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Siemens Transformers – Case study

# Reduced downtime thanks to TLM repair

## From outage to grid reconnection in just six weeks

### The challenge

Transformer outages are always a cost(ly) factor. However, for a generator transformer in a power plant, the outage costs affect the balance sheet more directly than for a partially utilized grid transformer.

In the case of Mehrum power plant, a coal-fired power plant in Lower Saxony, Germany, an arc caused the explosion of a high-voltage bushing. The affected 780 MVA transformer, rated at 220/21 kV, was built in 1977

by Trafo Union (now Siemens) and had been in continuous reliable operation since that time.

Because the power plant operator had to reconnect to the grid in order to restore profitable operation as quickly as possible, the shortest feasible timeframe for diagnostics, repair, testing, and reconnection of the transformer was a prerequisite for the contract.

### Mehrum power plant

Mehrum power plant is a hard coal-fired power plant in Germany with a net output of 690 MW. It is owned by Stadtwerke Hannover AG and Braunschweiger Versorgungs-AG & Co. KG. The efficiency of the Mehrum coal-fired power plant was significantly increased with a variety of upgrade measures in 2012. Since then, the plant has conserved 80,000 tons of coal per year while maintaining a comparable output level. The environmental balance is correspondingly impressive, preventing more than 180,000 tons of CO<sub>2</sub> emissions per year.



Defective bushing element and bushing pin

### The solution

As a manufacturer with over 100 years of experience in the development and construction of transformers, Siemens has its own division for transformer service, Transformer Lifecycle Management (TLM). Experienced personnel evaluate the condition of older units and also perform investigations on damaged units. The detailed electrical assessment report prepared by TLM for the affected transformer at this plant showed inconspicuous resistances and transformer ratios. Arcing damage to the winding could therefore be ruled out.

The experienced Siemens TLM repair team first performed a fact-finding inspection of the damaged area, then removed the dome and evaluated the condition of the removed parts. Various measures were implemented to upgrade the transformer, which was then professionally recommissioned. Only six weeks passed from the occurrence of the damage to reconnection of the power plant to the grid.



### Special technical features

#### 1. Root cause analysis

The arc in the bushing had caused an explosion of the capacitor element, which was split. This resulted in melting of the copper on the copper pin. The pressure of the evaporated oil exploded the element and bent the 80 mm thick copper pin.

#### 2. Fact-finding inspection of damaged area

The oil was drained from the transformer. A variety of measures were taken to prevent contamination of the damaged area. For example, the opened roof was covered with a plastic sheet and all exposed parts were immediately cleaned with an oil vacuum.

#### 3. Removal of dome

With continuous observation of cleanliness guidelines, the dome was lifted off and the defective insulating elements on the high-voltage lead were removed. Contaminant particles were immediately removed. The other visible parts proved to be undamaged.

#### 4. Evaluation of condition of removed parts

The removed particle board elements as well as the insulated electrodes were carefully examined and any minor damage repaired. A new insulating cylinder and attachment for the bushing needed to be fabricated. The shielding brackets also had to be replaced.

#### 5. Evaluation of overall transformer condition

With the exception of the damaged components, the overall condition of the transformer was evaluated as good. The electrode and lead were repaired and the bushing was replaced.

#### 6. Additional measures performed

After filling with oil, the transformer underwent a special oil cleaning process. This involved filtering the oil at special cleaning intervals, during which the oil is pumped through the tank. This removes any contaminants still in the core and coil assembly, reducing any residual risk of a failure.

After reassembly, the transformer was tested using the Siemens TLM portable test facility. The unit was specifically tested for partial discharges.

### Prevention or repair?

Expert transformer repairs can be performed in a short time and can even improve the service life of the affected unit. Siemens sees itself as a true partner with its customers, especially in emergencies. In emergent situations, we make every effort to provide flexible and swift solutions that are in the customer's best interest.

However, these "fire alarms" can also be prevented. Transformer operators can implement valuable condition assessment management to guard against failures and to schedule the performance of any necessary repairs or modernization measures. The required investment costs are offset by a lower risk of outages and increased efficiency of the units involved.

Sample calculation: Outage & repair costs vs. Condition Assessment & scheduled repair	
Outage costs at German coal-fired power plant (1 GW) per day	approx. €1 million
Probability of failure	1% per year
Effect on lifecycle costs (for an assumed service life of 50 years)  50 years x 1%/year x 15 downtime x €1 million/day = €7.5 million additional lifecycle costs	
Costs of condition assessment/bushing replacement	
<b>Level 1</b> Assessment (visual inspection, oil analysis, thermography during operation)	approx. €1,000 per transformer per year
Bushing diagnostics (max. 8 bushings)	approx. €2,500 about every 5 years
Online bushing monitoring	by type/one-time
<b>Level 2</b> Assessment (electrical measurements, transformer not in operation) – generally only in the event of irregularities found in Level 1  Depending on size, voltage series and complexity	approx. €3,500–12,000
<b>Level 3</b> Assessment (deployment of portable power and maximum-voltage test facility)	approx. €45,000

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