technical paper

Periodic Relay Maintenance Tests Extend Relay Functioning Life and Save Money

Maintaining protective relays ensures the highest degree of protection for the Power System Network. The protection engineer is concerned with limiting the effects of disturbances in a system network, which, if they persist, may damage the plant and interrupt the supply of energy. These disturbances, described as faults (short circuits and open circuits), or power swings, result from natural hazards, plant failure, or human error. The purpose of an electrical power system is to generate and supply electrical energy to consumers. The system should be designed and managed to deliver this energy to the utilization points with both reliability and continuity.

After a mint condition protective relay has been installed, deterioration may take place, which in time could interfere with the relay's correct functioning. For example, contacts may become rough or burnt owing to frequent operation, or tarnished because of atmospheric contamination. Coils and other circuits may become open-circuited, electronic components may fail, mechanical parts may become clogged with dust or corroded to an extent that it may interfere with movement.

A peculiar difficulty of protective relays is that the time between operations may be measured in years, during which period defects may have developed unnoticed until revealed by the failure of the protection device to respond to a power system fault. For this reason, relays should be given simple basic tests, at suitable intervals, in order to check that their reliability has not deteriorated.

The other advantage of relay maintenance is that, using test results, the relay coordination study and the conformity of the relay with the requirements of network protection can be checked. If the relay is not able to provide adequate discrimination of the protected zones, and if the relay does not have much selectivity, the relay maintenance will project whether protective gear needs an upgrade with new generation relays.

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Periodic Maintenance Tests

The clearance of a fault on the system is correct only if the number of circuit breakers opened is the minimum necessary to remove the fault. A small number of faults are incorrectly cleared, the main reasons being:

- Limitations in protection design;
- Faulty relays;
- Defects in the Secondary wiring;
- Incorrect connections; and
- Incorrect settings

Protective relay evaluation started with:

First generation: Electro-mechanical Relays
Second generation: Static relays with Transistors
Third generation: Static relays with Integrated Circuits
Fourth generation: Processor based relays

Most of the first, second, and third generation relays do not have the capabilities of auto-testing of internal circuits or providing an alarm in case a failure is detected. Electromechanical relays have a lot of mechanical parts, which may become clogged with dirt or corroded due to environmental conditions, affecting both operation, calibration and movement of the disks.

Static relays generally employ a lot of electronic components made by other manufacturers. If these electronic components are not tested with rigorous quality control, the chances of failure of components during the relay life time may exist. A reliable DC power source within the relay, to electronically measure circuits has to be generated from available external power sources. Most of the static relays employ series, shunt, or switched mode power supply designs. For a variety of reasons, if these power supplies fail, the measuring circuits are inoperative and the relay is dead for any measurements. No protection is available to the network. Most of the static relays in use do not have the means to detect the failure of power supply and initiate an alarm.

The fourth generation processor-based relays do have the watchdog feature which facilitates the checking of power supply rails, clock frequencies, and other patterns. Most of these relays have auto test features which test the electronic circuit functions.

The periodic maintenance tests performed after commissioning prove

- continued reliability
- accuracy limits
- levels of deterioration of components
- correctness in tripping circuit connections
- adopted settings
- fatal failure of a protective relay

From periodic maintenance test results, we can also generate the following:

1. Inadequate network protection
2. Maintenance cycle required for particular types of relays
3. Different manufacturers' protective relay functioning and behavior
4. Requirements for upgrades with the new generation of relays

Protective relays may be in sound condition when first put into service, but many failures can develop unchecked because of infrequent operation. It is therefore advisable to inspect and test protective gear at regular intervals, approximately every 6-12 months. Maintenance tests may have to be conducted when the protected circuit is on load. It is desirable to carry out maintenance on protective gear at times when the associated power apparatus is out of service.

Primary injection tests are not recommended during maintenance unless an error has occurred and protective gear is suspect. Secondary injection tests should be carried out to check the relay performance, and the relay should be allowed to trip the circuit breakers.

Automated Testing

The quality of testing is an essential feature when assembling reliability and considering means for improvement. The test equipment and procedures should be capable of producing the required outputs. Testing personnel must be technically competent and adequately trained.

Generally, to perform manual maintenance tests on relays at one substation, several pieces of test equipment need to be set up. Also, to start tests, electrical connections (sometimes complicated) of all the test equipment is required. Test setup takes a longer time than the actual testing itself.

Computer-based relay testing is becoming a vital asset in relay testing as a result of

- reduced shutdown periods
- uninterrupted power systems
- reduced skills required for relay tests

The speed, accuracy and repeatability comes with the computer-based relay test equipment. Generally, a single computer-based relay test equipment can produce all the output parameters required to test a wide variety of relays, thereby minimizing test setup time. Depending on the type of relay, test software can be developed with its manufacturer-stipulated test procedures and accuracy specification at its office. For any relay the accuracy limits can be defined, whereby the printouts will show the test results.

Computer-based relay testing provides consistent testing procedures with easy-to-read and understand result reports. Once the relay test software is setup in the database, it will be tested the same way every time, opening other options such as the "Maintenance Audit."

For each relay, specific information can be stored, including

- procedures for testing a certain relay
- unique features
- adaptations of a particular relay
- changes in test parameters

Test results can be stored in database files and each year results can be compared and analyzed with the use of computer-based test equipment. Dynamic relay testing can be performed for better understanding of a relay's performance during abnormal conditions.

Also, the fault investigative reports can be generated by performing various dynamic testing and simulated inputs to the relay for observation of the relay behavior.

Maintenance Audit

From the results of the periodic maintenance test, it is important to audit the output data and generate recommendations for the system integrity, reducing downtime and prevention of relay problems. The chart for maintenance audit is given below:

Relay Test Results

Relay calibration drift

- Locate obsolete relays;
- Locate emergency for repairs;
- Locate possible emergency for relay replacements.

Relay Coordination

- Option for new generation relays;
- Protective zone selection

Plant Outage

- Shutdown requirements planning
- Maintenance cycle

Adequacy of Plant protection

- Retrofit Planning

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