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WORKING PRINCIPLES OF CONSTANT CURRENT REGULATOR (CCR) AS CHARGE WITH CONSTANT FLOW AT THE AIRPORT INTERNATIONAL JENDRAL AHMAD YANI SEMARANG

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ABSTRACT

The Airfield Lightning System (ALS) is an important part of this airport operations. Without the help of these lights, landings and flight departures can be very dangerous. It can be said to be Airfield Lightning System (ALS) is the key in handling the safety of the operating authority aviation services. The Airfield Lightning System (ALS) really requires intensity fixed and unchanging light so that the pilot can see the lights that clearly. Given a very vital function in aviation services required a power supply that supports the operation of the Airfield Lightning System (ALS). The required power supply system must of course meet Airfield's criteria Lightning System (ALS). Because a constant current is needed, then di use the Constant Current Regulator (CCR). The supporting components are also involved designed so that Runaway Lightning operations can take place continuously maximum, and can support flight safety.

ABSTRAK

Airfield Lightning System (ALS) adalah bagian yang penting dalam operasional Bandar Udara. Tanpa bantuan lampu-lampu tersebut, pendaratan dan keberangkatan pesawat bisa sangat berbahaya. Dapat dikatakan Airfield Lightning System (ALS) merupakan kunci dalam penanganan keselamatan otoritas operasi jasa penerbangan. Airfield Lightning System (ALS) sangat membutuhkan intensitas cahaya yang tetap dan tidak berubah agar pilot pesawat dapat melihat lampu-lampu tersebut secara jelas. Mengingat fungsi yang sangat vital di jasa penerbangan maka diperlukan catu daya yang menunjang operasional Airfield Lightning System (ALS). Sistem catu daya yang dibutuhkan tentu harus dengan sesuai kriteria Airfield Lightning System (ALS). Karena di butuhkan arus yang konstan maka di gunakanlah Constant Current Regulator (CCR). Komponen pendukung juga turut dirancang agar operasional Runaway Lightning dapat berlangsung secara maksimal, dan dapat menunjang keselamatan penerbangan

Keywords: *Airfield Lightning System (ALS), safety, Constant Current Regulator (CCR), Runaway Lightning and Power supply*

I. Introduction

Jendral Ahmad Yani International Airport is one of the airports air that is managed by PT. Angkasa Pura 1 (Persero) which is also State-owned enterprises (BUMN) which are specifically engaged in services air Transport [1]. The name of this airport is taken from one of the heroes' names the Indonesian revolution namely Ahmad Yani. The airport is located in the City Semarang, which is 5 km from the center of Semarang City. Airport International Jendral Ahmad Yani is at the coordinate point 06˚58'35'LS - 110˚22'38'BT [2].

The main power supply for Jendral Ahmad Yani International Airport Semarang is supplied by the State Electricity Company (PLN) with the system medium voltage distribution network 20 KV 50 Hz cable N2XSEBY 3 x 25 mm2 and is equipped with a Load Break Switch (LBS). For the power supply used in airports using low voltage 220/380 V 50 Hz [3].

20 KV input from the State Electricity Company (PLN) which comes from 2 feeder goes to Incoming cubicle Angkasa Pura I. From cubicle Angkasa Pura there is Outgoing. There are also 4 generators with a 2000 KVA capacity fruit as a backup power supply when the power from PLN experiences a disturbance, so that airport operations are not disrupted [3].

From the outgoing goes to the step down transformer to lower it voltage, one of the transformers namely 2500 KVA transformer is used for load. Furthermore, the reduced voltage is distributed through the panels. This reduced voltage can then be obtained used for all existing facilities at the airport. Where is the airport has very many facilities so that the power capacity must also be sufficient for the burden at the airport. Among the many burdens that are on Jendral Ahmad Yani International Airport includes electronic devices, 2 Computers, Terminal Lights to offices, Chiller, Street Lighting General (PJU), flood pumps, escalators, lifts to the Airfield Lightning System (ALS).

This panel supplies loads that are essential / important from airport work system. Where is the meaning of importance, namely the burden must always be operates in all circumstances without stopping and takes precedence over other expenses besides essential expenses. At Jendral Ahmad Airport Yani Semarang, the essential panels are distributed / distributed for the load, namely Airfield Lightning System (ALS), Tower or Air Traffic Control tower (ATC), Doppler Very High Frequency Omni Range (DVOR), and Non Directional Radio Becon (NDB).

Airfield Lightning System (ALS) has an important role in airport aviation service safety. Where is the Airfield Lightning System (ALS) is a vital tool in aircraft landing and repair so that it needs to be kept constant in the intensity of the light produce

II. Research methodology

In determining the need for electrical power as well as electrical installations for airports, it is adjusted to existing building facilities so that in calculating electrical power requirements and planning installations and operating facilities and equipment, they can operate properly adjusted to developments on the land side and the air side during operating hours. which is set at the airport. In anticipating future developments, it is necessary to prepare the development of existing facilities including electrical facilities, both capacity, quality and reliability so that activities on the land and air sides can support each other in serving the flow of passenger and goods traffic using air transportation services. Apart from electrical facilities as support at the airport, it must meet general requirements, including:

1. Capacity of electric power can meet the nominal needs at the airport
2. Have high reliability and integrity in providing continuous services;
3. Safety for humans and the environment.

In addition to the conditions above, the electric power facility in its implementation must meet the following conditions and standards:

1. Standards from ICAO (International Civil Aviation Organization) Annex 14
2. PUIL Standards (General Rules for Electrical Installations)
3. Standards from SPLN / LMK (Institute for Electrical Problems) 4) Standards IES (Illuminating Engineering Society)(PT Angkasa Pura II 2017).

PLN electricity is planned as the main source of electricity and generator as a backup power source if PLN experiences a disruption. Turning on the generator backup power source is done automatically after the PLN power source does not work. The following is a wiring diagram that is installed and becomes the electrical system of Jendral Ahmad Yani International Airport Semarang in general:

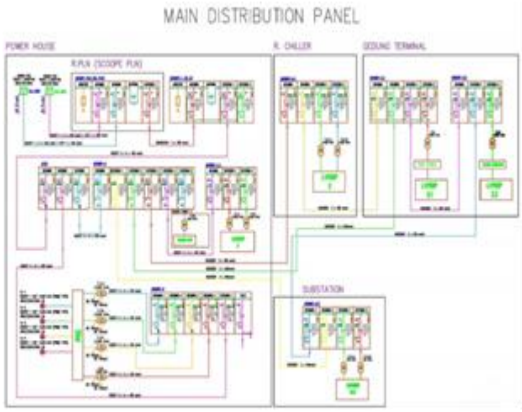

Figure 1. Distribution wiring at Jendral Ahmad Yani International Airport

2.1 *Main Power House*

The Main Power House (MPH) is a place where airport electricity is centered and is a place for airport electrical equipment which is part of the support at the airport. All airport electricity needs are located here, from distribution from PLN to distribution according to load requirements, from terminals, flight lights, to Tower Air Traffic Control (ATC). In the Main Power House (MPH) there are electrical equipment including:

1. Generator Set
2. Uninterruptible Power Supply (UPS)
3. Transformator Step-Up dan Step-Down
4. Medium Voltage Distribution Panel (MVDP)
5. Low Voltage Distribution Panel (LVDP)
6. Contant Current Regulator (CCR)
7. Genset Control Panel (GCP)
8. Supervisory Control and Data Acquisition (SCADA)

2.2 *Load Sharing*

Distribution at Jendral Ahmad Yani International Airport Semarang uses medium voltage (MV) and low voltage (LV). This is done because the distance is quite far and to avoid a voltage drop. The way the power system comes from the State Electricity Company (PLN), namely the incoming load from PLN through two feeders, with a voltage of 20 KV entering through Incoming cubicle and Outgoing cubicle going to Incoming ACTS panel (there are two Incoming ACTS, one from cubicle and the other from the generator panel) Outgoing ACTS goes to Incoming MVMDP 2/1. From this panel divides the load into:

1. Outgoing 2/2 Cubicle Panel goes to Incoming substation building or SS3. In SS3 there are 2 step-down transformers each 315 KVA with an autocoupler system where if one of them occurs interference then the other transformer will work. In the transformer there is a voltage drop (Step Down). Next go to the LVMDP 3.3 panel.
2. Outgoing 2/3 Cubicle Panel from the Main Power House (MPH) to the Incoming Panel of the terminal building or D0. There are 2 step-down transformers, each 3000 KVA with an autocoupler system where if one of them occurs a disturbance the other transformer will work. In the transformer there is a voltage drop (Step Down). Next go to the divider panel and from the divider panel it will be divided again into the LVMDP 3.1 and LVMDP 3.2 panels.
3. Outgoing 2/4 Cubicle Panel from the Main Power House (MPH) goes to the Incoming Chiller panel. There are 2 step-down transformers, each 2500 KVA with an autocoupler system where if one of them occurs a disturbance the other transformer will work. In the transformer there is a voltage drop (Step Down). Next go to the LVMDP 2 panel.
4. The Outgoing 2/5 Cubicle Panel from MPH goes to the Incoming panel of the Main Power House (MPH). There are 2 step-down transformers, each 2500 KVA with an autocoupler system where if one of them occurs a disturbance the other transformer will work. In the transformer there is a voltage drop (Step Down). Next go to the LVMDP 1 panel.
5. Outgoing 2/6 Cubicle Panel leading to the CCR has a step down transformer with a capacity of 630 KVA. In the transformer there is a voltage drop (Step Down). Next go to the LVMDP-CCR panel.

The generator voltage goes to GCP (Genset Control Panel) with the generator output voltage of 220/380 (Low Voltage). The genset control panel is a generator voltage control panel that will be raised in the step-up transformer to medium voltage. After the voltage is increased in the step up transformer. After the voltage is increased, enter each of the Incoming genset panels. The generator voltage synchronous process occurs. The results of the sync will go to the Incoming ACTS panel. The Power House is the place for the main panels from the entire electricity distribution network at Semarang Ahmad Yani International Airport. Power House is located in the Airport Electrical Section office complex, next to the generator room.

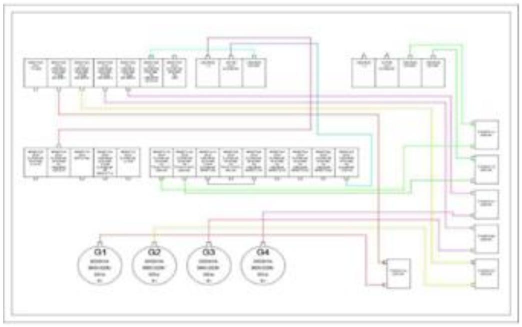

Figure 2. Panel layout plan in Power House

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Airfield Lightning System (ALS) has an important role in airport aviation service safety. Where is the Airfield Lightning System (ALS) is a vital tool in aircraft landing and repair so that it needs to be kept constant in the intensity of the light produced.

III. Research results and discussions

Constant Current Regulator (CCR) is a constant current regulatoras desired, usually used in equipment that regulates flow constant for signposts on visual equipment. There are several CCR operations including :

1. Moving Coil Constant Current Regulator (CCR) Moving Koil CCR is a variable reactance device which flows in the colonized secondary circuit is constant despite the load impedance may change continuously and the primary supply voltage varies within reachable limits. This equipment consists of a transformer which one coil can move with respect to which other and the position of the windings is very dependent on electromagnetism force between 2 turns of the Static Type CCR.
2. Static Type Constant Current Regulator **i**s a device with a static type CCR resonance process using a combination of inductive and capacitive reactance for transferring energy from fixed potential to constant current. Principles and means the work of the regulator and stator is widely used in the arrangement the intensity of the airport lighting level at the airport, especially at the airport in Indonesia.
3. Thyristor Type Constant Current Regulator The basic principle of setting up a transformer with a series thyristor is where electronic circuit on the monitor output and output compare the output current with the reference price and set the trigger thyristor in order to obtain an output current equal to the magnitude reference. The process of setting the CCR old series thyristor is widely used to supply fixed flow airport lighting system at the airport is wrong **one of them is** CCR type 6 SF-SIEMENS **and** CCR type TCR 5000 **–** ADD

3.1 Working Principle of Constant Current Regulator (CCR)

Constant Current Regulator (CCR) is a constant current power supply used to supply Airfield Lighting System (ALS) equipment (Wijaya 2019). At Jendral Ahmad Yani International Airport, the type of CCR used is coded MCR3 from ADB Airfield Solution. This type of CCR is specifically designed as the CCR used in Airfield Lighting Systems. This CCR will supply power to electrical equipment that has been connected in series with a brightness level that can be controlled up to 5 steps, controlling this using a microcontroller as the control system. CCR has a working principle that is almost the same as a transformer.

Broadly speaking, in the CCR there are two windings which are divided into primary winding and secondary winding. The primary winding is the winding that is connected to the incoming power on the CCR. This power will induce the transformer core so that it becomes an electromotive force. The EMF will then induce winding in the secondary. In the process of controlling transformer performance at CCR, electronic components that have been assembled in a module are used (Irawan 2017).

The CCR will receive control from the control tower via multiwire logic. Data received from the multiwire logic will be sent to the local master controller logic. The local master controller is a microcontroller that will receive control data and then forward it to the current control logic (Wijaya 2019).

CCR can be controlled via the control tower and can also be controlled directly on the CCR via the user interface. Based on orders from the local master controller, the thyristor block module will instruct the thyristor THP 1 to become an actuator. In terms of incoming power, power will enter through the input terminals, even though the incoming power should be of good quality because it has previously passed through the UPS, but the power will still pass through fuse as a protection medium. The power that enters the CCR will pass through the main contactor and part of it is used to supply the logic power supply.

The power supply logic is a microcontroller which functions to read the amount of voltage entering the CCR. Furthermore, the incoming voltage will be sent to the thyristor and then the thyristor will regulate the amount of power entering the transformer. The output of the transformer will be measured using the output measurement transformer and the data will be sent to the current control logic (Feedback). Then the power that is in accordance with the wishes will be sent to the series in the field.

Because CCR uses almost the same principles as the transformer, the equations that apply to transformers also apply to CCR. This equation is very helpful for a technician to help determine the proper CCR capacity to use. For example, there is a CCR with a capacity of 20 KVA which is intended to power the taxiway lights. If the lamp specifications used are

$$PLampu = 200\ Watt \quad (1)$$

$$Imax = 6{,}6\ A \quad (2)$$

Then,

$$Vlampu = 30{,}3\ V_{olt} \quad (3)$$

$$F = 50\ hz \quad (4)$$

Then the maximum number of lamps that the CCR can accommodate is known,

$$Pin\ CCR = 20.000\ VA\ (Primary) \quad (5)$$

$$Imax\ Lampu = 6{,}6\ A_{mpere} \quad (6)$$

Transformer equation,

$$\text{Vp x Ip} = \text{Vsx} \quad (7)$$

Because the efficiency of CCR reaches 95%, and Is must be <6,6 A then,

$$20{,}000\ x\ 0{,}95 = Pout \quad (8)$$

$$Pout = 19.000\ VA \quad (9)$$

$$Vout = 19.000\ VA : 6{,}6\ A = 2.878{,}78\ V \quad (10)$$

Based on the calculations that have been done, to keep the output current constant at 6,6 A, with the input power of 20.000 VA, the output voltage is 2.878,78V. To keep the current in the circuit, the series used is a series circuit. In accordance with the principle of the circuit which is a voltage divider, the amount of output voltage obtained is the sum.

of each voltage that is in each lamp used. In accordance with the following equation

$$Vout = V1 + V2 + \ldots. + Vn \quad (11)$$

By using step (6.6A), each taxiway lamp with 200VA power will have voltage is 30.3V, then the maximum number of lights connected to the CCR is

$$n = Vout\ V1 \quad (12)$$

$$n = 2.878{,}78V\ 30.3V \quad (13)$$

$$n = 95 \quad (14)$$

Which,
P = Power
I = Current
V = Voltage
F = Frequency
VA= Volt Amperes
n = Each

So that you get the number of lights that can be connected to the 20KVA CCR with step 5, which is 95 lamps. However, it is not recommended to use the full capacity of the CCR, because it will shorten the life of the tool. The reason for using step 5 of the calculation is because step 5 is the maximum condition of the tool. For the use of the steps below, of course, it will be safe because it will use a lower capacity than the CCR capacity.

3.2 How the Constant Current Regulator (CCR) Works

Constant Current Regulator (CCR) is a constant current power supply used to supply Airfield Lightning System (ALS) equipment. CCR is an equipment that produces constant current output with different current steps according to the needs of the user. Constant The voltage obtained by the Constant Current Regulator (CCR) is taken from the power supply of Ahmad Yani International Airport in Semarang with a 2500 KVA main transformer and can be backed up with a 2000 KVA generator set, then the source voltage is distributed to the Constant Current Regulator (CCR) room with voltage low 380 V. The input voltage is then processed to obtain a constant current as the supply of the runway lights. This current is obtained from a parallel series circuit between the capacitor and the coil.

The Low Voltage Input is then increased by the Constant Current Regulator (CCR) engine to 3.7 KV. The Medium Voltage is then distributed to the lamp circuit through series transformations. In distributing the runaway lamp voltage from the Current Regulator (CCR) room to the runaway lightning, a medium voltage is needed to avoid voltage drop due to voltage losses. The voltage loss occurs due to the impedance of the conducting cable. In addition, a series transformer is also used, the use of this scries transformer to reduce the medium voltage generated from the Current Regulator (CCR) output to a low voltage.

In the installation of runway lighting it is divided into two circuits.Each circuit provides electrical power to the runway lights through isolating transformers in alternating series by paying attention to the distribution of the load to be the same and arranged so that each pair of opposite runway lights is connected to the same circuit, so that if one circuit is off, then the distance between the lights on will be the same.

In addition to the Constant Current Regulator (CCR), there are also other similar instruments, namely the Microprocessor Controlled Constant Current Regulator (MCR III), a function of the Microprocessor Controlled Constant Current Regulator (MCR III).) This is the use of the microprocessor and thyristor as the main controller. The use of the microprocessor as the main controlling device in the electronic circuit Microprocesor Controlled Constant Current Regulator (MCR III), while the thyristor is used to generate a fixed current and adjust the current value so that the current output is always constant. Microprocesor Controlled Constant Current Regulator (MCR III) is equipped with safety and is equipped with other protection modules including Earth Fault Detector (EFD) and Lamp Falue Detector (LFD). Microprocesor Controlled Constant Current Regulator (MCR III) has 3 basic parts, namely the power module, control module and output transformer module and the Microprocesor Controlled Constant Current Regulator (MCR III) operating system can be done in 2 ways, namely trace operation and remote control.

3.3 Types of Contant Current Regulator (CCR) at International Airports Jendral Ahmad Yani Semarang

At Ahmad Yani Airport Semarang there are 2 units of Constant Current Regulator (CCR), 1 unit for PAPI lamps on runway 13 and another unit for PAPI lamps on runway 31. At Ahmad Yani Airport Semarang there are 10 units of Microprocessor Controlled Constant Current Regulator (MCR III), namely as follows:

1. Three (3) Microprocesor Controlled Constant Current Regulator (MCR III) units for Taxiway A, F, and G lamps
2. Two (2) units of Microprocesor Controlled Constant Current Regulator (MCR III) for Approach Light Runway 13 lamps
3. Two (2) units of Microprocesor Controlled Constant Current Regulator (MCR III) for Approach Light Runway 31 lamps
4. One (1) unit Microprocesor Controlled Constant Current Regulator (MCR III) for PAPI (Precision Approach Path Indicator) Runway 13 & Runway 31 lamps
5. Two (2) units of Microprocesor Controlled Constant Current Regulator (MCR III) for Runway Edge Light and Threshold Light.

Table 1. Data Sheet CCR Jendral Ahmad Yani International Airport Semarang

Information	Details
Armature Merk / Type	MCR-III
Made in	Belgium
Input (V)	380 V/ 220 V
Output (kVA)	- 25 kVA (Taxiway G & F, PALS CCT 1 & 2) - 20 kVA (Runway CCT 1 & 2) - 10 kVA (Taxiway A, MALS CCT 1 & 2) - 4 kVA (PAPI)
Amount	10
Install Year	2018
Ampere Max	6,6 A

IV. Conclusions

The author observes that the Airfield Lightning System (ALS) is a special part because it is only owned by airline service companies. Therefore, the authors feel like exploring the Airfield Lightning System (ALS). So that finally the author took the title "The Working Principle of Constant Current Regulator (CCR) As A Power Supply With A Constant Current At Jendral Ahmad Yani International Airport Semarang". From the description of the material that has been described and the activities that the author has carried out, the authors can conclude that Constant Current Regulator (CCR) is a constant current power supply used to supply Airfield Lightning System (ALS) equipment, Airfield Lightning System (ALS) is a very important part for the continuity of airport operations. So the Airfield Lightning System (ALS) needs special handling so that the quality produced from these aids does not endanger aircraft passengers, The required load sharing is adjusted to the existing Constant Current Regulator (CCR) specifications, The lamps on the ground are connected in series, using the series transformer, the primary part of the series transformer is connected in series between all series transformers used, then a constant current power supply (CCR) is attached.

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