GENERATOR ROTOR REPAIR FOLLOWING THERMAL SENSITIVITY PROBLEM

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ABSTRACT
Generator rotor thermal sensitivity is a phenomenon found on the generator rotor causing change in vibration as the field current is adjusted. The discussion in this paper has been experienced in the two-pole gas-turbine-driven generators which are installed at South Bangkok Combine Cycle Power Plant Block No.2. The second block consists of two 291 MVA gas-turbine-driven generators and one 291 MVA steam-turbine-driven generator. After careful investigation, the thermal sensitivity problem has been found on both gas-turbine-driven generators. In one generator, namely SB-C22, the thermal problem caused mal-operation in reactive power generation. The excitation controller failed to achieve its maximum reactive power due to the excessive vibration in the rotor. This problem was clearly observed and successfully fixed. It has also been found that another generator, namely SB-C21, shows the similar manner as the SB-C22.

UNIT HISTORY AND DATA
The South Bangkok Power Plant is a multi-unit plant located in Samutprakarn, a province in the outskirts of Bangkok. The power plant has installed total capacity of 2,289 MW. Its capacity is contributed by five thermal power plants and two blocks of combined cycle power plant. The second combined cycle which is considered in this paper has been generating power using two gas-turbine-driven generators since 1996 and the steam-turbine-driven generator was completed in 1997. In 2002, the second gas-turbine-driven generator, SB-C22, faced the thermal sensitivity problem and it was unable to generate reactive power due to its excessive vibration. It was able to generate real power up to based load but reactive power is none. Highest field current is 950 A and the casing vibration at exciter-end bearing was limited at 0.5 in/s. Moreover, the vibration records showed that the generator had been increased the vibration level remarkably after every trip. The unit was closely monitored and tested in order to investigate whether it is the severe problem of thermal sensitivity. The results indicated that the generator was in critical condition and then the repair work was set up with the cooperation of the manufacture. Meanwhile, the first gas-turbine-driven generator, SB-C21, also shows the sign of thermal sensitivity behavior but it is not severe and it has been operating without any significant sign.

The generators are indirect H2-cooled, 291 MVA, 15 kV, 0.85 power factor and 3600 rpm. Their two-pole cylindrical rotor consists of 32 slots containing 13 turns of copper winding on each slot. Rated field current is 1,672 A and rated field voltage is 550 V. The cooling system of the rotor is radial flow cooling using two axial flow fans.

DIAGNOSIS TESTING
The operational condition monitoring and online thermal sensitivity testing were performed on both generators in order to diagnose the severity of the problem.

Figure 1 Bearing vibration variation due to the increasing field current
Figure 2 Shaft vibration changes proportional to the MVAR variation
Figure 3 Polar plot showing once-per-revolution vibration vector comparison on the generator SB-C21
Figure 4 Slot configuration of the generator field

Thermal Sensitivity Testing
The test is conducted to prove whether the vibration problem is caused by field current changes or prime mover force changes. Vibration as a function of megawatt loading is not a thermal sensitivity mechanism [1]. The two generators did not involve the test under constant field current due to certain constraints but they were investigated under the constant megawatt.

The SB-C22 generator was tested at 130 MW while the MVAR was varied from -30 to 65 MVAR. The results revealed serious condition of thermal sensitivity shown in Figure 2. The reactive power is -30 MVAR at point A then it was increased to 65 MVAR at point B. The vibration reached to point C in 40 minutes while the reactive power was fixed. Afterward, the vibration was decreased immediately while the reactive power was reduced. The results on the generator SB-C22 had been concerned as a critical reversible thermal sensitivity problem. Therefore the unit was shutdown to perform the repair work.

The SB-C22 generator is able to operate without any limitation. It has also been found that another generator, namely SB-C21, shows the similar manner as the SB-C22.

INVESTIGATION USING OPERATIONAL DATA
The operational data of SB-C22 was collected during 28 to 31 January 2003. The result in the figure 1 shows that the vibration of generator bearing changes directly due to the change in field current. At exciter end (BB9), the increment reveals obviously while it is smaller change on turbine end (BB7, BB8). Whereas, none of significant change appears on the other bearings neither located at turbine or compressor (BB1, BB2, BB4 and BB5). For SB-C21 which is considered as a non-severe case, even though the thermal sensitivity sign is revealed by the thermal sensitivity testing, no significant change is revealed by operational data monitoring.

Figure 5 Sub slot cover migrated with maximum distance of 300 mm
Figure 6 New designed leaf springs (left) and the positive stopper (right)

After the repair work, thermal sensitivity investigation was performed when the unit starts and the test was repeated three month later. The result indicated that generator had been operating without thermal sensitivity problem. However, the test did not involve online flux-probe test, an additional test which is recommended by the manufacturer, because this case revealed obviously that it is associated with the vent holes blockage.

CONCLUSION
The thermal sensitivity problem due to vent holes blockage which is taken place on the two generators shows that the risk of thermal sensitive rotor can be governed under appropriate monitoring and testing. This thermal sensitivity contributes to the reversible vibration, nevertheless, the generator is still able to operate if the vibration does not exceed the limit. Otherwise, the problem is needed to mitigate.

REFERENCES