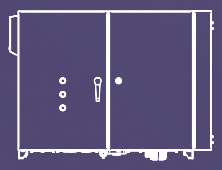


CONNECTING DATA TO DECISIONS

Case Study 1
South Korean Transmission Company

Linking Total Transformer Monitoring & Actionable Information
to Drive Business Value for Utilities

camlin energy

SOUTH KOREAN TRANSMISSION COMPANY REPLACES BUSHINGS DUE TO ONLINE MONITORING

Details
South Korean Transmission Company successfully replaces 345 kV bushing.

Evidence
Online monitoring showing capacitance increase and high energy events.

Bushing and partial discharge monitoring was installed in 2015 on a single-phase transformer bank in Ulsan, South Korea. The installed device was continuously monitoring the currents from the bushings and the partial discharges from both the main tank and bushings using properly designed tap adaptors installed at the bushing test taps. The acquisition was continuous (not scheduled) and simultaneous in all phases with the results summarized every hour. The bushings, from NGK, were 30 years old, OIP, 345 kV, around 430 pF of capacitance.

On February 2015, a sudden step increase of the capacitance (C1) in bushing A was detected by the monitoring system, estimating a capacitance change in the order of 1.7% which corresponds to a rough increase of 7 pF. Such a small change could have been caused by a partial short circuit between two layers in the condenser core, considering >60 control layers for 345 kV bushings. South Korean Transmission Company planned an offline test to confirm the online readings, but the results proved difficult to interpret. Indeed, the absolute value of bushing A capacitance had not changed significantly from the previous measurements, as shown in Table 1.

Table 1. Offline results before (2012, 2014) and after (2015) the online alarm.

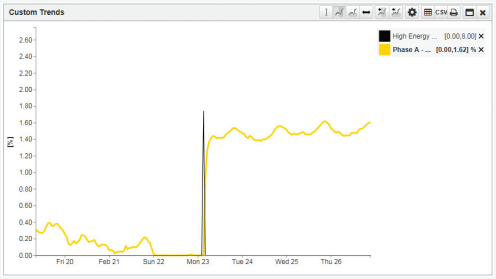
345 kV NGK Bushing OFFLINE Capacitance C1 (pF)				
	2012	2014	2015	Increase since 2012
Bushing A	435	429	438	0.60%
Bushing B	433	430	426	-1.60%
Bushing C	432	NA	430	0.46%

345 kV NGK Bushing OFFLINE Capacitance C1 (pF)				
	2012	2014	2015	Increase since 2012
Bushing A	435	429	438	0.60%
Bushing B	433	430	426	-1.60%
Bushing A-B	+2 pF	-1 pF	+12 pF	2.7%

However, it was noticed that while the increase of capacitance in bushing A was quite small, both bushings B and C were showing a decrease of capacitance. This led to the assumption that the test setup was different when readings were taken. In order to take this into consideration, the relative difference between capacitance A and B was analysed over time. It was then possible to spot that this difference was quite constant in 2012 and 2014 (below 2 pF), while it was significantly high in 2015, exceeding 12 pF (roughly equal to 2.7% of capacitance increase).

This offline test was not conclusive but led to further investigation of the online data.

Figure 1. Capacitance increase in bushing A1 and high energy event recorded at the same time.

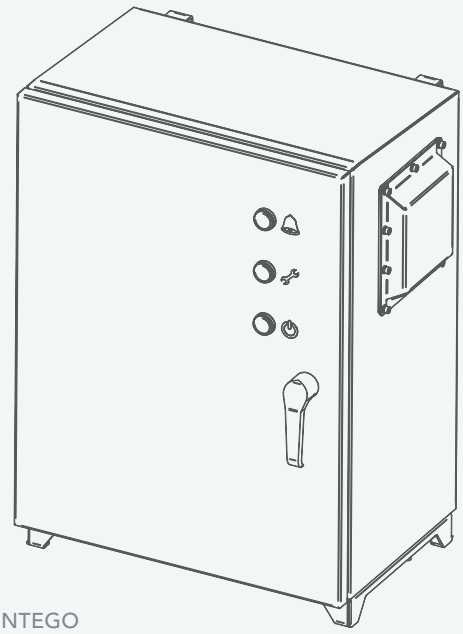


It was then found that at the precise moment of the bushing capacitance increase, a high energy event (partial discharge activity with significantly high magnitude, generally equal or higher than 20 V peak-peak [6]) was recorded in the same phase (from same sensor) by the online monitoring system. In this case, the recorded event had just 8 pulses per second and it happened just once. The fact that this event was recorded in conjunction with the capacitance increase was an important detail that prompted an additional offline test: oil sampling from the bushing and Dissolved Gas Analysis (DGA). Table 2 reports the results of the DGA analysis for bushings A and C. It can be clearly seen that the amount of acetylene in bushing A is well above the tolerance values, being 76 ppm; while level of acetylene in bushing C was zero, as expected.

Table 2. Offline DGA results for bushings A and C

OFFLINE DGA results for Phase A and C bushings		
	Phase A	Phase C
H_2	17	28
CH_4	40	39
C_2H_2	76	0
C_2H_4	44	1
C_2H_6	32	62
CO	71	53
CO_2	564	789
N_2	150.862	156.665
O_2	10.280	4.337

Following the results shown in Table 2, South Korean Transmission Company promptly planned and executed the bushing replacement within a few months, thus saving the bushing from a potentially catastrophic incident. It must be noted that both the capacitance change and the repetition rate of the high energy event were quite small in terms of absolute magnitude. But being able to detect both these phenomena online and see that they occurred in the same moment provided crucial information enabling South Korean Transmission Company to take a very successful action.



INTEGO

South Korean Transmission Company was able to take a very successful action thanks to the correlation of online data showing small variations of capacitance and partial discharges.

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