TRANSFORMER OVERLOAD PROTECTION

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ABSTRACT

This paper presents a way to sought out the problem of transformer overload by keeping the problem of biggest power failure all over the world in mind. It is possible to design transformer protection relay that detect overload condition based on calculated hot spot temperature. It contain all the transmission subject: a) transmission design b) hot spot detection (transmission diagnostic) c) transmission failure d) overload protection

Keywords – Connection, Design, Diagnostic, Overload, Power Failure, Transformer

I INTRODUCTION

Transformer is basically defined as a a static electrical device that transfers energy by inductive coupling between its winding circuits. A transformer plays a very critical role in our daily routine life. In the short span of two centuries electrical power has become an indispensible part of modern day life. Our work, leisure, healthcare, economy, and livelihood depends on a constant supply of electrical power. Even a temporary stoppage of power can lead to relative chaos, monetary setback and possible loss of life, decrease in productivity, loss revenue.There are many causes of power failure and to protect ourselves from its adverse devastating effect one should know about its main causes:

Natural cause (70% of power outage 2)Other cause (11%) 3) Short circuit 4)Overloading 5)Power surge
Here in this paper we are dealing with only transformer overload and requirement of overload protection. We think it is better to install transformer overload relay to protect ourselves from the great failures.

1.1 Power outages:

Power outage means it should conform he following criteria:

i. The outage must not be planned by the service provider.
ii. The outage must affect at least 1,000 people and last at least one hour.
iii. There must be at least 1,000,000 person- hours of disruption.

The table below shows some of the largest power outages:

Article	Millions people affected	Location	Date	Reference
July 2012 India blackout	670	India	30-31 july 2012	[1]
2005 Java-Bali blackout	100	Indonesia	18 august 2005	[2]
1999 southern brazil blackout	99	Brazil	11 march 1999	[3]
2009 Brazil and Paraguay blackout	87	Brazil and Paraguay	10-11 november 2009	[4]
Northeast blackout 2003	55	The united states Canada	14-15 august 2003	[5]
Italy blackout 2003	55	Italy, Switzerland, Austria, Slovenia, Croatia	28 september 2003	[6]
Northeast blackout 1965	30		9 november 1965	[7]

1.2 Transformer Protection Principles

The type of protection for the transformers varies depending on the application and the importance of the transformer. Transformers are protected primarily against faults and overloads. The type of protection used should minimize the time of disconnection for faults within the transformer and to reduce the risk of catastrophic failure to simplify eventual repair. Any extended operation of the transformer under abnormal condition such as faults or overloads compromises the life of the transformer, which means adequate protection should be provided for quicker isolation of the transformer under such conditions

1.3 Transformer Failures

Failures in transformers can be classified into

i. Winding failures due to short circuits (turn-turn faults, phase-phase faults, phase-ground, open winding)
ii. Core faults (core insulation failure, shorted laminations)
iii. Terminal failures (open leads, loose connections, short circuits)
iv. On-load tap changer failures (mechanical, electrical, short circuit, overheating)

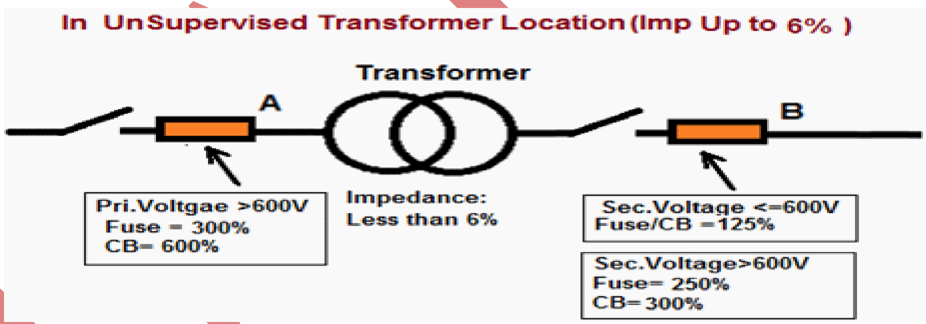
Conditions	**Protection Philosophy**
Internal	
Winding Phase-Phase, Phase-Ground faults	Differential (87T), over current (51, 51N) Restricted ground fault protection (87RGF)
Winding inter-turn faults	Differential (87T), Buchholz relay,

Core insulation failure, shorted laminations	Differential (87T), Buchholz relay, sudden pressure relay
Tank faults	Differential (87T), Buchholz relay and tank-ground protection
Over fluxing	Volts/Hz (24)
External	
Overloads	Thermal (49)
Overvoltage	Overvoltage (59)
Over fluxing	Volts/Hz (24)
External system short circuits	Time over current (51, 51G), Instantaneous over current (50, 50G)

II OVER CURRENT PROTECTION OF TRANSFORMER (NEC 450.3)

The over current protection required for transformers is consider for protection of transformer only. Such over current protection will not necessarily protect the primary or secondary conductors or equipment connected on the secondary side of the transformer.

2.1 Unsupervised Location of Transformer (Impedance <6%)



i. Over Current Protection at Primary Side (Primary Voltage >600V)

ii. Rating of Pri. Fuse at Point A= 300% of Pri. Full Load Current or Next higher Standard size. or

iii. Rating of Pri. Circuit Breaker at Point A= 600% of Pri. Full Load Current or Next higher Standard size.

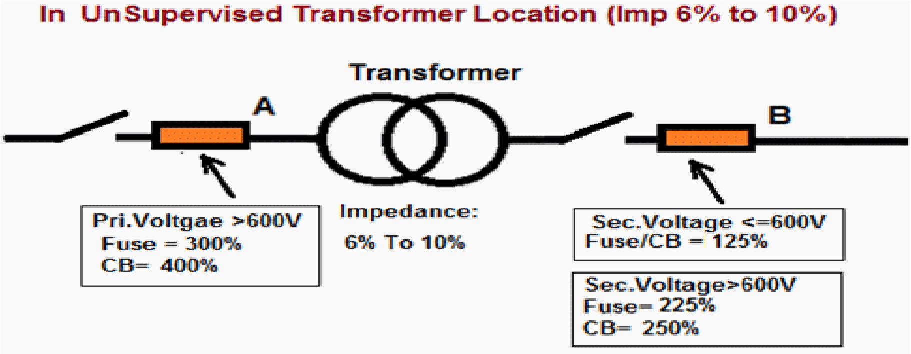
iv. Over Current Protection at Secondary Side (Secondary Voltage <=600V):

v. Rating of Sec. Fuse / Circuit Breaker at Point B= 125% of Sec. Full Load Current or Next higher Standard size.

vi. Over Current Protection at Secondary Side (Secondary Voltage >600V):

vii. Rating of Sec. Fuse at Point B= 250% of Sec. Full Load Current or Next higher Standard size. Or Rating of Sec. Circuit Breaker at Point B= 300% of Sec. Full Load Current**.**

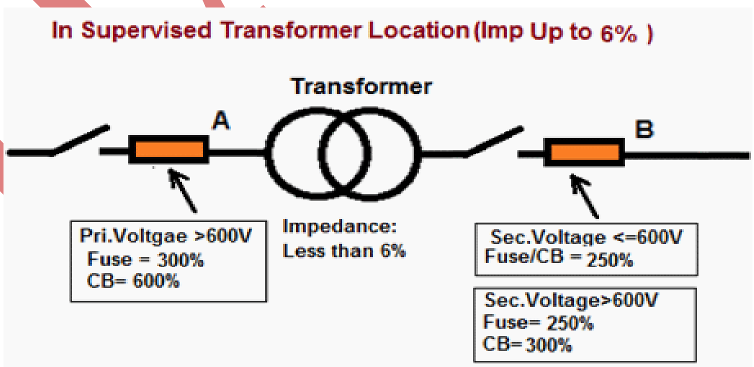
2.2 Unsupervised Location of Transformer (Impedance 6% to 10%)



Unsupervised Location of Transformer (Impedance 6% to 10%

i. Over Current Protection at Primary Side (Primary Voltage >600V):
ii. Rating of Pri. Fuse at Point A= 300% of Primary Full Load Current or Next higher Standard size.
iii. Rating of Pri. Circuit Breaker at Point A= 400% of Primary Full Load Current or Next higher Standard size.
iv. Over Current Protection at Secondary Side (Secondary Voltage <=600V):
v. Rating of Sec. Fuse / Circuit Breaker at Point B= 125% of Sec. Full Load Current or Next higher Standard size.
vi. Over Current Protection at Secondary Side (Secondary Voltage >600V):
vii. Rating of Sec. Fuse at Point B= 225% of Sec. Full Load Current or Next higher Standard size.
viii. Rating of Sec. Circuit Breaker at Point B= 250% of Sec. Full Load Current or Next higher Standard size.

2.3 Supervised Location of Transformer (Impedance Up to 6%)



i. Over Current Protection at Primary Side (Primary Voltage >600V):
ii. Rating of Pri. Fuse at Point A= 300% of Pri. full load current or next lower standard size.
iii. Rating of Pri. Circuit Breaker at Point A= 600% of Pri. full load current or next lower standard size.
iv. Over Current Protection at Secondary Side (Secondary Voltage <=600V):

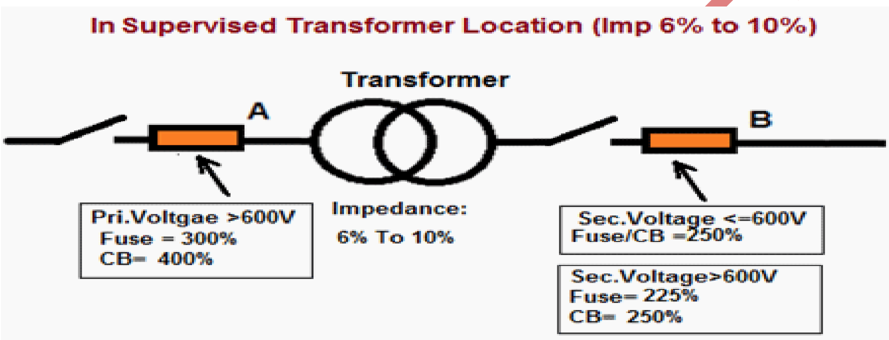
v. Rating of Sec. Fuse / Circuit Breaker at Point B= 250% of Sec. Full Load Current or Next higher Standard size.

vi. Over Current Protection at Secondary Side (Secondary Voltage >600V):

vii. Rating of Sec. Fuse at Point B= 250% of Sec. Full Load Current or Next Lower Standard size.

viii. Rating of Sec. Circuit Breaker at Point B= 300% of Sec. Full Load Current or Next Lower Standard size.

2.4 Supervised Location of Transformer (Impedance 6% to 10%)



i. Over Current Protection at Primary Side (Primary Voltage >600V):

ii. Rating of Pri. Fuse at Point A= 300% of Pri. full load current or next lower standard size.

iii. Rating of Pri. Circuit Breaker at Point A= 400% of Pri. full load current or next lower standard size.

iv. Over current protection at secondary side (Secondary voltage <=600V):

v. Rating of Sec. Fuse / Circuit Breaker at Point B= 250% of Sec. full load current or next higher standard size.

vi. Over current protection at secondary side (Secondary voltage >600V):

vii. Rating of Sec. Fuse at Point B= 225% of Sec. full load current or next lower standard size.

viii. Rating of Sec. Circuit Breaker at Point B= 250% of Sec. full load current or next lower standard size.

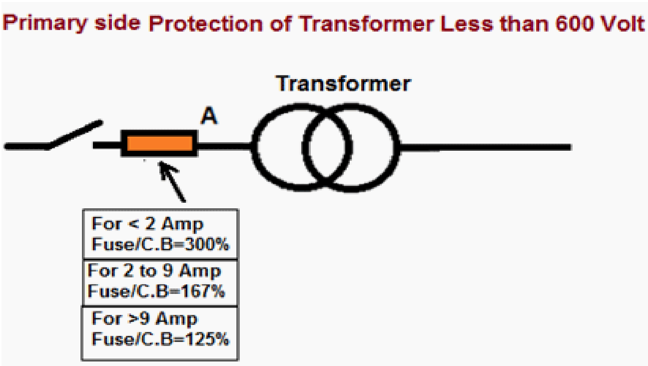
III OVER CURRENT PROTECTION FOR MORE THAN 600V

Maximum Rating of Overcurrent Protection for Transformers more than 600 Volts						
Location Limitations	Transformer Rated Impedance	Primary Protection (More than 600 Volts)		Secondary Protection		
				More than 600V		Less than 600V
		C. B.	Fuse Rating	C. B.	Fuse Rating	C.B or Fuse
Any location	Less than 6%	600%(NH)	300%(NH)	300 %(NH)	250%(NH)	125%(NH)
	6% To 10%	400%(NH)	300%(NH)	250%(NH)	225%(NH)	125%(NH)
Supervised locations only	Any	300%(NH)	250%(NH)	Not required	Not required	Not required
	Less than 6%	600%	300%	300%	250%	250%
	6% To 10%	400%	300%	250%	225%	250%

NH: Next Higher Standard Size.

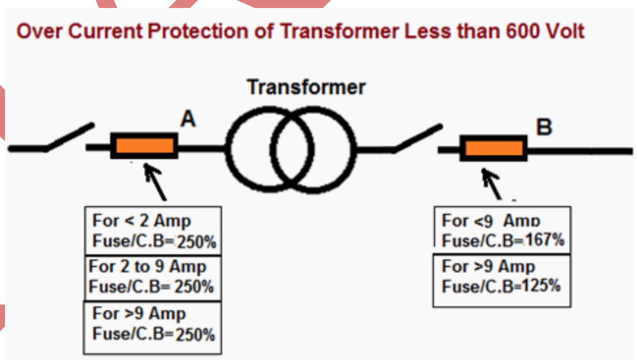
Over current Protection of transformers <600V (NEC 450.3B)

3.1 Only Primary Side Protection of Transformer



i. Over Current Protection at Primary Side (Less than 2A):
ii. Rating of Pri. Fuse / C.B at Point A = 300% of Pri. full load current or next lower standard size.
iii. Example: 1KVA, 480/230 3Phase transformer, full load current at Pri. side = 1000/(1.732X480) = 1A
iv. Rating of Primary Fuse = 3X1A = 3A, so next lower standard size of Fuse = 3A.
v. Over Current Protection at Primary Side (2A to 9A):
vi. Rating of Sec. Fuse / C.B at Point A = 167% of Pri. full load current or next lower standard size.

3.2 Primary and Secondary side Protection of Transformer



Over Current Protection at Primary Side (Less than 2A):

i. Rating of Pri. Fuse / C.B at Point A = 250% of Pri. full load current or next lower standard size.
ii. Over Current Protection at Primary Side (2A to 9A):
iii. Rating of Sec. Fuse / C.B at Point A= 250% of Pri. full load current or next lower standard size.
iv. OverCurrent Protection at Primary Side (More than 9A):

v. Rating of Pri. Fuse / C.B at Point A= 250% of Pri. Full Load Current or Lower Higher Standard size.

IV SUMMARY OF OVER CURRENT PROTECTION FOR LESS THAN 600V

Maximum Rating of Overcurrent Protection for Transformers Less than 600 Volts					
Protection Method	Primary Protection			Secondary Protection	
	More than 9A	2A to 9A	Less than 2A	More than 9A	Less than 9A
Primary only protection	**125%(NH)**	**167%**	**300%**	**Not required**	**Not required**
Primary and secondary protection	**250%**	**250%**	**250%**	**125%(NH)**	**167%**

V CONCLUSION

It is possible to design transformer protection relay that detect overload condition based on calculated hot spot temperature and react in an intelligent way. This paper describes some of the largest power failures, transformer protection principle, transformer failures.

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