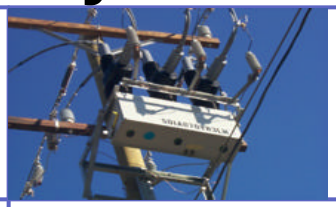
Overhead Distribution Systems Reliability



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Power Reliability

- **What are the utilities looking at for power reliability ?**
- Why are they looking at these items?
- How can Reliability be improved

ABB

Performance Based Measures

SAIFI
System Average Interruption Frequency

= Total Number of Customer Interrupted
Total Number of Customers Served

CAIDI
Customer Interruption Duration

= Sum of Customer Interruption Duration
Total Number of Customers Interrupted

SAIDI
System Average Interruption Duration

= Sum of Customer Interruption Duration
Total Number of Customers Served

MAIFI
Momentary Ave. Interruption Frequency

= Total Number of Customer Momentary Interruptions
Total Number of Customers Served

ASIDI
Average System Interruption Duration

= Connected KVA Minutes Interrupted
Total Connected KVA Served

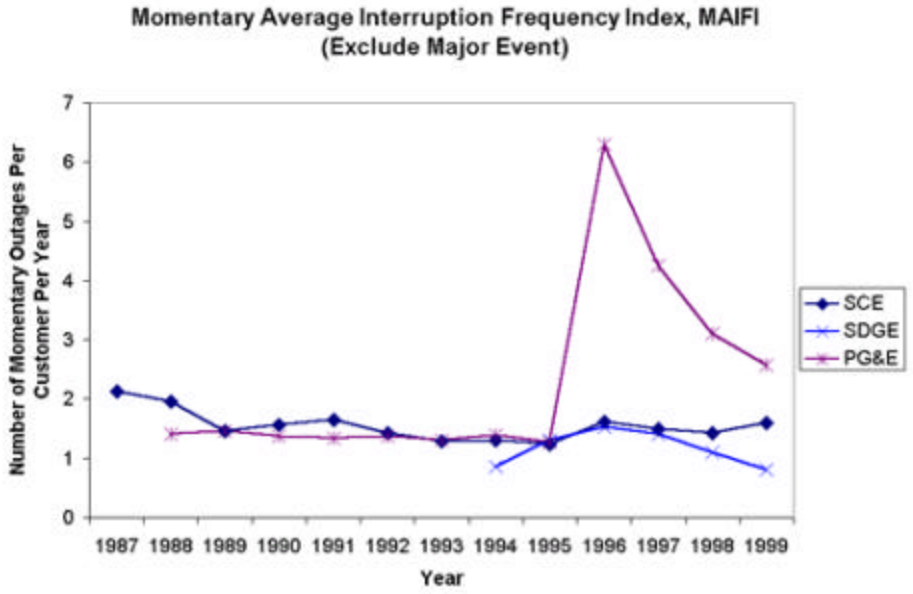
ASIFI
Average System Interruption Frequency

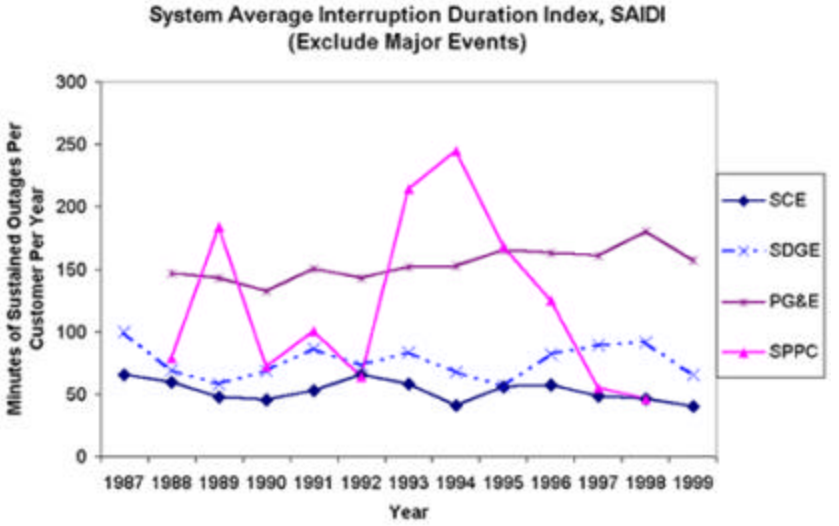
= Connected KVA Interrupted
Total Connected KVA Served

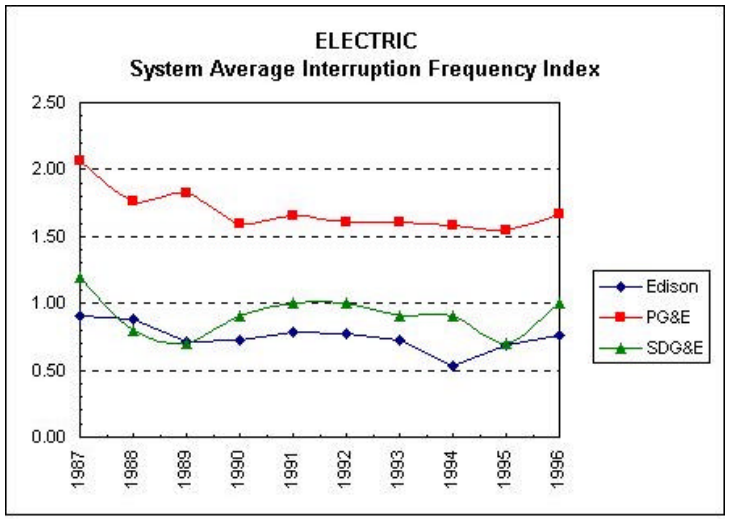
Customer Based Indices | Load Based Indices

ABB

California Public Utilities Commission







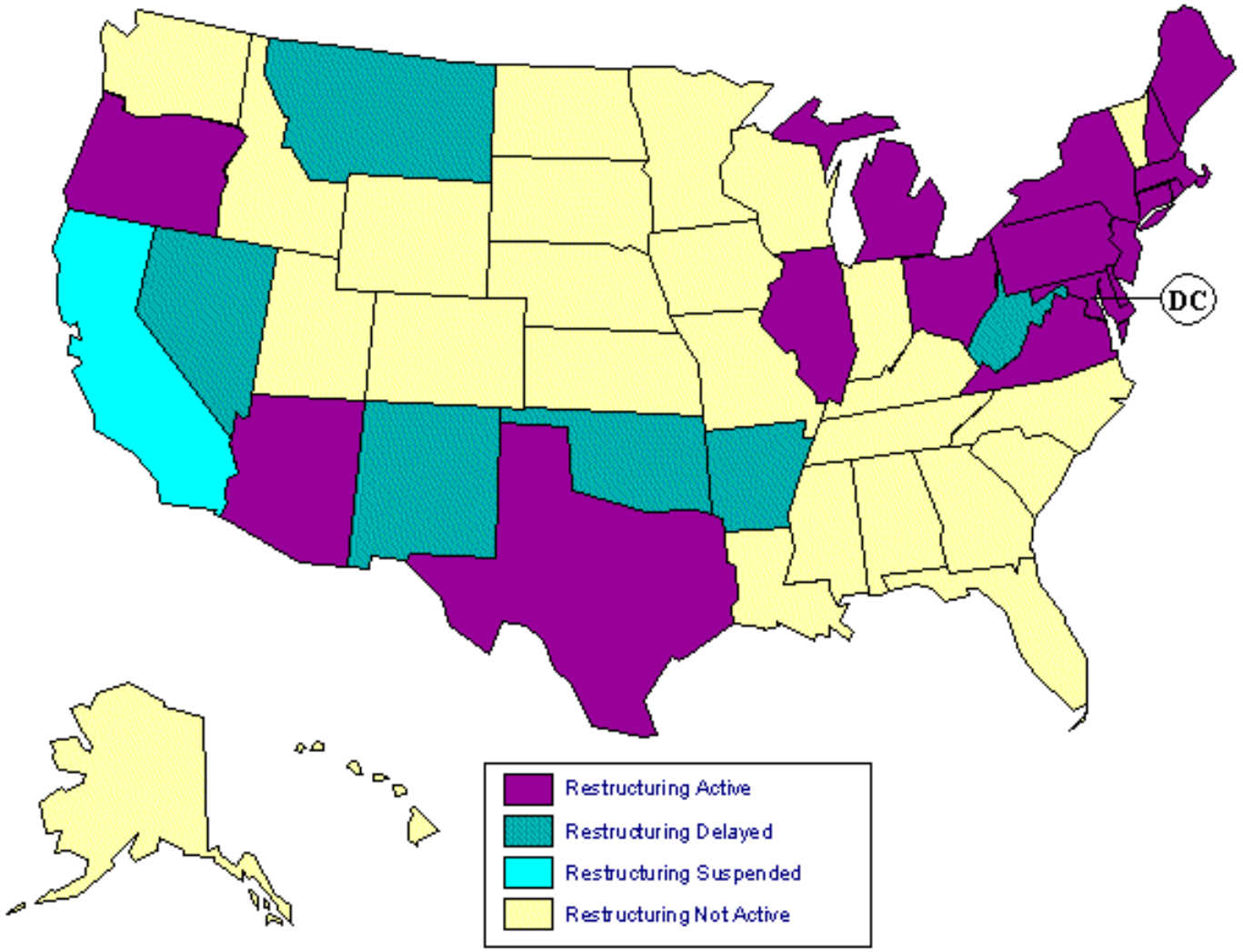
ABB

Power Reliability

- What are the utilities looking at for power reliability ?
- **Why are they looking at these items?**
- How can Reliability be improved

ABB

Status of State Electric Industry Restructuring Activity



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Utilities Impact on Measurements

August 27, 2001 Orlando Sentinel
Just how reliable is "OUC -- The Reliable One?"

Florida Power Corp., the company that may lose all of its customers in Winter Park to the city-owned Orlando Utilities Commission, wants to know. **A Florida Power lawyer slapped OUC with a public-records request demanding the right to inspect dozens of obscure documents relating to the frequency of the smaller utility's power outages.** The spat boils down to the two companies' competition for customers in Winter Park. In June, city leaders there decided not to renew the city's 30-year-old contract with Florida Power. If a judge gives Winter Park permission to buy the electric distribution lines, the city could be served by neighboring OUC. The move was prompted by complaints of frequent power outages in Winter Park under Florida Power's watch. The average customer in Winter Park goes without power for about 150 minutes a year, according to Florida Power statistics. OUC customers go without electricity for about 35 minutes a year, according to OUC. The company is so proud of the infrequency of its power outages that it made its logo "OUC -- The Reliable One," and employees even answer phones by boasting of the reliability record. Florida Power officials aren't convinced. **OUC doesn't calculate its power outages in the same way, so the two companies can't be fairly compared**, **Florida Power officials said**. "We're not saying OUC is doctoring its numbers," Florida Power spokesman Craig Eicher said. "But we have a company making claims about reliability to 12,000-plus of our customers, based on their calculations. We just feel we need to verify these things." OUC officials say they use the standard formula set by the Florida Public Service Commission, though, as a city-owned utility, they aren't required to do so. Last week, OUC general manager Bob Haven sent a letter to his counterpart at Florida Power suggesting the two companies put the matter to rest once and for all. Haven proposed hiring an independent third party to examine records from both utilities and determine how often their customers' lights really go out. Eicher said Florida Power won't participate in the review because the utility wants to focus on serving its customers rather than slinging mud. Regardless, Haven said he'll commission an outside study of only OUC's records.

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Public Utility Commission of Texas

§25.52(f) continued

(1) **System-wide standards.** The standards shall be unique to each utility based on the utility's performance, and may be adjusted by the commission if appropriate for weather or improvements in data acquisition systems. Interim standards shall be established for the 24-month period ending December 31, 1999. The interim standards shall be the system-wide average of the 1998 and the 1999 reporting years for each reliability index. The interim standards will be adjusted based on performance during the 36-month period ending December 31, 2000. The resulting standards will be the average of the three reporting years 1998, 1999, and 2000.

(A) **SAIFI.** Each utility shall maintain and operate its electric distribution system so that the SAIFI value for the 2000 reporting year does not exceed the interim system-wide SAIFI standard by more than 10%. For the 2001 reporting year and thereafter, the SAIFI value shall not exceed the system-wide SAIFI standard by more than 5.0%.

(B) **SAIDI.** Each utility shall maintain and operate its electric distribution system so that the SAIDI value for the 2000 reporting year does not exceed the interim system-wide SAIDI standard by more than 10%. For the 2001 reporting year and thereafter, the SAIDI value shall not exceed the system-wide SAIDI standard by more than 5.0%.

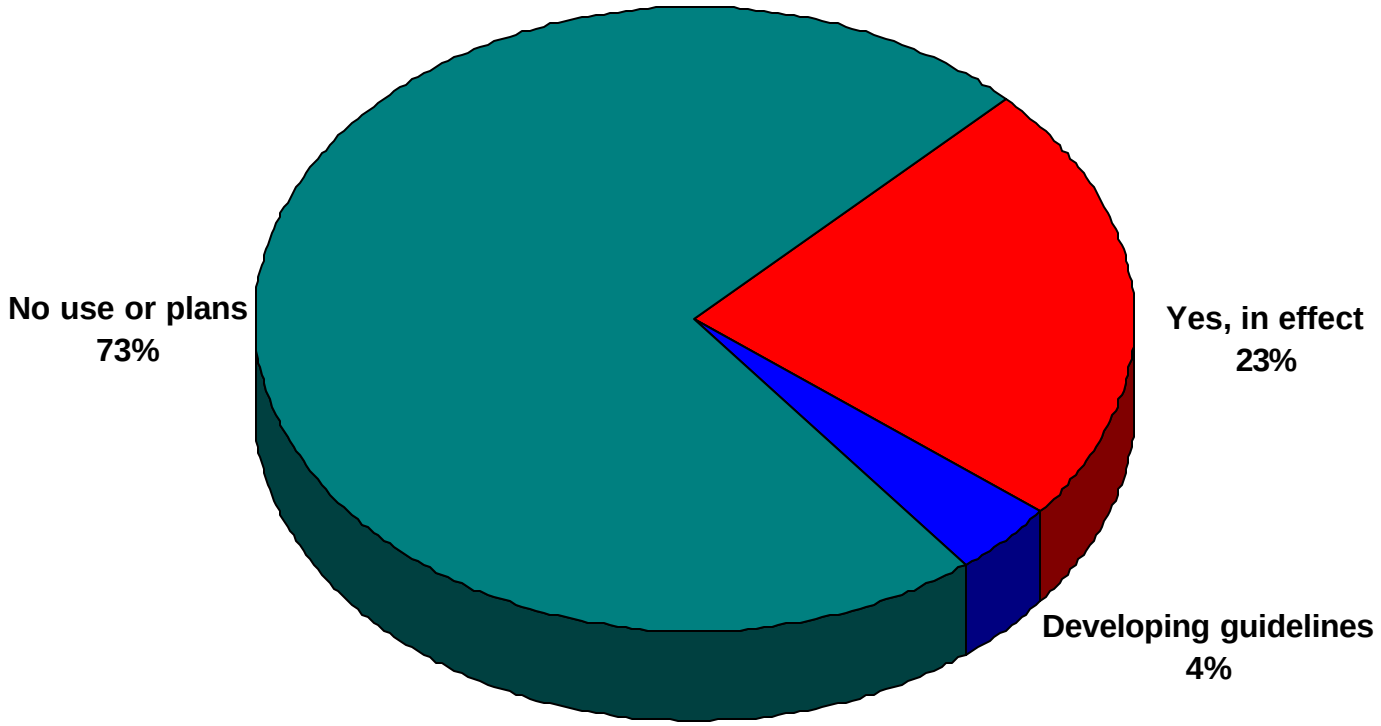
(2) **Distribution feeder performance.** The commission will evaluate the performance of distribution feeders with ten or more customers beginning with the performance in the 2000-reporting year.

(A) Each utility shall maintain and operate its distribution system so that no distribution feeder with more than ten customers sustains a SAIDI or SAIFI value for a reporting year that is among the highest (worst) 10% of that utility's feeders for any two consecutive reporting years.

(B) Each utility shall maintain and operate its distribution system so that no distribution feeder with more than ten customers sustains a SAIDI or SAIFI value for a reporting year that is more than 300% greater than the system average of all feeders during any two consecutive reporting years.

ABB

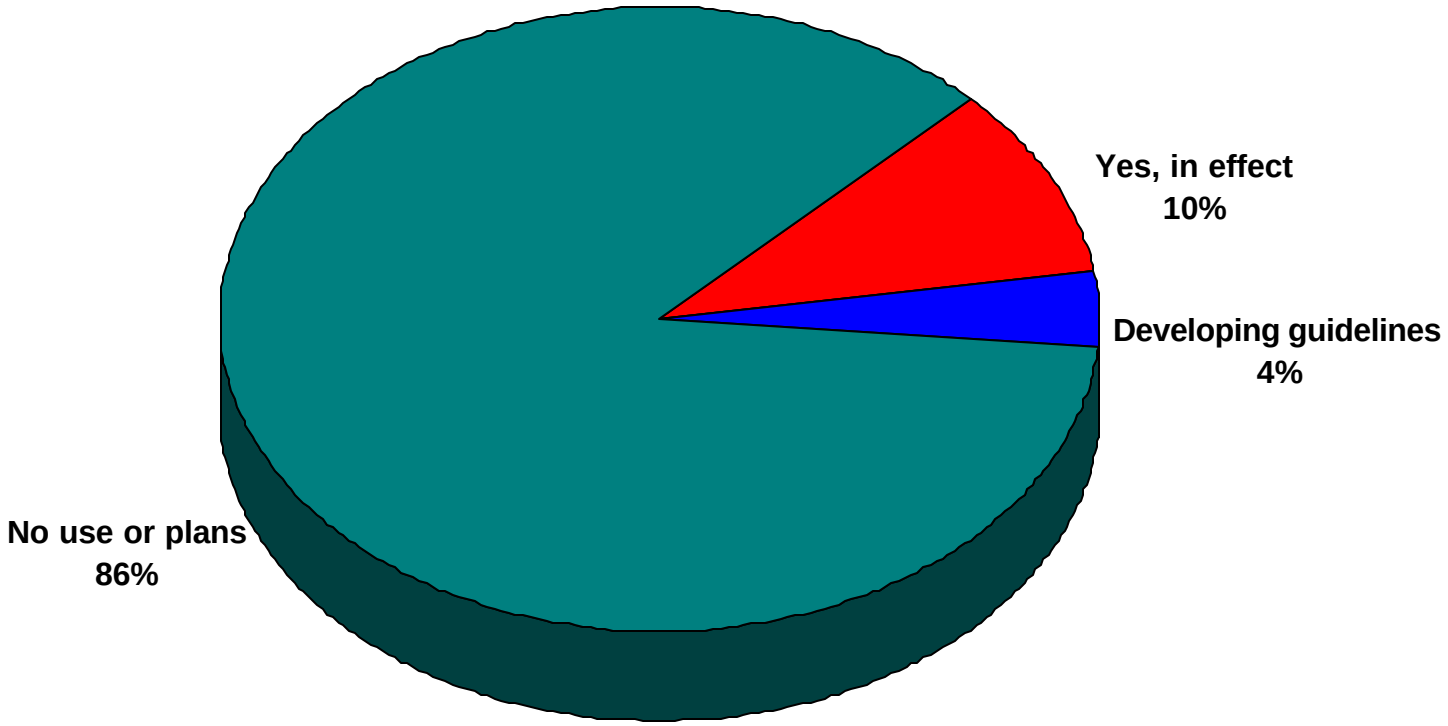
Survey of the States
Current/Planned Use of Performance-Based Rates



Newton-Evans Research Co. 1/02

ABB

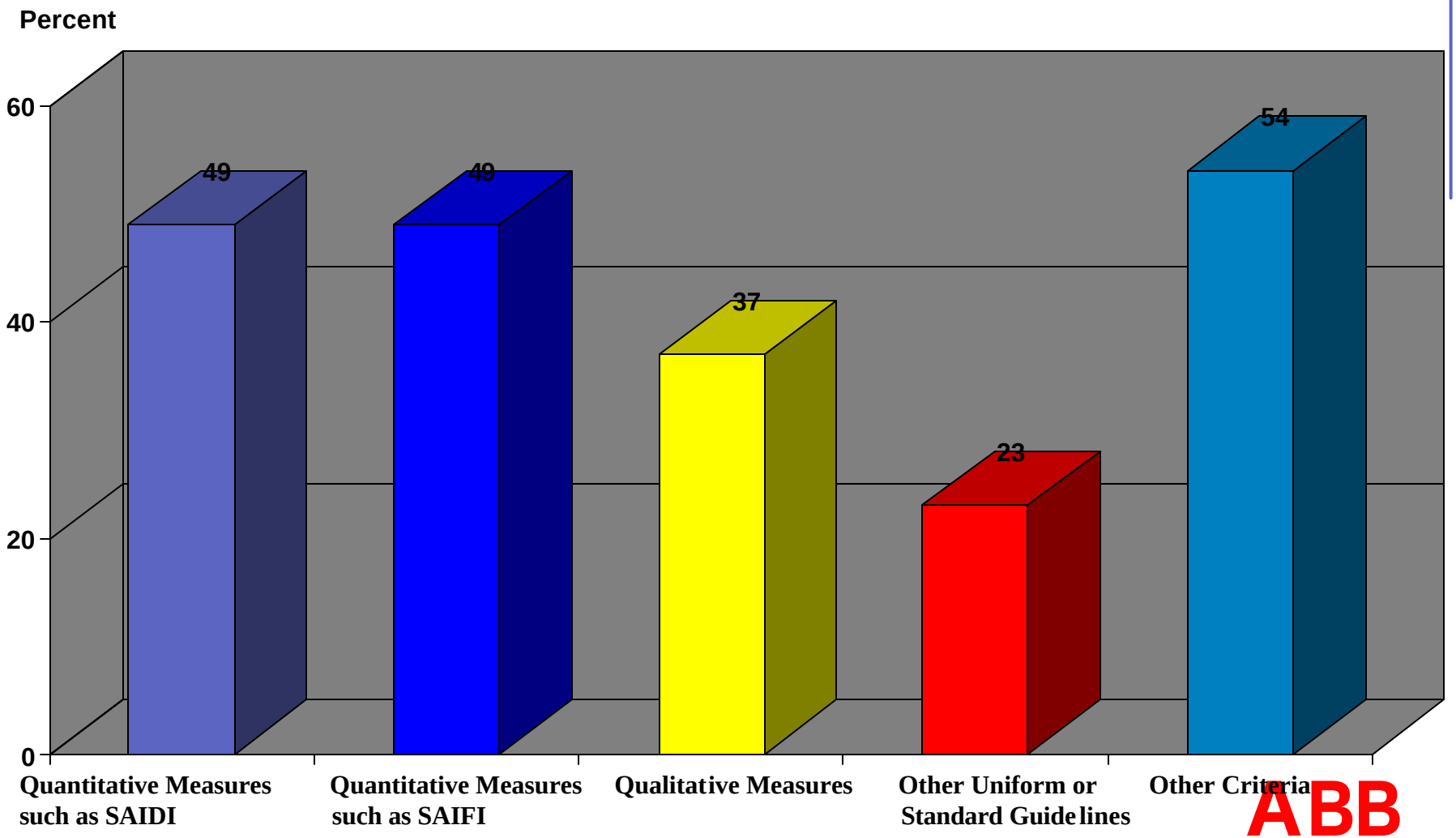
Survey of the States
Current/Planned Use of Penalty-Based Rates



Newton-Evans Research Co. 1/02

ABB

Criteria for Measuring Electric Utility Performance



Newton-Evans Research 1/02

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Which states?

ABB

California

Started in 1994 with some but not all utilities

Colorado

Not penalty-based, but have a bill credit for quality of service issues that come into effect (in effect since 1997)

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Florida

Have incentives. Refunds are made if revenues exceed a certain amount, and refunds are made if earnings exceed a certain amount. The FPL revenue sharing plan expires 4/15/02.

Maine

Central Maine Power was first to implement

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Massachusetts

Mississippi

For Mississippi Power (Southern Co) have a performance evaluation plan that includes: 1) customer satisfaction survey 2) reliability 3) price. Utility files every 6 months to determine rate of return. Other state IOU (Entergy Mississippi) also operates under a formula rate plan

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Missouri

as early as 1994 with some but not all utilities

Colorado

There is no deregulation, so primarily operate under cost-of-service or return on equity regulation

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New York

Since 1992, but this is done individually on a case by case basis.
If utility does not meet performance standards it will be penalized

Oklahoma

Done in conjunction with performance-based rates

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Oregon

Penalty based rates implemented as part of performance based package. Penalty - 2 levels 100,000/measure; and 1000000/measure

Rhode Island

Have service quality standards in place, measured annually, due to a merger rate filing where company wanted to have opportunity to recoup the acquisition premium. There is a rate freeze thru 2004, but if company earns over 12% during freeze there is a sharing mechanism. This will be in place for 15+ years. If rates grow beyond 80% CPI, company loses the opportunity to share, so there is an incentive for the company to control their costs.

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Power Reliability

- What are the utilities looking at for power reliability ?
- Why are they looking at these items?
- How can Reliability be improved

ABB

Conventional Improvements

- Tree trimming
- Animal Guards
- Lightning Protection
- Maintain problem circuits

75% of faults are Temporary

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Newest Improvements

- Configuration of system
- Loop Control
- Single phase reclosing
- Remote automation

=Feeder Automation

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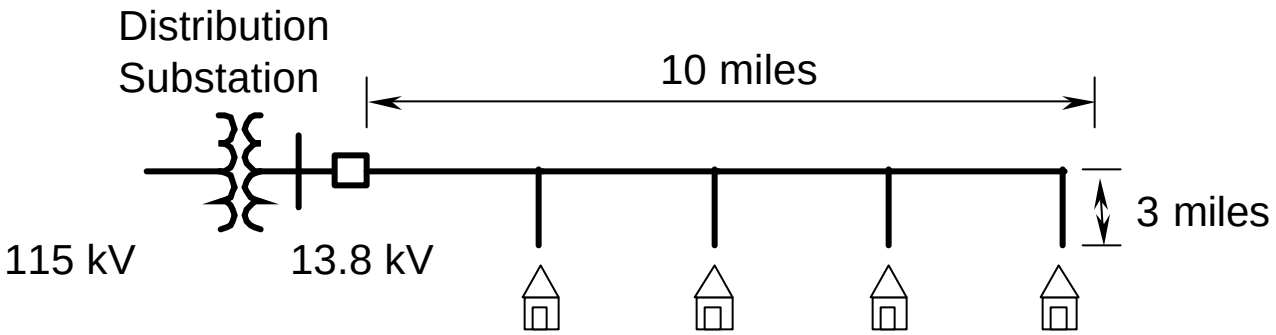
The Example Distribution Circuit

- Typical of suburban/rural circuits
- 10 miles of 3-Phase 13.8 kV Main Feeder
- 8 single-phase laterals, evenly distributed on the main feeder. Each lateral 3 miles long, and connected to the main feeder through a fuse
- A total of 1800 customers (8 x 225 customers/lateral)

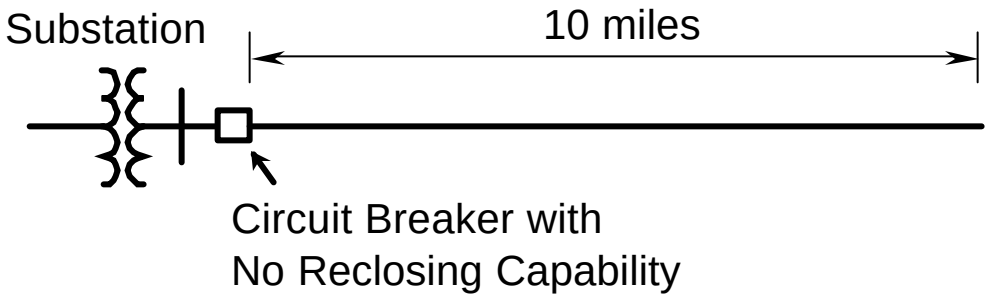


ABB

Improving Distribution Reliability with Reclosers

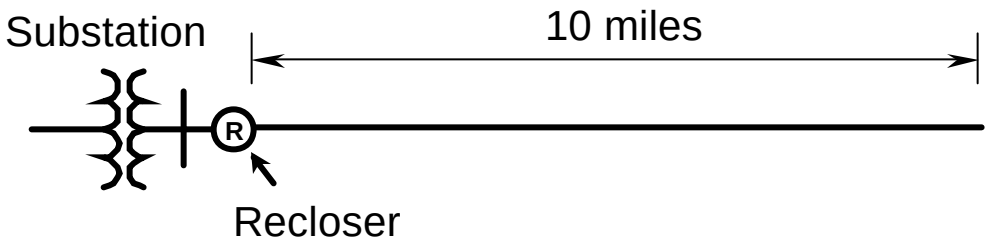
Basic Radial System

Case 1



SAIFI: 4.3 int/cust/yr
SAIDI: 8.8 hrs/yr
MAIFI: 0.0 mom/yr

Case 2

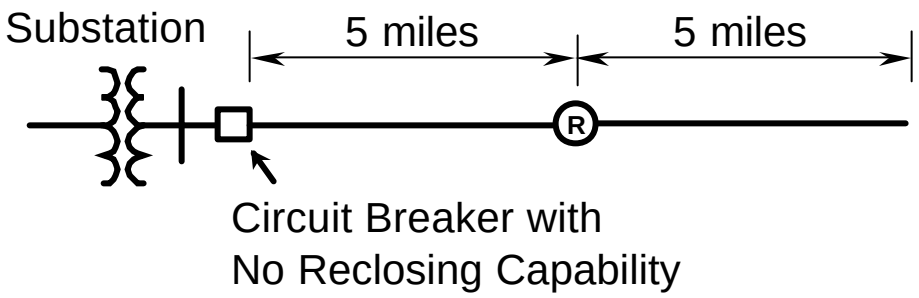


SAIFI: 1.6 int/cust/yr
SAIDI: 3.3 hrs/yr
MAIFI: 8.7 mom/yr

ABB

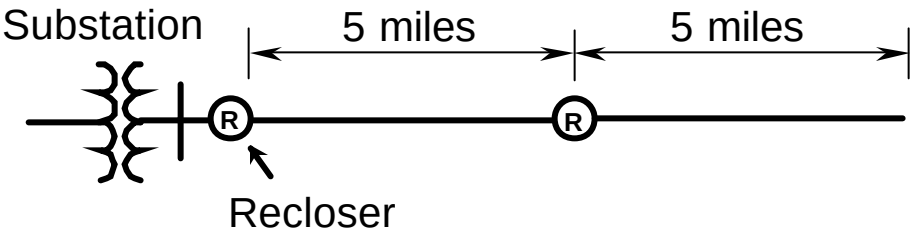
Use of Line Reclosers

Case 3



SAIFI: 2.6 int/cust/yr
SAIDI: 5.4 hrs/yr
MAIFI: 2.1 mom/yr

Case 4

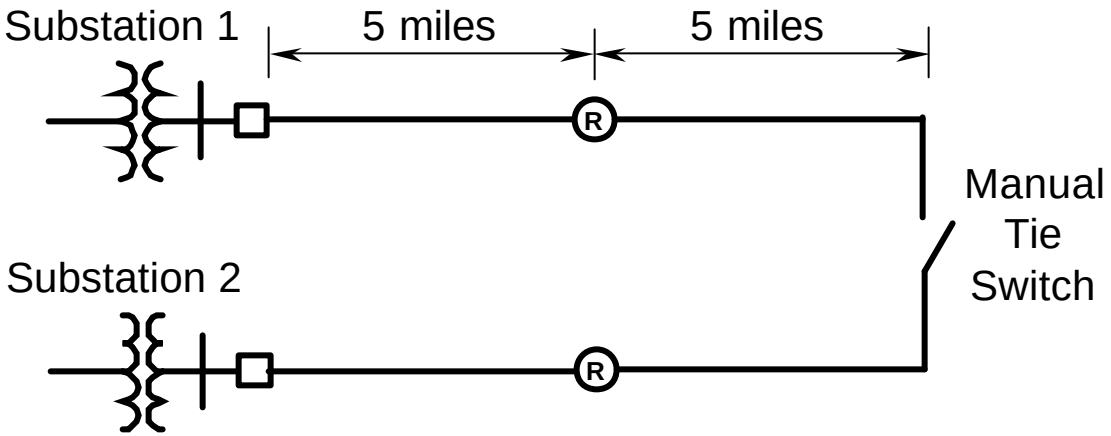


SAIFI: 1.2 int/cust/yr
SAIDI: 2.6 hrs/yr
MAIFI: 6.5 mom/yr

ABB

Loop Configuration with Manual Switch

Case 5



SAIFI: 1.2 int/cust/yr
SAIDI: 2.3 hrs/yr
MAIFI: 6.5 mom/yr

Assumptions

- Circuit breakers have reclosing capability
- Manual Tie Switch requires 1 hour to switch
- Reclosers require 1 minute to switch

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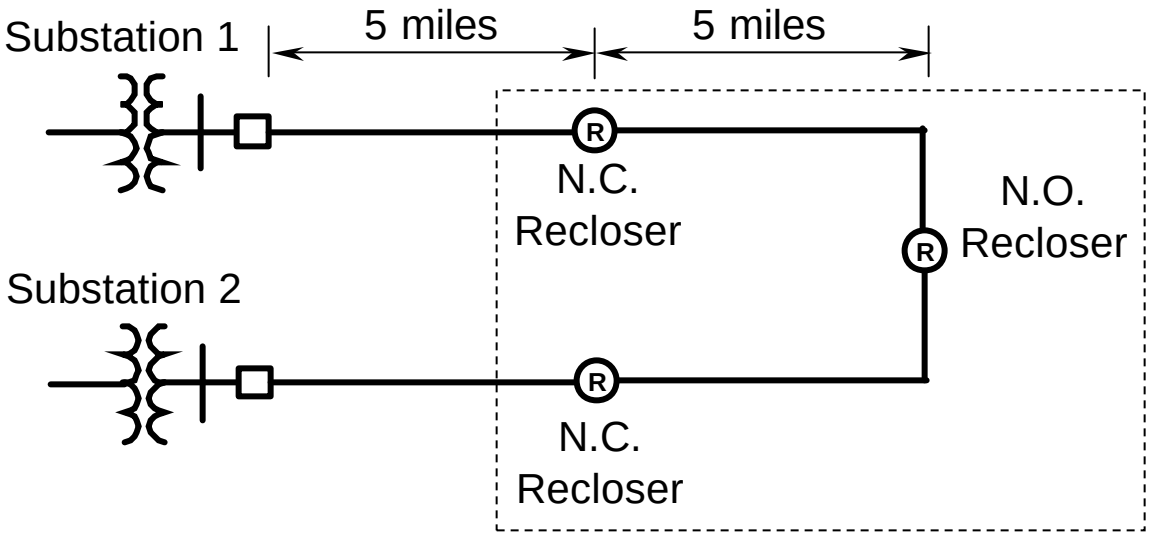
Automatic Loop Restoration - 3 Reclosers

Case 6



SAIFI: 1.0 int/cust/yr
SAIDI: 2.1 hrs/yr
MAIFI: 6.8 mom/yr

N.C. - Normally-Closed
N.O. - Normally-Open

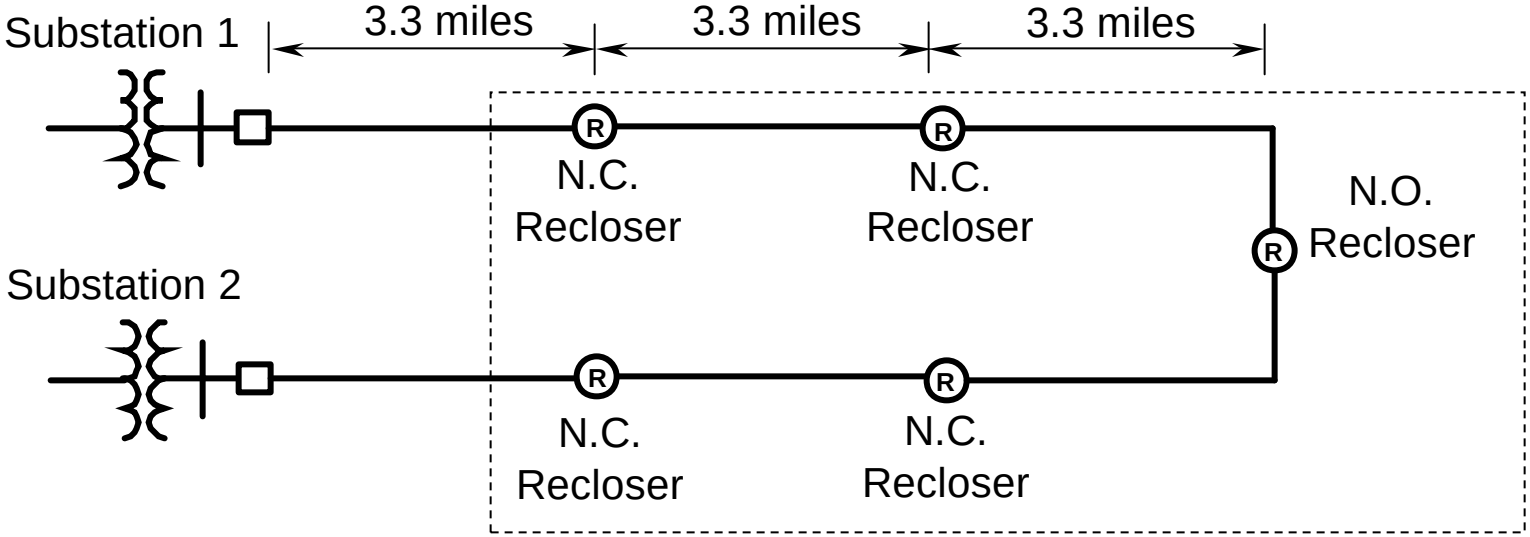
Assumptions

- Circuit breakers have reclosing capability
- Reclosers require 1 minute to switch

ABB

Automatic Loop Restoration - 5 Reclosers

Case 7



N.C. - Normally-Closed
N.O. - Normally-Open

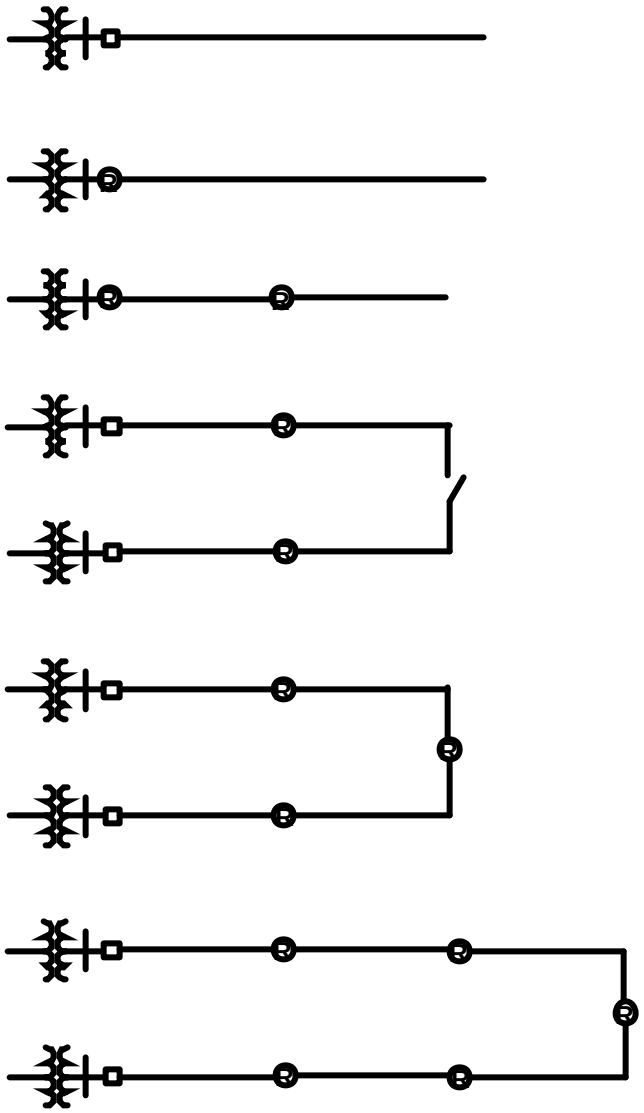
Assumptions

- Circuit breakers have reclosing capability
- Reclosers require 1 minute to switch

SAIFI: 0.8 int/cust/yr
SAIDI: 1.7 hrs/yr
MAIFI: 6.5 mom/yr

ABB

Summary of Reclosing Benefits



	Hrs/Yr	%*
Case 1 - No reclosing	8.8	----
Case 2 - Substation reclosing	3.3	63%
Case 4 - Line Recloser	2.6	70%
Case 5 - Loop with Manual Switch	2.3	74%
Case 6 - 3-Recloser Automatic Loop Restoration	2.1	76%
Case 7 - 5-Recloser Automatic Loop Restoration	1.7	81%

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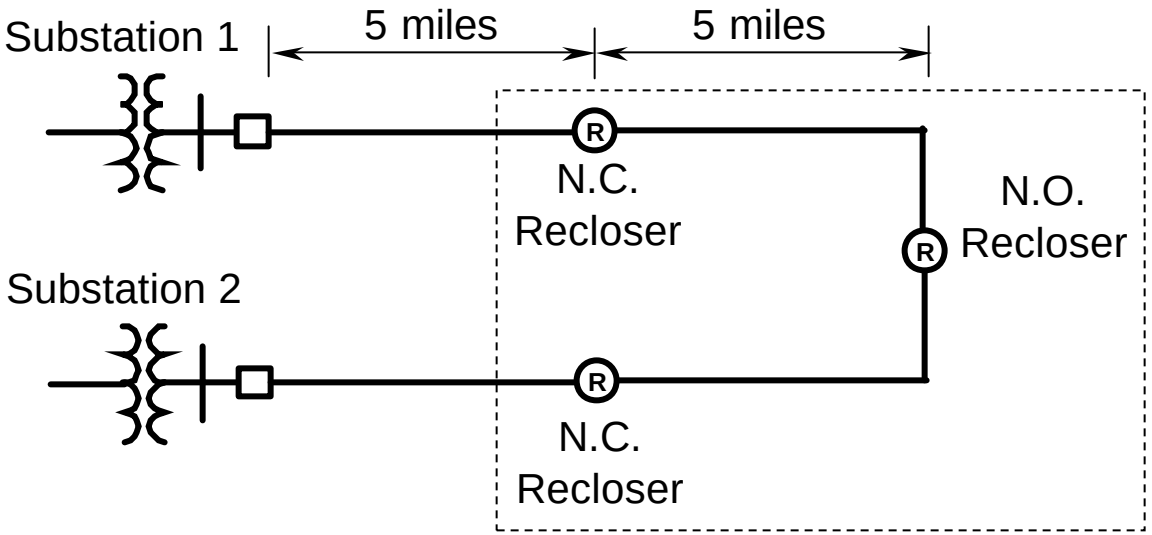
**% Improvement as compared to Case 1*

Automatic Loop Restoration - 3 Reclosers

With Single-Pole Reclosing



SAIFI: 0.8 int/cust/yr
SAIDI: 1.8 hrs/yr
MAIFI: 3.1 mom/yr

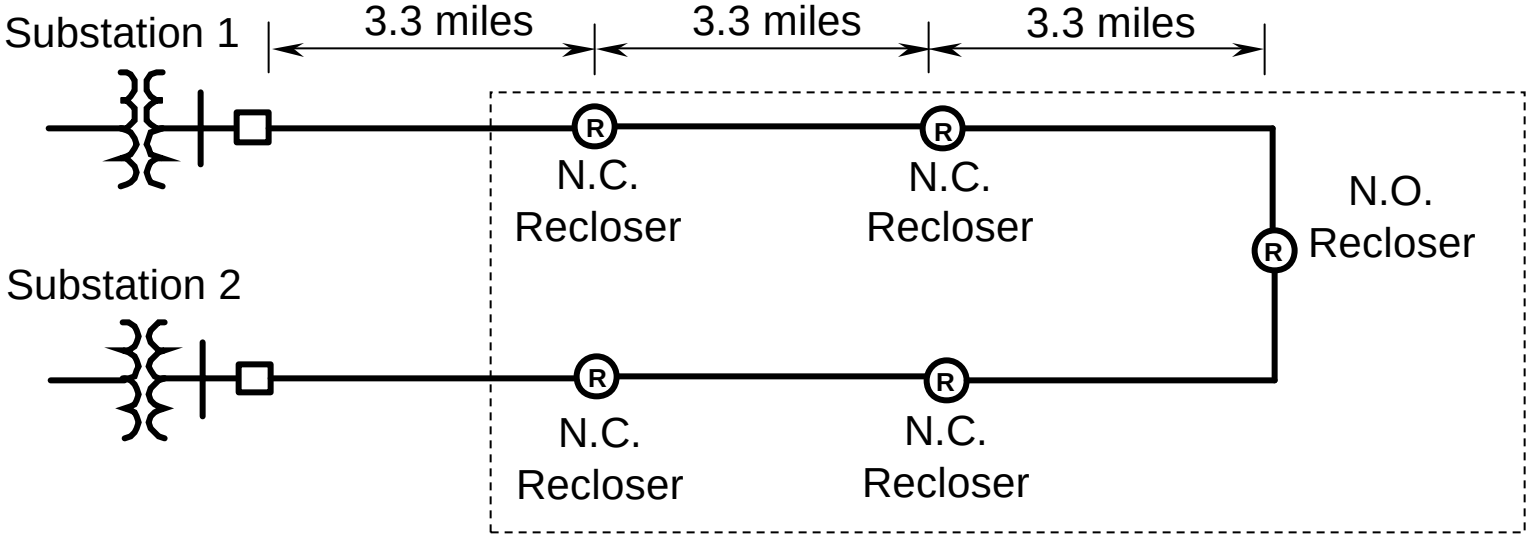
N.C. - Normally-Closed
N.O. - Normally-Open

Assumptions
- Circuit breakers have reclosing capability
- Reclosers require 1 minute to switch

ABB

Automatic Loop Restoration - 5 Reclosers

With Single-Pole Reclosing



N.C. - Normally-Closed
N.O. - Normally-Open

SAIFI: 0.6 int/cust/yr
SAIDI: 1.4 hrs/yr
MAIFI: 2.7 mom/yr

Assumptions
- Circuit breakers have reclosing capability
- Reclosers require 1 minute to switch

ABB

Benefits of Single-Pole Reclosing

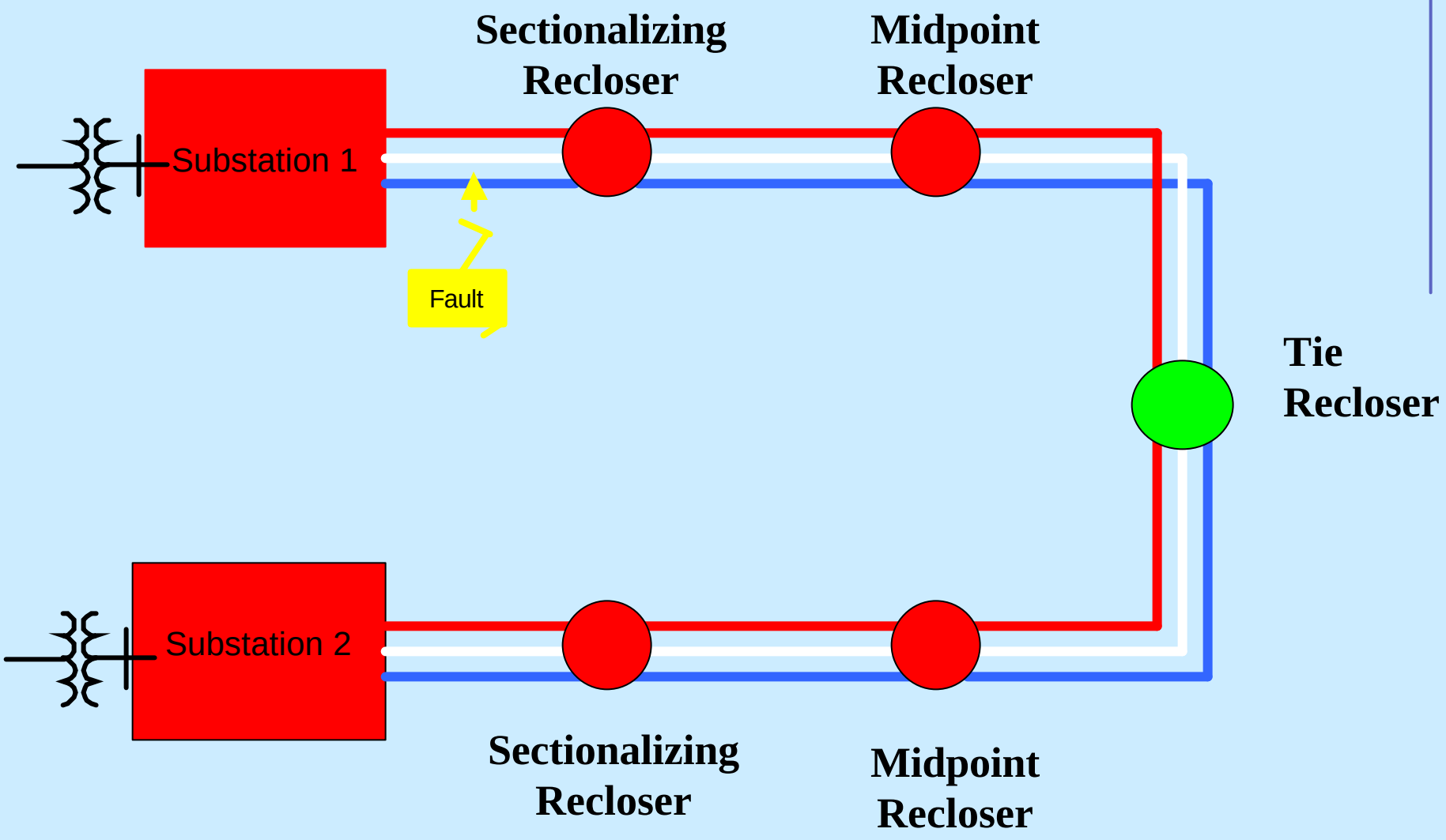
	SAIFI	SAIDI	MAIFI
3-Recloser Automatic Loop Restoration			
3-Pole Reclosing	1.0	2.1	6.8
Single-Pole Reclosing	0.8	1.8	3.1
5-Recloser Automatic Loop Restoration			
3-Pole Reclosing	0.8	1.7	6.5
Single-Pole Reclosing	0.6	1.4	2.7

ABB

Loop Scheme Fault Scenarios

ABB

Fault occurs on normal system



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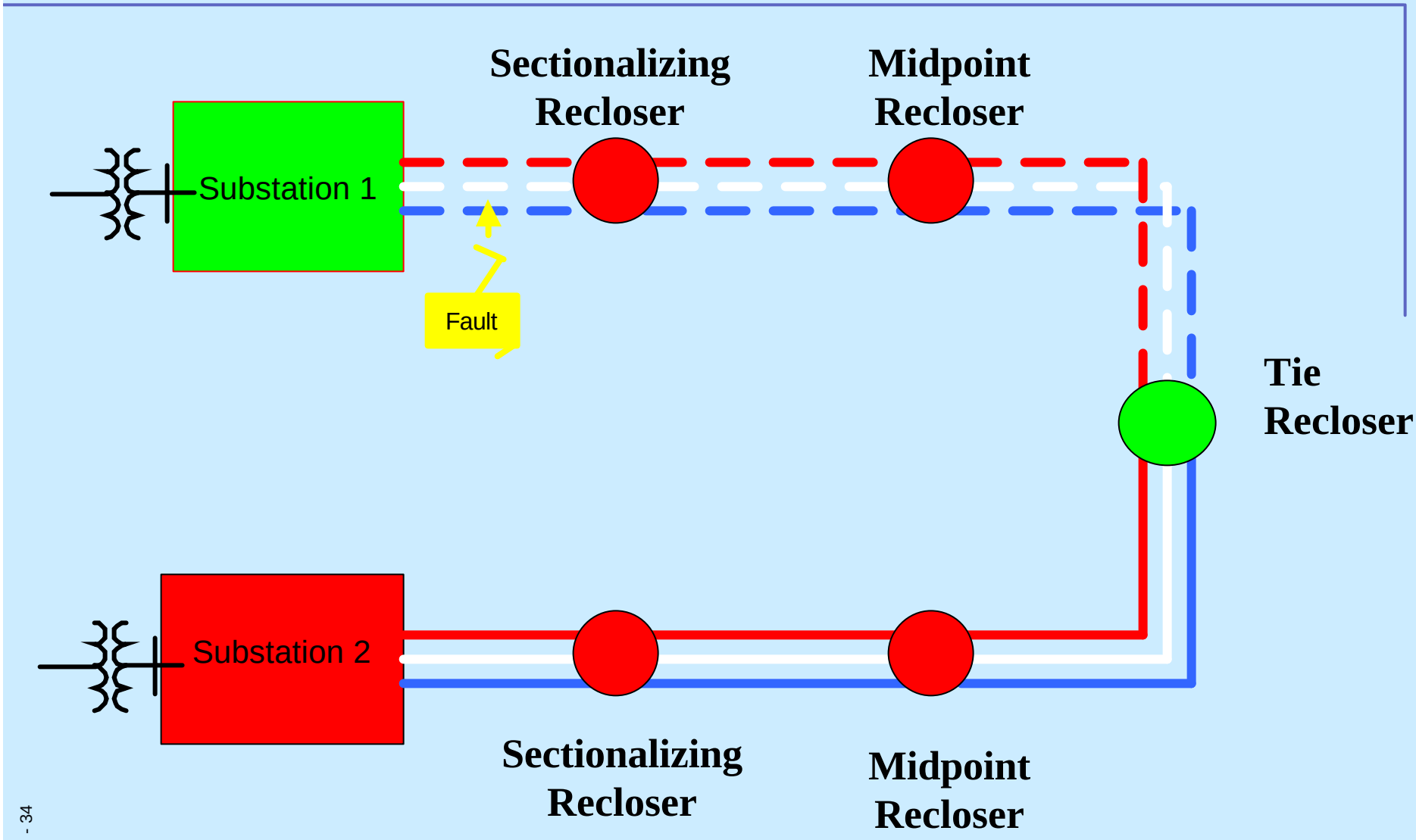
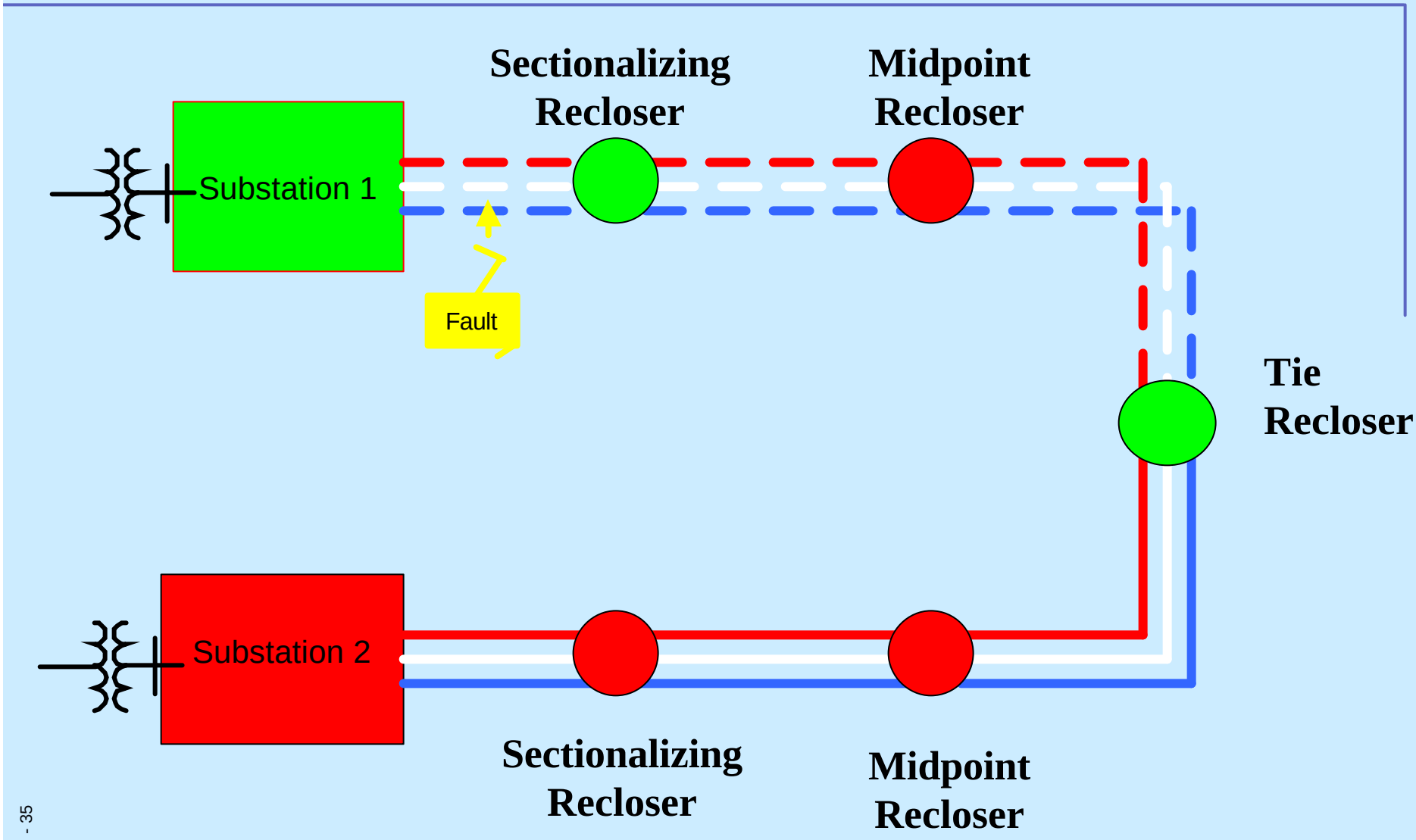
Substation Breaker recloses and goes to lockout



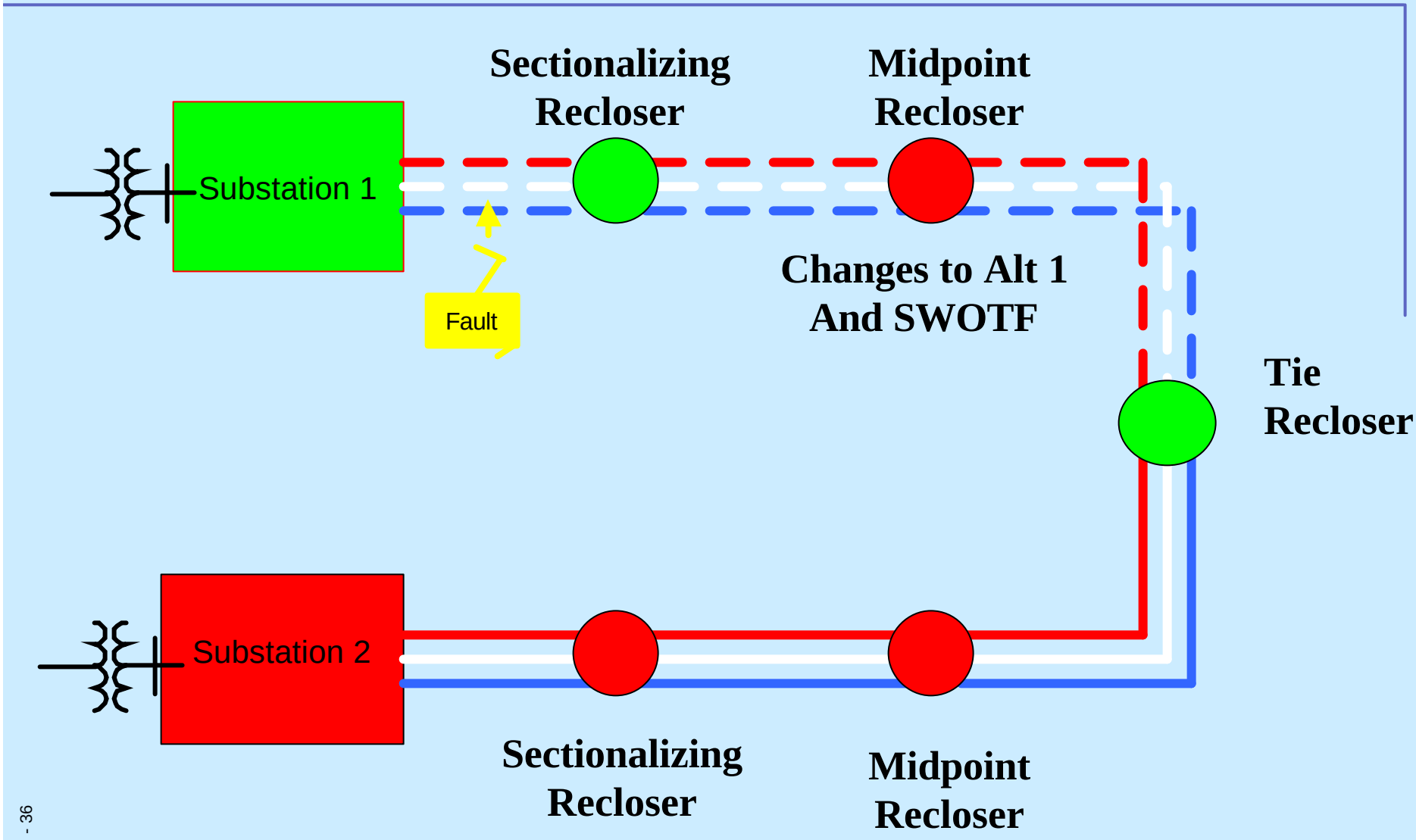
ABB

Sectionalizer times out and opens



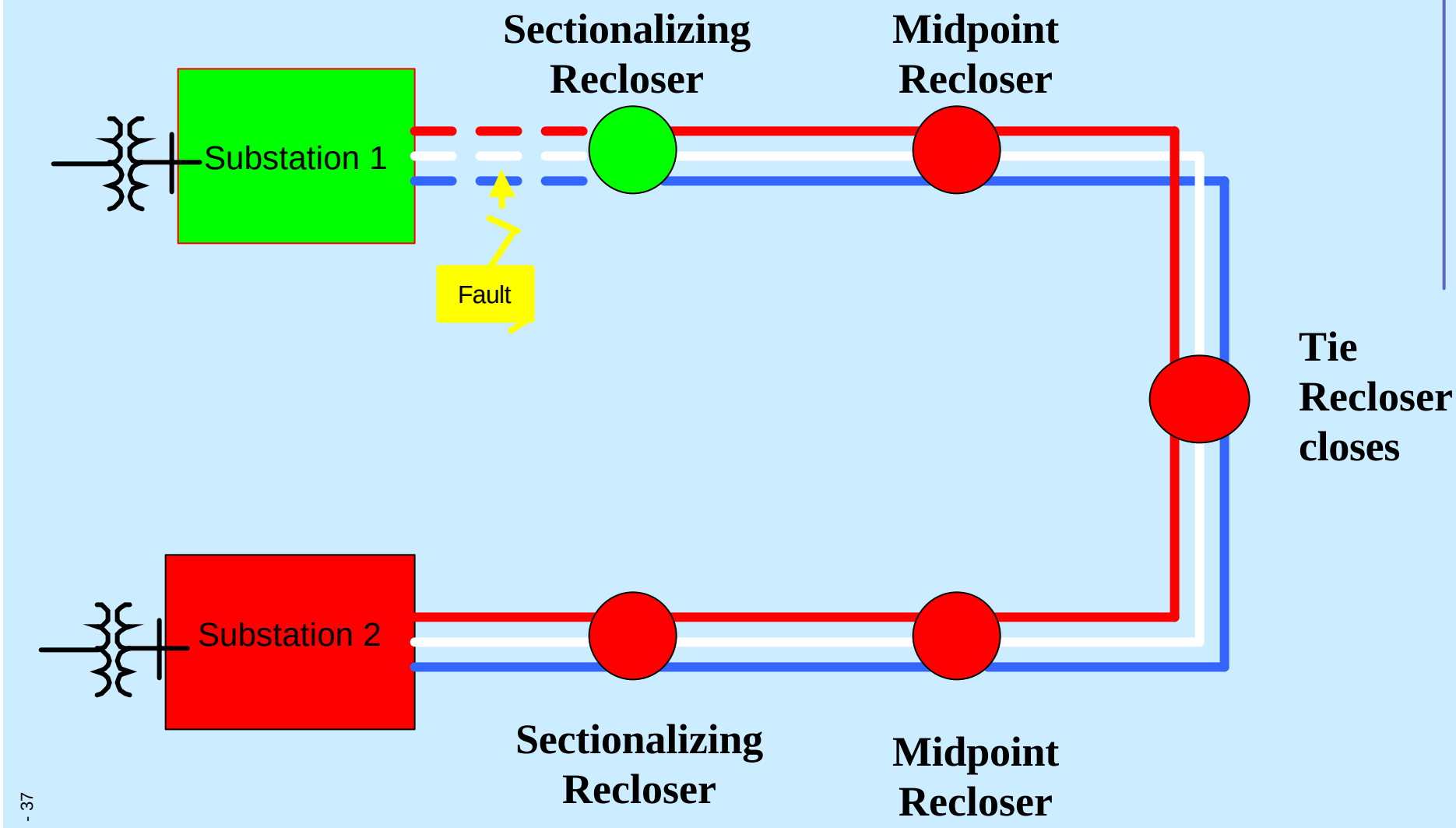
ABB

Midpoint times out and goes to alt 1 and SWOTF



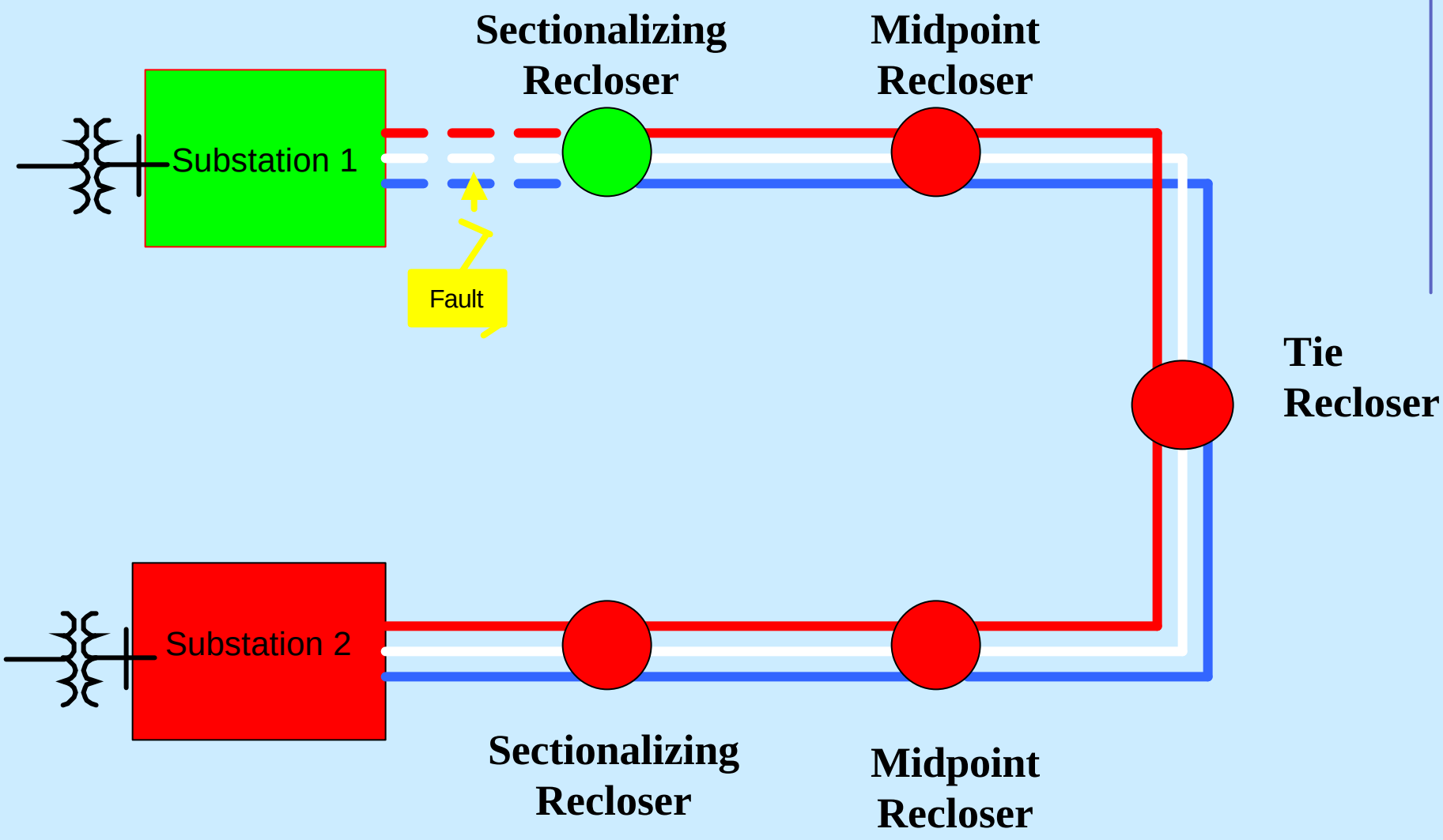
ABB

Tie times out and closes on one shot



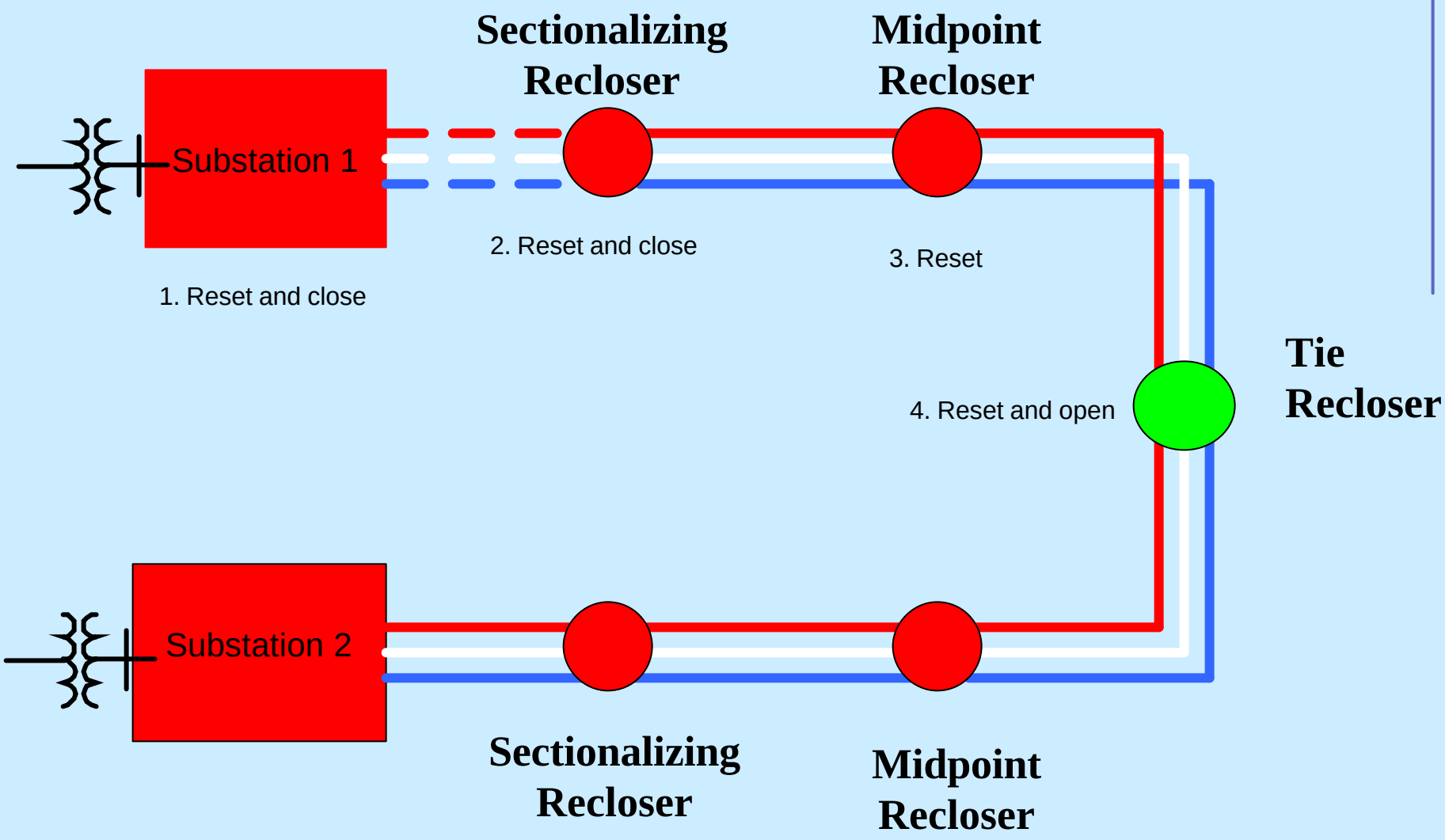
ABB

Tie and Midpoint reset and go to normal reclosing



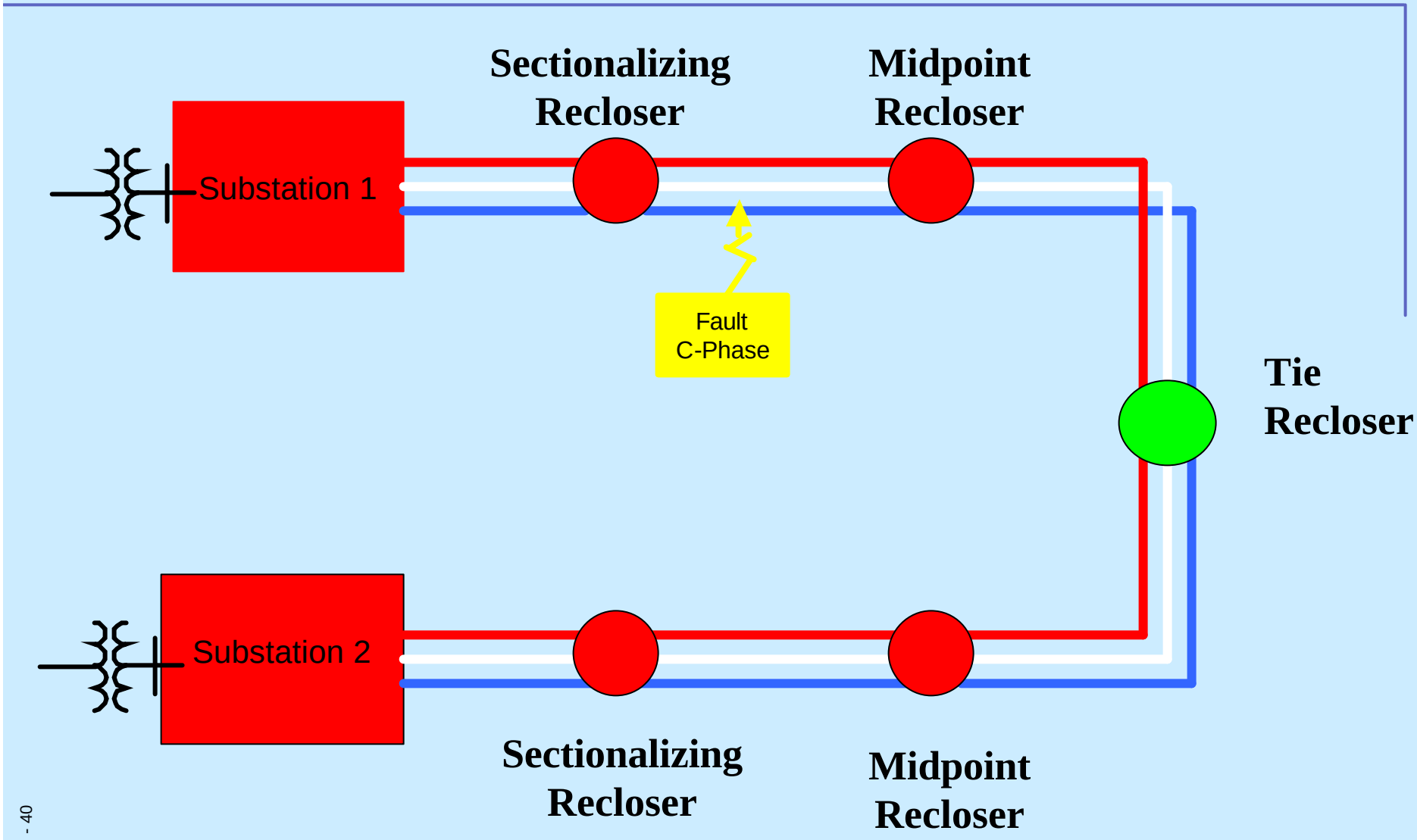
ABB

Reset system starting at source



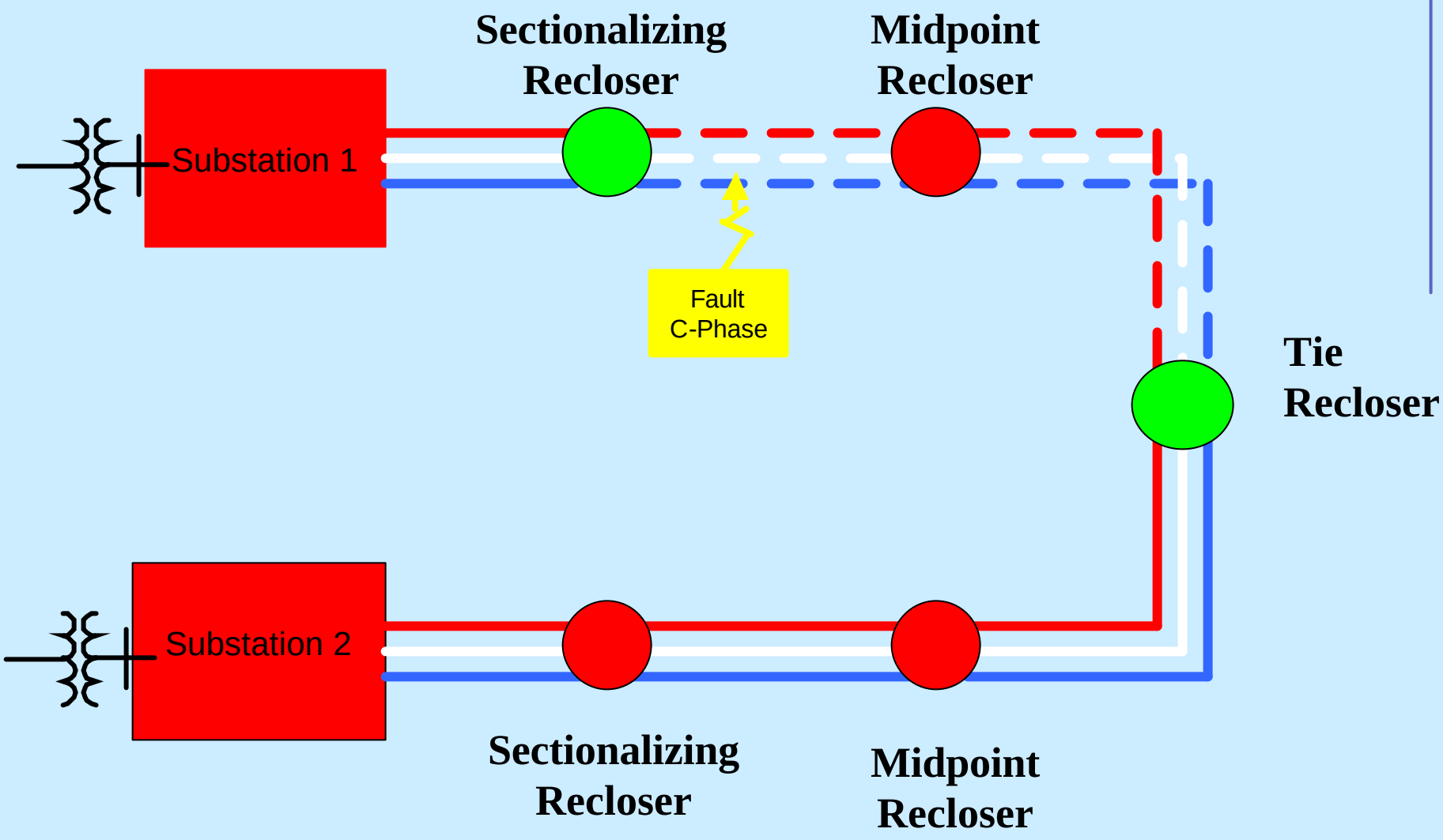
ABB

Fault occurs on normal system



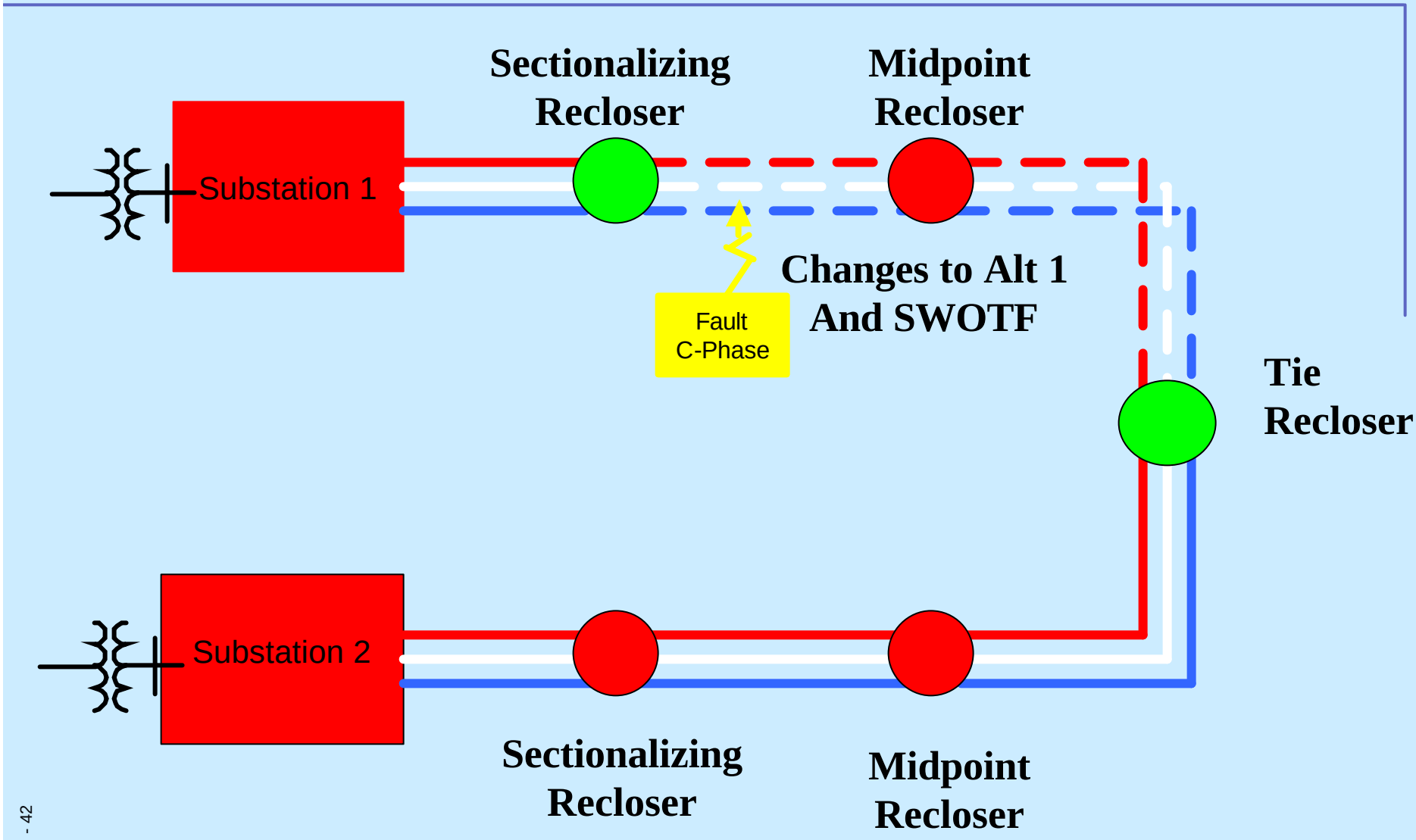
ABB

Sectionalizer does single phase reclosing on C-phase and locks out 3 phases



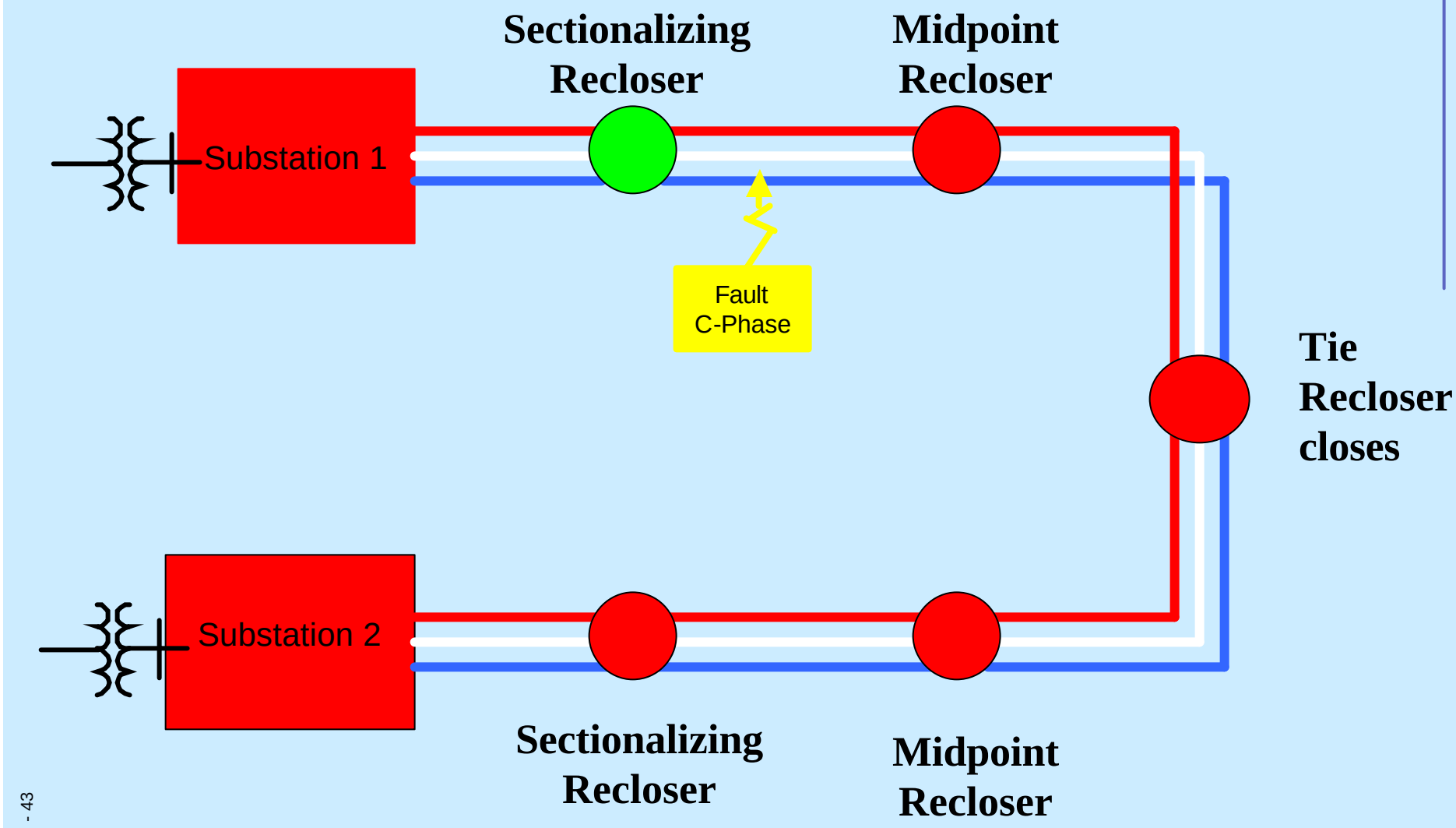
ABB

Midpoint times out and goes to alt 1 and SWOTF



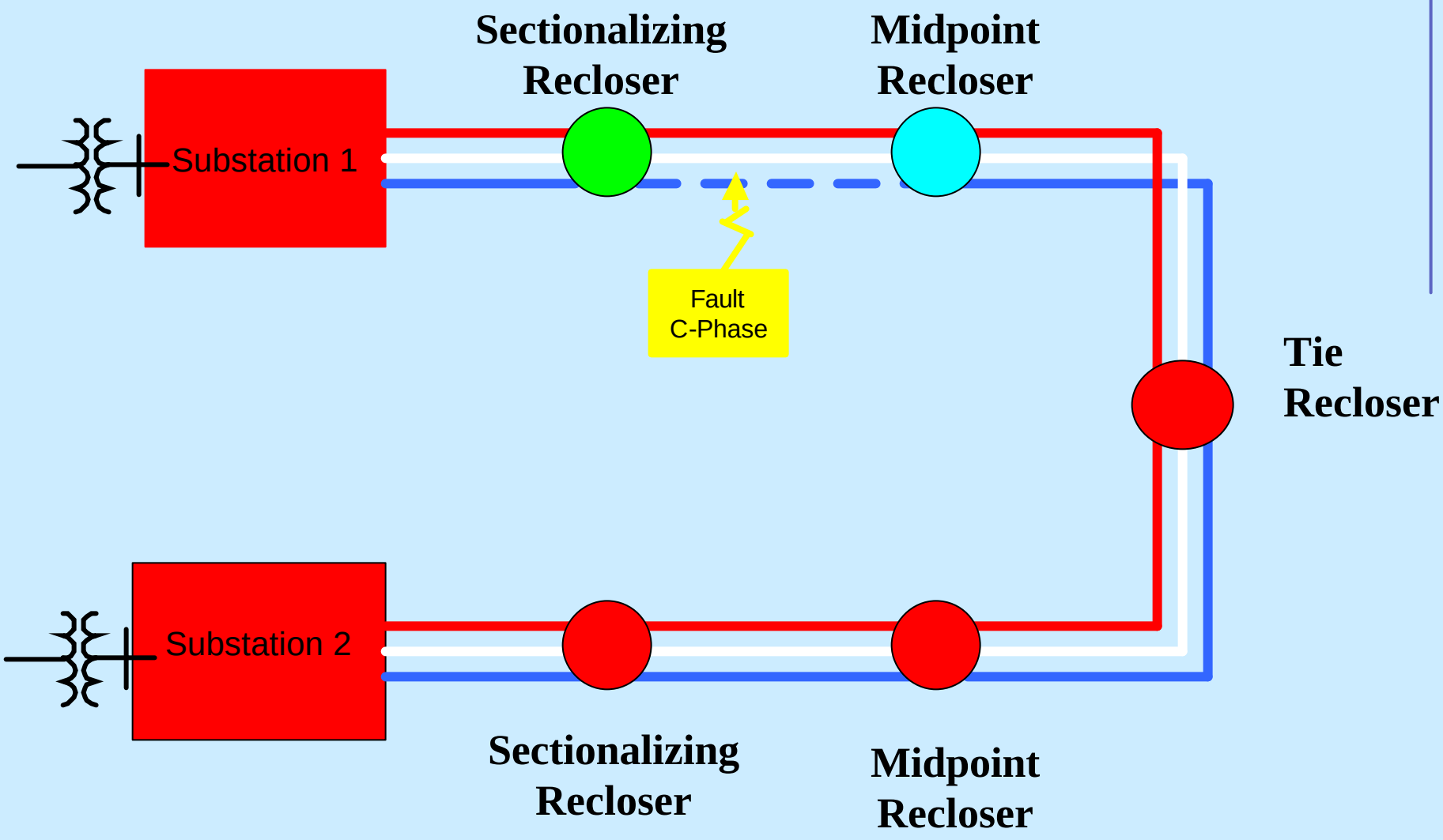
ABB

Tie times out and closes on one shot



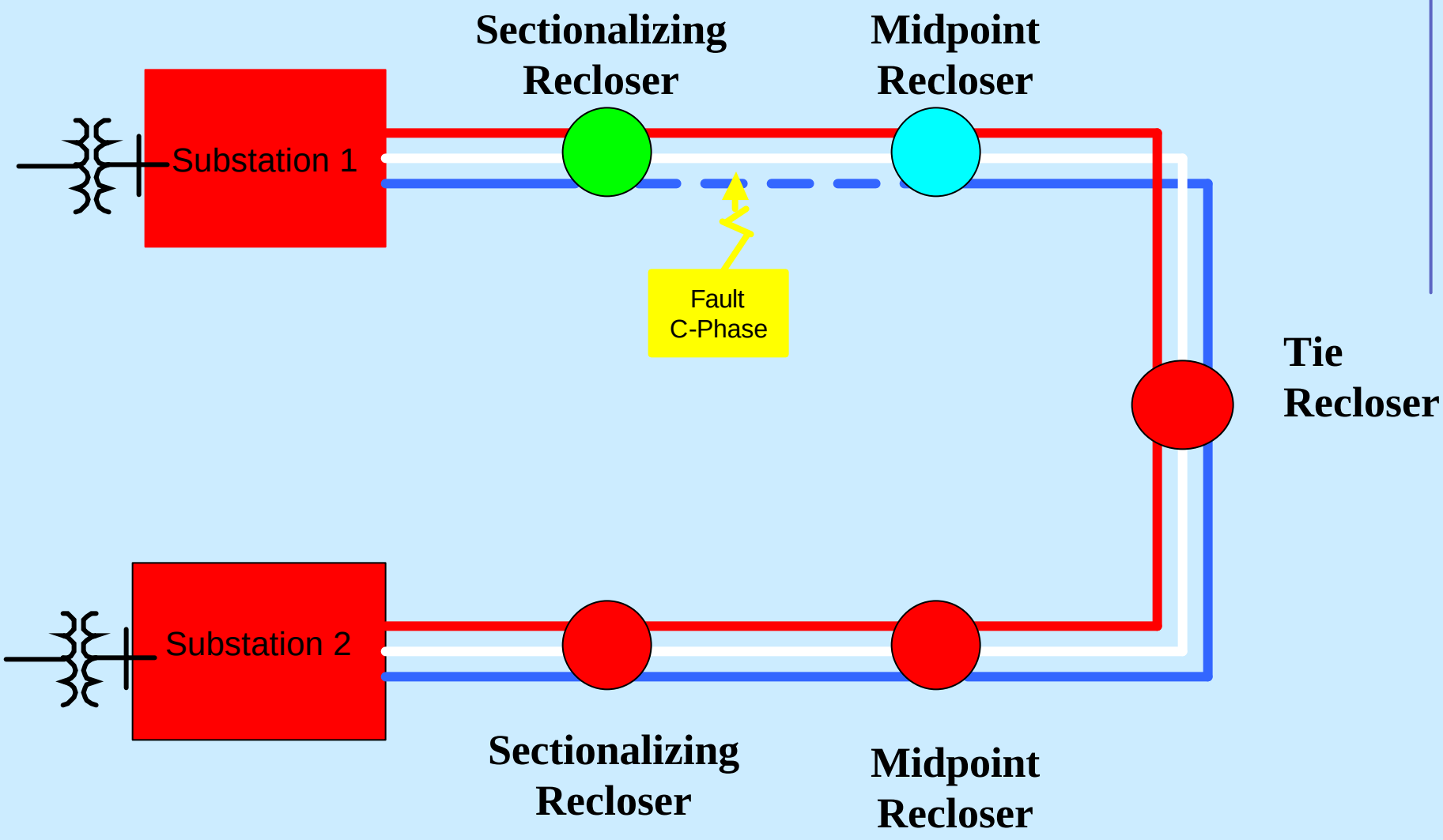
ABB

Midpoint trips C phase on one shot



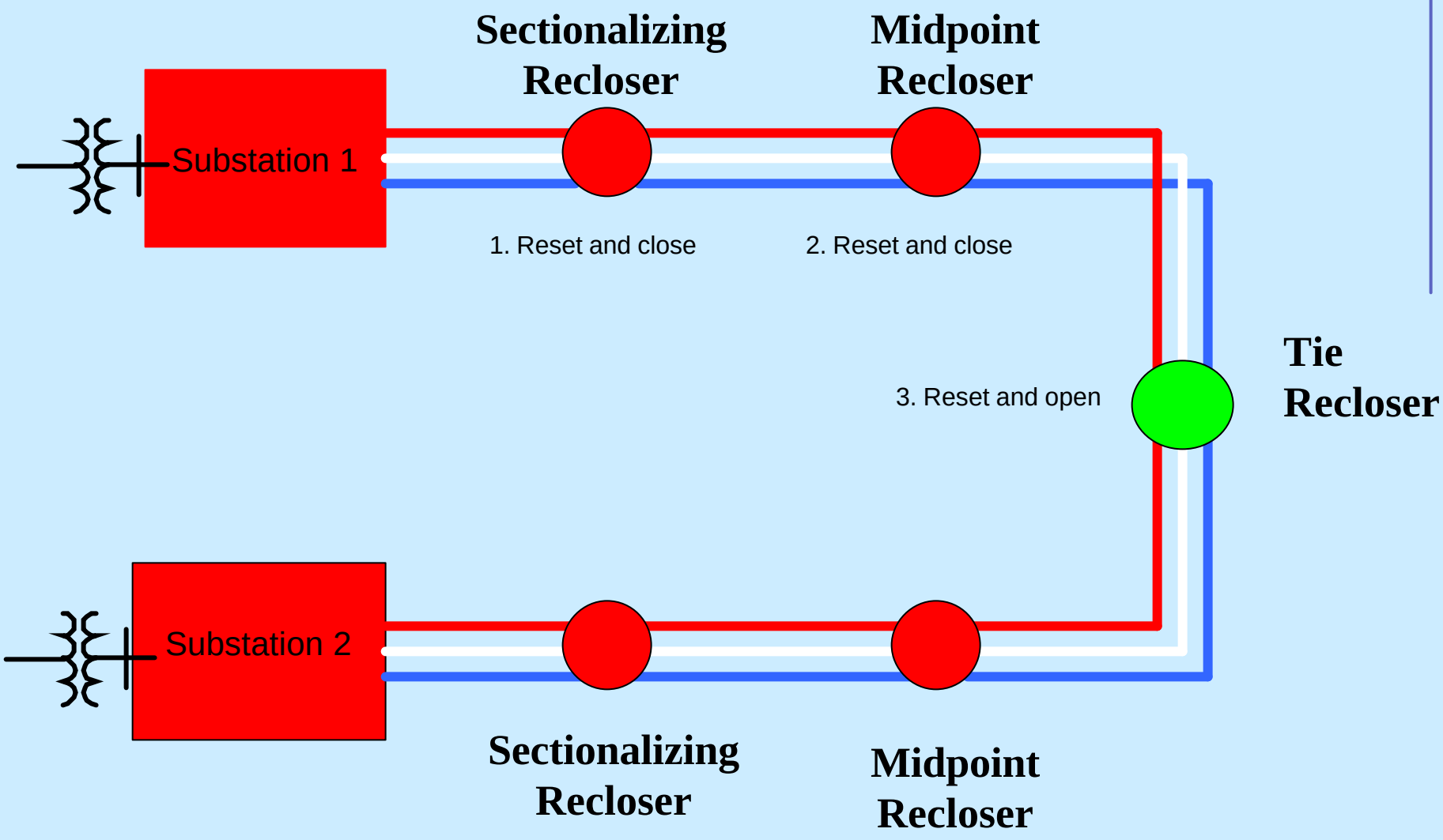
ABB

Tie resets and goes to normal reclosing



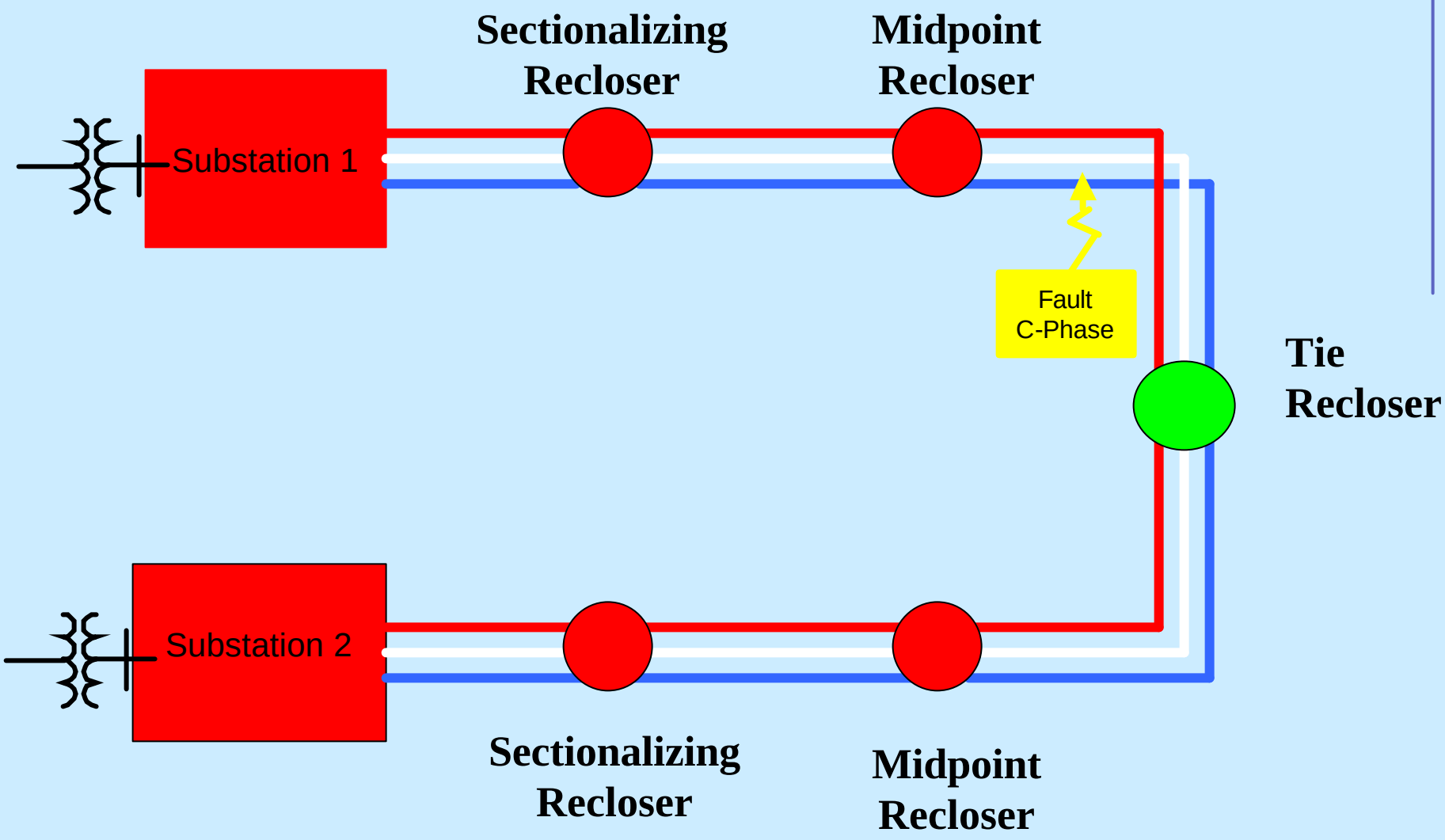
ABB

Reset system starting at source



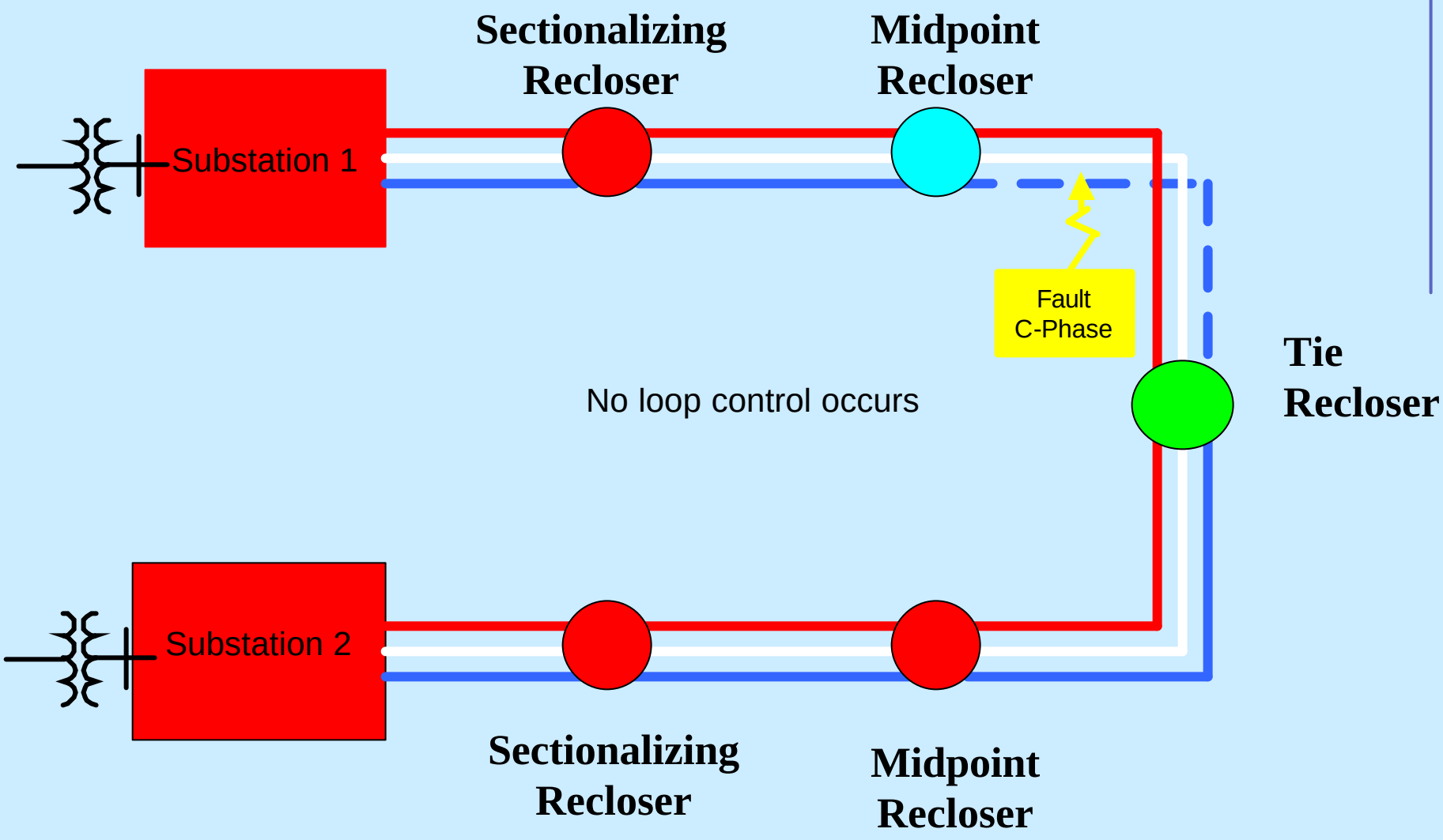
ABB

Fault occurs on normal system



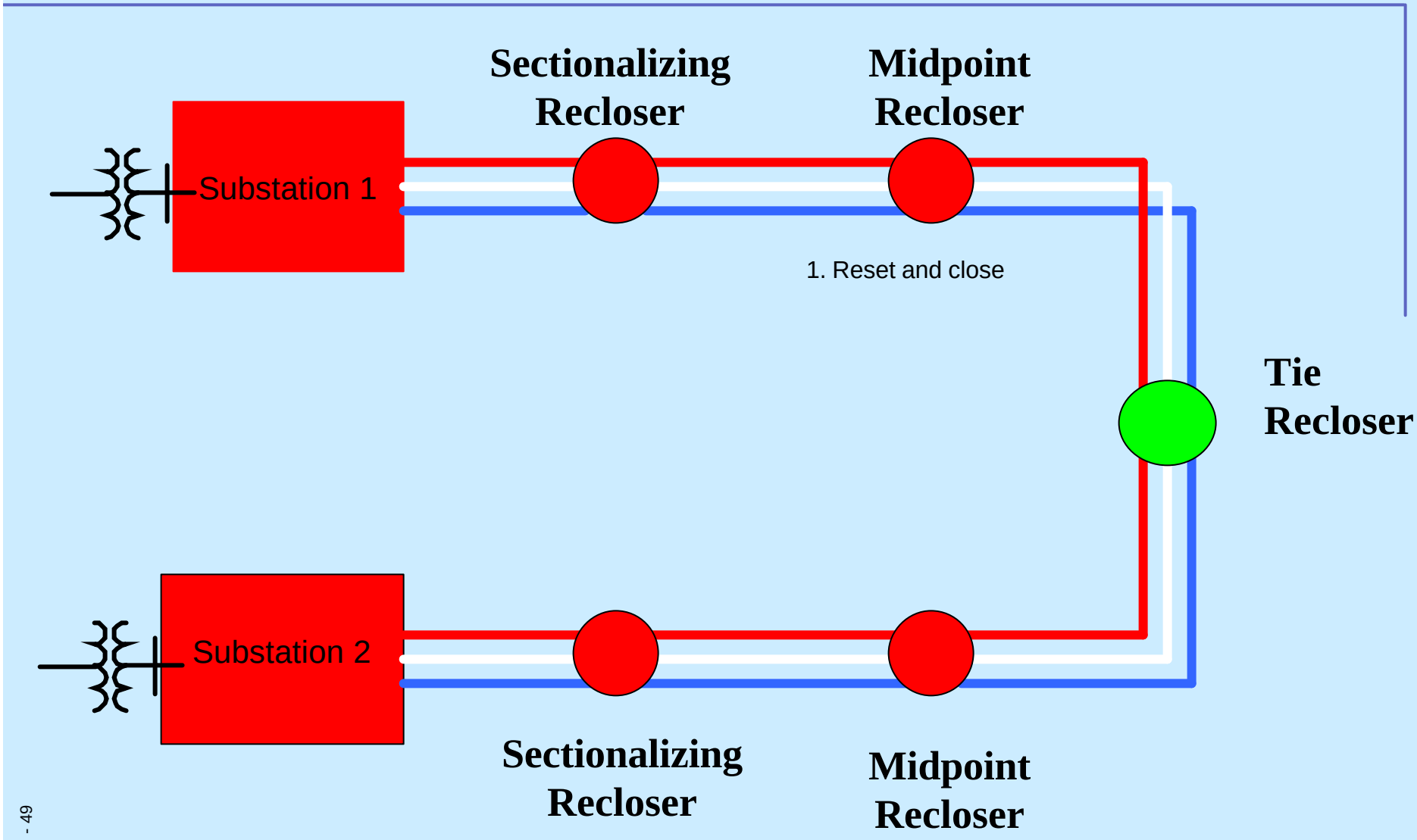
ABB

Midpoint does single phase reclosing on C-phase and locks out C phase



ABB

Reset system starting at source



ABB