ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 7, Issue 5, May 2020

Review on Field Testing of Protective Relays

Srimayi Y.

Technical Support Engineer, LS Electricals, Hyderabad, India

sri.mayi99@gmail.com

Abstract: Today's Protective relays are the vital components in the electrical power system. These relays monitor the set electrical parameters like voltage, current etc. and initiate action to isolate the faulty component from the electrical network so that the balance healthy system will continue to extend the services to its customers. These important elements in the electrical system require regular maintenance and field testing so as to ensure their availability in the system. This paper intends to overview the type of relays and their field maintenance requirements for their reliable service.

Keywords: Protective Relay, Field Maintenance, Secondary Injection Testing, Static relay, Digital Relay.

I. INTRODUCTION

Protection is the main diagnosis system in the electrical power network which will continuously monitor the power network and detects the faults as and when they occurs simultaneously they will isolate the faulty equipment from the network and protects the network. There are various types of protective relays like electromechanical relay, as in fig. 1a, solid state relays, as in fig. 1b and digital relays, as in fig. 1c. For their reliable service, all of these relays require a regular care and maintenance like preventive medical checkups by human. They also required to be tested frequent Intervals for their functional testing. The details of maintenance and functional testing to be done on various types of relays will be discussed in subsequent sections. Table I summarize the field maintenance and tests to be done on various relays with their testing frequency.

Fig. 1c. Digital Relay

Fig.1a. Electromechanical Fig. 1b. Solid State Relays

TABLE I
FIELD MAINTENANCE AND TESTS

Maintenance or Tests to be done	Frequency
Electromechanical relays calibration and functional testing	Once in every 1 year in clean environment or once in every 6 months in polluted area. [1]
Solid-state relays calibration and functional testing	Once in every 2 years [2]
Microprocessor1 (digital) relays functional testing.	Once in every 4 years [3]

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 7, Issue 5, May 2020

II. MAINTENANCE OF RELAYS

Like any other machines relays also requires regular maintenance on them. They are discussed here with category wise.

1.Electro-Mechanical relays: These are the first generation relays having so many moving mechanical parts to be maintained as follows:-

i. Cleaning of relay case, terminals, and all the internals.
ii. Check the tightness of all the wire connections and parts.
iii. Lubrication of all the moving parts.
iv. Check for the free rotation of disc in case of IDMT (Inverse Definite Minimum Time) relays.
v. Check the contact gap with feeder gauge.
vi. Check for any dents on the disc and repair/replace the worn out disc, other hardware like washers, springs and screws.
vii. Visual checking for intervals healthiness.

2. Solid State Relays: These are of second generation which generally do not have any mechanical/moving components except contacts. These relays require some maintenance as follows:-

i. Cleaning of relay case, terminals, and all the internals.
ii. Check the tightness of all the wire connections and parts.
iii. Check for overheated electronic components like Thyristors, heat sinks, resistors, inductors, capacitors etc.
iv. Check for black spots on Printed Circuit Board (PCB).
v. Visual checking for internal healthiness.

3. Digital relays: These are the latest third generation relays which require basic minimum maintenance .They do not have any moving or mechanical parts, hence they are more reliable but the dust is the main culprit for their mal operation. Following minimum maintenance is required for these relays:-

i. Cleaning of relay case, terminals, and all the internals.
ii. Check the tightness of all the wire connections and parts.
iii. Check for overheated electronic and microprocessor based components.
iv. Check for black spots on Printed Circuit Board(PCB).
v. Visual inspection for internal healthiness.

III. DESIRABLE PROPERTIES OF PROTECTIVE RELAYS

The desirable attributes are as follows [4]:

i. Dependability- It means relay trips only when it is expected to trip

$$\text{Dependability} = \frac{\text{Number of correct trips}}{\text{Number of desired trips}}$$

This can be improved by increasing the sensitivity of the protection system.

ii. Sensitivity: The relay shall be able to detect even the smallest faulty protected parameter.

iii. Security: It is nothing but the relay not acting when it is not desired to act.

$$\text{Security} = \frac{\text{Number of correct trips}}{\text{Total Number of trips}}$$

This can be improved by improving the selectivity of the protection system.

iv. Selectivity: It is the ability to discriminate between different faults

v. Reliability: It is the performance of the relay consistently.

$$\text{Reliability} = \frac{\text{Number of correct trips}}{\text{Number of desired trips+Number of incorrect trips}}$$

IV. Functional Testing of Relays

To confirm their readiness of action as and when required, the following functional tests are to be carried out on all relays :

1. Insulation Resistance (IR) test:

With the available lowest voltage rated insulation tester (of range generating 250V), the insulation resistance of relay case, wiring and covers to be test checked. The value shall be a minimum of 1 mega ohm and above. Care shall be taken while meggering digital relays where sophisticated microprocessor and micro controllers are existing. They should not be subjected

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 7, Issue 5, May 2020

for higher voltages of the IR value are less than 1 mega ohm. Check and replace the faulty wires/components.

2. Functional Tests: All the relays are to be tested for their operation if their monitoring parameter crosses the set point. These tests are to be done in condition to initial Factory Acceptance Test (FAT) and Initial Commissioning Tests (ICT).The tests to be conducted are

   i. Pick up test (Electromechanical relays)
   ii. Operation test as per set point
   iii. Reset test as below/above values

In general the test error shall be less than ±5 %. If the error is beyond the acceptable values, calibration to be done by relay manufacturer as their factory or the relay has to be replaced with a new relay.

Before doing these functional tests, the service set values are to be recorded and to be normalized on completion of tests. Since these tests will be carried out by injecting the required electrical parameters (like voltage or current), these tests are also known as Secondary Injection testing. The relays are to be tested off line (by removing from the system) with the test kit. One model of test kit is shown in the fig. 2. A sample flow chart of testing is shown in fig. 3.

Fig. 2. Relay test kit (Model:SMRT43D of Megger Company)

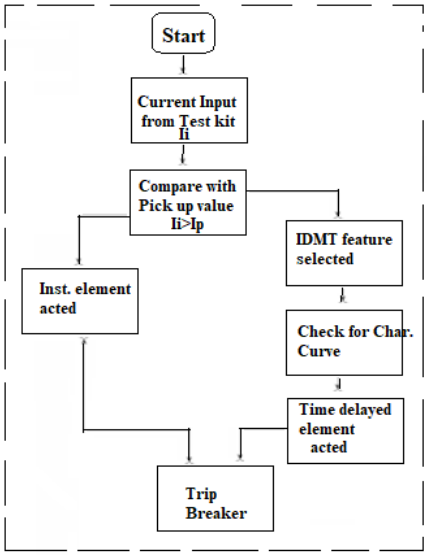

Fig. 2. Relay functional testing flow diagram

The sample test formats of various relays are shown in fig. 4, 5,and 6.

ELECTROMECHANICAL RELAY TEST REPORT

Date of Test _____

1. Location :
2. Mounted on :
3. Relay details :
   a) Type : CDG - 11/13 /31/ 34/....
   b) Model No. :
   c) S.No. :
   d) CT Ratio : 110 / 220 V. D.C.
   e) Auxiliary Voltage :
   f) Relay Range :
4. General Inspection :
5. Secondary Injection tests :

Pick-up and closing tests:

Element (Terminals)	Settings		Pick-up Current (A)	Closing Current (A)	Remarks
	PS	TMS			

b) Operation Tests :

Element (Terminals)	Settings		Operating time in seconds			Remarks
	PS	TMS	I = 2.5 X PS	I = 5 X PS	I = 10 X PS	

6. Conclusion: The relay have been tested as per standard recommendations and found OK. Initial settings are made again.

Fig. 4. Sample test format of electromechanical relay

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 7, Issue 5, May 2020

SOLID STATE RELAY TEST REPORT

Date of Test _____

1. Location :
2. Mounted on :
3. Relay details : 1 / 55 Amp. Relay
   a) Type : DTH - 31
   b) S.No. :
   c) Auxiliary Voltage : 110 / 220 V. D.C.
   d) Relay Range : % Bias= 15, 30 &45.
4. General Inspection :
5. Secondary Injection tests :
   A) Pick-up (Differential & Instantaneous) :

Phase	Injection Terminals	Current injected (Amps) Diff.	Inst.	Result
R	14-12			
	11-12			
Y	18-16			
	15-16			
B	10-8			
	7-8			

B) Second Harmonic Rest. Check :

Injection Terminals	Iac Injected to operate relay(A)	Idc Injected to restrain relay(A)		
14-12				
18-16				
10-8				

6. Conclusion :
   i) The relay have been tested as per standard.
   ii) Relay Settings are made as per actual settings.

Fig. 4. Sample test format of solid state relay

DIGITAL RELAY TEST REPORT

Date of Test _____

1. Location :
2. Mounted on :
3. Relay details : SPAJ 140 C of ABB make.
   a) S.No. :
   b) Nominal current : 1 / 5 Amps.
   c) Auxiliary voltage : 220 Volts DC
   d) SETIINGS :

Over Current : I > / In = t > = I >>/In= t >>=

Earth Fault : Io > / In = to > = Io >>/In = to >>=

Switch Groups (Checksum) :

SGF = **SGB =** **SGR 1 =**

4. General Inspection : _____

Secondary injection test results :

Unit	Current injected Amps.	Relay Operation in Seconds R	Y	B	Remarks
$I_{o>}$					
Io >>					
I >	2.5				
	5.0				
	10.0				
I >>					

Conclusion: The relay have been tested as per standard recommendations and found OK. Initial settings are made again.

Fig. 5. Sample test format of digital relay

For IDMT Relays, it is to be ensured that the set Time-Current Characteristic (TCC) curve, as shown in fig. 6.

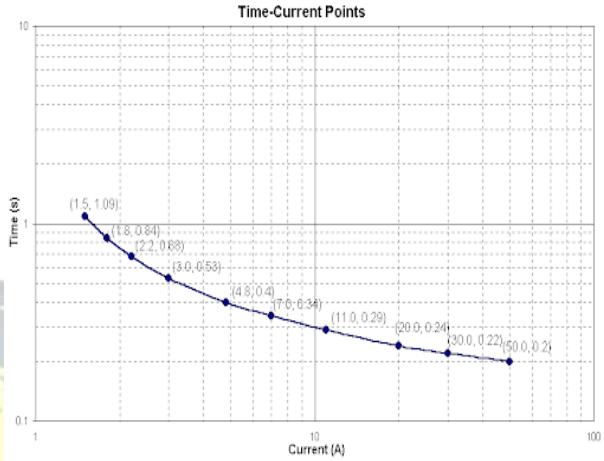

Fig. 4. TCC of IDMT relay

V. CONCLUSION

In this paper various types of relays with their field maintenance is discussed. The requirement of field functional tests and their testing schedule is highlighted. The sample formats of functional tests are also given here. Of these guidelines are followed, the protection system will definitely ensures the reliability, sensitivity, dependability, security and selectivity.

REFERENCES

[1]. IS 9124-1979 (R2013), "Guide for maintenance and field testing of electrical relays", by Bureau of Indian Standards.

[2]. NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance", 2019.

[3]. FIST 3-8, "Operation, Maintenance, and Field Test Procedures for Protective Relays and Associated Circuits", by U.S. Department of the Interior Bureau of Reclamation, May 2011.

[4]. IEEE Std C37.233-2009, "IEEE Guide for Power System Protection Testing".