NOTES & REFERENCES

Module 3

ELECTRICAL PROTECTION SCHEMES

OBJECTIVES:

After completing this module you will be able to:

Page 2 ⇔ 3.1 State the four purposes of electrical protection schemes.

Pages 2–3 ⇔ 3.2 Describe the four essential qualities of an effective electrical protection scheme.

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INSTRUCTIONAL TEXT

INTRODUCTION

Electrical circuits and machines are subject to faults. A fault is generally the breakdown of insulation (between a conductor and ground or between conductors) due to a variety of causes, that has a resulting flow of excess current through a relatively low resistance. There is potential for severe damage due to the effects of these high currents.

The majority of systems and devices in our stations are three phase in nature. The principal types of faults experienced by three phase equipment are:

a) phase to ground,

b) phase to phase,

c) three phase, with or without ground.

In this module, we will discuss the purpose and essential qualities of electrical protection schemes. Subsequent modules will deal with faults such as those mentioned above and various means of protecting equipment against them.

NOTES & REFERENCES

Obj. 3.1 ⇔

PURPOSE OF ELECTRICAL PROTECTION

Every item of electrical equipment should have some form of electrical protection which will remove electrical power from the equipment in the event of it becoming faulty or overloaded. This is necessary to ensure that:

a) **Damage is minimized** on the faulty equipment and any damage is not allowed to spread to other equipment. For example, if a fault occurs in a motor, we want to isolate the motor before damage occurs to the bus supplying the motor.

b) Healthy **equipment not directly affected by the fault is left in service.** For example, if we have two buses tied together by a tie breaker, and a fault occurs on one bus, we want only the faulted bus to be isolated, by isolating all paths to/from it. We will provide an alternate source of power to the healthy bus to keep the unaffected equipment energized.

   Another example is when a fault occurs in a motor. In this case, we only want the motor to trip, while still providing power to the unaffected equipment on that same bus.

c) Equipment is **protected from damage due to continuing overload.** For example, most motors are designed to run in an overload condition for at least a short duration without experiencing damage*. We must remove the electrical power when the overload gets too great, preventing damage to the equipment.

d) Electrical **system stability is maintained.** For example, when systems come on or off line, transients are introduced into the electrical system. If these systems are large enough to cause large transients, then instability can occur (stability will be discussed in Module 8 of this course).

Obj. 3.2 ⇔

ESSENTIAL QUALITIES OF ELECTRICAL PROTECTION

Since there are numerous generators, transformers, power lines and other electrical equipment connected together to form the Ontario Hydro system, a comprehensive electrical protection system must be used to ensure safety and continuity of supply. To guarantee this, electrical protection must have the following four qualities:

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* *This is known as the Service Factor of the motor and is discussed further in Module 5.*

Reliability

The protective system **must function whenever it is called upon** to operate, since the **consequences of non–operation can be very severe.** It is impossible to achieve 100% reliability but a high degree of reliability can be achieved by careful design, construction and maintenance.

Selectivity

The protection must be able to **select and shut down** that section of the system that caused the fault condition to exist. At the same time, the **healthy sections of the system should continue operating.** For example, a short circuit or fault on a domestic stove should be cleared by the stove fuses and should not cause the main incoming fuses to blow, which would shut off the supply to the entire house.

Sensitivity

The protection must be able to **distinguish between healthy and fault conditions,** ie, to detect, operate and initiate tripping before a fault reaches a dangerous condition. On the other hand, the protection must not be too sensitive and operate unnecessarily (and affect electrical system stability)*.

Speed

When electrical faults or short circuits occur, the **damage produced is largely dependent upon the time the fault persists.** Therefore, it is desirable that **electrical faults be interrupted as quickly as possible.**

SUMMARY OF THE KEY CONCEPTS

- An electrical protection scheme must ensure that damage is minimized and localized, healthy equipment is not affected, equipment is protected from overload and system stability is maintained.
- The qualities required by an electrical protection scheme are reliability, selectivity, sensitivity and speed.

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You can now do **assignment questions 1–16.**

* *Some loads take large inrush (starting) currents which must be accommodated to prevent unnecessary tripping (while still tripping for fault conditions). This is discussed later in the course.*

NOTES & REFERENCES

ASSIGNMENT

1. The four purposes of an electrical protection scheme are to:

   a) _____

   b) _____

   c) _____

   d) _____

2. Discuss the four essential qualities of an electrical protection scheme:

   a) _____

   _____

   _____

   _____

   b) _____

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   c) _____

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   _____

   d) _____

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Before you move on to the next module, **review the objectives** and make sure that you can meet their requirements.

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