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Best practices for Partial Discharge Monitoring of HVDC Cable Systems and Qualification Tests

Taking into account that the most important internal insulation defect, which corresponds to a cavity, causes pulses with a low repetition rate and a limited amplitude value, online PD monitoring systems must have a powerful noise filtering tool and an efficient PD clustering tool that allows to separate the noise signals and the different PD sources detected by the sensors.

They must also identify each PD source with a type defect : cavity, external surface defect, corona, floating potential, etc. using a robust AI recognition tool. To do this, a wide catalog of PD patterns associated with different types of defects must be available for the learning process. The way to distinguish one defect from another is through the pulse analysis of PD trains associated with each PD source (figure 1). It is necessary to analyze: a) Apparent charge of the individual PD pulses vs. time, b) Accumulated apparent charge vs. time, c) Monotone decreasing PD histogram, d) Histogram in PD charge intervals e) PD pattern of variations of time intervals between consecutive pulses Δt_n-Δt_{n-1}, f) PD pattern of variations between the values of apparent charge of consecutive pulses Δq_n-Δq_{n-1}.

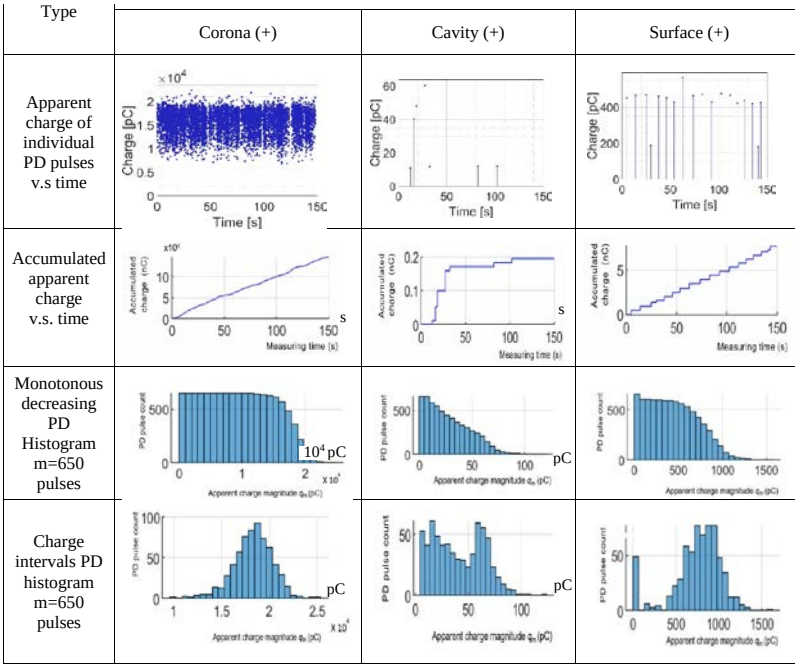

Figure 1. PD Patterns associated to different insulation defects.

Thanks to a European project, which began in 2020 and ends in May 2023, a reference database of PD current pulses linked to type defects has been generated by laboratory tests. It is advisable that other research institutes develop more reference databases of "defect types" to make international comparisons that lead to international traceability of reference PD event trains linked to "defect types".

A testing setup and a procedure have been also developed (figure 2) for qualification of PD analyser working up to 30 MHz. Five qualification tests have been defined: a) noise rejection test, b) sensitivity test, c) clustering test, d) recognition test and e) PD location test (Table 1). Using the testing setup, a round robin test is being carried out among five research institutes that apply the developed qualification procedure.

Figure 2. Testing Setup : PD emulator for PD analyser qualification

Table 1

		Qualification Tests
PD Analyser	PD Measuring System	1) Non-impulsive noise rejection (for AC and DC).
		2) PD sensitivity
		2.1 Largest repeatedly occurring PD magnitude (for AC)
		2.2 Linearty check of the measuring system (for AC and DC).
		2.3 Resolution time, T_r of the measuring system (for AC and DC).
		2.4 Determination of the Scale factor, k vs PD time, T_{PD} (for AC and DC).
		3) PD clustering performance (for AC and DC)..
		4) PD recognition performance (for AC and DC)..
		5) PD location performance (for AC and DC).

If, in addition, the HVDC cables are long, many tens of km or hundreds of km without access to the cable screen, it will be necessary to have sensors along the cable, e.g. integrated and self-powered.