SURVEY ON GENSETS & GUIDE FOR GENSET PROTECTION

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Abstract - *A Genset (or a power generator set) is a machine used to produce electrical energy from fuel. Depending upon the type of application, the electrical energy produced by the genset may be used as prime power (absence of utility) or back up power (utility is prime power). This application guide for the relay protection of synchronous generators presents a review of the generally accepted forms of protection for the generator and its excitation system. It summarizes the use of relays and devices and serves as a guide for the selection of equipment to obtain adequate protection. The guide is primarily concerned with protection against faults and abnormal operating conditions for large hydraulic, steam, and combustion-turbine generators. This guide is not a standard and does not purport to detail the protective requirements of all generators in every situation. Standby and emergency use generators are specifically excluded. However, sufficient background information relating to protection requirements, applications, and setting philosophy is given to enable the user to evaluate the need, to select, and to apply suitable protection for most situations.*

Key Words: Genset, Electrical Energy, Fuel, Application, Protection

1. INTRODUCTION

A Genset (or a power generator set) is a machine used to produce electrical energy from fuel. Depending upon the type of application, the electrical energy produced by the genset may be used as prime power (absence of utility) or back up power (utility is prime power). This guides for the relay protection of synchronous generators presents a review of the generally accepted forms of protection for the generator and its excitation system. This paper primarily concerned with protection against faults and abnormal operating conditions for large hydraulic, steam, and combustion-turbine generators. This guide is not a standard and does not purport to detail the protective requirements of all generators in every situation. Standby and emergency use generators are specifically excluded. The suggestions made pertain to typical generator installations. However, sufficient background information relating to protection requirements, applications, and setting philosophy is given to enable the reader to evaluate the need, to select, and to apply suitable protection for most situations.

2. CATEGORIES OF GENSETS

All the general gensets i.e. Generators are classified into various categories. Classification of diesel generator is based on their engine which is the prime mover for the alternator. The diesel engine can be classified on various categories like the power ratings, number of strokes, duty type, rotational speed, cooling systems and start-up arrangement.

Figure: Prototypical of a Generator

2.1. Based on power ratings:

The power ratings in diesel gensets are governed by three international standards.

- SAE (North America)
- DIN (Europe)
- JIN (Japan)

The power rating for small engines starts from 20 kW and extends up to 1000 kW. The medium engines range in between 1000-2500 kW. The higher power rated engines which are used in mining industries can go up to 60,000 kW. While kW is the real power, kVA is apparent power which is a combination of real power and reactive power. So, the kVA rating is always higher than the kW value. The kW rating is in common use in the US and a few other countries whereas most of the countries use kVA as the reference.

The engines classified based on the number of strokes are the two-stroke engine and the four-stroke engine. Less common are the five-stroke, six-stroke and the two-and-four-stroke engines. In a two-stroke engine, the power cycle is completed in every two strokes of the piston with only one crankshaft revolution. In a four-stroke engine, the power cycle is completed with four strokes of the piston during which the crankshaft has two revolutions.

2. 3. Based on the service duty:

Here the engine is classified on the load application and the time duration of the load within a set period. It is further divided into:

i. Emergency Standby power (ESP) duty: The engine will not run for more than 100 hours in a year and at not more than 80% of the full rating for the power outage duration. The average load should not exceed 60% of the rated power. The primary power generator is used to supply power for limited duration during a power disruption. This type of diesel gensets is used for residences and shops.

ii. Prime power (PRP) duty: Here the engine can run for unlimited hours per year at 100% of the prime power rating. The average engine load should not exceed 70% of the rated power. The prime power rated generators are used when the user does not purchase utility power.

This is divided into two:

• Indefinite running time- The engine should not run for more than 250 hours per year and the variable load should not exceed 70% of the prime power rating.

• Limited-time running prime (LTP) duty- Here the engines are typically designed to supply electric power to a utility as per the financial arrangement. This is used for circumstances where the power cuts are expected such as a planned utility power reduction.

iii. Continuous power (COP) duty: The engine can run at unlimited hours per year (continuously) at 100% of the continuous power rating of the engine. The average load can range from 70% -100%. This is like prime power but it cannot handle overload or work efficiently for variable loads. This type of gensets is used in remote locations like mines and rigs where grid access is not possible.

2.4 Based on the rotational speed:

Diesel engines are designed to rotate at low, medium or high speeds. Also, the same engine can run at two different speeds to satisfy the international electricity markets of 50 Hz and 60 Hz. The large machines have low speeds of 150-450 rpm. The medium engines have speeds across 600-1200 rpm and the small size machines fall under the rotational speed of 1500-1800 rpm.

2.5 Based on start-up arrangement:

i. Manual start- These generators have no specified start-up time. Here the startup is achieved by manual barring of the engine. The decompression lever is released upon the achievement of the desired RPM and the engine comes to life.

ii. Automatic start-up, Long Break- This generator is started from stationary on grid failure. The engine start-up procedure is managed by electrical, hydraulic and air-start (air-start and air camshaft start).

iii. Automatic start-up, No Break- In a no break setup, the user gets power from a generator which is driven by a huge flywheel which in-turn is driven by a motor running on the main supply. During main supply operation, the flywheel is continuously in operation at the desired RPM. In a power outage scenario, the motor stops getting the main supply resulting in the motor shutting down. Thus, the flywheel RPM experiences a slight dip, but continues its rotation due to inertia. So, the power supply continues without interruption with negligible reduction in voltage. In the meanwhile, the diesel genset can be started and power supply restored to the drive motor. This once again restores the flywheel RPM to the desired level. The interruption experienced is very small in magnitude as there is no breakdown in voltage and it is restored quickly to the desired level.

iv. Automatic start-up, Short Break- In this arrangement, the genset is equipped with an electrical panel which keeps monitoring the health of the mains voltage. If any abnormality is observed by the system, in such a scenario the command is given to the genset to start. After the genset starts, power is restored automatically by the generator till the time of healthy mains supply power restoration. The switchover from mains to genset supply in case of power outage and genset supply to mains in case of power restored takes about 10 to 20seconds.

2.6 Based on the cooling systems:

Some sort of cooling process is required to prevent the diesel generator from overheating when the engine runs. Diesel generators have different cooling systems, but the two main types are air-cooling system and the water-cooling system. While both the methods are effective, water cooling systems are more durable. The smaller generators usually have air-cooling systems while the larger generators go in for water-cooled systems.

i. Air-cooled Diesel Generator: This type of diesel generator relies on air to perform the cooling function required for the heated engine. These diesel generators have no additional parts but for only a specialized air intake system. The air-cooling systems force the air to the metal fins surrounding the diesel engine thus cooling it. This type of generator does not need any coolant or radiator and most of the smaller portable generators use the air-cooling system. This works as good as the water-cooled diesel generators but may overheat when run continuously for longer durations. Over-heating generally requires complete engine overhaul and the repair tasks will be more frequent. The portable small generator works at faster speeds making them wear out faster. So, running them full-time is not suggested and it is generally advised to shut down the engine every few hours so that it can cool.

ii. Water - Cooled Diesel Generator: Water-Cooled diesel generators use an extra system of a radiator and water pump to achieve the cooling effect of the engine with water that flows around the engine as it runs. The pump forces the liquid coolant to the engine surroundings through the hoses. The heat of the engine is transferred to the coolant. This heated coolant is then made to pass through a radiator for it to cool down. This cooled liquid is then again forced into the engine block and this cycle continues for as long as the engine runs. The water-cooled diesel generators require more maintenance than the air-cooled diesel generators with the regular check of water level and the cooling system's effectiveness. All the modern-day diesel generators use water-cooling for their engines. Marine engines and the stationary engines have ready availability of water to cool the engines.

3. DESCRIPTION OF GENERATOR'S, EXCITATION SYSTEMS AND GENERATING STATION ARRANGEMENTS

A brief description of typical generator design and connections, generator grounding practices, excitation systems design, and generating station arrangements. The intent of this section is to present information that affects the protection arrangement and selection of protective relays. A discussion of auxiliary system transfer and the possible negative impacts of disoperation and faults on these systems is beyond the scope of the generator protection guide. The methods employed for grounding and fusing the secondary circuits of voltage transformers and the methods for grounding current-trans- 9 former secondary circuits are not generally the same for all installations. For this reason, no secondary fuses or ground points are indicated in the figures throughout this guide. However, all current and voltage transformer secondary circuits should be grounded in a way that is consistent with accepted practices for personnel safety.

4. PROTECTION REQUIREMENTS

Briefly describes the damaging effects of faults and abnormal operating conditions and the type of devices and their settings commonly used to detect these conditions. A clear understanding of the effects of abnormalities on generators will assist the reader in evaluating the need for and the means of obtaining adequate generator protection in any specific situation.

5. OTHER PROTECTIVE CONSIDERATIONS

A discussion of other forms of protection and factors that may be considered in the generator zone.

Current Transformers: The performance of the sensitive, high-speed differential protection used in the generator zone depends to a large degree on the overall performance of the current transformers (cts) used with these schemes. There are several factors which may affect cts, of concern are the effects of residual
flux and stray external flux fields (proximity effects).

Residual Flux: It can be left in cores of conventional cts by normal interruption of an offset fault current and using direct current (dc) in the testing of cts. Regarding the latter point, it is common practice to use a dc source to check ct polarity and a bell ringing circuit to check circuit continuity making these tests, the interruption of the dc source can leave high levels of residual flux in the corc. This residual flux can adversely affect both the steady-state and the transient performance of the cts used in a differential scheme, especially when the residual flux levels arc different in each ct. With unequal residual flux levels in differentially connected cts, the difference in ratio errors between the cts can be sufficient to cause the disoperation of sensitive differential relays under normal load conditions.

6. PROTECTION SPECIFICATIONS

Presents detailed tabulations and diagrams that are classified according to the method by which the generator is connected to the system. These tables and diagrams show the combination of relays (and their control function) often applied for generator and excitation system protection in accordance with good engineering practices. These tables and diagrams also consider the protective devices on other equipment in or adjacent to the generating station that are connected to trip or shut down the generator.

CONCLUSION

Under the survey of all different types of gensets we can conclude that there are vivid specifications available for any descriptive use of genset required according to the application.

After selecting the genset applicable we can also go through the protection measures with which we can know the complete maintenance of the genset.

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