ODEN primary current injection test system used to test MCCBs in situ

Introduction

No matter how well specified a test set is, it's certain that users will find ways of pushing it to its limits and beyond. That was certainly the case with the high-current test equipment in use at the Diablo Canyon nuclear power plant in the USA – and addressing the problem wasn't easy.

Moulded case circuit breakers (MCCBs) play a key role in the operation of nuclear power plants, as was all too convincingly demonstrated when, around two years ago, the failure of an MCCB to trip led to a major incident at just such a plant. For this reason, the technicians at the PG&E (Pacific Gas and Electric) nuclear power plant in Diablo Canyon have always regularly tested the many hundreds of MCCBs used on their plant.

Until recently, however, this was a complicated and costly task. Every MCCB had to be removed from the equipment in which it was being used and a temporary replacement fitted in its place. The unit to be tested then had to be taken to an electrical workshop where the test equipment was located, a process that involved time-consuming security check-in/check-out procedures. While looking for a more efficient way of carrying out MCCB testing, the PG&E maintenance team realised that by using a Megger ODEN portable high-current test set, they could take the test equipment to the MCCBs, rather than bringing the MCCBs to the test equipment. This meant that the MCCBs could be tested in situ, making the testing process far less time consuming and costly. And so it proved, except that during the first year of operations the test sets failed twice, once in the spring and once in the autumn. This was bad enough, but the situation was made worse when enquiries revealed that these were the only times of year that the test sets were being used! To gain a better under-standing of the problem, Megger's engineers carried out further investigations, which showed that PG&E was subjecting the test equipment to extreme operating conditions. In order to minimise the disruption caused by testing the MCCBs, the PG&E technicians scheduled the work to take place over just four days, during which time the test equipment was operated continuously, twenty-four hours a day. This duty was well beyond the original design parameters for the ODEN test sets.

At this point, it would have been easy to advise the PG&E that it was using the test equipment improperly, and to walk away from the problem. Instead, Megger saw the issue as an opportunity to improve the design of its products, and to make them a better fit for the requirements of all its customers, no matter how demanding those requirements might be.

Unfortunately, it proved impossible to replicate in the development laboratory the severe conditions that provoked the equipment failures. Nevertheless, sufficient data was gathered during the laboratory work to suggest a possible solution. This was discussed in detail with the PG&E technicians who concurred with the conclusions, and agreed that the modified equipment would be used during the next scheduled period of testing.

During this testing, a top-level engineer from Megger was present on site at all times, to provide PG&E with a lifeline should a further failure occur. The services of the engineer were not, however, required – the equipment performed faultlessly. Nevertheless, at the end of the testing period, it was returned to the development laboratory where it was examined in detail to ensure that there was no concealed damage or degradation.

During the upgrade process for the instruments, the opportunity was taken to incorporate a further modification to allow direct operation from a 480 V 60 Hz supply. This meant that PG&E no longer needed to use a step-down transformer that weighed around 50 kg and cost several hundred dollars. While these are clearly significant benefits for PG&E, it's worth noting that the upgrades are now included as standard in all new ODEN test sets.

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By responding positively to very specific customer requirements, users of the ODEN test sets will now benefit from product enhancements.

PG&E is delighted with the outcome of this project. Before it switched to in-situ testing of MCCBs, testing took seven days and involved 840 man-hours of work. With the new test equipment, testing is completed in four days and requires less than 400 man-hours of work. In addition, the new testing regime is helping to avoid breakers being replaced unnecessarily. The total savings amount to over $30,000 per year, which means that the test equipment easily covered its costs in the first year of use.

Despite these very successful outcomes, development work on the ODEN test set continues. A new high current test probe that is well suited for in-situ MCCB testing has recently been made available, as has a software application that will capture every single test result form the test set, as required by current NRC (Nuclear Regulatory Commission) regulations.

When this software is used, the test set automatically dumps the test results to the PC at every trip. When the test is completed, the data can be synchronised with a PC and imported to Excel or Word for reporting. Manufacturers and users alike abhor equipment failures, even if they can be justified because the equipment is being pushed beyond its design limits. As has been shown however, a positive reaction to such failures can guide manufacturers toward product improvements that will ultimately benefit all users.

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ABSTRACT: A US based nuclear power generator needed some particularly robust test equipment to cope with testing MCCBs. By working collaboratively with Megger, Diablo Canyon has saved significant costs in its testing regime.