ETAP FAQ # 17

Differences Between Active and Passive Failure Rates

Description: What are the differences between Active and Passive Failure Rates?

Version: ETAP 4.0 and higher

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Introduction

Power systems have evolved over decades with their main emphasis focused towards providing reliable and economic supply of electrical energy to their customers. Spare or redundant capacities in generation and network facilities can be built but the main question has been, “how much redundancy and at what cost?” Economic concerns like these have been widely recognized and are part of the design, planning, and operating criteria for most power system operators. Techniques such as Reliability Assessment have been developed in an attempt to resolve and satisfy the dilemma between economic and reliability constraints.

Distribution system reliability assessment is concerned with the availability and quality of power supply at each customer’s service entrance. Analysis of customer failure statistics shows that failures in distribution systems contribute as much as 90% towards the unavailability of supply to a load as compared with the rest of the electric power system. These statistics reinforce the need for reliability evaluation of distribution systems.

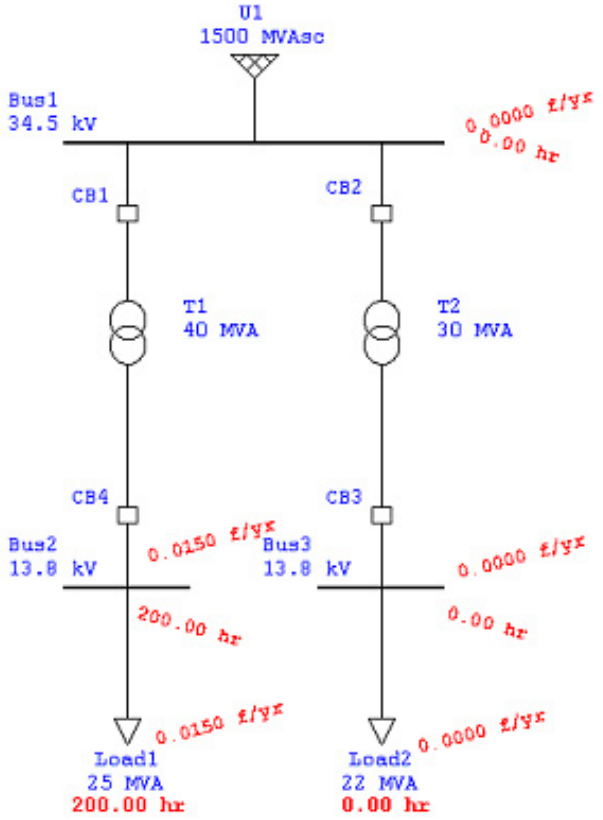
Failure Rate

The main cause for reliability concern is “failure” and the rate at which it occurs. IEEE STD 493-1990 defines a “failure” as any trouble with a power system component that causes any of the following events to occur:

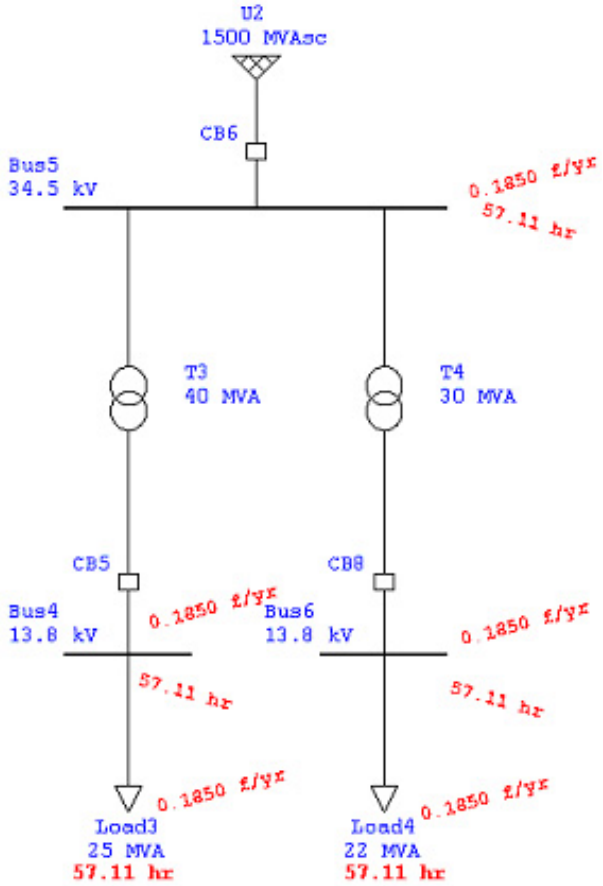
1. Partial or complete plant shutdown or below-standard plant operation
2. Unacceptable performance of user’s equipment
3. Operation of the electrical protective relaying or emergency operation of the plant electrical system
4. De-energization of any electric circuit or equipment

The failure rate or forced outage rate is defined as the mean number of failures of a component per unit exposure time. Usually exposure time is expressed in years and failure rate is expressed in failures per year.

It must be noted that failure is not only caused by equipment failure but also switching operation of breakers following short circuit faults. Consider the two simple substations as shown.

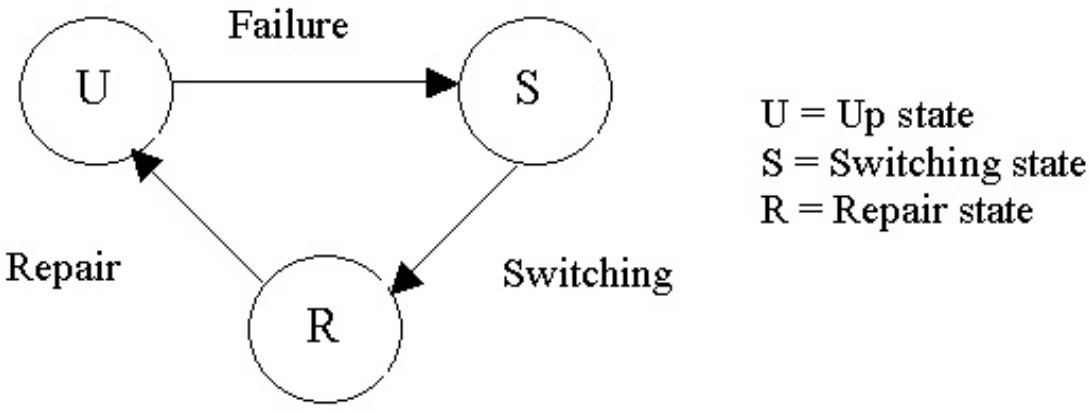


When T1 fails, the input breaker CB1 should operate causing an interruption of load point Load1 only. Similarly failure of T2 will interrupt load point Load2 only.



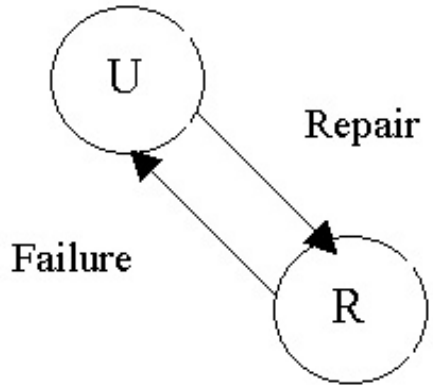
When T3 fails, input breaker CB6 will operate causing interruption of both load points. Similarly failure of T4 will interrupt both load points. If it is not possible or practical to isolate the failed component, breaker CB6 will remain open until the relevant component has been repaired or replaced. In this case both load points will remain disconnected until repairs are done.

It is now evident that switching actions must be modeled and simulated in the reliability evaluation process. When switching actions occur, a three state model is required. The three states are:
i. State before fault
ii. State after fault but before isolation
iii. State after isolation but before repair is completed

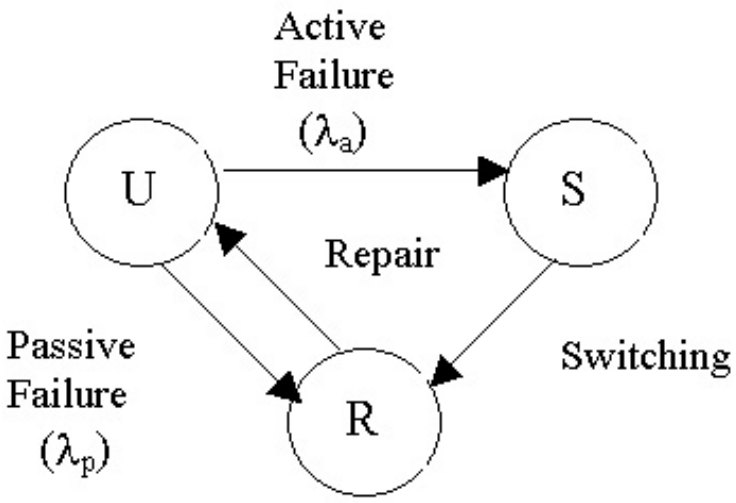


In some cases breakers are not required to operate, e.g., open circuits and inadvertent operation of breakers. In these cases a two state model only is necessary.

These states are:
1. State before the fault
2. State after the fault but before repair is completed.



If the repair process is assumed to be the same in both cases, the two models can be superimposed to give a combined state space diagram.

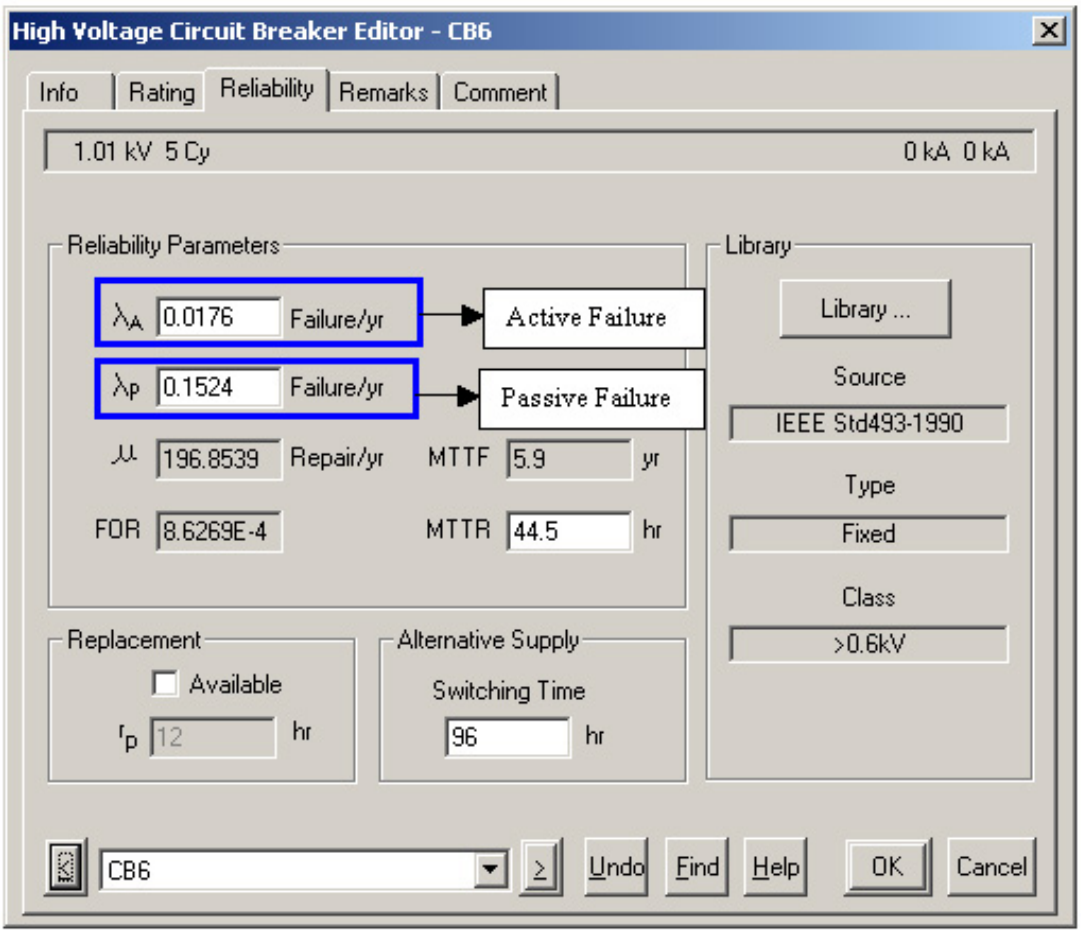


The two modes of failure, one leading to state R and the other to state S, have been designated active and passive failures respectively.

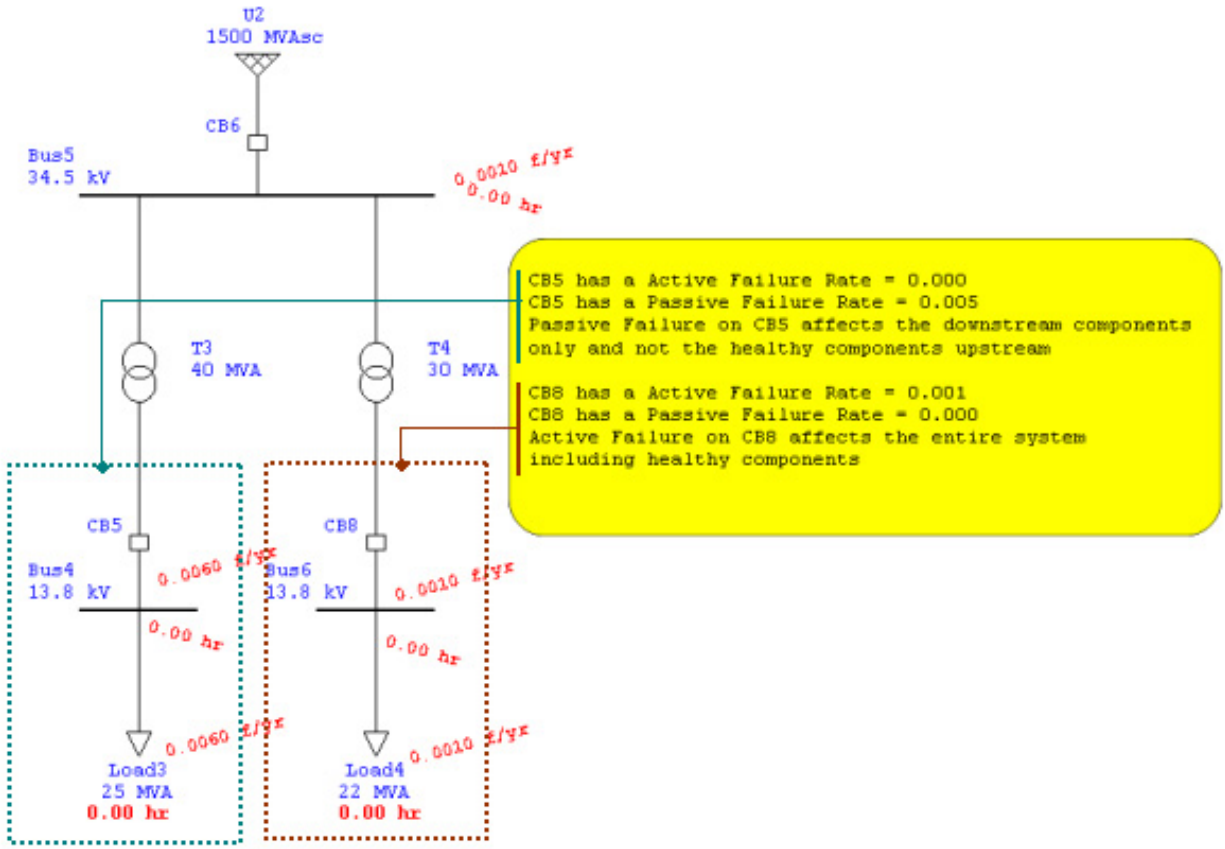
Active and Passive Failures

Passive event can be defined as a component failure mode that does not cause operation of protection breakers and does not have an impact on the remaining energized system. Service is restored by repairing or replacing the failed device. Examples are open circuits and inadvertent opening of breakers.

Active event can be defined as a component failure mode that causes the operation of the primary protection zone around the failed component and can cause the removal of other energized components and branches from service. The actively failed component is isolated and the protection breakers are reclosed. This leads to service being restored to some or all load points.


High Voltage Circuit Breaker Editor - CB6
Info
Rating
Reliability
Remarks
Comment
1.01 kV 5 Cy
0 kA 0 kA
Reliability Parameters
λA 0.0176 Failure/yr
Active Failure
λp 0.1524 Failure/yr
Passive Failure
μ 196.8539 Repair/yr
MTTF 5.9 yr
FOR 8.6269E-4
MTTR 44.5 hr
Library
Library ...
Source
IEEE Std493-1990
Type
Fixed
Class
>0.6kV
Replacement
Available
rp 12 hr
Alternative Supply
Switching Time
96 hr
CB6
Undo
Find
Help
OK
Cancel

Example:


U2
1500 MVAsc
CB6
Bus5
34.5 kV
0.0010 f/yr
0.00 hr
CB5 has a Active Failure Rate = 0.000
CB5 has a Passive Failure Rate = 0.005
Passive Failure on CB5 affects the downstream components only and not the healthy components upstream
CB8 has a Active Failure Rate = 0.001
CB8 has a Passive Failure Rate = 0.000
Active Failure on CB8 affects the entire system including healthy components
T3
40 MVA
T4
30 MVA
CB5
CB8
Bus4
13.8 kV
0.0060 f/yr
0.00 hr
Bus6
13.8 kV
0.0010 f/yr
0.00 hr
0.0060 f/yr
0.0010 f/yr
Load3
25 MVA
0.00 hr
Load4
22 MVA
0.00 hr

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