RELAY COORDINATION WITH ARC FLASH ANALYSIS BASED PROTECTIVE SYSTEM

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ABSTRACT

The relay is essential to minimize the outages. The flash arc danger is associated with electrical protection in an effort place. The electrical workers have elaborated calculations are prerequisites for influential arc-flash incident energy revelation. In several industrial sites, starting from small factories to large chemical plants, alone arc-flash energy studies were completed without any relay coordination which gives less stability in the plants. This paper offers knowledge in the installation of electrical equipment and safe handling techniques against the arc flash voltage that promotes safety management for electrical engineers.

Keywords: Relay coordination, Arc flash Analysis, Arc flash boundary

I. INTRODUCTION

An Over Current Protective Device (OCPD) synchronization learning and a flash arc hazard exploration. This methodology will require the computer simulation exertion exhausting two power scheme trainings. A few repetitions influence be needed among the two trainings in order to achieve optimum results. In this technique [10] [11] [12] to improve protection reliability and preserve selective coordination throughout the system have been obtainable. An arc flash study is to establish safety protocol for qualified electrical personnel required to work on electrical equipment and circuit parts that cannot be placed in an electrically safe work condition. In utmost cases, the flash arc energy and the sustainability of powerfully reducing this energy to conventional altitudes are used in the assortment of a primary Over Current Protective Device. In Most horrible level incident energy of various voltage level switch gear is presented. An arc flash activates when the electricity exits its proposed path and initiates traveling over the air toward a grounded area. Once this happens, it ionizes the air, which additional diminishes the overall resistance along the path. This helps attraction in surplus electrical energy [2].

Protective System Model

The GDC [15] Putrajaya Plant 1 has a maximum connected demand of 22.60 MW. GDC draws power from two TNB PMU’s namely PMU Abu Bakar Baginda and PMU NUNI through underground cables of 4kM and 9kM length respectively, which are terminated to the 33kV bus bar 1L and 33kV Bus bar 1R ability for relay synchronization [1], which is shown in Fig.1
Relay Coordination System

Relay organization [13] is necessary to acquire continuous operation of scheme, to afford best service to the consumer in addition to earn the most revenue.

- Quickly isolated the faulty area
- To minimize the magnitude of fault current
- To minimize the operation fault

A. PRIMARY AND BACK UP PROTECTION

- Primary Protection: Device closest to the fault
- Back up Protection: Device next in the line
- Security: If the major protection [14] fails to maintain the integrity of the system, reverse up defense should operate.

B. STAGE 50 (PHASE AND NEUTRAL)

50 is the instantaneous overcurrent protection relay this relay have a phase and neutral protection 50P & 50N.

\[ \text{Pickup (50 p)} = 1.3 \times LRA \]

\[ \text{CT ratio} \]

LRA = locked rotor current

Curve type: DMT (instantaneous)

Table 1: Stage 50 Setting for Relay
<table>
<thead>
<tr>
<th>Relayid</th>
<th>CTRatio</th>
<th>Pickup value</th>
<th>Curvetype</th>
<th>Time dial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay3</td>
<td>150:1</td>
<td>11.25</td>
<td>INSTANTANEOUS</td>
<td>0.01</td>
</tr>
<tr>
<td>Relay4</td>
<td>200:1</td>
<td>10.16</td>
<td>INSTANTANEOUS</td>
<td>0.01</td>
</tr>
<tr>
<td>Relay2</td>
<td>2500:1</td>
<td>3</td>
<td>INSTANTANEOUS</td>
<td>0.21</td>
</tr>
<tr>
<td>Relay1</td>
<td>400:1</td>
<td>9.7</td>
<td>INSTANTANEOUS</td>
<td>0.3</td>
</tr>
</tbody>
</table>

**Relay Coordination Output for Two Bus System**

If proper co-ordination is not done, then CB incomming trips for any fault on the outgoing feeder. Instead of tripping one load, an entire bus is lost Fig 2 shown in proper co-ordination only relav and CB trips isolating the faulty equipment at the earliest. This minimizes the damage.

![Figure 2 Simulation Output](image-url)

**Figure.2 Simulation Output**

A time-over current relay characteristics generally plotted as a single line curve shown in Fig.3 and also time delay settings values as mentioned in Table 1. The Electromechanical time over current relays that have a dial with continuous modification from typically 0.5 to 10 milli seconds [12]
Figure 3: The Curves Representing Arcing Currents

ARC FLASH ANALYSIS

An arc flash activates when the electricity exits its proposed path and initiates travelling over the air toward a grounded area. Once this happens, it ionizes the air, which additional diminishes the overall resistance along the path. This helps attraction in surplus electrical energy.

A. NFPA70e and arcflash hazard

NFPA 70E means a series of boundaries concerning to electrical safety when functioning on animated apparatus. Only "qualified" people can go through these boundaries and they are prerequisite to wear appropriate personal protective equipment within these boundaries. There are four safeguard boundaries are shown in Fig 4

Figure 4 Arc Flash Boundary

B. Personal Protective Equipment (PPE)

All quantities of the body which may be uncovered to the arc flash require to be enclosed by the appropriate type and quality of Personal Protective Equipment. The complete Personal Protective Equipment set may be comprise of FR clothing, helmet or head gear, face shield, safety glasses, gloves, shoes, etc. conditional upon the magnitude of the arc energy. The number of PPE prerequisite and its superiority requirement to be resolute on the source of the considered incident energy on the worker's body. In Fig.5 shown in PPE category level chart NFPA 2009[4][5].

![PPE Category Level Chart NFPA 2009](chart.png)
Figure5: The PPE Category Level Chart.

C. Regulate the arc fault currents

In Fig. 6 shows the arc flash output for two bus system. The arc fault current has to be subject to mentioned primarily on the bolted fault current. The bolted fault current in the defensive mechanism can be initiate from the short circuit study by looking at a one-bus-away run. This will divide fault assistances from normal feeder, alternate feeder, and down stream motors [6][7]. The arc fault currents can be premeditated as in Table 2. For medium voltage applications the arc current is still lower than the bolted fault current.

Table 2 Arc Flash output

<table>
<thead>
<tr>
<th>Bus ID</th>
<th>Bolted current (ka)</th>
<th>Arching current (ka)</th>
<th>Incident energy (cal/cm²)</th>
<th>Arcflash boundary (m)</th>
<th>Energy level PPE (NFPA70E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus 1</td>
<td>40.19</td>
<td>40.19</td>
<td>649.23</td>
<td>10.66</td>
<td>Exceed maximum level</td>
</tr>
<tr>
<td>Bus 2</td>
<td>40.19</td>
<td>40.19</td>
<td>649.23</td>
<td>10.66</td>
<td>Exceed maximum level</td>
</tr>
<tr>
<td>Bus 3</td>
<td>38.47</td>
<td>17.13</td>
<td>147.464</td>
<td>5.067</td>
<td>&gt;4</td>
</tr>
</tbody>
</table>

Figure6 Arc Flash Output for Two Bus System

II. CONCLUSION AND RECOMMENDATIONS

The Characteristics curves which are inherent properties of the protection relays are playing important role in clearing the fault. Based on how quick the relays are acting to the fault is formative. The Various characteristic curves are used to find best possible settings. System grounding which is foremost important to identifying the system is also playing major role in reducing the fault level, so that the incident energy level is getting reduced.
III. SCOPE OF FUTURE WORK

- Possibilities to reduce the Arc flash levels and its mitigation in grounded system.
- Possibilities of reducing the arc flash level with help of other protection devices viz., fuse, MCB, Contactors, etc.,
- Ensuring the arc flash level to bare minimum based on the other system design considerations

REFERENCES