

# CHAPTER 1

## INTRODUCTION



This study has investigated the use of special test for hydroelectric generator. On-line Partial discharge measurement was used for monitoring some generator conditions without shut down. All interpreted data were used for maintenance program and improving availability.

### 1.1 Background of the problem

Generator is the critical component of power plant and power system generation. Most generators are put in service for a long time and always have some troubles during their operation. Some of them have been instantaneously shut down and some of them could not be operated at their full capacities. Most troubles come from stator winding insulation deterioration during operation. In the power system generation, generator must be operated continuously without any fault in order to make power system reliable. Generator must have high availability for operation. To attain high availability, a good maintenance program for generator must be applied. For large machines like generators, power plant operators can not keep certain spare parts such as a completely new generator set or other essential parts because of high cost and skillful works required for replacing them. Appropriate maintenance program should be applied as yearly inspection and major overhaul. During operation, some conditions of critical part of generator should be monitored or measured. Some data and results could be used to show generator conditions on a real time basis. Other could be used as useful information for corrective a measures in the next overhaul period.

Courses of most generator failure during operation come from stator windings and their insulation system. The phenomena of partial discharge that occurred within stator winding insulation are dominant cause of insulation failure. Partial discharges are small sparks that occurred in gas gaps within the stator ground wall insulation. These sparks can damage directly to the insulation system and progress slowly until insulation system become weak and then quickly progress to make insulation breakdown and seriously damage the stator winding. These phenomena depend on load of generator, temperature and moisture.

Two types of partial discharge pulses, positive pulses and negative pulses are generated during operation. High magnitude of partial discharge pulse and large number of partial discharge pulses show serious deterioration of insulation. Several methods of partial discharge measurement can be used to detect both types of partial discharge pulses including electrical noise. It is very difficult to separate noise from measurement data and errors in analysis can always happen. To achieve the correct data of partial discharge pulses, an appropriate method of measurement should be studied and selected. The actual partial discharge pulses shall be measured and true results of analysis could then be achieved.

The topic of this study is to use an appropriate measurement method to measure and collect partial discharge pulse that occurred within insulation of stator winding, analyze and interpret the collected data in order to monitor hydroelectric generator conditions and use these useful information for corrective measures and improved maintenance of the generator in next overhaul period.

Three units of hydroelectric generators of the Sirikit Power Plant, one of the largest hydro-power plants of the Electricity Generating Authority of Thailand (EGAT), were selected to implement the on-line partial discharge analysis for improving availability and maintenance of the machines. Some couplers were designed, fabricated and installed at

suitable locations of stator winding. Counter measurement periods have been set up and compile data of partial discharge pulses during generator operation. The output measurement data are shown in term of number of partial discharge pulses relate to magnitude of partial discharge pulses to make a pattern of graph and indicate total of pulses as Normalized Quantity Number (NQN) for each unit of generator.

The interpretation of data is done by analysis the relationship of partial discharge activities and some kind of deflected or damaged parts of stator winding and also compared with literature survey where past experiences of partial discharge analysis done by well-known institution were recorded, etc. In case when very high magnitude of partial discharge pulses are detected, the generator may be requested to shut down for inspection and correction as soon as possible. In case interpreted results show something that show sign of damage of some parts, these useful data will be used in next overhaul period for correction.

## **1.2 The main objectives of this thesis**

The main objectives of this research are :

- 1.2.1 *To study partial discharge measurement of hydroelectric generator.*
- 1.2.2 *To determine insulation deterioration of generator stator winding during operation.*
- 1.2.3 *To set up suitable method of partial discharge measurement for hydroelectric generator.*
- 1.2.4 *To interpret the results of partial discharge measurement in term of generator stator winding conditions.*
- 1.2.5 *To apply the results of the interpretation as a tool for maintenance program with the aim of improving availability of generator.*

### **1.3 Scope of research**

The scope of the research is confined to the study of hydroelectric generators at Sirikit Power Plant. The steps of research procedure can be listed below:

1.3.1 *Study the partial discharge phenomena of stator winding insulation, method to measure partial discharge pulse both off line and on line.*

1.3.2 *Select three units of hydroelectric generator of EGAT, install special couplers into suitable part of stator winding in each selected generator and select one unit for implementation of partial discharge analysis.*

1.3.3 *Compiling measured data of partial discharge from periodic measurement.*

1.3.4 *Define partial discharge output measurement, interpret and manage all results as a maintenance tool to improve availability of generator.*

### **1.4 Expected Benefit**

The results could be beneficial as follow:

1.4.1 *Use of on-line partial discharge measurement and its interpretation for maintenance program of hydroelectric generator.*

1.4.2 *Monitoring of hydroelectric generator condition without shut downs and prepare suitable maintenance program by using useful results of measurement and analysis.*

1.4.3 *Correct and improve the appropriate parts of generator in overhaul period, decrease time and cost of maintenance program.*

## 1.5 Research Procedure

The research would cover the on-line partial discharge measurement of hydroelectric generator, the study and creation of conceptual measurement and data interpretation, implementation of the on-line measurement into hydroelectric generator unit 2 of Sirikit hydropower plant. The procedures of study are:

- 1.5.1 *Review of concerned literatures.*
- 1.5.2 *Selection of on-line measurement method*
- 1.5.3 *Installation of sensors and electrical noises elimination*
- 1.5.4 *Measurement*
- 1.5.5 *Study and analysis of results*
- 1.5.6 *Conclusion and Discussion*
- 1.5.7 *Recommendation*