CASE STUDY
GENERATOR HOT SPOT DETECTION

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ABSTRACT

Generator Condition Monitors (Core Monitors) have been protecting hydrogen cooled generators through the early detection of overheating for over three decades. In recent years, a major portion of new power plant installations involve larger air cooled generators. Both generator manufacturers and power producers recognize the need to monitor overheating in air cooled machines as well.

This paper discusses the utilization of a Generator Condition Monitor for Air Cooled Apparatus (GCM-A) and an incident on a 255 megawatt generator at Blackstone Energy Project. The incident illustrates the effectiveness of a GCM-A, in detecting generator hotspots.

INTRODUCTION

Advancements in air-cooled generator designs have resulted in increasingly higher power ratings. The higher power densities place significantly greater stresses on materials and structures, making slight decreases in cooling efficiencies much more critical. Probability of overheating in these air-cooled machines becomes greater as designs are pushed ever closer to their critical limits [1].

Corrective action prompted by early warning of generator hotspots can mean the difference between a brief shut down for minor repairs and a major and costly overhaul.

American National Power (International Power) decided to use Generator Condition Monitors for Air Cooled Apparatus (GCM-A) to protect their generators at Blackstone Energy Project, Bellingham Energy, Hayes Energy Project and Midlothian Energy Project. Prior to making that decision, extensive testing was conducted, by National Power, at the Deeside Power Station in England to confirm the effectiveness of the GCM-A (Figure 1).

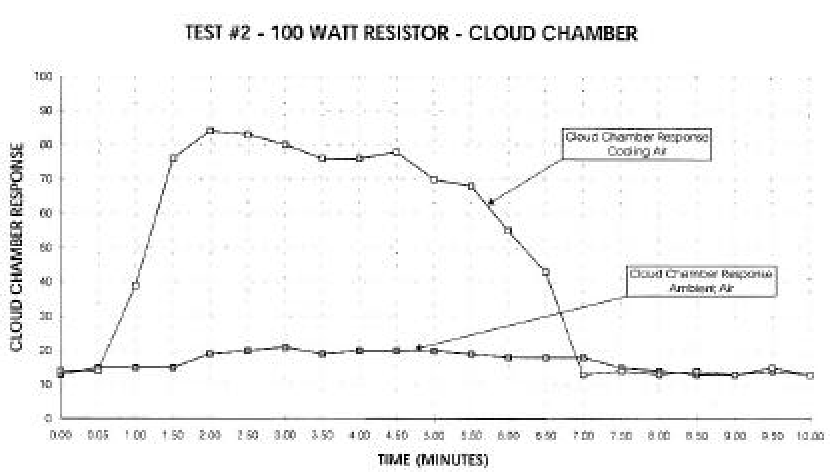

Figure 1. Resistor Overheat Test

All of the International Power generators incorporate "Totally Enclosed Water to Air" (TEWAC) cooled ventilation systems. The rated outputs of the generators are 300/340 MVA and use class F stator winding insulation. The GCM-A's have been in operation since 2001.

EARLY DETECTION OF GENERATOR HOTSPOTS

High concentrations of sub-micrometer particles (pyrolysis products) are released whenever any material is heated sufficiently to create thermal decomposition. The GCM-A detects the pyrolysis particles emitted into the cooling air (or ambient air) as a result of overheating or arcing.

The GCM-A monitors multiple air sample lines (locations) using a highly sensitive particle detector. The detector used to make these invisible particles large enough to monitor for concentration is a Wilson Cloud Chamber. The Wilson Cloud Chamber has been used and proven effective as an early warning, air sampling type, fire detector for several decades.

One sample line monitors ambient air, which serves as a reference since the particle level in the ambient air can change significantly and influence the particle level of the generator cooling air. One or more additional sample lines (or probes) are used to monitor the generator cooling air, which is compared against the particle level of the ambient air (Figure 2). High particle levels in the generator cooling air, without a corresponding increase in the ambient air, confirms the source of the pyrolysis particles is from within the generator. Conversely, if the particle level in the ambient air increases the source of the overheating must be outside the generator.

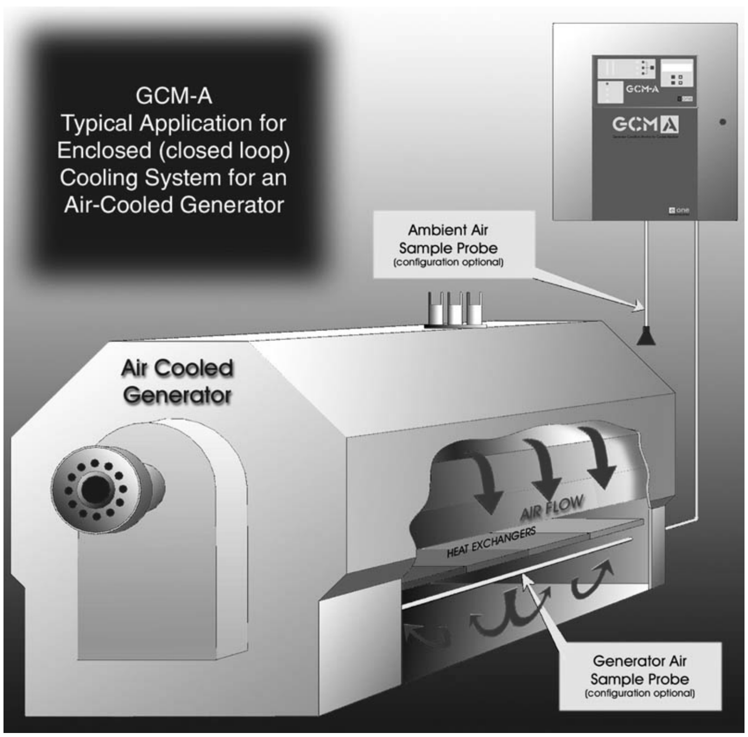

Figure 2. GCM-A Installation

INCIDENT

On Wednesday, May 14, 2003, an ambient alarm was received in the control room from the Unit 1 GCM-A (Figure 3). Since there was no activity (welding, cutting) taking place in the turbine hall that would cause an ambient alarm, the I&C Department was asked to investigate. Investigation of the exciter end of the generator found arcing and sparking coming from the slip ring assembly (Figure 4).

The slip ring assembly consists of two slip rings; positive and negative. Each slip ring has five brush holders, two on one side and three on the opposite side. Each brush holder holds three carbon composite brushes.

Figure 3. Blackstone, GCM-A Installation

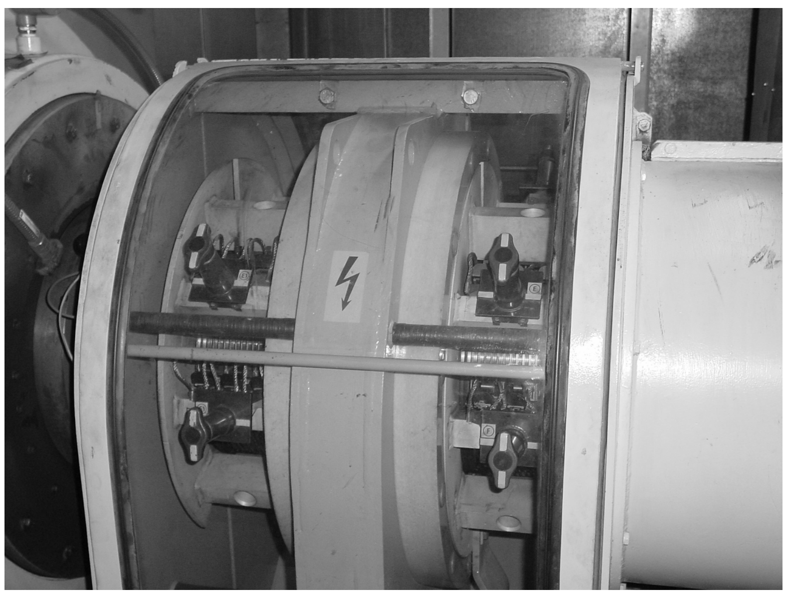

Figure 4. Brush Holders

It was discovered that the brushes in the top two brush holders on the positive slip ring were arcing and sparking. It was also noted that one brush in each of the top two brush holders was glowing.

When the three brushes were removed from the first top brush holder, the arcing and sparking in the second top brush holder became more severe, due to the increase in load. After all the brushes in both top brush holders were replaced the arcing and sparking stopped.

The most affected brush holders held brushes with an estimate life of 3 months to 2 weeks left. The brushes (Figure 5a & 5b) had a very uneven brush wear patterns (broken edges, rough surfaces, pitted sections, and lacked sharp edges, shiny and smooth surfaces like new brushes). There was evidence of brush overheating, including the pigtail shunt wiring and the spring tension pad.

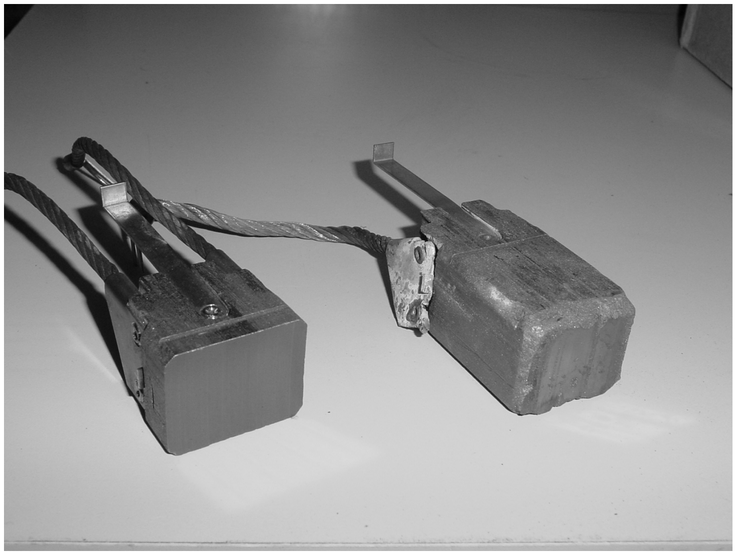

Figure 5a. Good Brush/Bad Brush

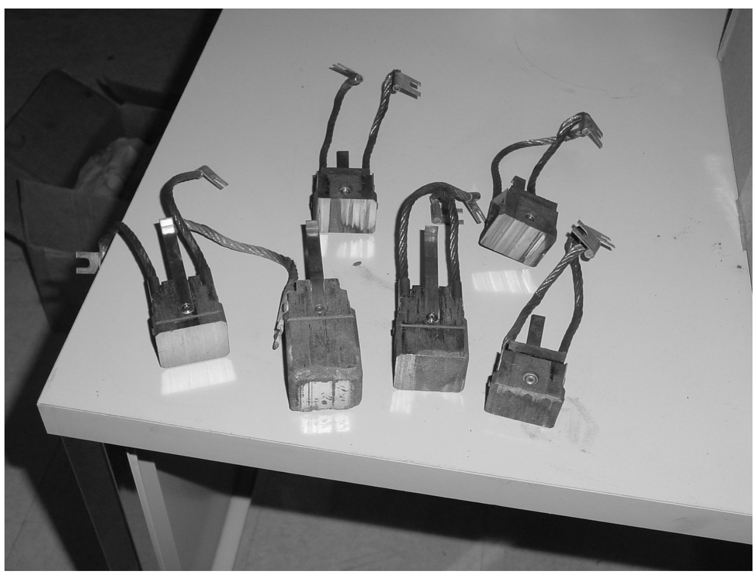

Figure 5b. Good Brush/Bad Brushed

This incident was the first sign of vibration at Unit 1 since a rotor swap out. Replacing all brushes with new, full length brushes was viewed as a temporary solution to the problem. To fully correct the problem, the collector ring had to be re-machined and honed. Both the positive and negative rings were machined, removing 3 to 5 thousandths. The rings were then honed. A vibration analysis was performed on turning gear up to full speed with good results

REFERENCES

D.J. Wallis, Steve Kilmartin "Can You Believe Your GCM?", Eighth EPRI Steam Turbine Generator Workshop and Vendor Exposition, August 2003.