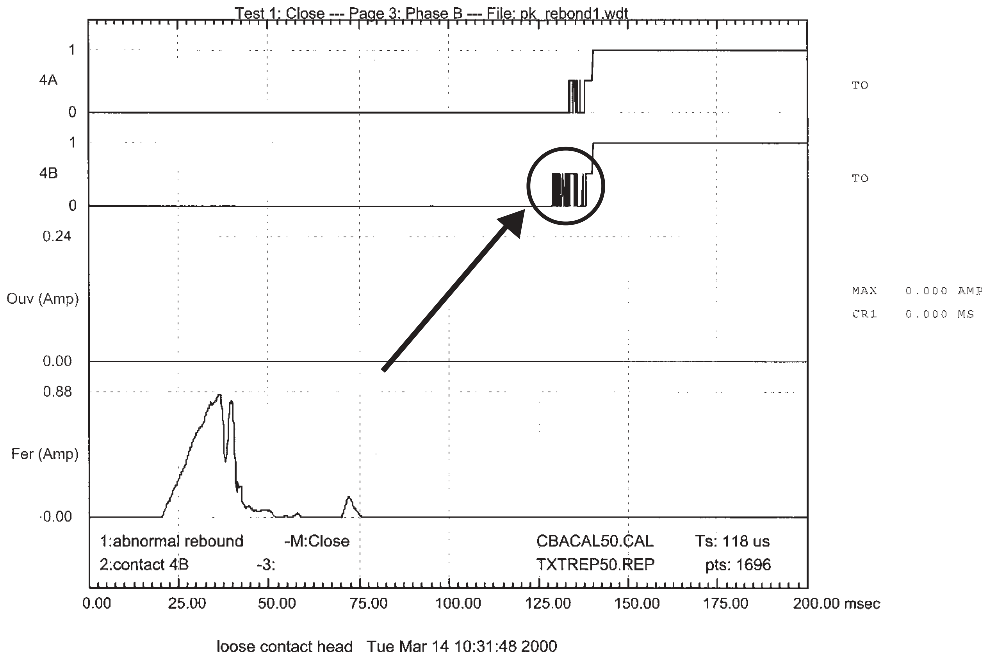
SF_6 Breaker with Hydraulic commands — Adjustment Screw — Correction

The adjustment screw was set to obtain similar closing times on all phases and contacts. A timing test shows that the closing time on contacts CO3 and CO4 are now comparable to those on the other contacts.



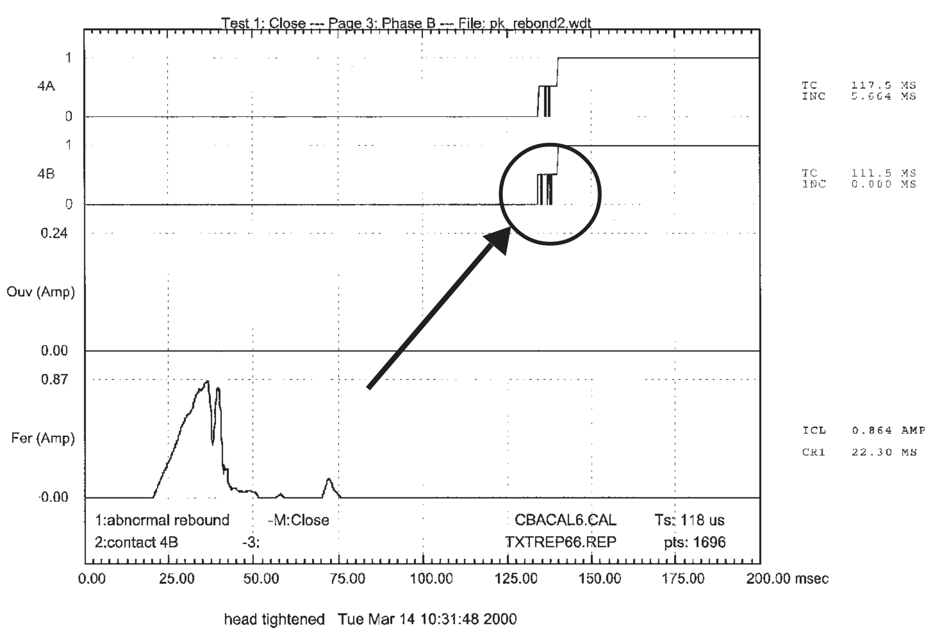
PK – Rebounds

Abnormal rebounds on an auxiliary (resistive) contact — The head on the semimobile contact is loose.



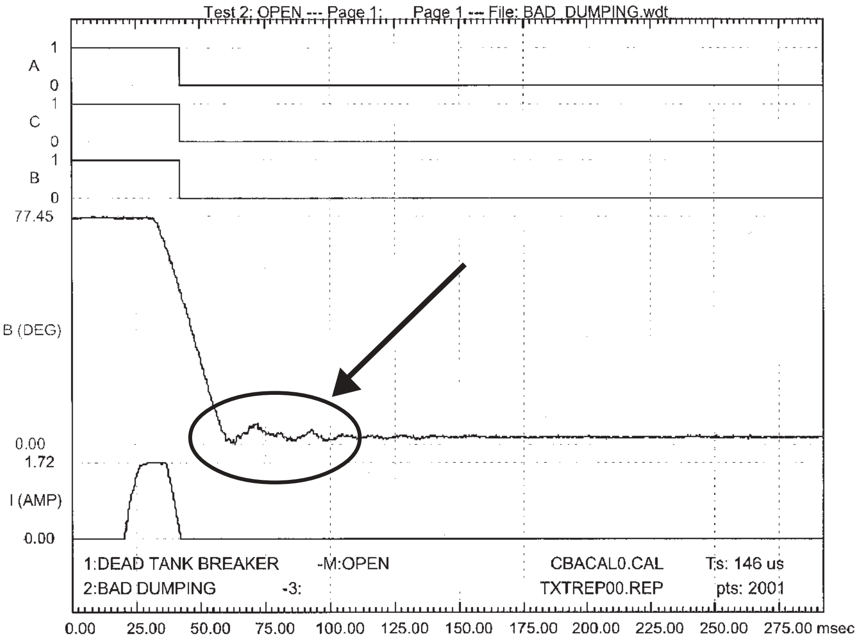
PK – Correction

Disassembly of the auxiliary moving contact — Observe the problem (loose head). Tighten the head and immobilize with Loctite and punching, followed by reassembly. A timing test shows the disappearance of the unusual rebounding on the resistive trace.



Dead Tank — Bad Damping

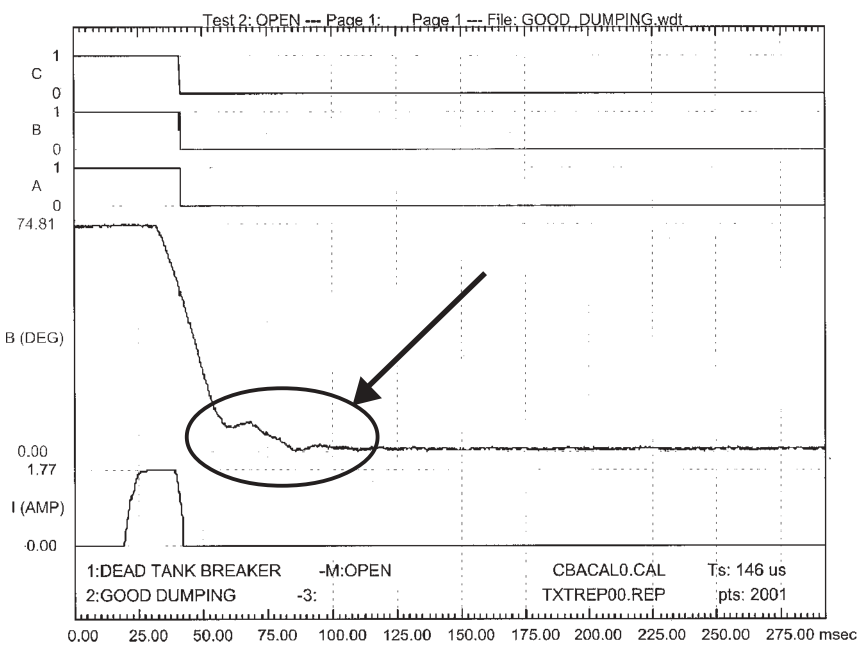
The following timing diagram shows a hard rebound at the bottom of the displacement curve, during a Trip operation on a Dead Tank type circuit breaker. This suggests a lack of damping at the end of travel. Excess energy is poorly absorbed and damage may already have occurred.



BAD DUMPING

Dead Tank – Correction

After examining the internal components, it is observed that damage has indeed occurred on the main rod of the moving contact. The source of the problem is a defective dashpot. After repair, the timing test shows correct damping at the bottom of the travel curve.



GOOD DUMPING

Dr. Fouad Brikci is the president of Zensol Automation Inc. He was the first to introduce on the market the concept of true computerized test equipment in the field of circuit breaker analyzers. As a former university teacher and CNRS researcher in France, Dr. Brikci has developed experience in the fields of electronics, automation, and computer science. Most activities were focused on the industrial application of computers. Among his achievements are the development of a major automated system made for paint manufacturers, development of fully computerized measuring systems for quality control manufactured by circuit breaker manufacturers, laboratories and maintenance services of electric utilities. Dr. Brikci holds a PhD degree in electronics and a Master in Sciences in EEA (electronics, electrotechnics, and automation) from the University of Bordeaux, France.