33KV & 11KV circuit breaker related problems and troubleshooting

A very common problem 33/11kV Substations, **Circuit Breaker not closing Electrically**. The Troubleshooting steps are as under:

- **Circuit Breaker not closing Electrically.**

CANNOT CLOSE

Mechanism	
Fault	What to do
Closing spring damaged or dislocated	Replace
Closing catch seized or galled	Replace
Closing paddle dislocated.	Replace
Closing coil burnt.	Replace
Motor burnt	Replace

Control Circuit	
Fault	What to do
Auxiliary switch poor contact or burnt.	Replace switch
Control relay poor contact or burnt.	Replace PCB
Auxiliary relay poor contact or burnt.	Replace PCB
PCB connector poor contact or burnt.	Replace if necessary
Microswitch poor contact or burnt.	Replace if necessary

Step 1: Basic Checks:

1. Check the DC Supply to the Breaker. Connect the Multimeter between K1 and K2, it should show full voltage (220V/24 VDC).
2. Check, if the Closing Spring are charged, because an NC Spring Charge limit Switch contact is used in the Closing Circuit, so if the Closing Springs are not charged, the Breaker will not Close.
3. Check if the Master Trip Relay (86) is Reset.
4. Check if the TCS Circuit is Ok.

Step 2: Check if the Breaker is Closing Locally:

1. Put the Local Remote Switch on Local and try to Close the Breaker through Local TNC Switch.

Step 3: Check if its a Electrical problem or a Mechanical Problem:

1. Sometimes the Breaker Mechanism gets jammed and when we try to close the Breaker, the Breaker trips immediately.
2. Switch Off the Breaker DC and try to close the Breaker Mechanically.
3. If the Breaker Closes Mechanically, we are sure that its an Electrical Problem.

Now, that it is clear that its an Electrical Problem, we need to check the Local Closing Circuit for any fault (Open). For the purpose of Fault Finding, we can divide the Closing circuit in two parts viz. the one after the Local TNC Switch (where we should get negative voltage) and before the Local TNC Switch (Where we should get Positive Voltage). We need to take following steps: But before starting the Troubleshooting, we need to know the Breaker Ferrules

1. DC Positive to the Breaker – K1
2. DC Negative to the Breaker – K2

3. Closing Positive – K5
4. Closing – K21

Step 4: Checking the Circuit after the Local TNC Switch for Negative Voltage:

1. We know that, a Permanent Negative is given to the Closing Coil and when the Breaker is in OFF Position, the Closing Circuit is through after the Local TNC Switch, if all the basic conditions are satisfied. If there is no break in the Closing Circuit, the negative will come through the Closing Coil till the TNC Switch. So, we will check the Voltage between K1 (Positive) and the K21 (at the C Position of the TNC Switch). If there is Voltage between K1 and K21, the Closing Circuit after TNC Switch is OK. But, if there is No Voltage, we keep checking the Negative Voltage with the Black Probe, till we get the Voltage. Please note Red Probe will be held, constant at K1 (Positive).
2. Let us assume that the Closing Resistor is Faulty (Open). Red probe of the Multimeter is held at K1 (Positive) and when the black probe of the Multimeter is held at incoming of the Closing Resistor, we will not get any Voltage. When the Black probe is held at Outgoing of the Closing Resistor, the Multimeter shows Voltage. This implies that the Closing Resistor is Faulty.

Lets assume that the circuit after the TNC Switch is Ok, but still the Breaker is not Closing. So we need to check the Circuit before the TNC Switch.

Step 5: Checking the Circuit before the Local TNC Switch for Positive Voltage:

1. We know that a Permanent Positive is given to TNC Switch. So, we will hold Black probe of the Multimeter, to the K2 (Negative) and Red Probe to Positive at the TNC Switch. If Multimeter shows the Voltage, this circuit is also OK.

Step 6: Checking the Local TNC Switch Closing Contact:

1. Now, the only option left, is that the TNC Switch Closing Contact is faulty. To check the TNC Switch Closing Contact, we take a Shorting and short the K1 and K21 on the TNC Switch. If the Breaker Closes, the TNC Sitch Closing Contact is Faulty.
2. We will check, if there is any spare contacts available in the TNC Switch. If spare contact is available, we will shift the wires K1 and K21 to it.

- **Circuit Breaker not Tripping Electrically**

CANNOT TRIP

Mechanism	
Fault	What to do
Trip coil burnt or galled.	Replace
Trip shaft and catch galled.	Replace
Trip paddle dislocated.	Replace
Main shaft galled.	Replace

Control Circuit	
Fault	What to do
Auxiliary switch poor contact or burnt	Replace
Trip coil burnt, armature damaged or galled	Replace
Terminal and connector poor contact or burnt	Replace

Tripping Circuit of VCB can be divided into Four parts:

1. Local Control through the Local TNC Switch in Breaker
2. Remote Control through the Remote TNC Switch in CP/RP
3. Automatic Tripping through Protection Relay
4. Monitoring through the TCS Relay in CP/RP

Local Controlling:

1. A Breaker can be Tripped Locally in the yard through Breaker TNC Switch. For this we have to keep Local/Remote Switch in Local Mode and turn the Breaker TNC Switch to C Position.

Remote Controlling:

1. A Breaker can be Tripped Remotely from the Control Room through the TNC Switch in the Relay Panel/Control Panel and through the SCADA System.

Protection Tripping:

1. Breaker Trips Automatically for Protection when the Master Trip Relay is Operated.

Monitoring:

1. Breaker Tripping Circuit is Continuously Monitored for Healthiness through, Trip Circuit Supervision (TCS) Relay in the Relay Panel in the Control Room.

There are following Elements in the Tripping Circuit:

1. Tripping Coil
2. Remote Control through the Remote TNC Switch in CP/RP
3. Automatic Tripping through Protection Relay
4. Monitoring through the TCS Relay in CP/RP

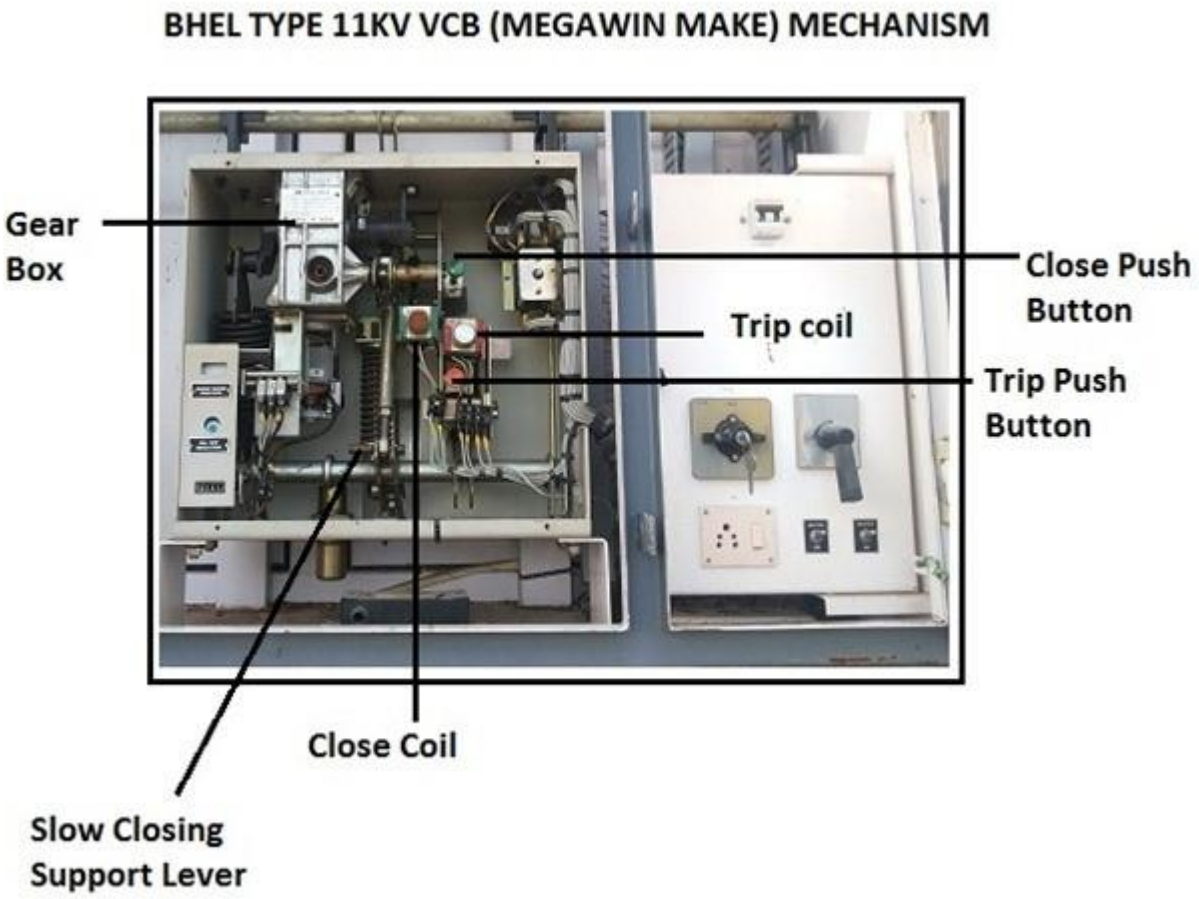
Tripping Coil:

1. A Permanent Negative (K2) is given to one end of the Tripping Coil.
2. When Positive is received by other end of the Tripping Coil through the TNC Switch, the Tripping Coil gets energised and attracts the Tripping Plunger which then attracts the Tripping Mechanism and the Breaker Trips.

NO Auxiliary Contact (52a):

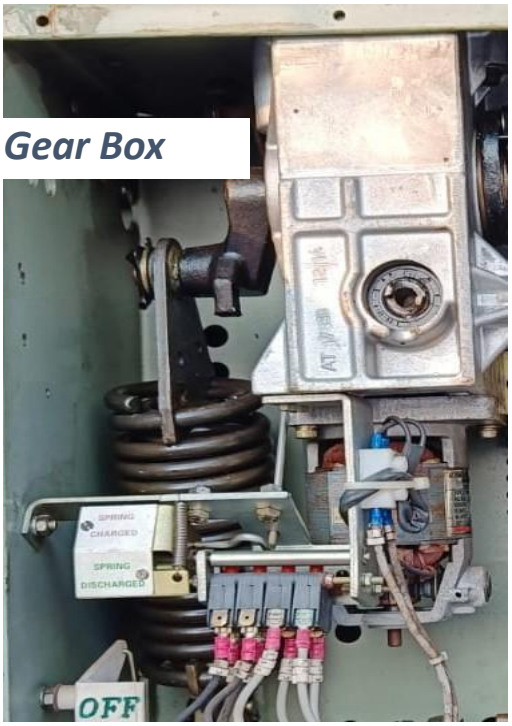
1. Before the Tripping Resistance, we use NO Breaker Auxiliary Contact 52a as an Interlock.
2. When the Breaker is in OFF Condition, 52a does not allow, the Breaker to be closed. In other words, when the Breaker is OFF, tripping command cannot reach the Tripping Coil.

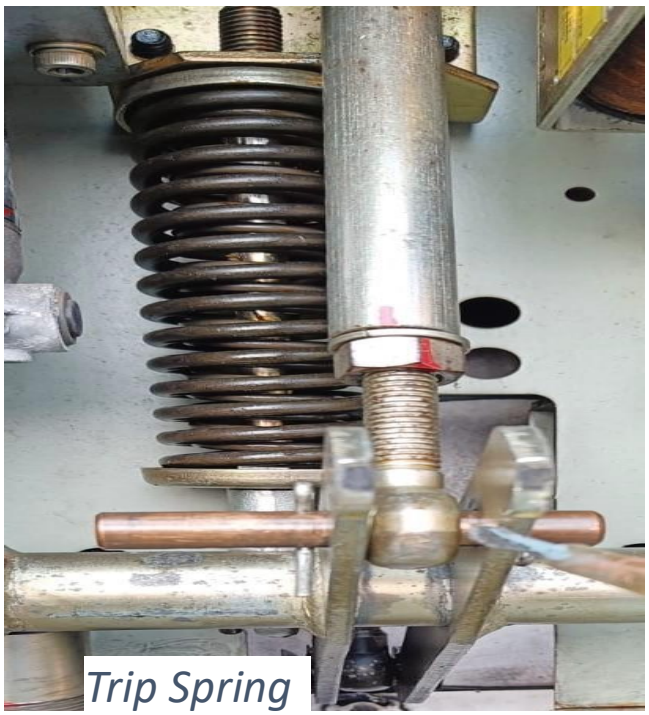
33kV and 11kV BHEL Make VCB Main parts of the mechanism: -



1. Close spring with charging mechanism.
2. Eccentric wheel with cam-roller mechanism with closing latch and close coil assembly.
3. Common operating shaft
4. Trip spring.
5. Tripping latch mechanism with Trip coil assembly.
6. Pole base mechanism

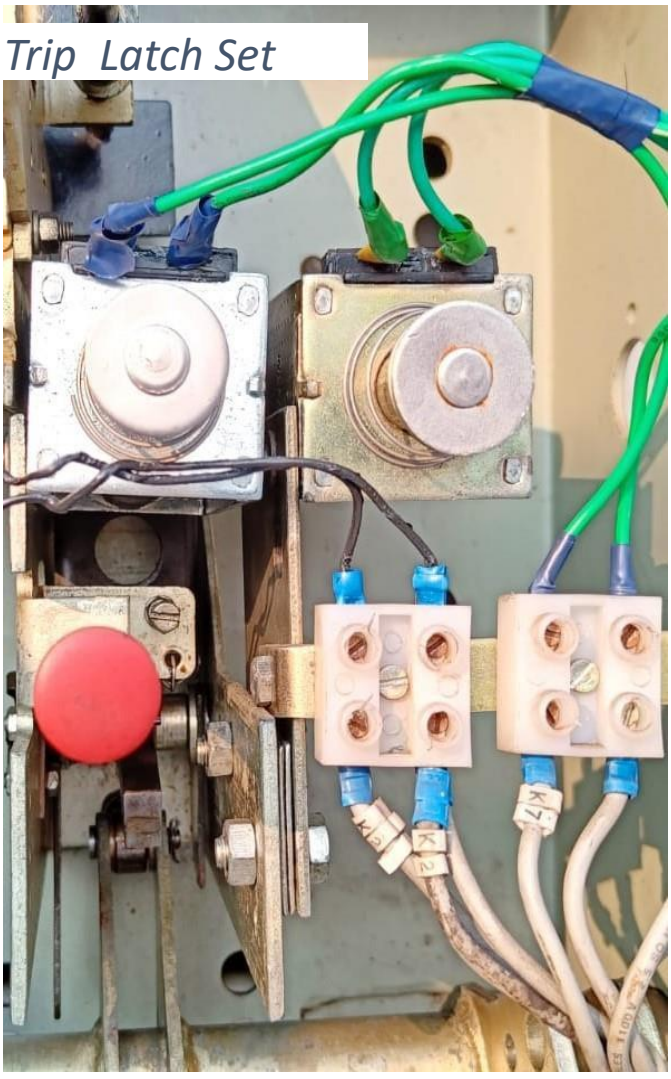
Gear Box





Trip Spring

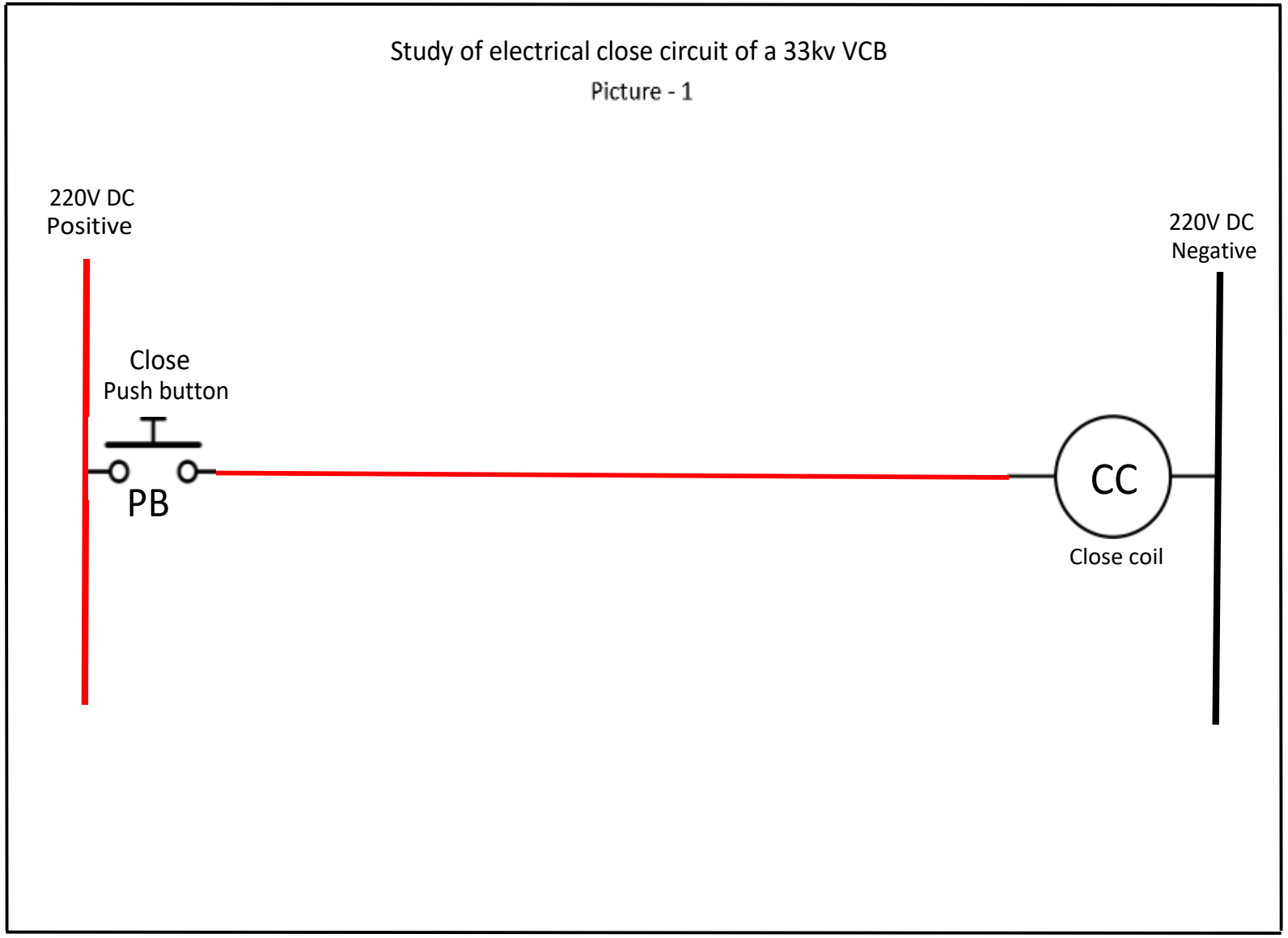
Trip Latch Set



Study of electrical close circuit of 33kv Vacuum Circuit Breaker

The close coil is triggered manually to close the breaker. Closing coil should create mechanical stroke of plunger sufficient enough to operate closing mechanism of breaker. Each breaker manufacturer will calculate the plunger stroke force to operate the mechanism accordingly closing coils are designed and these close coils are not of continuous rating.

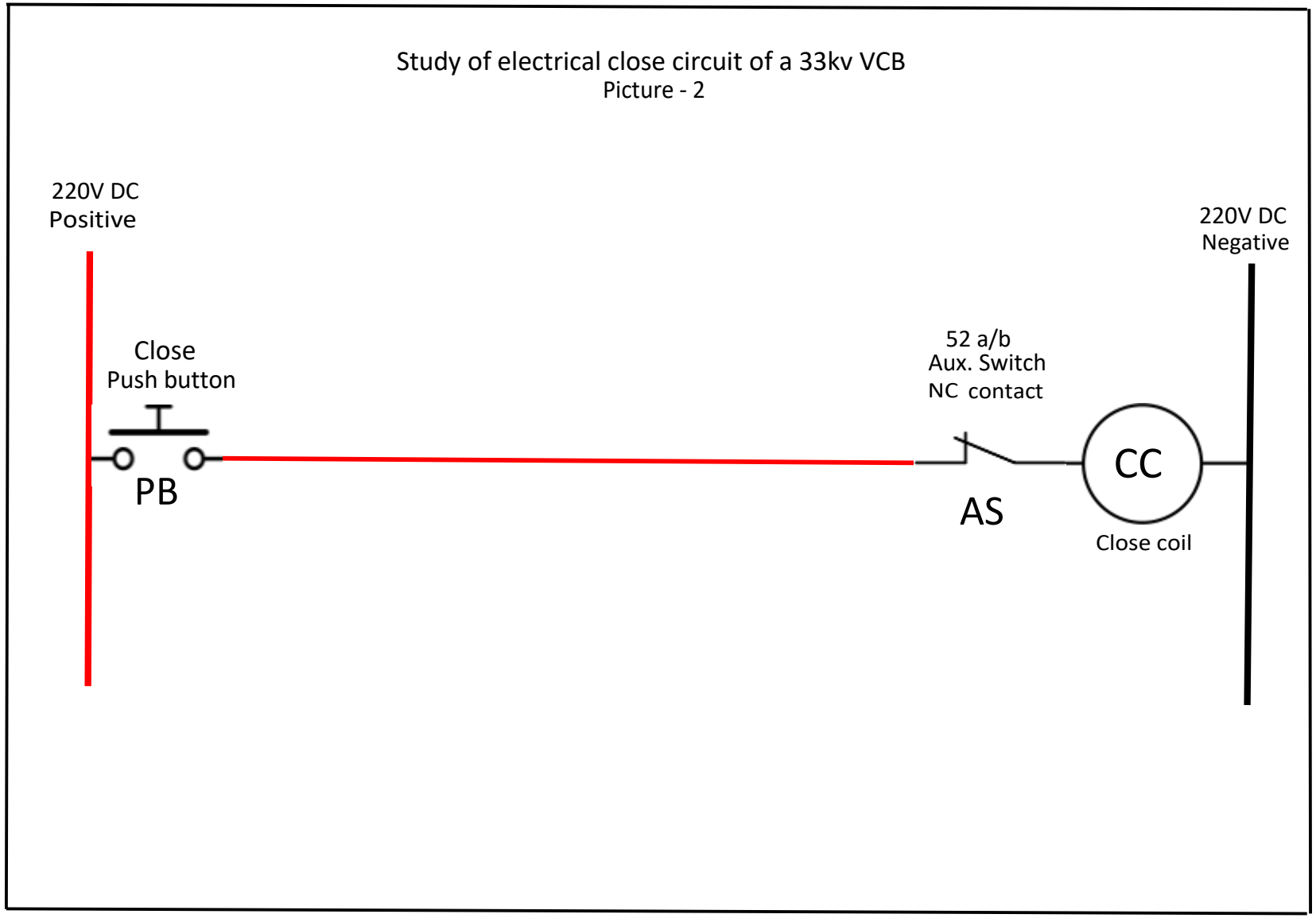
Hence the close coil will be interlocked with various safety systems to not permit the breaker to close if an abnormal or unsafe condition exists.
The following are the safety interlocks existing in closing circuit of a typical 33kv VCB.



Study of electrical close circuit of 33kv Vacuum Circuit Breaker

1. Auxiliary switch (52 a/b) is mechanically interlocked with the Circuit Breaker Operating Mechanism. When circuit breaker operates, the auxiliary switch contacts also changes their state, i.e. open contacts become close and close contacts become open.

Here the NC (52b) contact is introduced in the circuit to disconnect the DC positive pulse to close coil when the CB is closed. Hence protects the close coil from continuous DC positive pulse.



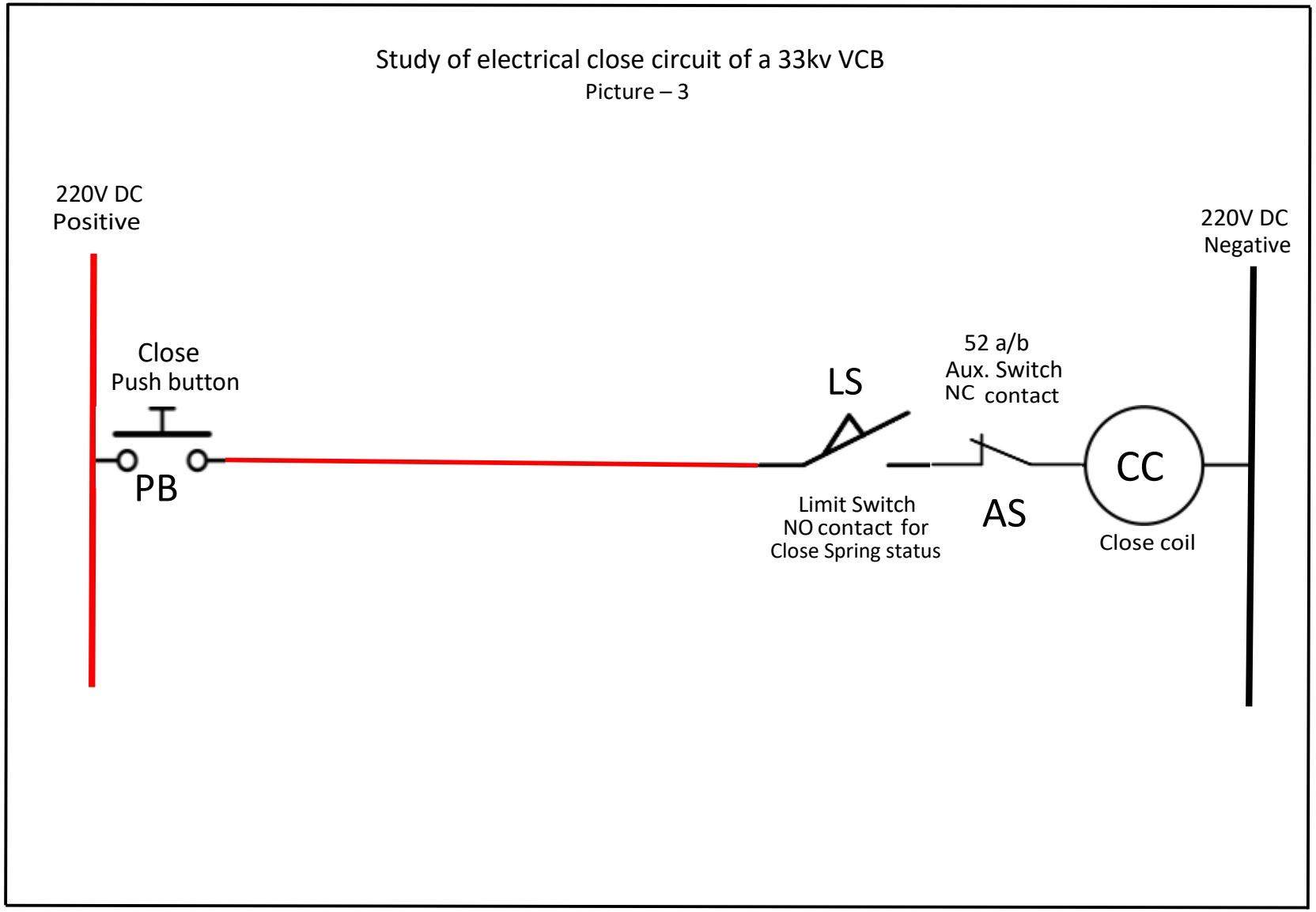
Study of electrical close circuit of 33kv Vacuum Circuit Breaker

2. Limit Switch (LS) is mechanically interlocked with the close spring charging mechanism. It consists NO / NC contacts. When close spring is fully charged, the contacts will change their state.

Hence an NO contact of Limit switch is introduced in the circuit to protect the close coil when close spring is not charged. It allows electrical close pulse to close coil when close spring is fully charge.

Study of electrical close circuit of a 33kv VCB

Picture – 3

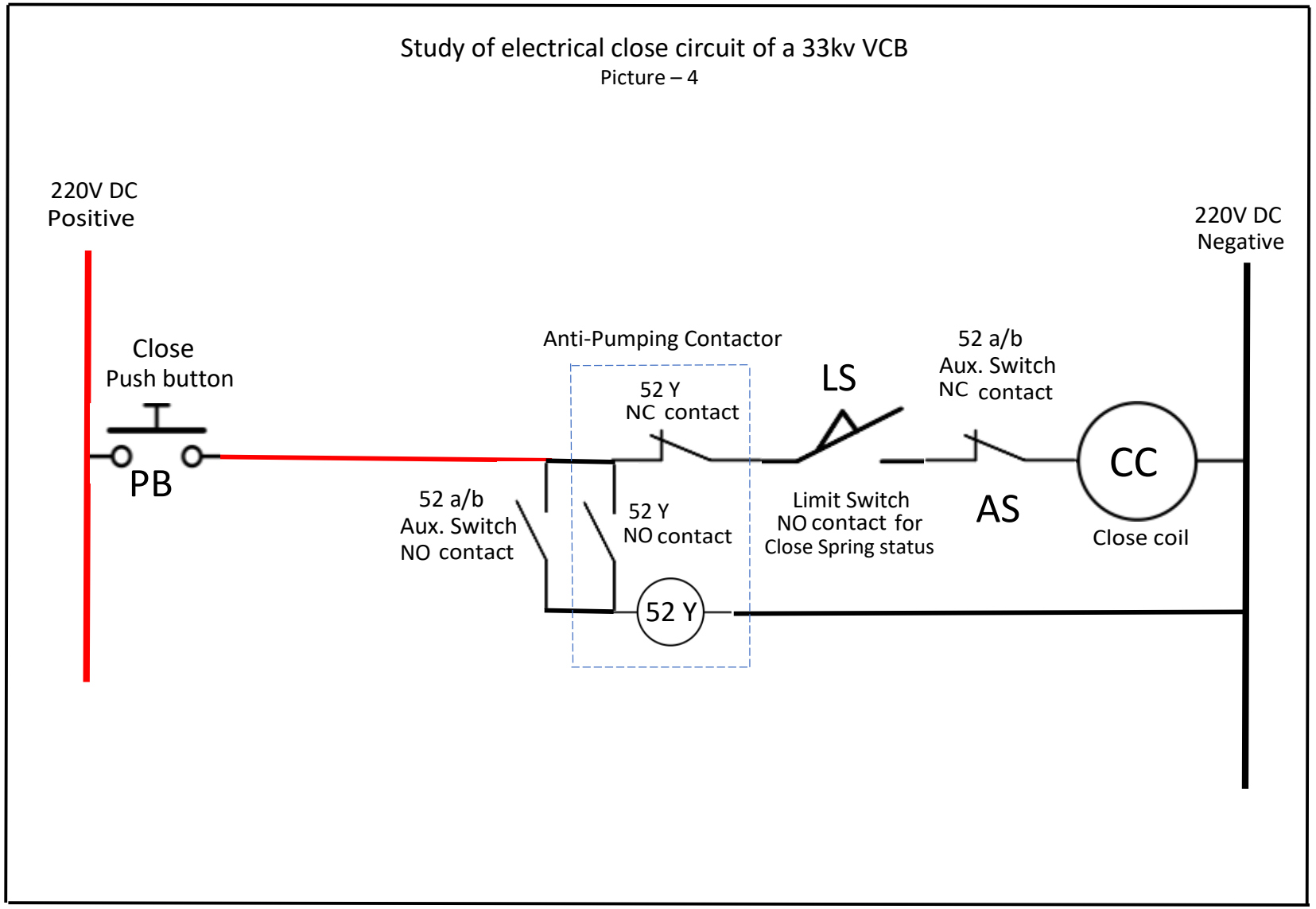


Study of electrical close circuit of 33kv Vacuum Circuit Breaker

3.Anti-pumping relay: The anti-pumping relay or anti-hunting relay is a device in circuit-breaker whose function is to prevent multiple closing operations of breaker during SOTF condition, which can damage the closing mechanism of the breaker.

Anti-Pump relay also provides protection from repeated closing operations in the event breaker close push button gets jammed in the close position.

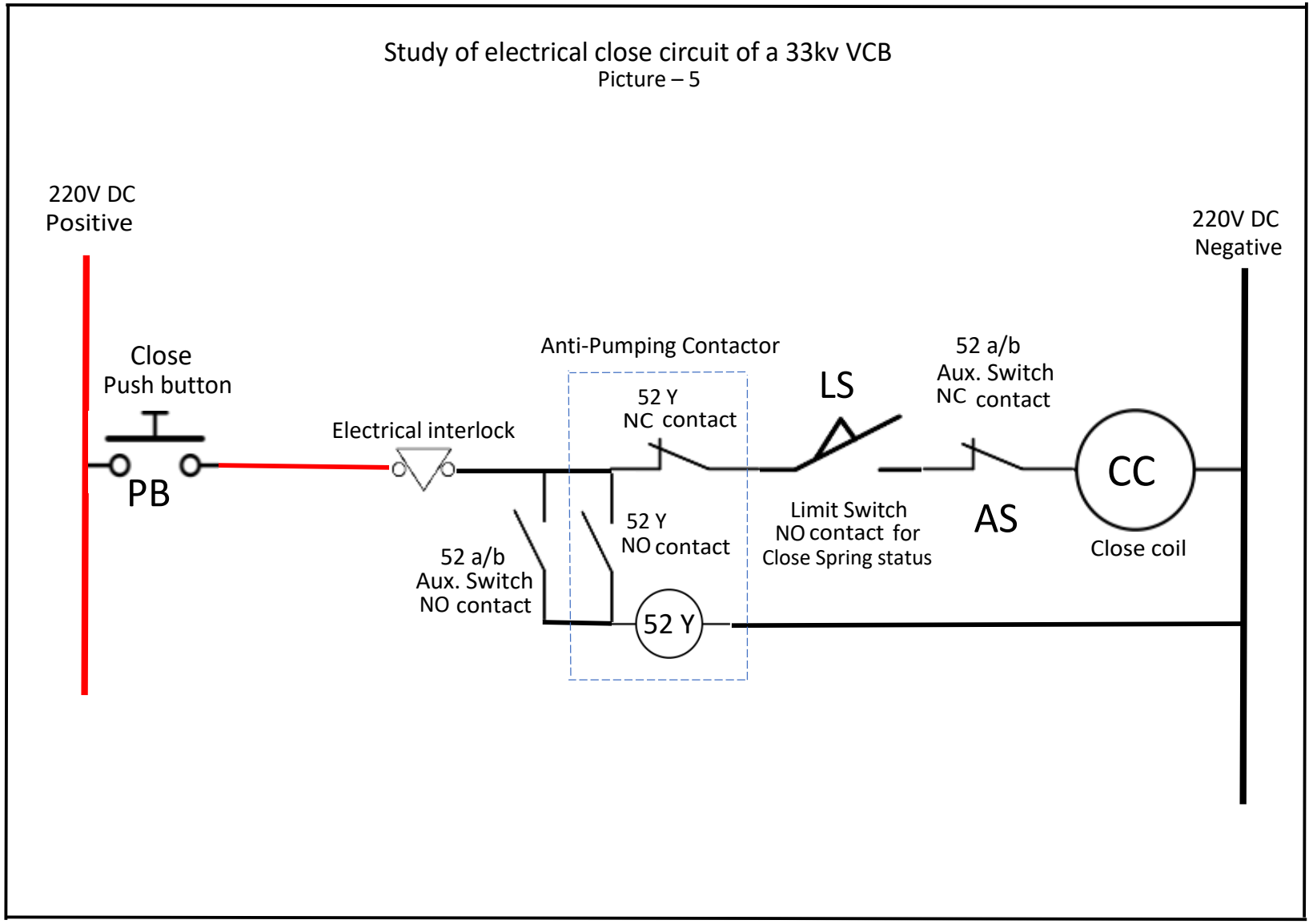
Hence an anti-pumping relay is introduced in the circuit to prevent continuous closing of circuit breaker.



Study of electrical close circuit of 33kv Vacuum Circuit Breaker

4. Electrical interlock is introduced in the circuit to interlock with the associated equipment in the bay or other equipment in the sub-station for conditional operations.

Normally this interlock is shorted when no interlocking is needed.



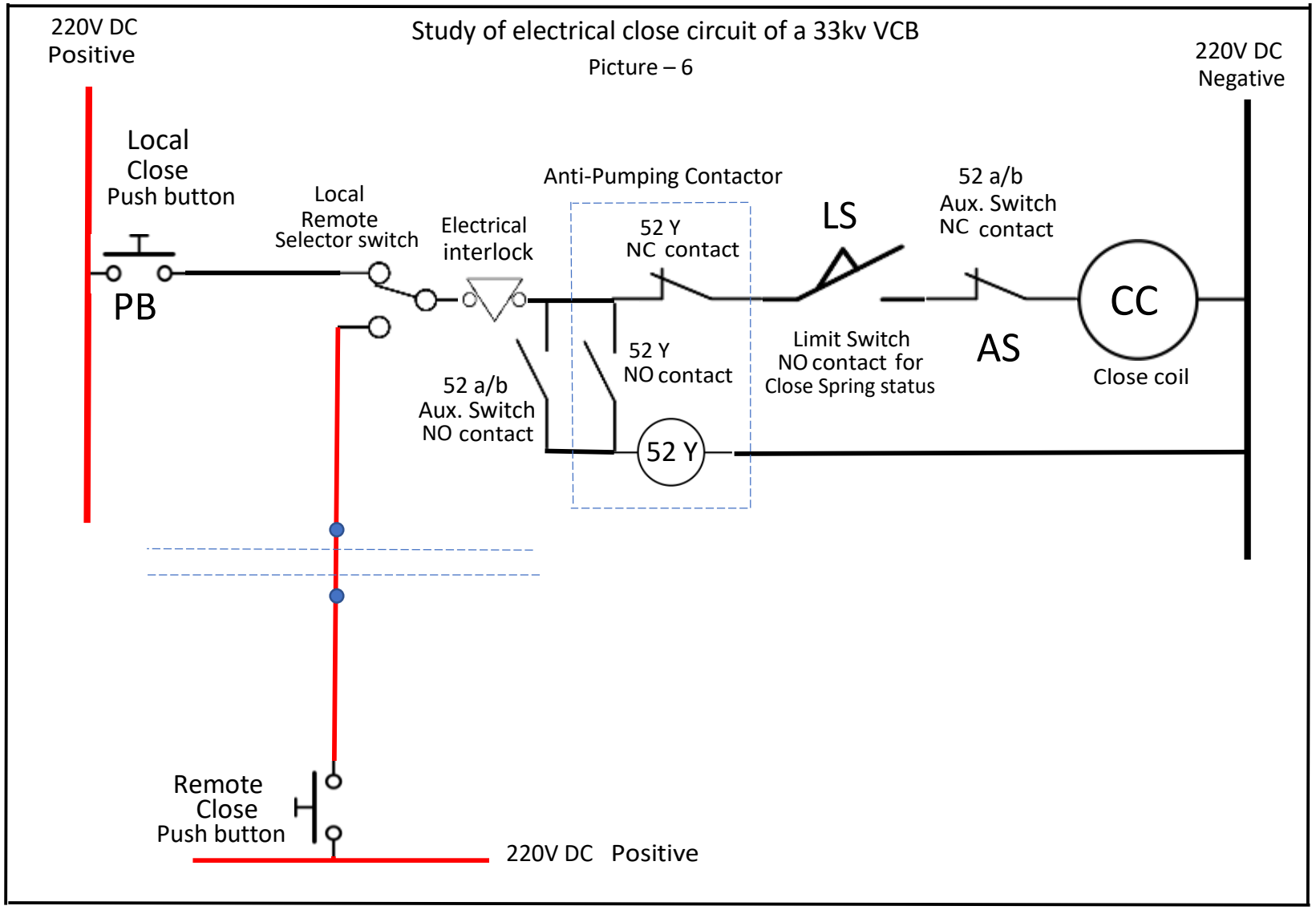
Study of electrical close circuit of 33kv Vacuum Circuit Breaker

5.Local-Remote selector switch is introduced in the circuit to operate the Circuit breaker locally or from C&R panel in the control room.

For local testing operations the LR switch can be kept in Local mode. To keep the circuit breaker in service, the LR switch should be kept in Remote mode and operate the CB from C&R panel.

Note:

Don’t operate the CB locally while in service.



Study of electrical close circuit of 33kv Vacuum Circuit Breaker

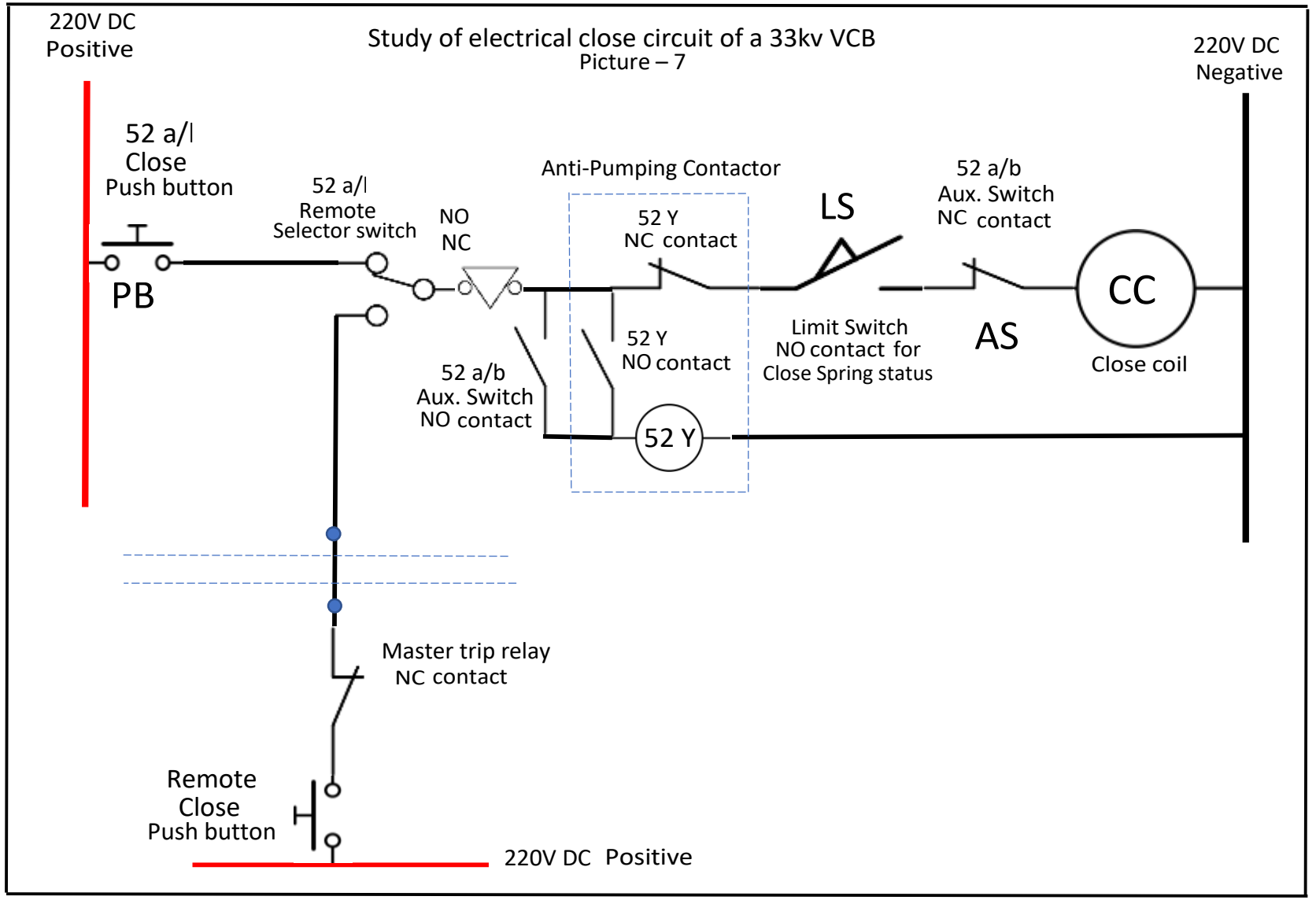
6.Master Trip Relay is a trip relay in C&R panel which receives command from protective relaying system and extends trip pulses to circuit breaker to trip under abnormal or fault current flow condition.

In addition to trip (NO) contacts, the Master Trip Relay contains one NC contact which is connected in the close circuit of CB.

The main function of this NC contact is to block the close pulse when master trip relay operates and till reset of relay. As long as the master trip relay is not done reset, the trip pulse will be present and the CB will get tripped immediately after closing.

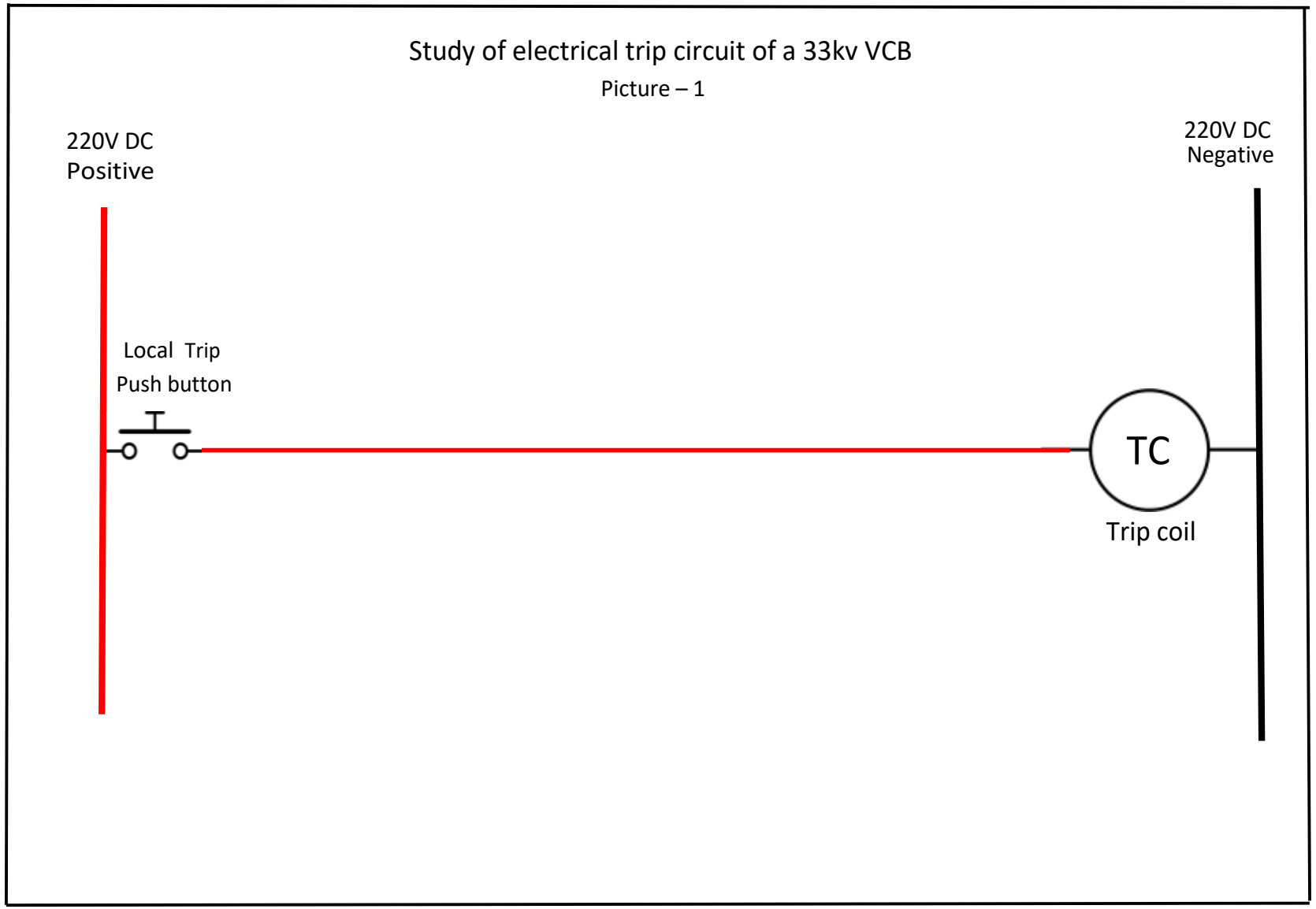
Note:

Before closing the CB, reset the master trip relay



Study of electrical trip circuit of 33kv Vacuum Circuit Breaker

Trip coil should create mechanical stroke of plunger sufficient enough to operate the trip mechanism of breaker. Each breaker manufacturer calculate the plunger stroke force to operate the mechanisms and accordingly trip coil is designed.



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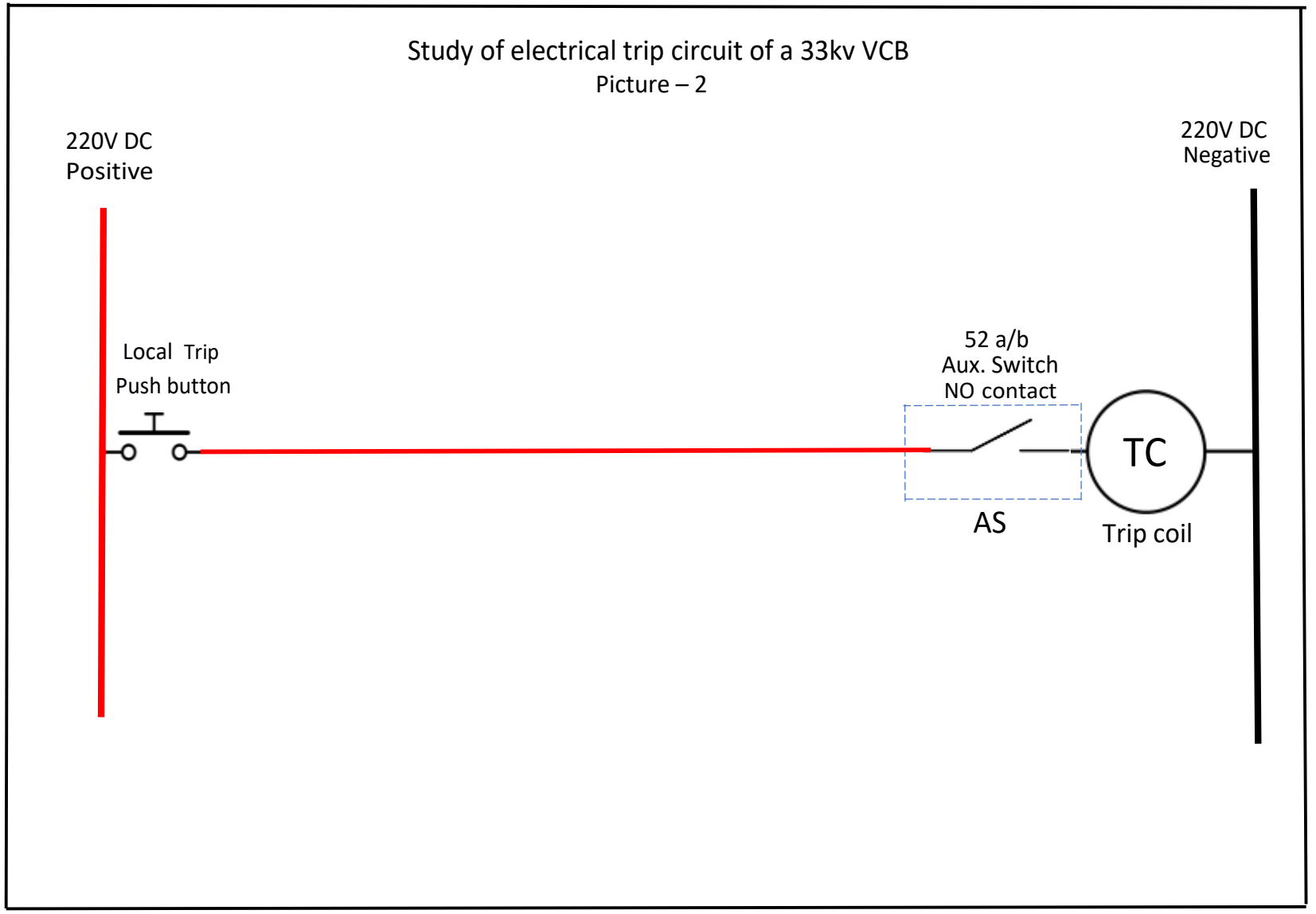
1. Auxiliary switch (52 a/b) is mechanically interlocked with the Circuit Breaker Operating Mechanism. When circuit breaker operates, the auxiliary switch contacts also changes their state, i.e. open contacts become close and close contacts become open.

Here the NO (52a) contact is introduced in the circuit to disconnect the DC positive pulse to trip coil when the CB is opened. Hence protects the trip coil from continuous DC positive pulse as the trip coil is not of continuous rating type.



Study of electrical trip circuit of 33kv Vacuum Circuit Breaker

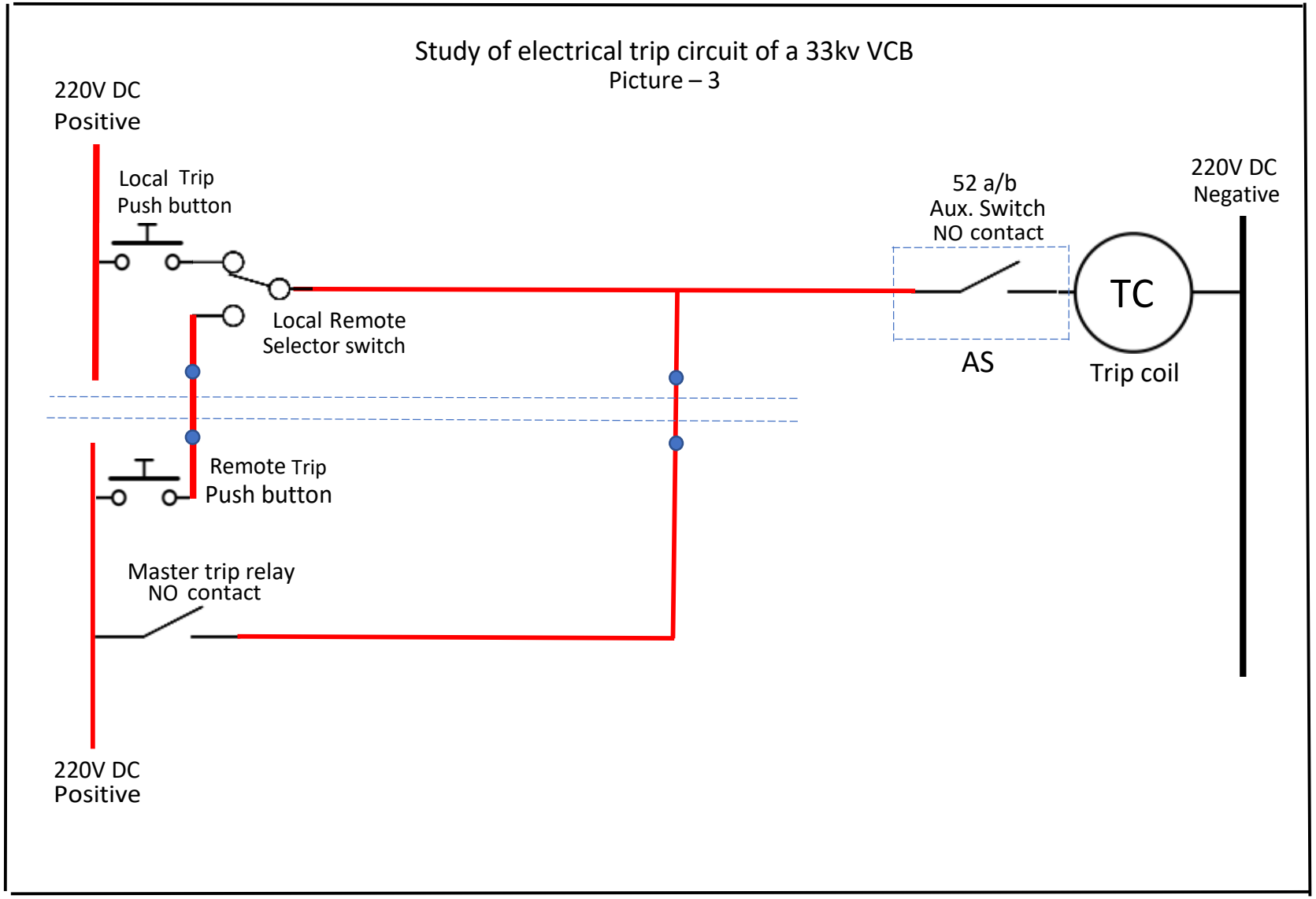
2. Local-Remote selector switch and Master trip relay is introduced in the circuit to operate the Circuit breaker locally or from C&R panel in the control room and to trip the CB under abnormal or fault current flow condition.

For local testing operations the LR switch can be kept in Local mode. To keep the circuit breaker in service, the LR switch should be kept in Remote mode and operate the CB from C&R panel.

Basically the Trip coil is connected to a sensitive circuit (protective relaying system) directly to disconnect power line under abnormal or fault current flow condition. Hence no other interlocks connected in the circuit.

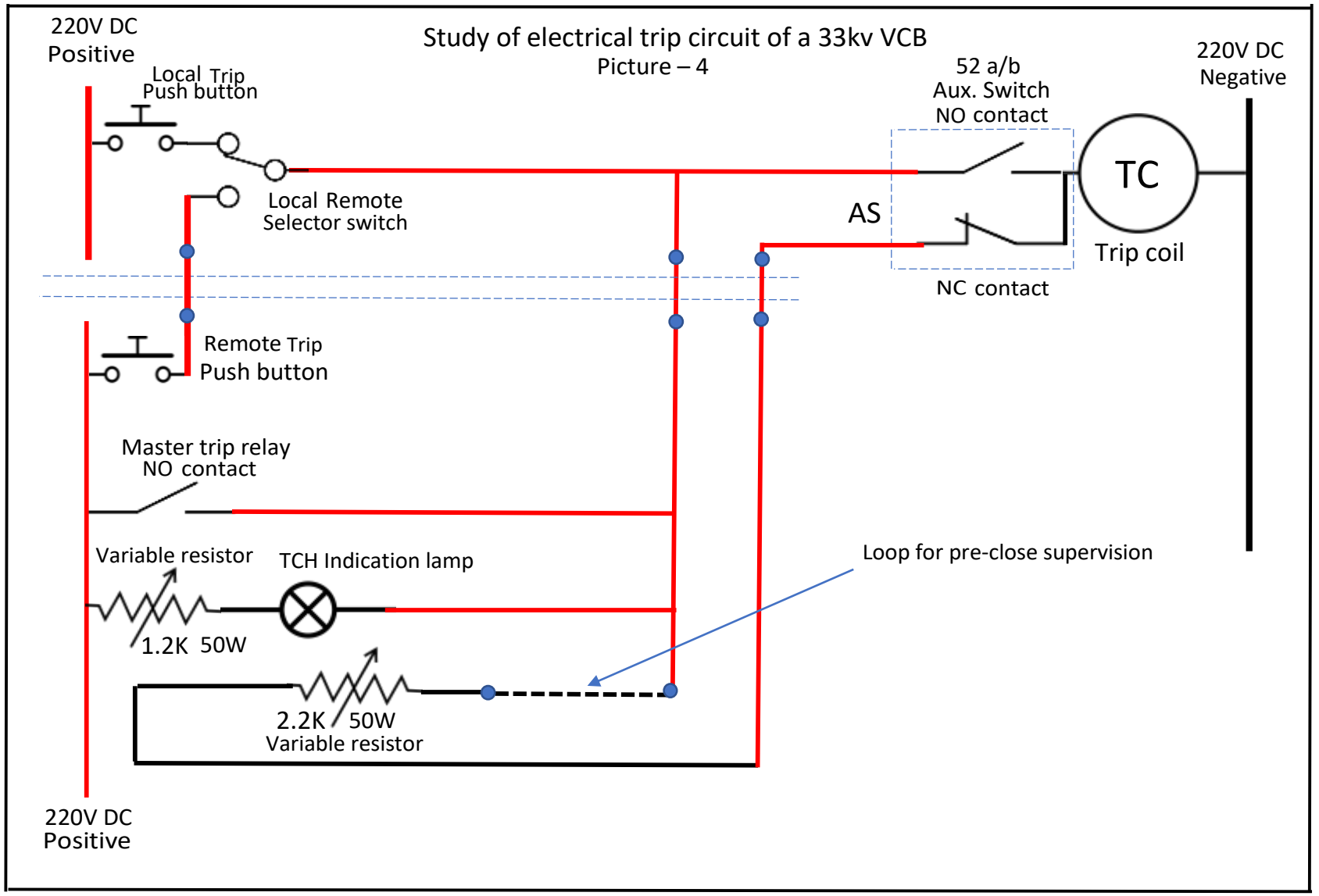
Note:

Don’t operate the CB locally while in service.



Study of electrical trip circuit of 33kv Vacuum Circuit Breaker

3. Trip circuit supervision is introduced in the circuit to monitor the healthiness of trip coil continuously.



Study of electrical trip circuit of 33kv Vacuum Circuit Breaker

Instead of loop, a push button is connected in pre-close supervision circuit to avoid coil failures.