A study on the Predictive Maintenance in NPP by Thermography diagnosis test

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1. Introduction

Predictive Maintenance(PdM) assumes that all equipment will deteriorate and partial or complete loss of function will occur. PdM monitors the condition or performance of plant equipment through various technologies. The data are obtained, analyzed, trended, and used to predict equipment failures. When equipment failure timing is known, then actions can be taken to prevent or delay failure. This allows equipment reliability to remain high.

Thermal measurement technology measures the absolute or relative temperatures of key equipment parts or areas being monitored. Abnormal temperatures indicate developing problems. Temperature and thermal behavior of plant components are the most critical factors in the maintenance of plant equipment. For this reason, temperature is frequently considered the key to successful plant maintenance and is the frequently measured quantity.

There are two types of equipment used in this technology: contact and non-contact. Contact methods of temperature measurement, using thermometers and thermocouples, are still commonly used for many applications. However, non-contact measurement using infrared sensors has become an increasingly desirable alternative to conventional methods.

2. Methods and Results

2.1 Infrared Thermography(IRT)

Infrared Thermography is based on measuring the distribution of radiant thermal energy(heat) emitted from a target surface and converting this to a surface temperarure map or thermogram.

Infrared Thermography is the technique of producing an image of invisible infrared light emitted by objects due to their thermal condition. The most typical type of thermography camera is shaped like a typical camcorder and produces a " live" TV picture of heat radiation. More sophisticated cameras can actually measure the apparent temperature of any object or surface in the image. The cameras can also produce color images that make interpretation of thermal patterns easier. An image produced by an infrared camera is called a *thermogram* or sometimes a *thermograph*.

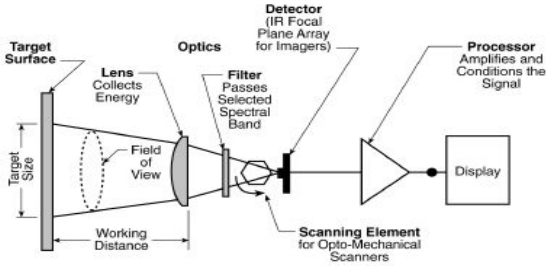

Fig. 1 Components of an Infrared Sensing Instrument

Infrared Thermography is a non-intrusive testing method that allows plant personnel to detect thermal anomalies in energized electrical equipment. To effectively use thermography as a predictive maintenance tool, the data collected during each thermographic inspection should be stored, thereby permitting easy development of a database of trend information so that incipient problems can be quantified and tracked.

2.2 Infrared Thermography(IRT) Testing Assessment Method

Providing a comprehensive IRT program requires a defined approach that is designed to meet specific IRT goals. These IRT goals should be driven by specific plant goals such as availability, forced outage rate, performance(heat rate), and so on. Over time, these goals might change due to the operating mode of the plant, as well as technology advancements that might allow for new applications not previously possible.

Therefore, it is important to continuously monitor a program's direction to ensure that it is current with existing plants goals and the technological advancements. Over the year, EPRI has designed a method to monitor a plant's current condition for various programs, as compared to the industry's best practices. This method was first started to gauge the effectiveness of a Predictive Maintenance(PdM) program. The success of the PdM model has inspired new models to include Plant Maintenance Optimization(PMO) and several technology models(vibration, IRT, lube oil, and motor monitoring). Each model uses industry experts to define the categories and sub-categories that determine which activity is required to achieve a best practice or world class ranking. The results are tabulated and displayed in the form of a spider chart. The spider chart's best practice grade is considered world class and is numerically graded by 8 grades for each of the respective categories.

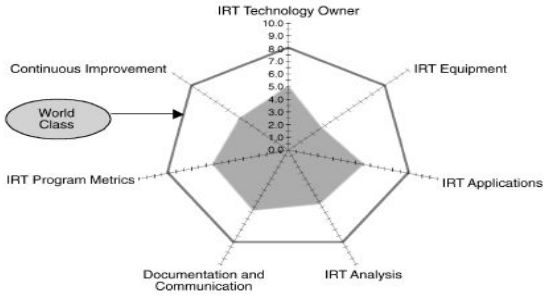

Fig. 2 Infrared Thermography Program Assessment

2.3 Plant Thermography Diagnosis Test Results

In accordance with the plant preventive maintenance program process, the thermography diagnosis condition grade reference value (alert value and limit value) was determined after thermography diagnosis equipment to be inspected and inspection frequency were chosen.

With the data base for the Integrated Preventive Diagnosis System's thermography measurement obtained, the thermography photograph and result were entered and consulting the thermography diagnostics guideline, thermography analysis was performed using the Integration Preventive Maintenance System's thermography diagnosis program (Infrared Analysis). After analyzing the thermography results, it was checked whether they exceeded each criteria or if there existed any abnormal trends. With the thermography diagnosis results, maintenance was conducted on the equipment that has been determined as "Red/Yellow" according to the Plant Procedures Preventive Maintenance Program.

Grade	Condition Criteria
Green (Good)	- Parameters monitored and results from analysis are normal.
White (Monitoring)	- Equipment doesn't exceed the performance criteria but changes (increase, decrease) are found that require monitoing
Yellow (attention)	- Exceeding Normal operation range(alert value) or abnormal changes detected.. - Whether the measures need to be taken or the monitoring cycle needs to be shortened.
Red (Immediate Respond)	- The permitted range or limited range(limit value) is exceeded. - Measures must be taken immediately.

Fig. 3 Thermography Diagnosis Condition Grade Reference Criteria Chart

3. Conclusions

Maintenance is conducted every six months to two years on all the 428(in Young Gwang NPP #1,2) plant thermography diagnosis equipment to be inspected including pumps, fans, transformers.

Through the thermography measurement, there was a abnormal temperature detected recently on the transformers and pumps which was promptly responded to before showing any signs of malfunction, contributing to improving reliability of the facility.

In case of the high-voltage switchgear, for the safety of the thermography inspector, additional safety precautions should be taken by installing the thermography measurement inspection window on the transformer's panel door.

REFERENCES

[1] Predictive Maintenance Primer, TR-1007350, EPRI, 2003

[2] KHNP Engineering Work instructions(rev. 03)

[3] KHNP Maintenance management procedures

[4] Young Gwang NPP #1,2 Thermography diagnosis test results report