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Modification of Electrical Supplay System on Fuel Feeder Gas Engine Power Plant Based on Inverter (DC-AC) in PLTMG Balai Pungut

Muhammad Fadlan Syahputra[1], Siti Anisah[2], Adi Sastra P Tarigan[3]
[1,2,3]*Program Study Electrical Engineering, Faculty of Science and Technology, Universitas Pembangunan Panca Budi, Indonesia*
Fadlan.syah22@gmail.com

Abstract: *The Balai Pungut Gas Engine Power Plant (PLTMG) is one of the plants in the Pekanbaru sector and part of the North Sumatra Plant (KITSBU). This PLTMG has a capacity of 7 x 17 MW with dual fuel systems, namely Solar and Gas. For gas fuel, it is the main fuel of PLTMG because the gas efficiency is higher than diesel. However, diesel fuel is the main fuel that must be used for PLTMG engines as gas fuel, so diesel fuel must be supplied continuously for the consumption of PLTMG needs. Therefore, the Fuel Feeder system for Solar fuel must have reliable performance. However, at PLTMG Balai Pungut, there are often problems or problems with the Fuel Feeder, this is because the protection system shows the occurrence of a Fuel Feeder travel system that occurs in fuel feeder equipment components that experience voltage input instability. After analysis due to the impact of resources in the SUTT System Network as a supply center line experienced Transient. Therefore, the Power Supplay Electrical System for Fuel Feeder equipment needs to be modified with the addition of an inverter, the source of which is taken from the battery as a source of constant direct voltage and voltage converted back and forth to play the electricity system of the Fuel Feeder PLTMG Balai Pungut.*
Keywords: *PLTMG; fuel feeder; SUTT; transient; inverter*

I. Introduction

The Pekanbaru Sector Collection Center Electricity Center in the Gas Engine Power Generation Unit (PLTMG) is a power plant whose fuel system uses two fuel sources, namely Solar (HSD) and Gas. For the supply of diesel fuel, it functions as an ignitor when PLTMG uses a gas fuel source and also starts the engine, therefore the supply of HSD fuel must always be continuous for the consumption of this Power Plant. In other words, the supply and distribution of diesel fuel (HSD) is the main organ in the PLTMG Balai Pungut performance system. At the Gas Engine Power Plant (PLTMG) the Pekanbaru Sector Collector's Office often occurs disturbances that cause Black Out of the entire unit, this is because the diesel fuel supply system (HSD) for the PLTMG Engine Unit is not supplied continuously because the solenoid valve and the Fuel Feeder pump have tripped/stopped as a whole, which forces the protection system in the PLTMG to make an Engine Stop. In the Fuel Feeder system, the main stop or trip was because the electrical power supply for the solenoid valve and Fuel Feeder pump was unstable and a trip occurred, where power plants generally have a location far from the load center, the electrical energy generated from the power plant is distributed through the transmission network then to the substation and distribute it to the customer's load. In this distribution process there are various disturbances that can cause the distribution to be interrupted or obstructed. The point is that with the emergence of these disturbances, it can disrupt the network system which results in improper voltage and current of the electrical network. This is not far away because there are frequent disturbances in the unstable electrical power supply system due to the power network experiencing a Transient. The Electrical Network that experienced a Transient turned out to be the influence of the High Voltage Air Duct System Network (SUTT) in the Transmission section experiencing instability, this was

caused by the factors that caused it, including the following:

1. Internal problems of PLTMG Balai Pungut, there was a disturbance of one or several machine units that disrupted the SUTT Network System.
2. Natural disturbance factors, such as: lightning surge, short circuit conductor of the electricity network due to fallen trees or broken conductors
3. External Generating Factors that suddenly loose on the network or experience Black Out.
4. Load factor that rises suddenly (Surja Hubung).

The above factors cause transient or unstable electricity supply energy, which has an impact on the entire electrical energy network system.

Destination

The aims of this journal are as follows:

1. Learn about PLTMG Balai Pungut especially the Solar fuel system (HSD).
2. Knowing the cause of the Black Out disturbance of the entire PLTMG Balai Pungut Unit.
3. Knowing the cause of problems in the Fuel Feeder.
4. Make recommendations for modifying the power supply of the electrical system on the Fuel Feeder with the Inverter.

II. Research Methods

In the power generation system of PLTMG Balai Pungut Sector Pekanbaru often a very fatal disturbance occurs, namely the Black Out Engine system disturbance, this causes the power plant engine to stop as a whole. And the cause is allegedly from the frequent fuel supply systems (fuel feeder pumps and solenoid valves) that trip or stop suddenly when the electrical power is interrupted due to a transient in the network system, which is because the supply is obtained from the electrical system directly. Therefore, to find out what problems actually occur in the fuel supply at the Fuel Feeder Pump, several steps are taken, namely:

1. Identify the problem by seeking information through mentors and daily operators what the real cause of the Fuel Feeder Pump disturbance is to make the entire system Black Out.
2. Collecting data and documentation needed to assist field investigations such as data on disturbances that occur from year to year.
3. Formulate the origin of the disturbance through the Root Cause Failure Analysis (RCFA) chart
4. Draw conclusions about what problems must be solved and overcome with a Root Cause Problem Solving (RCPS) chart
5. Provide the right solution by prioritizing the state of the unit to deal with disturbances by taking into account the profit-taking impact of the solution.

The following table shows the Black Out PLTMG Balai Pungut disturbance caused by the Fuel Feeder Pump problem.

Table 1. Trip Recapitulation of PLTMG Center for Picking Up Fuel Feeder Disturbances Year January 2016 to January 2017 (Disruption data obtained from the Office of the Pungut Electricity Center's Op-Har Division)

WAKTU KEJADIAN	PEMBANGKIT TRIP	INDIKASI	SEBAB GANGGUAN	WAKTU PEMULIHAN
Rabu, 13 Januari 2016 / 23:26	PLTMG Balai Pungut #3, #5, #6	OVR Fuel Feeder Pump	Gangguan penghantar Garuda sakti - Koto panjang	Kamis, 14 Januari 2016 / 00:45
Rabu, 27 Januari 2016 / 08:20	PLTMG Balai Pungut #1, #2, #3, #5, #6	OVR Fuel Feeder Pump	Mv Busbar Trafo 2 Overvoltage (17 Kv)	Rabu 27 Januari 2016 / 09:29
Jumat 29 Januari 2016 / 18:01	PLTMG Balai Pungut #1, #2, #3, #4, #5, #6	OVR Fuel Feeder Pump	Gangguan CT Fasa S GI Teluk lembu	Jumat 29 Januari 2016 / 18:31
Selasa, 15 Maret 2016 / 16:19	PLTMG Balai Pungut #1, #2, #3, #4, #5, #6	UVR Fuel Feeder Pump	Gangguan penghantar Duri - Bagan batu (Undervoltage 13.2 Kv)	Selasa, 15 Maret 2016 / 16:32
Jumat, 13 Mei 2016 / 15:58	PLTMG Balai Pungut #1, #2, #3, #4, #5, #6	UVR Fuel Feeder Pump	Gangguan penghantar 2 Balai Pungut - Duri (Undervoltage 11,96 Kv)	Jumat, 13 Mei 2016 / 16:25
Selasa, 7 Juni 2016 / 20:49	PLTMG Balai Pungut #1, #2, #3, #4, #5	UVR Fuel Feeder Pump	Gangguan penghantar 2 Balai Pungut - Duri	Selasa, 7 Juni 2016 / 21:01
Minggu, 25 Juli 2016 / 19:47	PLTMG Balai Pungut #2, #4, #5, #6	UVR Fuel Feeder Pump	Over Voltage sistem 150 KV (18.56 KV)	Minggu, 25 Juli 2016 / 20:16
Senin, 1 Agustus 2016 / 20:40	PLTMG Balai Pungut #2, #3, #4, #5, #6	UVR Fuel Feeder Pump	Under Voltage sistem 150 KV (14.2 KV)	1 Agustus 20162016 / 21:13
Minggu,7 Agustus 2016 / 05:29	PLTMG Balai Pungut #2, #3, #4, #5, #6	UVR Fuel Feeder Pump	Gangguan Penghantar Balai Pungut - Duri	Minggu, 7 Agustus 2016 / 05:56
Senin, 15 Agustus 2016 / 01:35	PLTMG Balai Pungut #2, #3, #4, #5, #6	UVR Fuel Feeder Pump	Gangguan Undervoltage sistem 150 Kv	Senin, 15 Agustus 2016 / 02:58
Minggu,29 Oktober 2016 / 15:13	PLTMG Balai Pungut #1, #2, #4, #5, #6	UVR Fuel Feeder Pump	Gangguan Penghantar Balai Pungut - Duri	Minggu, 29 Oktober 2016 / 15:25
Senin, 7 November 2016 / 17:14	PLTMG Balai Pungut #1, #2, #4, #5, #6	UVR Fuel Feeder Pump	Gangguan Penghantar Garuda sakti - Balai pungut Auto reclose	Senin, 7 November 2016 / 17:30
Rabu, 16 November 2016 / 18:28	PLTMG Balai Pungut #1, #2, #4, #5, #7	UVR Fuel Feeder Pump	Gangguan Penghantar Garuda sakti - Balai pungut Auto reclose	Rabu, 16 November 2016 / 18:42
Jumat, 25 November 2016 / 16:18	PLTMG Balai Pungut #1, #2, #4, #5, #7	UVR Fuel Feeder Pump	Gangguan Penghantar Duri - Balai pungut Auto reclose	Jumat, 25 November 2016 / 16:38
Rabu, 30 November 2016 / 18:25	PLTMG Balai Pungut #4, #5, #6, #7	UVR Fuel Feeder Pump	Gangguan Penghantar Aur duri - Muaro bungo (Over voltage)	Rabu, 30 November 2016 / 19:35
Kamis, 29 Desember 2016 / 06:05	PLTMG Balai Pungut #1, #2, #4, #5, #7	UVR Fuel Feeder Pump	Gangguan Penghantar Duri - Bagan batu	Kamis, 29 Desember 2016 / 06:24
Sabtu, 28 January 2017 / 13:44	PLTMG Balai Pungut #1, #2, #4, #5, #6, #7	UVR Fuel Feeder Pump	Gangguan Penghantar 150 Kv	Sabtu, 28 January 2017 / 14:00

From the data on the disturbance of the PLTMG PLTMG Fuel Feeder system problem above, it can be seen that it has a very large and very detrimental impact, more than 15 times the Black Out of PLTMG for 1 year. Therefore, special attention should be paid to this situation.

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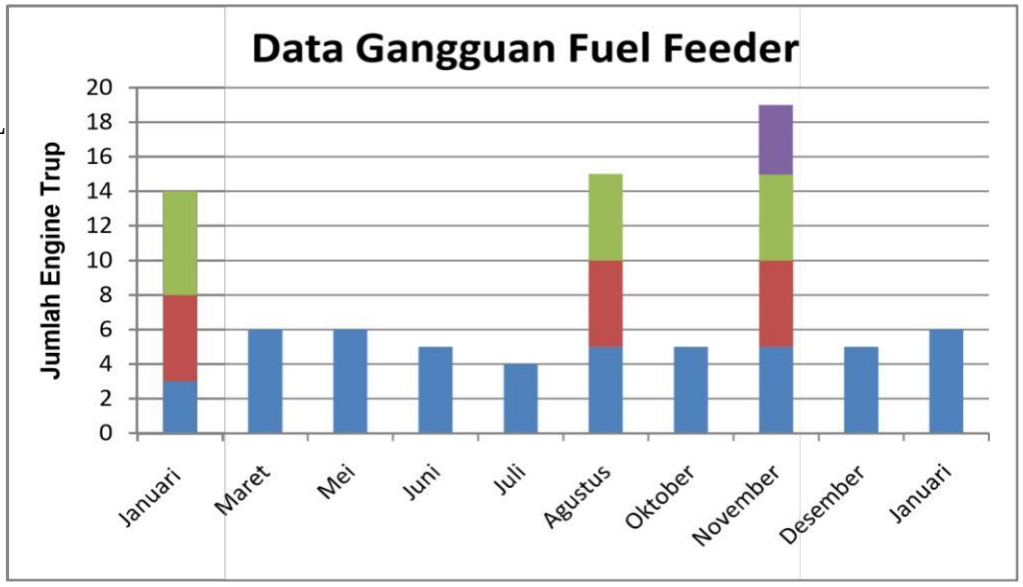

Figure 1. *Block Diagram of Trip Engine Recapitulation Impact of Fuel Feeder Disturbance January 2016 – January 2017*

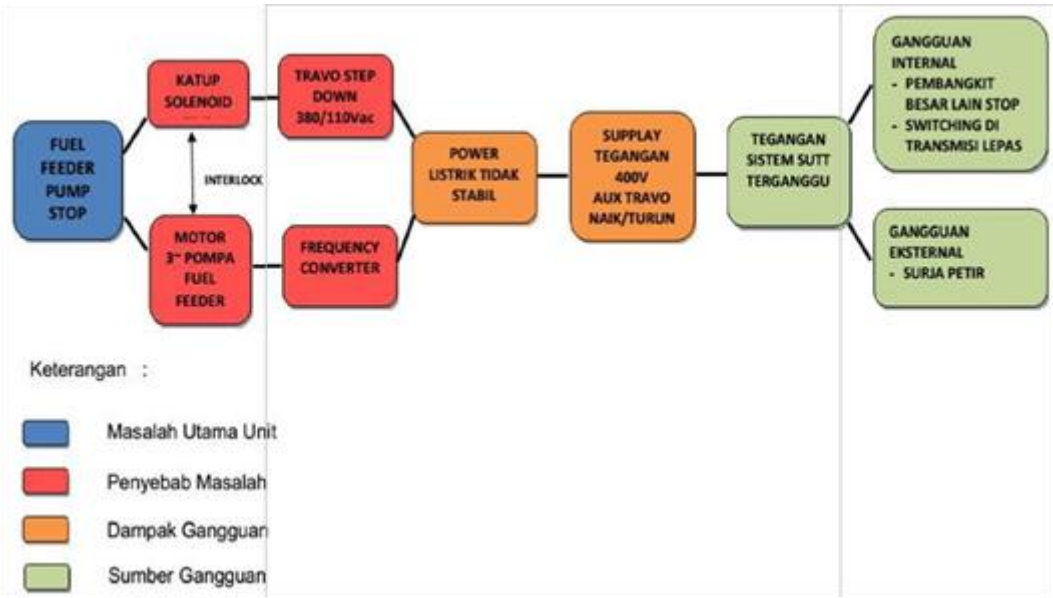

Figure 2. *RCFA Chart of Fuel Feeder Pump Trip Problem*

From the RCFA chart image that has been carried out on the analysis of existing problems in PLTMG, the following results are obtained:

1. The main disturbance that causes the Black Out System of Balai Pungut PLTMG is the Fuel Feeder Pump which has stopped. This is due to the Solenoid Valve and 3-Phase Motor for Trip Pumps.
2. Solenoid Valve and 3 Phase Motor The pump works interlockingly so that if one stops, both will stop as well.
3. Disruption of the electrical power supply from the Aux Self Use Transformer (PS) which causes the Solenoid Valve and 3 Phase Motor to Trip. Moreover, there is a Frequency Converter component to protect the performance of 3 Phase Motors.
4. Self-Use Aux Transformer gets input from the Medium Voltage Air Line Network (SUTT) directly, so that if the network is unstable, the Aux Transformer Output is also unstable.
5. An unstable or transient network system is due to several factors, namely internal disturbances and external disturbances. The most common is because the geographical conditions of the Sumatra Region, especially the Pekanbaru Sector are oil palm forests, so lightning surge disturbances often occur which affect the SUTT system network to

2.1 Formulation of the Problem

In this case, to increase the reliability of the PLTMG Balai Pungut performance and prevent the occurrence of continuous Black Out system disturbances due to fuel supply (HSD) problems, it is necessary to make RCPS (Root Cause Problem Solving).

The following shows the Root Cause Problem Solving for the problems that occur in the Fuel Feeder PLTMG Pekanbaru Sector Collection Center.

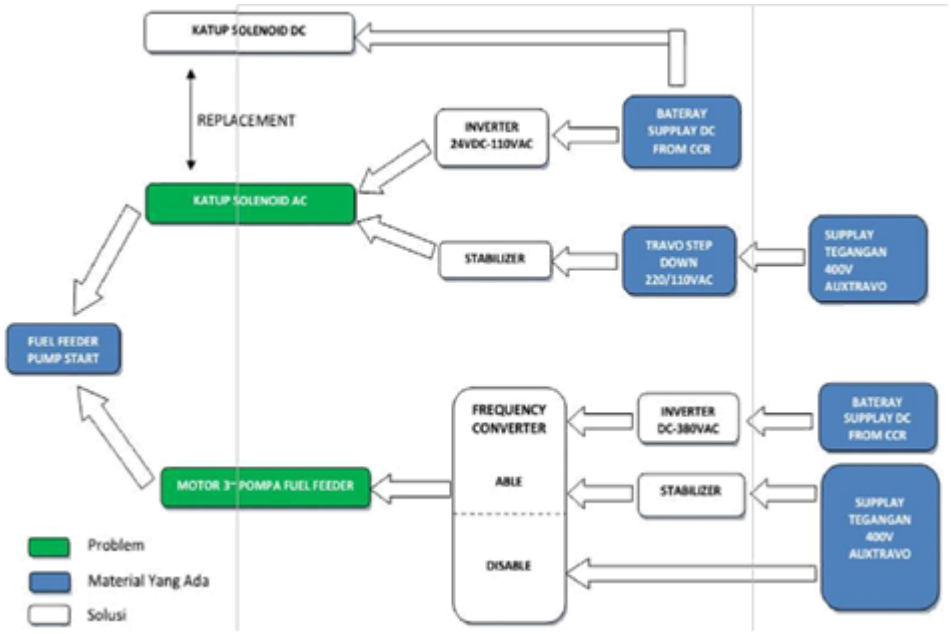

Figure 3. *Root Cause Problem Solving*

From the RCPS factors that have been carried out on the Fuel Feeder Problem Solving/Solution at the Balai Pungut PLTMG, the results show that the cause of the Fuel Feeder Trip is due to 2 main components that are interrelated with each other, namely Selenoid Valve and Frequency Converter. Therefore, it is strived that the two materials always work well and reliably, for that it can be solved in several alternative ways as follows:

2.2 Maintaining Solenoid Valve Performance

- Adding Inverter material (Converter direct current (DC) to alternating (AC) and the supply of electrical power is taken from the supply of direct current (DC) from the CCR (Center Control Room).
- Added Stabilizer material for Solenoid Valve supply.
- Replacing the solenoid valve from supply power alternating current (AC) to direct current (DC).

2.3 Maintaining 3-Phase Motor Performance for Fuel Feeder Pump

- Change the setting of the Frequency Converter as a 3-phase motor safety so that the OVR/UVR and OFR/UFR relay sensitivity ranges are disabled.
- Adding Stabilizer material to maintain the stability of the electric power of the 3-phase motor
- Adding an inverter so that the electricity supply is taken from a direct current source on the CCR.

From some of the problems above, the main problem is taken, namely the performance of the Fuel Feeder system as a supplier of HSD (diesel) fuel at PLTMG Balai Pungut Pekanbaru Sector is less reliable because the main material in the Fuel Feeder is directly supplied directly to the network system directly, where the state of the network in Sumatra, especially the KITSBU area, still often fluctuates electricity voltage because the stretch of the network is too far and there are still many forests that have the potential for external disturbances that affect it. Therefore, it is necessary to solve the solution of the problem by providing action initiatives on the internal scope of PLTMG Balai Pungut so that the condition of the unit continues to provide maximum and reliable electricity production. So, the author makes a priority scale in the form of a matrix to determine and choose it as a

solution that is considered appropriate and easy to implement and fits as expected. The following is the priority matrix of problem solving:

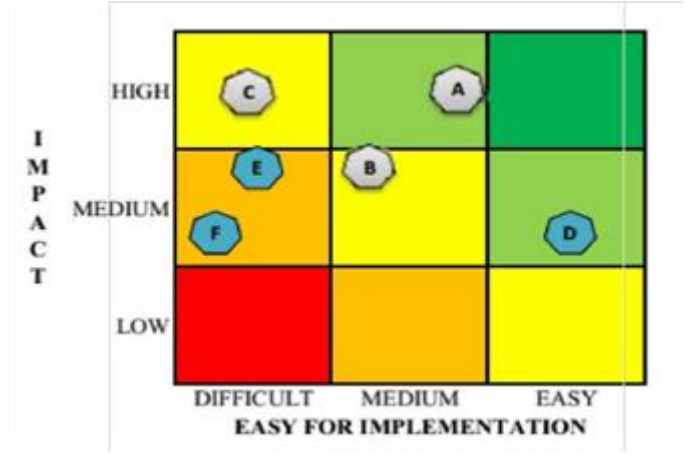

Figure 4. *Priority Matrix*

Table 2. Priority Matrix

PERMASALAHAN	LANGKAH	INISIATIF PILIHAN SOLUSI
KATUP SOLENOID TRIP	A	Menambah material Inverter
	B	Menambah material Stabilizer
	C	Mengganti Katub Solenoid
MOTOR 3Ø PUMP TRIP	D	Merubah setting-an ulang Frequency Converter
	E	Menambah material Stabilizer
	F	Menambahkan Inverter

Based on the problem matrix above, the solution that the author has initiated for the existing problems is to modify the power supply of the Solenoid Valve by adding an Inverter material whose input source is taken in the CCR room with direct current (DC) power supply, so that its performance will not be disrupted due to transient voltage. arising in the SUTT network system directly. And to avoid tripping disturbances in the pump motor supply, it is necessary to reset the Frequency Converter component so that the voltage and frequency range limits on the protection relay are widened so that they are not too sensitive due to the transient electrical network system.

III. Discussion

3.1 Action Plan

From the results of the problem solving in the RCPS block diagram, there is a choice of solutions to overcome the problems that occur. By analyzing more deeply the several solutions above, the appropriate priority scale of action is selected using the priority matrix method to consider what solutions are suitable for solving these steps.

There are reasons that led to the choice of this solution, namely in terms of the reliability of the working system and the efficiency of material procurement to prevent these disturbances and support the performance of the Balai Pungut PLTMG.

The main solutions are as follows:

- Changed the power supply of the electrical system on the solenoid valve as a control valve for the HSD fuel input system to the fuel feeder system.
  This is done by changing the electrical input from alternating current (AC) to direct electricity (DC), this is intended so that the performance of the solenoid valve can always be maintained as desired.
- And also resetting the Frequency Converter as a controller and safety 3 Phase motor for the Fuel Feeder Pump.

And if the main solution is to solve the problem, then a backup solution is used to provide more reliability so that problems with the Fuel Feeder problem are resolved properly, backup solutions include:

- Adding a Stabilizer to the input of a 3-phase electric power supply that will enter the Fuel Feeder panel from the Aux Transformer output for its own use.

3.2 Modification Tool Design (Design)

In the following, the author makes a simulation image of the field conditions according to the current state (before modification) and after being modified by using an inverter with a constant direct voltage source (DC) as a power supply for the solenoid valve which is used to solve the problem of disturbances that occur in the PLTMG Fuel Feeder. Collecting Hall.

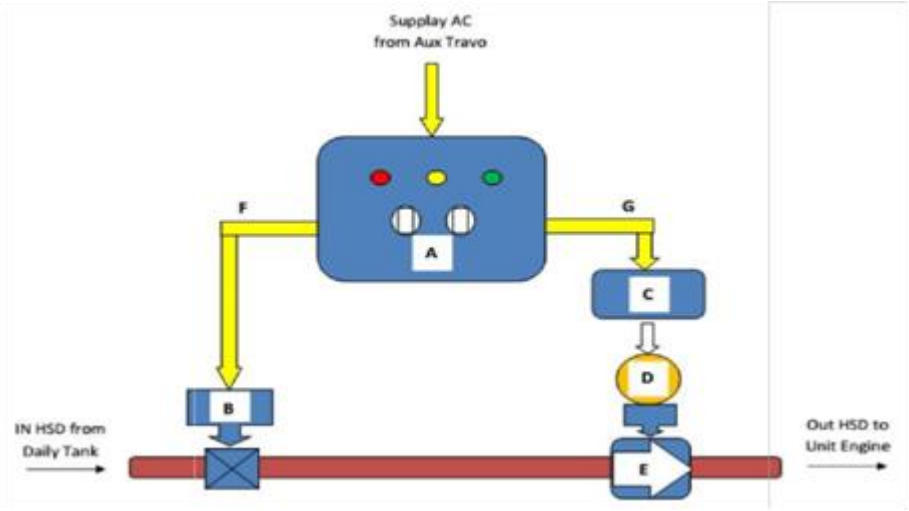

Figure 5. *Initial Condition Fuel Feeder Circuit (Before Modification)*

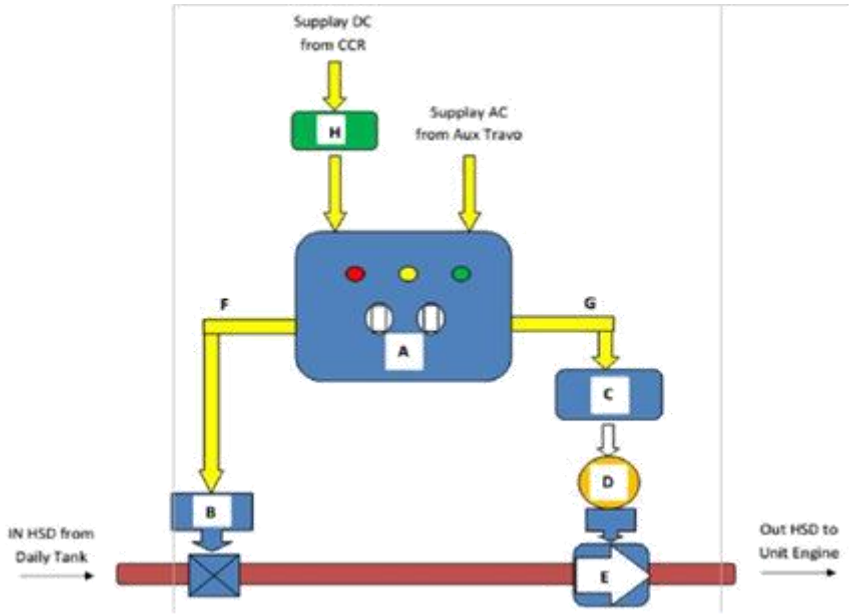

Figure 6. *Series of Fuel Feeder Components After Modification*

As for the description of the picture and explanation as follows:

3.3 Fuel Feeder Control Panel

It is the basic component of the brain controlling and monitoring the Fuel Feeder system. On the control panel, there is an important component, namely the Step-Down Transformer to reduce the input voltage from the Aux Transformer. Self-use as the need for electrical power for the solenoid valve and also other indicators on the panel. Step Down transformer has specifications as a voltage reducer from 380 VAC to 110 VAC (380/110 VAC).

Figure 7. *Fuel Feeder Control Panel*

Figure 8. *Step Down Transformer in the Control Panel*

3.4 Solenoid Valve

It is a valve or gate to open the flow of diesel fuel as a fuel supply from the Daily Tank to the Engine Unit. This valve is controlled by the solenoid as a controller for opening or closing, so this valve uses electric power to activate the solenoid as a control controller. Solenoid Valve has a specification of 110VAC as a control controller

Figure 9. *Photo of the Solenoid Valve in the Fuel Feeder of PLTMG Balai Pick Up*

3.5 Frequency Converter

Is a component that is used to regulate the speed of the motor with frequency control which is used to supply a 3-phase motor to the Fuel Feeder pump drive. In the Frequency converter there is a protection relay that is used as a motor safety, if there is Over or Under the supply Voltage or Frequency then the Frequency Converter works to secure the motor with a stop command.

Figure 10. *Photo of Frequency Converter in Fuel Feeder PLTMG*

3.6 3 Phase Motor

It is a pump drive component with a single shaft system for the Fuel Feeder pump. This motor has a power of up to 18.5 KW. The following are photos and specifications on the motorcycle nameplate.

Figure 11. *Photo of Pump Motor on Fuel Feeder*

3.7 Fuel Feeder Pump

Is the main component in the Fuel Feeder, where the pump can increase pressure so that it can distribute HSD (diesel) fuel to enter the Engine Unit which is located quite far apart. Pressure Fuel Feeder pumps range up to 4.0 Bar. This pump is also often damaged when a problem occurs in the Fuel Feeder, which is when the valve has closed the fuel flow, and the pump is still rotating with residual rotation and there is no fluid flow, then the pump impeller wears out friction until the pump material be damaged. Here's a photo of the Fuel Feeder pump and its materials.

Figure 12. *Photo of Fuel Feeder Pump*

3.8 Electrical Installation 110 VAC

Is the output cable from the Step-Down Transformer contained in the Control Panel that goes to the Solenoid Valve as input for its power supply.

3.9 3 Phase / 400VAC Electrical Installation

Is a connecting cable from the Control Panel to the Supplay Power Frequency Converter and forwarded to the 3 Phase Motor component.

3.10 Inverter

Is an additional component as a problem-solving solution on the Fuel Feeder, whose function is to convert direct current (DC) to alternating current (AC). This inverter input uses a DC battery source from the Central Control Room (CCR) which is converted into alternating current to supply the power voltage to the Solenoid Valve.

Figure 13. *Inverter Material*

So to determine how big the Inverter material capacity is for the need for 4 Solenoids, you must add up the 4 Solenoid loads to find out how much total capacity the Inverter can accommodate.

Solenoid Capacity

- 1 pc Solenoid 110VAC/50 Hz 0.6 A

P = V. A

= 110x 0.6

= 66 VA

- 4 Solenoids

= 4 x 66

= 264 VA

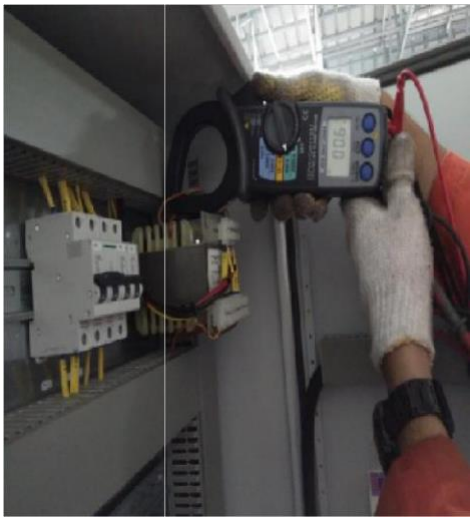

Figure 14. *Photo of Solenoid*

3.11 Single Diagram of Modification Tool Installation

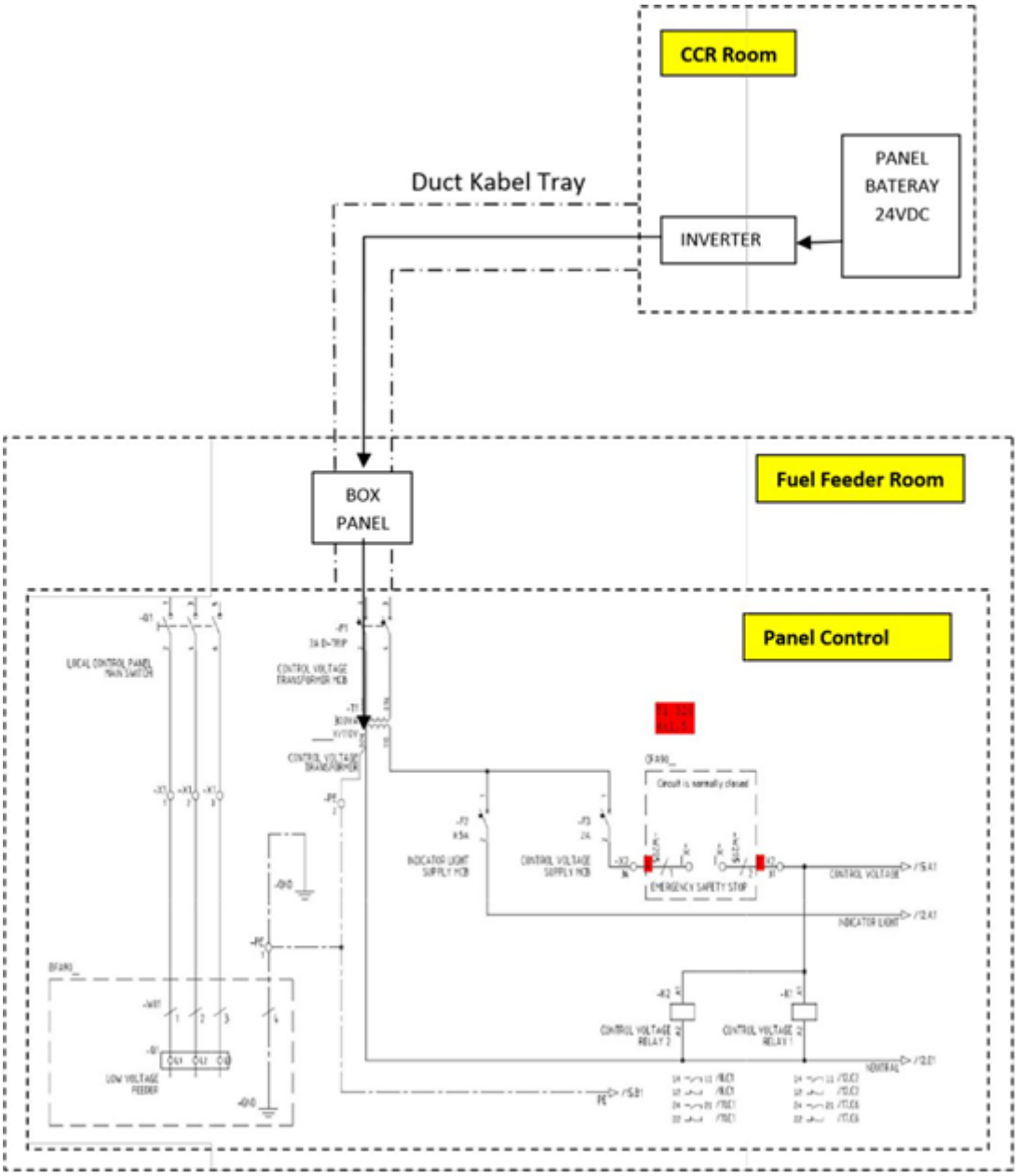

Figure 15. Single Diagram of Modification Tool Installation

IV. Conclusion

From the overall results of the analysis and design of the tool as a modification of Electric Power on the Fuel Feeder to prevent interference with the Black Out system of the PLTMG Balai Pungut Unit, the following conclusions can be drawn:

1. The Transient Voltage on the High Voltage Air Line Electrical System Network (SUTT) causes the impact of the PLTMG Balai Pungut Fuel Feeder system to be disrupted, because the Fuel Feeder system equipment uses alternating voltage (AC) from the direct network system.
2. Disturbances or problems caused by the Fuel Feeder result in a Black Out system of the entire PLTMG Balai Pungut Unit. So the loss of PT. PLN (Persero) can be interpreted up to billions of rupiah for a year because of the large number of KWH produced by PLTMG Balai Pungut when experiencing a Black Out system.

3. The inverter is the right solution as an additional tool to overcome interference or problems with the PLTMG Balai Pungut Fuel Feeder, namely changing the electrical power source of the equipment on the Fuel Feeder from alternating voltage (AC) to direct voltage (DC).
4. The source of the battery as input power on the inverter is obtained from the battery in the Central Control Room (CCR), because the CCR has an empty spare space.
5. To add a modification tool requires a fairly small fee in the range of only millions of rupiah, compared to the loss of PT. PLN (Persero) which loses KWH which cannot be channeled when converted to billions of rupiah.

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