A Study of Inspection for Electrical Safety Systems Case Study Four Locations in Thailand

S Charoenchit¹, C Thongchaisuratkrul²

¹Ph.D. Candidate, King Mongkut’s University of Technology North Bangkok, Bangkok, Thailand
²Assistant Professor, King Mongkut’s University of Technology North Bangkok, Bangkok, Thailand

surinalongkorn@hotmail.com

Abstract. This research presents study of inspection for electrical safety in electrical system. The four locations are observed. The objective of this research are to study the problems which may be occurred in electrical system and introduce the prevent ways. The four locations consist of 2 factories of paper and 2 animal food factories. For factory of paper, the total electrical load is 18,450 kVA which consists of 10 transformers and another 13,450 kVA which consists of 10 transformers. For the animal food 800 kVA, another is 1000 kVA which each location is a transformer. The inspected systems include transformer, main distribution board, ground and electrical wire systems. The check instruments are test oil maker, thermo scan, earth clamp tester, earth ground tester, infrared tester and outlet tester. The all data from test is analysed to compare among of four locations. For experimental results, it is of found that for transformer, the oil insulation transformer is lower than standard and silica gel is deteriorated and broken box, rubber shield and rubber gasket is broken and damage. For main distribution board, the ground value is lower than standard and the temperature of junction for breaker is high and more dust. For ground system, the ground value is lower than standard and broken. For wire system, the electrical is damaged because of heat and animal.

1. Introduction

Nowadays electrical system is very important especially in factory. According to statistic electricity consumption of Thailand, it is found that the quantity increases in the rate of 22% in ten years [1]. Moreover, according to 20 years’ power electricity development plane, it shows that the need is more and [2]. It means that the using of electricity is increased. Therefore, the safety system is become more important especially in the big system for example factory, big building and so on [3]. The electrical system should be inspected by professional which corresponding with standard [4-6]. The safety system is the good system which effect on stable of system also. Not only that but also safe system prevent accident; fire or damage, breakdown production. Hence it is seen that the safety is more needed.

The factory is more expand continuously [7]. Therefore, the electricity system is more system which generally it consists of medium distribution about 11kV–36kV, transformer, distribution line, main distribution board, wire system, ground system [8]. According [9, 10], the electrical system be need inspected. In 2015, it is found that there is about 50% of factory and building not passes inspection because the system is not standard [11]. These factories and building is not proved by electricity seller following standard MEA (Metropolitans Electricity Authority) and PEA (Provincial
Electricity Authority) [5]. That mean the factories are not run the process which it affects production process. Not only that but also they affect on export product to abroad and income to the country.

Although, in factory or building, they have technicians for checking the electrical system, sometime may be not enough because they lack of experience. Moreover, some information or point which should be focus may be neglected. The important thing is the technician should be known that problem and the solving.

Therefore, this research presents inspection for electrical safety in electrical system. The four locations are observed. The objective of this research are to study the problems which may be occurred in electrical system and introduce the prevent ways.

2. The Experimental Procedures

The research is test on four factories. The inspected sectors consist of transformer, main distribution board, ground and electrical wire. The testing is done by three engineers who test together. The standard instruments are calibrated before using. The check instruments are test oil maker, thermo scan, earth clamp tester, earth ground tester, infrared tester and outlet tester.

2.1. The observed four locations

To testing, four factories were considered; the locations are shown in figure 1-figure 4. The first location as shown in figure 1 is paper factory. Its electrical load is about 18,450 kVA. It is 10 transformers. This factory locates on Prachin Buri. The second location as shown in figure 2 is paper factory. Its electrical load is about 13,450 kVA. It is 9 transformers. This factory locates on Samut Prakan. The third location as shown in figure 3 is animal food factory. Its electrical load is about 800 kVA. It is 1 transformer. This factory locates on Chachoengsao. The forth location as shown in figure 4 is animal food factory. Its electrical load is about 1,000 kVA. It is 1 transformer. This factory locates on Bangkok.

2.2. Inspected system

The inspected systems in this research consist of four types; transformer, main distribution board, ground and electrical wire. For transformer, the checking lists include oil, high voltage bushing, low voltage bushing, silica gel, rubber shield, rubber gasket, transformer tank. For main distribution broad, the checking lists include physical box, circuit breaker, bus bar, junction, wire, ground, installation safety distance, thermo scan and lighting. For ground system, the checking lists include physical ground wire, ground value, ground junction, wire size and ground rod. For electrical wire, the checking lists include physical wire, type and size, thermo scan, junction and installation.

Figure 1. The four factories.

Figure 2. Inspected systems.
2.3. Instrument Tester

The instrument testers in this research consist of 6 types; test oil maker, thermo scan, earth clamp tester, earth ground tester, infrared tester and outlet tester. The model of equipment is shown in table 1 which shows details of testing and tested system. Figure 9 shows all 6 instruments.

| Instruments          | Testing     | System               |
|----------------------|-------------|----------------------|
| test oil maker       | Dielectric strength | Oil transformer      |
| thermo scan          | Heat        | High voltage transformer |
| earth clamp tester   | Ground      | Ground of Transformer |
| earth ground tester  | Ground      | Ground of MDB        |
| infrared tester      | Heat        | CB, bus bar, wire    |
| outlet tester        | Phase       | MDB, wire            |

3. Experimental Results

3.1. Transformer

From the inspection of 4 factories, it is found that all abnormal occurred in transformer it shows in table 2. The example of damage is shown in figure 4. From data in figure 8, it is found that the problems which always more found in the transformer include Dielectric strength of oil is lower than standard, Silica gel is deteriorated, Rubber shield is broken and Rubber gasket is broken about each of 17%. The next are Transformer tank occur rust, Oil leak from transformer tank and Bushing broken approximately each of 9%. The finally it is Silica gel is broken at 4%. The first four problems are shown in figure 4. Theses problem is found in all factories.

Figure 4. The abnormal in transformer.

Figure 5. The abnormal in MDB.
3.2. Main Distribution Board
From the inspection of 4 factories, it is found that all abnormal occurred in main distribution board, it shows in table 3. The example of damage is shown in figure 5. From data in figure 9, it is found that the problems which always more found in the main distribution board include more dust and terminal loose about each of 34%. The next is nut of air circuit breaker loose approximately 25%. The finally it is Case of air circuit breaker heat at 8%. The first three problems are shown in figure 5.

3.3. Ground system
From the inspection of 4 factories, it is found that all abnormal occurred in ground system, it shows in table 4. The example of damage is shown in figure 6. From data in figure 10, it is found that the problems which always more found in the ground system are ground injection broken about 50%. The next are ground test value is less than standard and ground wire heat approximately each of 25%. The first problems are shown in figure 6.
Table 2. Inspection of Transformers.

| The List                                 | F1 | F2 | F3 | F4 |
|-----------------------------------------|----|----|----|----|
| Transformer tank occur rust             |    | ✓  | ✓  |    |
| Oil leak from transformer tank          |    | ✓  | ✓  | ✓  |
| Dielectric strength of oil is lower than standard | ✓  | ✓  | ✓  | ✓  |
| Silica gel is deteriorated              | ✓  | ✓  | ✓  | ✓  |
| Silica gel is broken                    | ✓  | ✓  | ✓  | ✓  |
| Rubber shield is broken                 | ✓  | ✓  | ✓  | ✓  |
| Rubber gasket is broken                 | ✓  | ✓  | ✓  | ✓  |
| Bushing broken                          | ✓  | ✓  |    |    |

Table 3. Inspection of MDB.

| The List                                 | F1 | F2 | F3 | F4 |
|-----------------------------------------|----|----|----|----|
| More dust                               | ✓  | ✓  | ✓  | ✓  |
| Nut of air circuit breaker loose        | ✓  | ✓  | ✓  | ✓  |
| Terminal loose                          | ✓  | ✓  | ✓  | ✓  |
| Case of air circuit breaker heat        |    |    |    | ✓  |

Note: F1 is factory of paper with 18,450 kVA electrical. F2 is factory of paper with 13,450 kVA electrical. F3 is animal food with 800kVA electrical. F4 is animal food with 1000kVA electrical.

3.4. Electrical Wire

From the inspection of 4 factories, it is found that all abnormal occurred in wiring system, it shows in table 5. The example of damage is shown in figure 7. From data in figure 11, it is found that the problems which always more found in the ground system are wire insulation broken about 34%. The next are the wire is less than required load and wire injunction loose approximately each of 22%. The finally they are heat in wire and wire insulation is damaged by animal about each of 11%. The examples of problems are shown in figure 7.

Table 4. Inspection of ground system.

| The List                                 | F1 | F2 | F3 | F4 |
|-----------------------------------------|----|----|----|----|
| Ground injection broken                 | ✓  | ✓  |    |    |
| Ground test value is less than standard  | ✓   |    |    |    |
| Ground wire heat                        | ✓  |    |    |    |

Table 5. Inspection of Electrical Wire.

| The List                                 | F1 | F2 | F3 | F4 |
|-----------------------------------------|----|----|----|----|
| less than required load                 | ✓  | ✓  |    |    |
| Heat in wire                            | ✓  |    |    |    |
| Insulation broken                       | ✓  | ✓  | ✓  | ✓  |
| Wire injunction loose                   | ✓  | ✓  | ✓  | ✓  |
| damaged by animal                       | ✓  |    |    |    |

4. Discussions

For the problem in transformer; dielectric strength of oil lower than standard, silica gel deteriorated, rubber shield and gasket broken about each of 17%. For ways of preventive maintenance, the oil of transformer should be filtered at lease 6-12 month a year. Silica gel is checked monthly and should be changed when it is deteriorated. The problem of silica deteriorated may be from the rubber shield and gasket broken so they should be changed once a year. The problems in the main distribution board, more dust and terminal loose of 34%. MDB should be clean 6 months a year. The terminal and nut of air circuit breaker should tighten also 6 months a year. The problem in the ground system, 50% is injection broken. It should be checked 6 months a year. It should be changed and connected by mold cast.

5. Conclusion

From experimental results, it can be summarized as following:

1. From 4 systems, the problems are found the most occurring in transformer and the next is in main distribution board. While in wiring and ground system the problems are found quilt less
2. The problems found in the transformer include dielectric strength of oil lower than standard, silica gel deteriorated, rubber shield and gasket broken about each of 17%.
3. The problems found in the main distribution board include more dust and terminal loose about each of 34%. The next is nut of air circuit breaker loose approximately 25%.
4. The problem found in the ground system is ground injection broken at 50%.
5. The problem found in the wire system is wire insulation broken about 34%.

References
[1] Yearbook, G E S 2016 Electricity Domestic Consumption Available on: https://yearbook.enerdata.net/world-electricity-production-map-graph-and-data.html#electricitydomestic-consumption-data-by-region.html [Date accessed 20.10.16].
[2] Energy report, M E T 2018 Power development plan Available on: http://www.egat.co.th/index.php?option=com_content&view=article&id=325&Itemid=207 [Date accessed 23.08.18].
[3] Thongchaisuratkrul C 2016 Electrical Energy Conservation Pissanulok: Ann Production.
[4] Handbook, W S T 2014. Electrical Safety in the Workplace Bangkok: The Engineering Institute of Thailand under H.M. The King’s Patronage.
[5] Handbook, W S T 2013 Electrical Installation Bangkok: The Engineering Institute of Thailand under H.M. The King’s Patronage.
[6] Handbook, W S T 2013 High Voltage Safety Bangkok: The Engineering Institute of Thailand under H.M. The King’s Patronage.
[7] Report, N S O 2017 Business and Industrial Census. Bangkok: National Statistical Office.
[8] Thongchaisuratkrul C 2011 Energy management in buildings Bangkok: King Mongkut's University of Technology North Bangkok.
[9] John C 2006 Electrical Safety Handbook 3rd ed. New York: McGraw-Hill.
[10] Handbook, N F P A 2004 Standard for Electrical Safety in the Workplace Massachusetts: National Fire Protection Association.
[11] Yearly Report, M E A 2016. The Safety Report Bangkok: Metropolitans Electricity Authority.