



Critical Examination of Failures of Power System Design and its Importance

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ABSTRACT

The fault analysis of a power system is carried out to provide proper information for the selection of switchgear, relays setting and system stability operation. The basic circumstances for the occurrence of fault in a power system are due to insulation failure, physical damage or human error. The fault may be in nature of symmetrical or asymmetrical and also it is due to broken conductors in one or more phases. The fault analysis of a power system is carried out to provide proper information for the selection of switchgear, relays setting and system stability operation.

Keyword: Fault analysis, power system failure, and symmetrical faults

Introduction:

The generation, transmission and distribution of electrical power are concerned with large interconnected power system. First electrical power generation is take place in power plant, now for the distribution purposes we require high voltage in order to reduce line current thereby transmission loss. So for the transmission level generated voltage is stepped-up by means of transformer.

To maintain continuous power supply is the prime objective of any power system. There are a few abnormal or other natural events which disturb the stability of power system, like wind & ice, physical accident and broken conductor in one or more phases etc. The fault analysis of a power system is carried out to provide proper information for the selection of switchgear, relays setting and system stability operation. The basic

circumstances for the occurrence of fault in a power system are due to insulation failure, physical damage or human error. The fault may be in nature of symmetrical or asymmetrical and also it is due to broken conductors in one or more phases. A power system failure is not static but changes during operation (switching on or off of generators and transmission lines) and during planning (addition of generators and transmission lines). Faults may be symmetrical or a symmetrical nature. A symmetrical fault is one where one or two phases are involved. fault may be due to short-circuit between earth and live conductor, it may be due to broken conductor in one or more phases, but sometimes the occurrence of fault may be the reason involving both the factor means short-circuit as well as broken conductor.

When the insulation of the system fails at one or more points or a conducting object comes into contact with a live point, a short circuit or a fault occurs.

CAUSES OF POWER SYSTEM FAILURE

- Lightning
- Heavy winds
- Trees falling across lines
- Vehicles colliding with towers or poles
- Birds shorting lines
- Aircraft colliding with lines
- Vandalism
- Small animals entering switchgear
- Line breaks due to excessive loading

COMMON POWER SYSTEM FAILURE:

Power system failure may be categorized as one of four types; in order of frequency of occurrence, they are:

- Single line to ground failure
- Line to line failure
- Double line to ground failure
- Balanced three phase failure

The first three types constitutes severe unbalanced operating conditions which involves only one or two phases hence referred to as unsymmetrical faults. In the fourth type, a fault involving all the three phases occurs therefore referred to as symmetrical (balanced) fault.

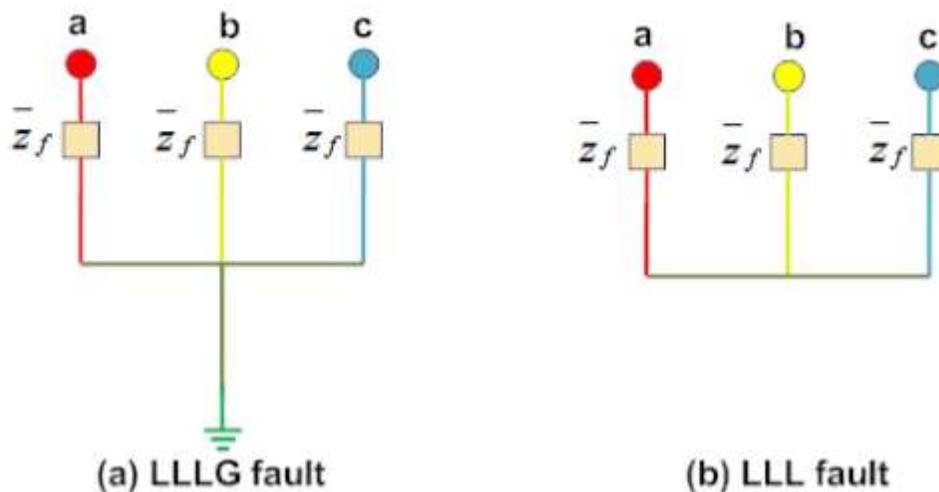
Fault Analysis:

Under normal condition, power system said to be working under balanced condition with all the equipment having a normal load current and bus voltage within a

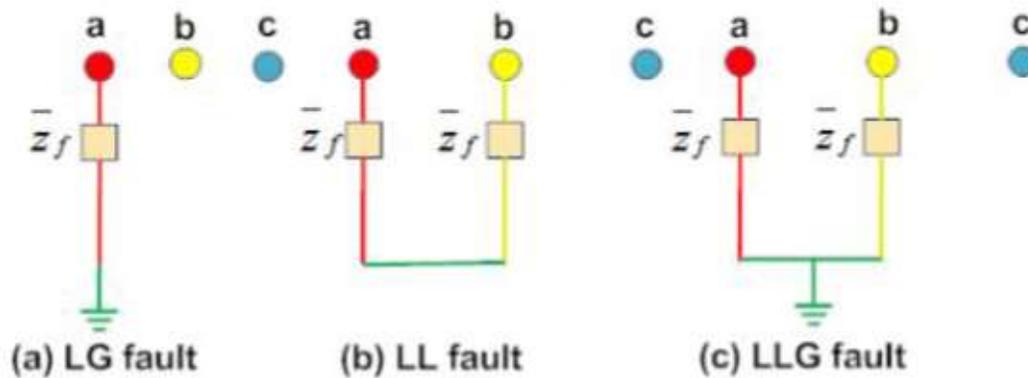
specified limit. The balance condition of a power system may be disrupted due to fault in the system. The fault in a system is nothing but a failure that interfaces with normal flow of current. Short circuit possess a very huge amount of current in the circuit, hence for the protection purpose we need protective equipment to avoid damage of equipment. Short circuit may be classified as:-

- Symmetrical fault
- Un symmetrical fault

Symmetrical fault (three-phase short-circuit): - in symmetrical fault occur when all of three phases are short-circuited to each other, and more often three phases with earth as well. Three phases short-circuited fault is very rarely occur but by nature it is one of the most severe type of fault which having large amount of current. Representation of such kind of fault is given below.

**Unsymmetrical fault: -**

The fault condition in which balance state of the system network disrupted is called as unsymmetrical or unbalanced fault. This kind of fault includes one or two phases, when such fault occurs voltage and current become unbalanced.) unsymmetrical fault includes line to ground (L-G), double line to ground (L-L-G), and line to line fault (L-L). Study says that among the power system fault almost 60 to 75 % faults are line to ground fault (L-G) fault. Occurrence of LLG fault is about 15 to 25%, and the least is 5-15% which is the case of L-L fault.



EFFECTS OF POWER SYSTEM FAILURE

Failure may lead to fire breakout that consequently results into loss of property, loss of life and destruction of a power system network. Faults also leads to cut of supply in areas beyond the fault point in a transmission and distribution network leading to power blackouts; this interferes with industrial and commercial activities that supports economic growth, stalls learning activities in institutions, work in offices, domestic applications and creates insecurity at night. It necessary upon occurrence of fault, the faulty section must be disconnected from the system as soon as possible, that's why because the healthy part of the system not affected.

Literature Review

There are so many literatures available on reliability of power system, stability and causes of fault and symmetrical and a symmetrical fault. Here a few has been taken for reference and further work has been carried out.

Research Methodology

To enable the analysis of failure potential during early design, functional modeling has been introduced in prior work as a basis for system representation for the majority of design stage reliability methods. Functional modeling is a system representation method, developed as a means to enhance the concept generation stage of product design (Pahl and Beitz, 1996). Using this approach, designers identify specific functions that a product must accomplish and connect these functions in a block diagram with the EMS flows that are transformed by the functions. Functional modeling has also been used in reverse engineering methods such as the Force Flow Analysis. This method dissects products into components and the forces acting on and between components and finally into the functions that components embody. Most of the function-based methods in the research community make use of the Functional Basis (Hirtz et al., 2002;

Stone and Wood, 2000) in order to provide a standard taxonomy for concept design and avoid the use of designer specific function and flow descriptions. Based on the usefulness of functional modeling for system representation in early design, it has also been used as part of the system representation in many early design reliability methods.

The first method that proposed a function-based approach to failure analysis was the Function Failure Design Method (FFDM) (Tumer and Stone, 2003; Stone et al., 2005). In FFDM, the functional model is developed to represent the system design, which serves as a basis for generating configuration concepts of component implementations of function. Based on historical failure data for these types of components, it is then possible to establish likely failure modes for a given function. However, because historic failure data for components is configuration-specific, failure propagation is difficult to incorporate into an analysis, limiting the method to single, independent faults.

Several other methods built upon the FFDM methodology. Hutcheson et al. introduced a methodology to enable the design of health monitoring modules concurrently with system conceptual design to reveal, model, and eliminate associated risks and failures (Hutcheson et al., 2006). Also the Risk in Early Design (RED) methodology determined functional failure likelihood and consequence-based risk assessment to identifying high-risk and low-risk function failure combinations (Grantham-Lough et al., 2008).

Failure Propagation Analysis in Design

A limitation of these previous methods is the singular and independent nature of the failure capable of analysis. To overcome this limitation, other research efforts have focused on including the propagation of failure in the analysis. As a direct extension of FFDM and RED

introduced above, a failure propagation method was introduced by Krus and Grantham-Lough (Krus and Grantham Lough, 2007) to develop failure propagation mapping based on historical data using a functional model for system representation.

Failure propagation is analyzed using a Function Event Network of all possible causation relationships in the function structure. This type of approach allows for a probabilistic analysis by applying a statistical reliability to the failure of each function in the function structure. An extension of this work is the Conceptual Stress and Conceptual Strength Interference Theory (CSCSIT) method (Huang and Jin, 2008), where the conceptual strength of a function is the ability of a function to continue to operate while under normal energy, material and signal (EMS) flows. In this method, conceptual stresses are the EMS flows in the function structure. The application of interference theory is used to define functional faults as when the output flow from a function is out of a specified normal range.

CONCLUSION

Fault analysis or short circuit analysis is carried out to determine the value of voltage and hence current during the event of fault, it helps for the appropriate selection of the circuit breaker. So that we can save the power network with abnormal or unbalance condition with a minimum time.

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