



Genius Engineering & Service Co., Ltd.

ELECTRICAL SERVICE

"TRUST OUR EXPERIENCE"

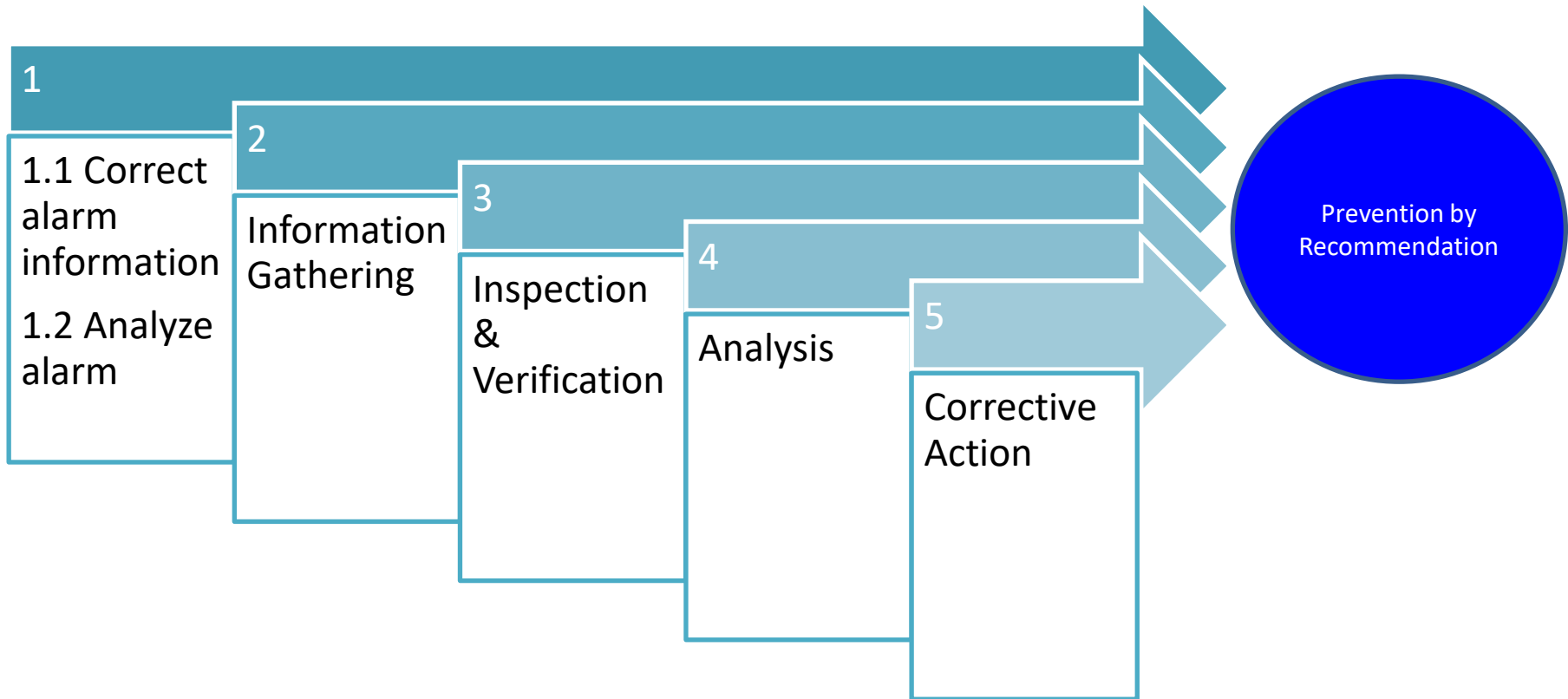
KNOWLEDGE SHARING

GT GENERATOR (GT21) TRIPPED BY VOLT PER HZ ROOT CAUSE ANALYSIS (RCA) REPORT

Shared by: Kongsit

Rev.1: 01 SEPT 2018

Root Cause Analysis Process



ALARM LIST



Alarm on Mark V HMI

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2018-08-29 12:35:38.000, 9279, -0.0, 98.23, 0.00, 0, 0, 1,
Section,Alarms
DATETIME,S,P,DROP/NAME,DESCRIPTION
2018-08-29 12:24:44.250,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:24:52.500,0,Q,0500,VOLTS PER HERTZ EXCESSIVE ALARM
2018-08-29 12:24:53.468,1,Q,0500,VOLTS PER HERTZ EXCESSIVE ALARM
2018-08-29 12:24:56.125,0,Q,0500,VOLTS PER HERTZ EXCESSIVE ALARM
2018-08-29 12:25:24.218,1,Q,0500,VOLTS PER HERTZ EXCESSIVE ALARM
2018-08-29 12:25:30.718,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:25:39.125,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:25:47.343,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:25:51.375,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:25:51.343,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:25:52.250,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:00.968,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:11.375,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:14.468,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:15.375,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:15.718,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:23.375,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:26.718,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:28.000,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:32.343,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:33.125,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:33.093,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:36.125,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:39.718,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:26:51.875,0,Q,0500,VOLTS PER HERTZ EXCESSIVE ALARM
2018-08-29 12:26:53.468,1,Q,0500,VOLTS PER HERTZ EXCESSIVE ALARM
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2018-08-29 12:28:16.125,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:28:19.843,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:28:25.000,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:28:25.343,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
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2018-08-29 12:28:28.625,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
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2018-08-29 12:29:09.375,0,Q,0500,VOLTS PER HERTZ EXCESSIVE ALARM
2018-08-29 12:29:14.468,1,Q,0500,VOLTS PER HERTZ EXCESSIVE ALARM
2018-08-29 12:29:47.000,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:29:47.718,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:29:52.750,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:29:55.718,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:30:03.125,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:30:05.468,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:30:08.750,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:30:08.968,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:30:11.750,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:30:12.468,1,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:35:35.093,1,Q,0196,GENERATOR LOCKOUT RELAY TRIP
2018-08-29 12:35:35.093,1,Q,0393,EXCITER VOLTS/HERTZ EXCESSIVE TRIP (59VH-2)
2018-08-29 12:35:35.156,1,Q,0424,TURBINE TRIP - L4T
2018-08-29 12:35:35.218,1,Q,0197,GENERATOR BREAKER TRIPPED
2018-08-29 12:35:35.875,0,Q,0151,EXHAUST FRAME COOLING AIR PRESSURE LOW
2018-08-29 12:35:35.875,0,Q,0484,BUS POTENTIAL TRANSFORMER TROUBLE
2018-08-29 12:35:36.000,0,Q,0090,FLAME DETECTOR TROUBLE
2018-08-29 12:35:36.000,0,Q,0197,GENERATOR BREAKER TRIPPED
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Bus potential transformer trouble

Exciter excessive volt per hertz

Exciter volts/hertz excessive trip

Generator breaker trip

GEN

TO SH. 3D

PHASE SEQUENCE 1-2-3

PPT

PT2 12000/120V

EXCITATION SYSTEM

96GV-1S

Relay 60 connected directly to PT2

Before check these lines (P1 & P2) make sure 11kV side are made out and off and make out and off - Transformer bkr - Ant bkr - starting motor bkr. only transformer bkr out. we have alarm pickup

Voltage
feedback
signal
to Excitation
System

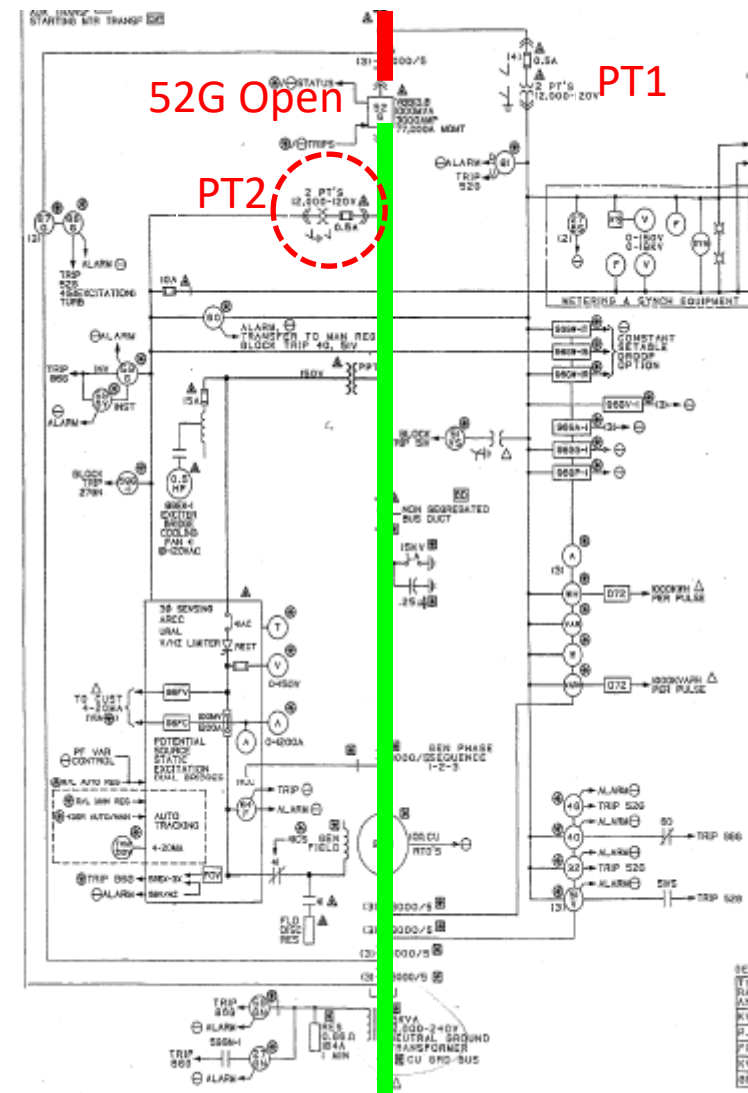
Relay 60 connected
directly to PT2

Relay 60

Initiated bus potential transformer trouble

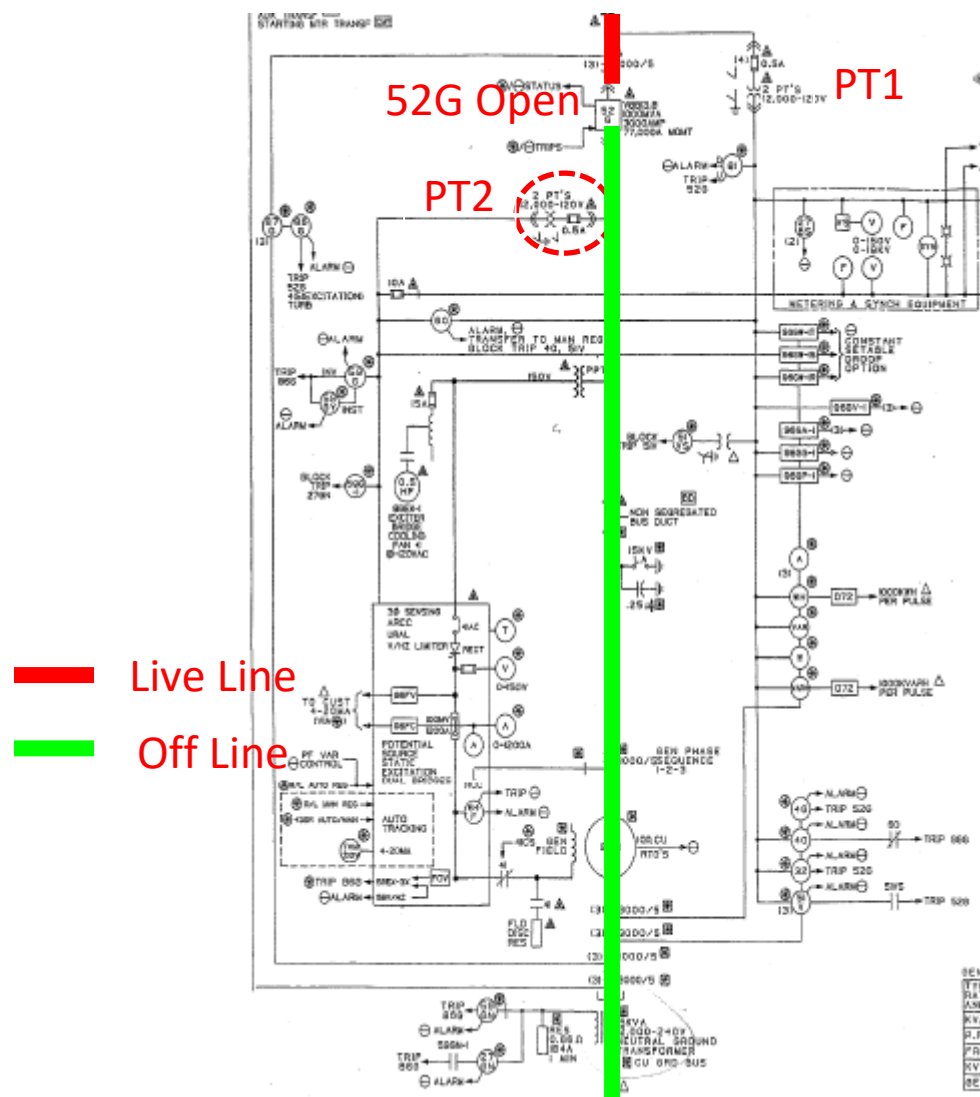
Initiated bus potential transformer trouble alarm

Status After UNIT Tripped



— Live Line
— Off Line

Note - Potential Transformer: PT

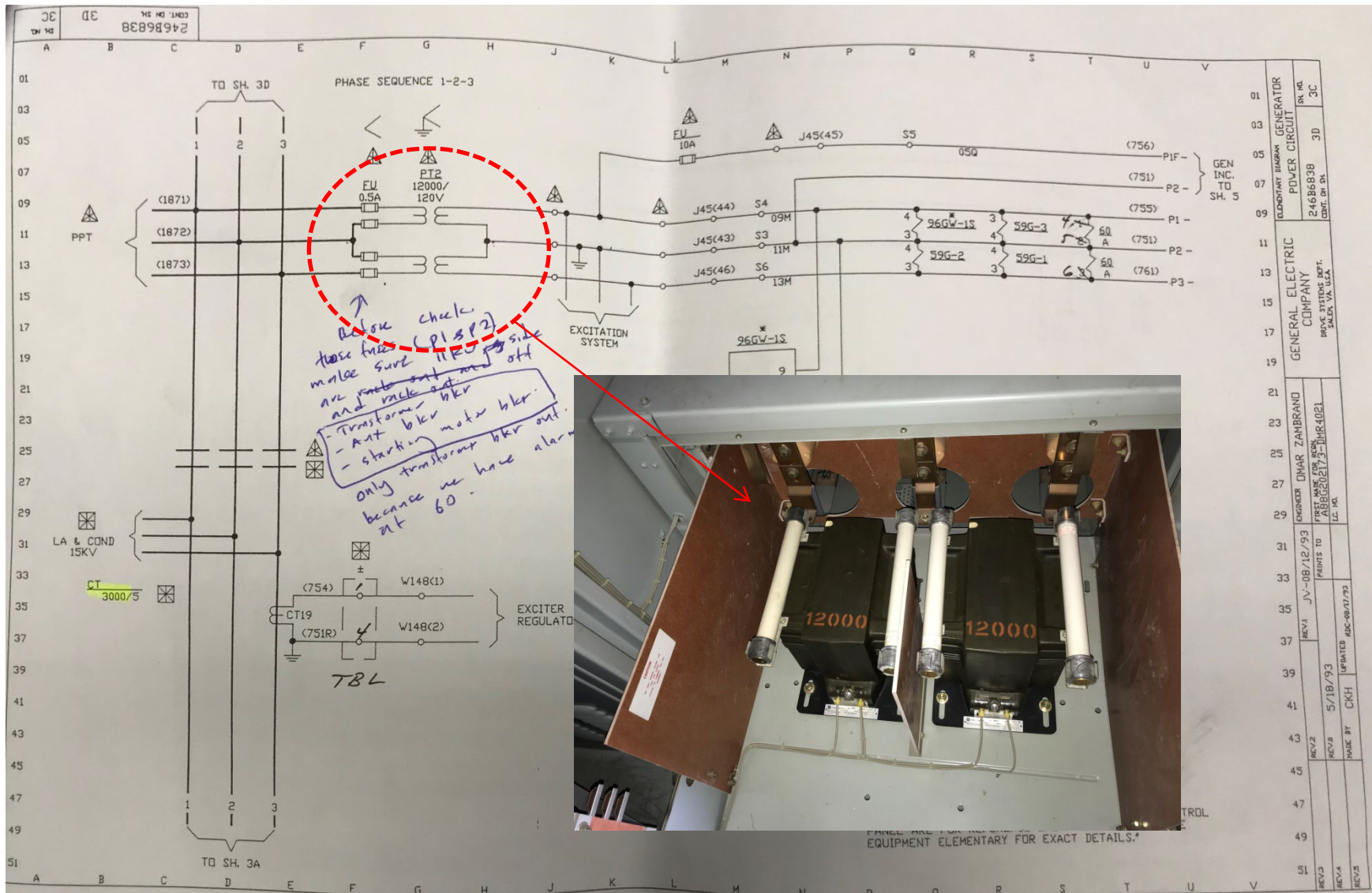


If PT2 fail cause Relay 60 operated then initiated alarm “Bus potential transformer trouble alarm”. And PT2 also send voltage feedback signal to Excitation System if no voltage appear on Excitation System means it don’t see the actual voltage. So it will generate more field current to rotor filed winding to try to increase generator voltage then cause excessive volt per hertz alarm.

This lead to investigate PT2.

Note – Volt per Hertz is overfluxing protection used to prevent generator stator core damage from heat due to high flux.

PT2 Inspection & Verification



Fuse resistance measurement & record



PT2 Inspection & Verification



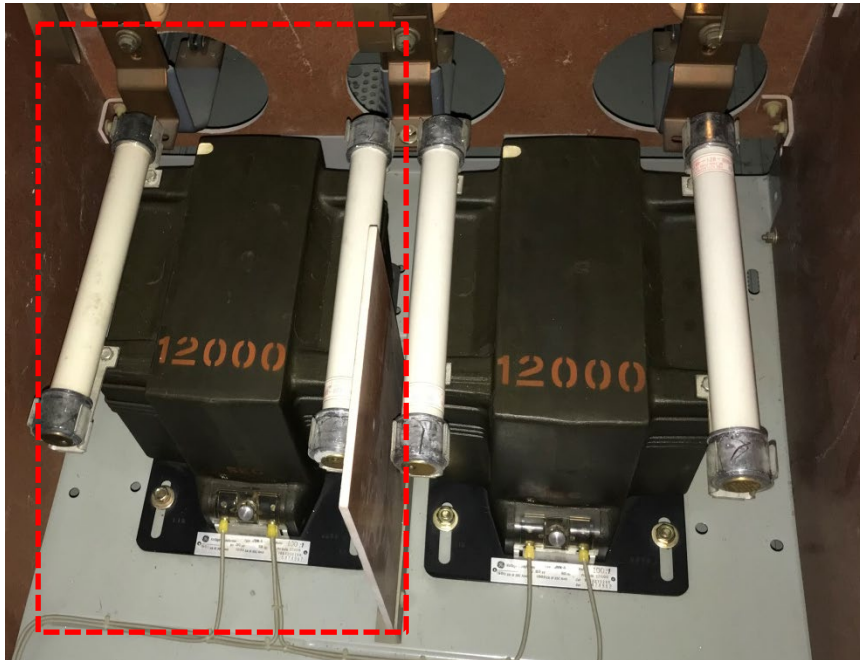
PT2 verification by electrical test

PT2 Specification

HV: 12000V

LV: 120V

Ratio: 100



Left Side PT2

ELECTRICAL TEST	RESULT	EVALUATION
DC Winding Resistance Test	HV: 893 Ω LV:151.5 m Ω	Passed
Ratio Test	99.756	Passed
Insulation Resistance (IR) Test	919 G Ω	Passed

PT2 Inspection & Verification



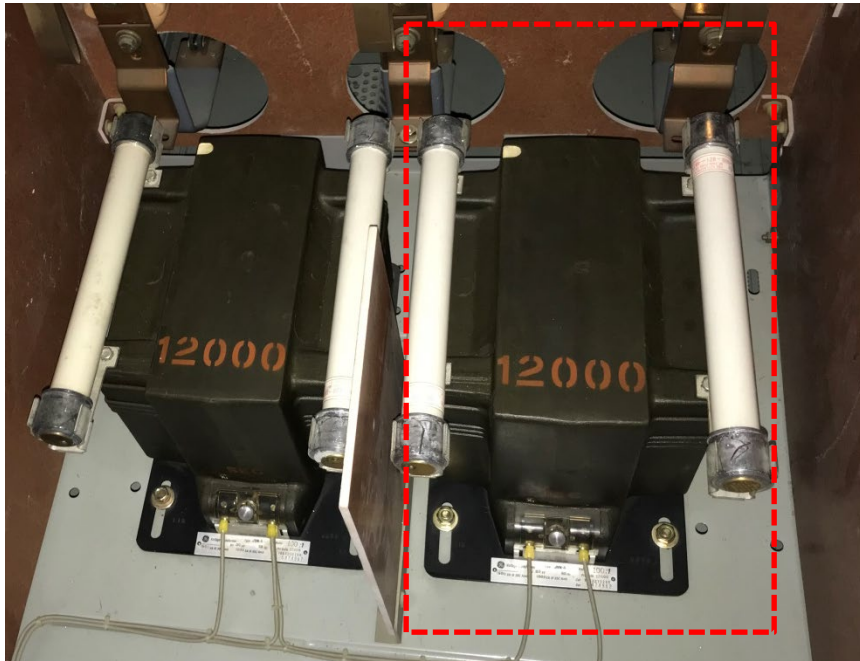
PT2 verification by electrical test

PT2 Specification

HV: 12000V

LV: 120V

Ratio: 100



Right Side PT2

ELECTRICAL TEST	RESULT	EVALUATION
DC Winding Resistance Test	HV: 895.5 Ω LV:151.89 m Ω	Passed
Ratio Test	99.734	Passed
Insulation Resistance (IR) Test	583 G Ω	Passed

Fuse resistance measurement & record



PT1 Inspection & Verification



As agreed with DES, PT1 also need to be verified by electrical test

PT1 Specification

HV: 12000V

LV: 120V

Ratio: 100



Left Side PT1

ELECTRICAL TEST	RESULT	EVALUATION
DC Winding Resistance Test	HV: 912.1 Ω LV:154.4 m Ω	Passed
Ratio Test	99.765	Passed
Insulation Resistance (IR) Test	171 G Ω	Passed

PT1 Inspection & Verification



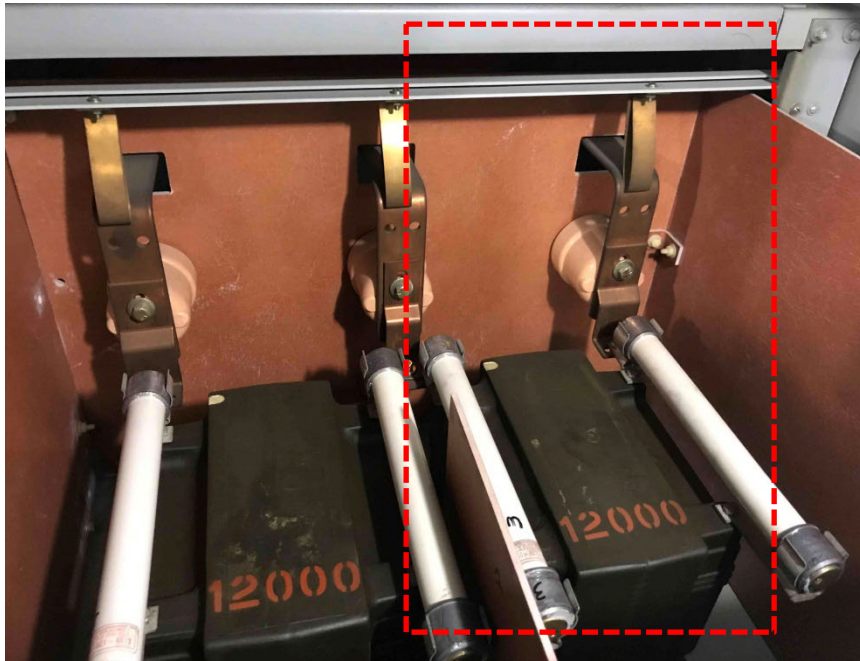
As agreed with DES, PT1 also need to be verified by electrical test

PT1 Specification

HV: 12000V

LV: 120V

Ratio: 100



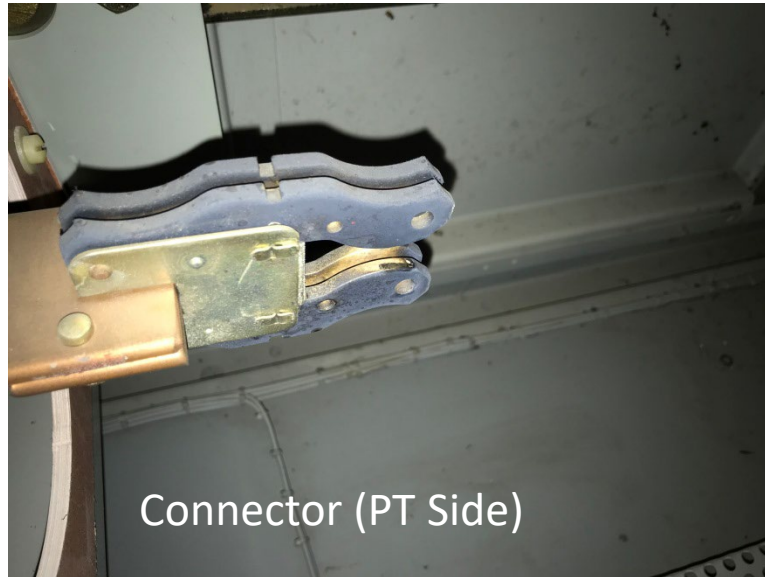
Right Side PT1

ELECTRICAL TEST	RESULT	EVALUATION
DC Winding Resistance Test	HV: 909.5 Ω LV:154.4 m Ω	Passed
Ratio Test	99.738	Passed
Insulation Resistance (IR) Test	1720 G Ω	Passed

PT2 & PT1 Visual Inspection & Cleaning



PT2



Connector (PT Side)



Connector (11kV Bus Side)

PT1



Connector (PT Side)



Connector (11kV Bus Side)

A large orange circle with a thin brown border, containing the text 'One PT2's Fuse Blow' in white.

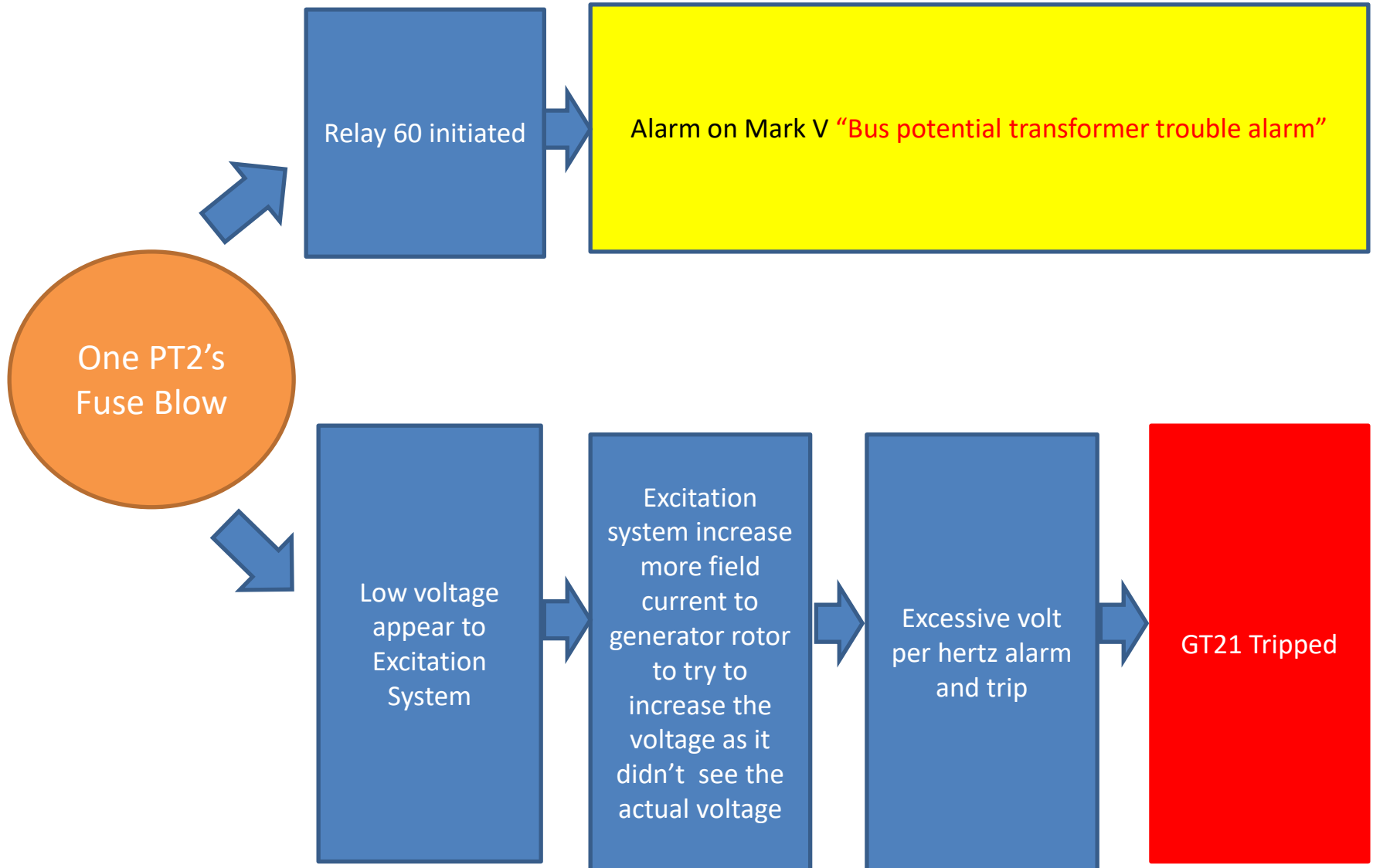
One PT2's
Fuse Blow

Possible Root Cause

- Defect of fuse itself
- Load of fuse shorted, in this case load of fuse is PT2 which we have verified that the PT2 still be Okay by electrical test

Therefore, we conclude that the root cause of the problem come from blow fuse.

Root Cause Analysis



From the investigation, we found abnormality only fuse blow of PT2 which is in the circuit that lead occurring of all the alarm and then cause GT21 tripped.

Two Fuses has been replaced (Blow one and the another one that has quite high resistance compare to the perfect good one).

The PT2 itself has been verified by electrical test. It is satisfy all the test results are in acceptance criterial.

Moreover, PT1 has also been verified by electrical test. It is satisfy all the test results are in acceptance criterial.

As we don't have trend of voltage of GT21 before unit tripped, therefore during the start up the generator voltage should be monitored and recorded.

- The fuse of PT1 and PT2 should be routine inspected, measured and recorded the resistance. We found 1 fuse of PT2 was high resistance (4.7 Ohms) compare to other 2 good fuses (3.8 Ohms) this can lead fuse to be hot then blow. Such fuse shall be replaced.



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Tel. 089-549-3277