

PROMOTioN DC GIS Technology Demonstrator Test requirements, procedures and methods

DNV GL, ABB, 20th of September 2018



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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691714.

Content

- Definition of test requirements, test methods (K. Dimitropoulos)
- Test procedure of prototype installation test (H. He)
- Status of testing of ABB 320kV pole (H. He)
- Test pole (M. Gatzsche)



Definition of test requirements

- Type tests are based on IEC 62271-203 and CIGRE JWG D1/B3.57
- Focus is given on the dielectric tests due to difference between AC and DC fields in insulating materials
- Additionally to the dielectric tests of AC GIS the following type tests are recommended by CIGRE for DC GIS:
 - Superimposed impulse tests
 - Polarity reversal test (not mandatory)
 - DC insulation system test



Test procedure of prototype installation test

Motivation

- Lack of operational experience
- Demonstrate the reliability of long term performance

Summary

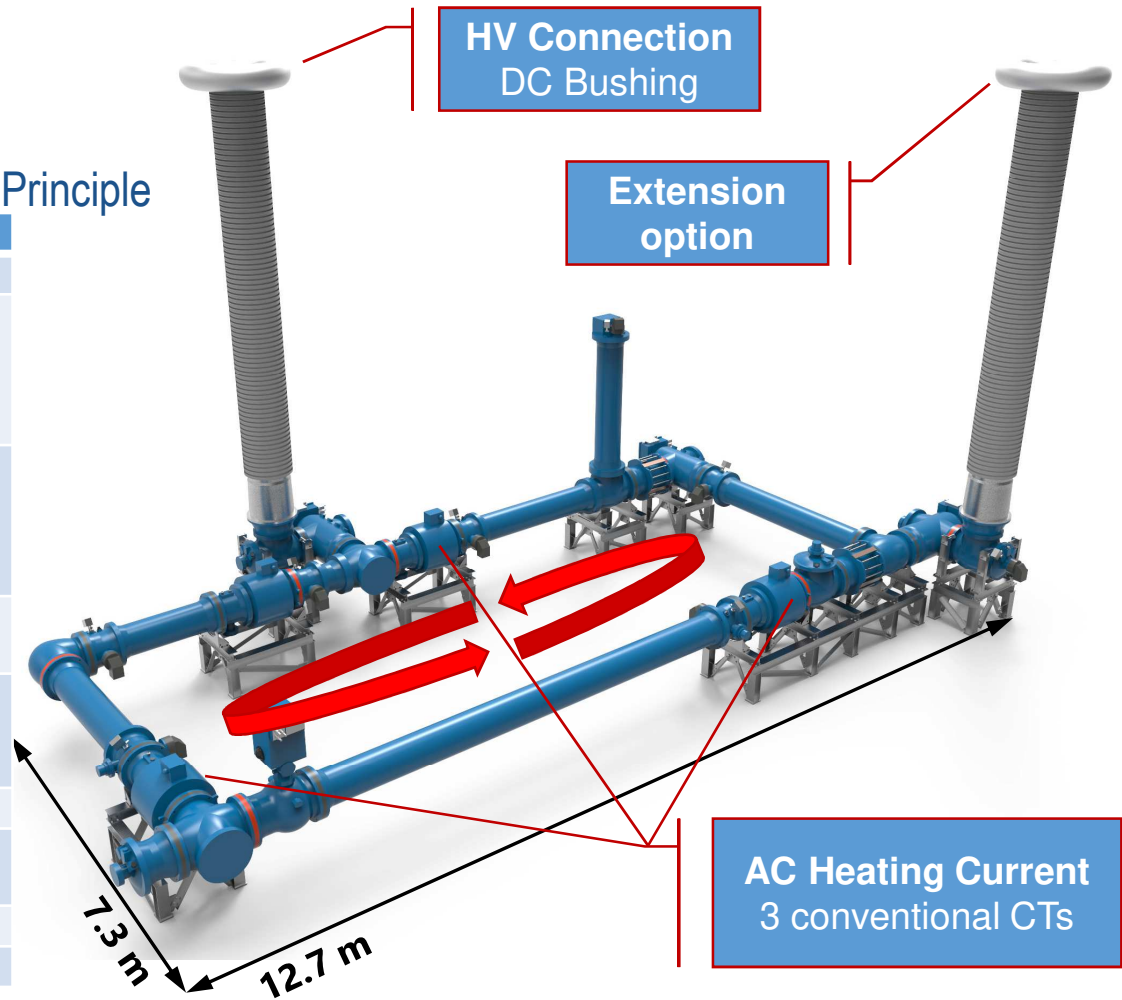
- Pre-tests
- **Long-term voltage test (one year test)**
 - Thermal and dielectric test simultaneously
- Subsequent tests



HVDC GIS demonstrator

ABB HVDC GIS Ratings & Test Pole Principle

Nominal DC voltage U_n	± 320	kV_{dc}
Rated DC voltage U_r	± 350	kV_{dc}
Rated superimposed LI withstand voltage U_P / U_r		
Lightning impulse voltage	± 1050	kV
DC voltage	± 350	kV_{dc}
Rated superimposed SI withstand voltage U_S / U_r		
Switching impulse voltage	± 950	kV
DC voltage	± 350	kV_{dc}
Rated DC withstand voltage to earth U_w	± 610	kV_{dc}
Rated normal current I_r	2000/ 2600/ 4000	A_{dc}
Rated peak withstand current	160	kA
Rated short-time withstand current	64	kA
Rated duration of short-circuit	1	s
Ambient temperature range	-30/+40	$^{\circ}\text{C}$



HVDC GIS demonstrator

Components

Ring

- 8 gas compartments
- 31 m busbar (straight, L, T, X elements, dismantling unit)
- Partition Insulator: 8 pcs.
- Support Insulator: 14 pcs.

GIS Instrument Transformers

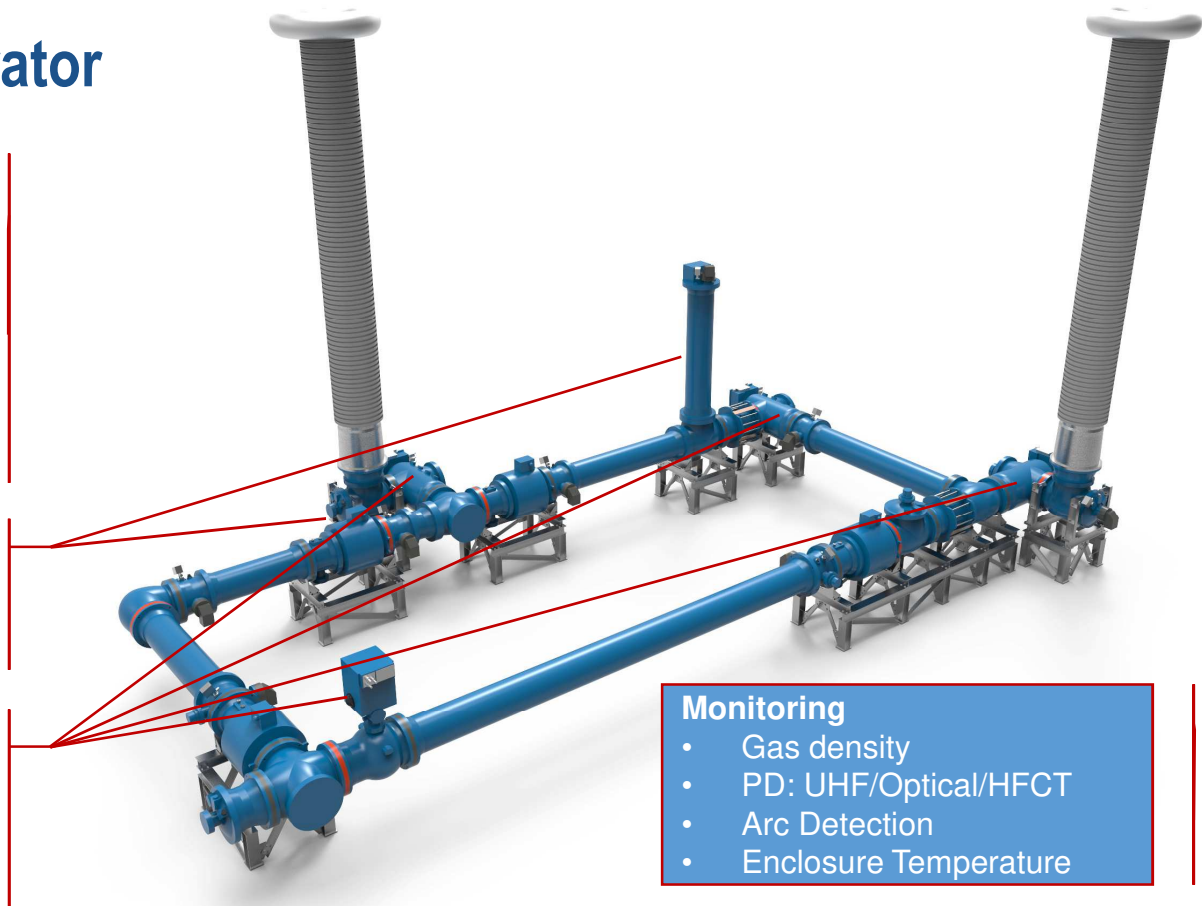
- Voltage: RC-divider
- DC/AC: Zero-Flux Sensor

Switching Devices

- 3 disconnect and earthing switches
- Fast-acting earthing switch

Monitoring

- Gas density
- PD: UHF/Optical/HFCT
- Arc Detection
- Enclosure Temperature



Pre-tests

Step	Test	Conditions	Load
1.	Thermal cycle pre-test	Heating up to steady state with I_{eqac} or I_r	LC / HL
2.	AC PD measurement	Pre-stress at U_{acpre} ; PD measurement at U_{acpd} .	ZL
3.	DC PD measurement	Pre-stress at $\pm U_{dcpre}$; PD measurement with $\pm U_{dcpd}$.	ZL
4.	Lightning impulse test	LI voltage U_{TP}	ZL
5.	Switching impulse test	SI voltage U_{TS}	ZL
6.	Superimposed LI test	Positive and negative rated DC voltage U_r and U_{TP}	ZL
7.	Superimposed SI test	Positive and negative rated DC voltage U_r and U_{TS}	ZL
8.	Polarity reversal test	Polarity reversal $\pm U_T$	ZL / HL

ZL = zero load (zero heating), HL = high load (continuous heating), LC = load cycle,



Long-term voltage test

	ZL	ZL	HL	HL	ZL	ZL	HL	HL		HL	HL	HL	HL	LC	ZL	LC	ZL
Number of days	60	1	60	1	60	1	60	1		60	1	60	1	15	1	15	1
Test voltage	-		-		+		+			-		+		+		-	
	U_T	SIM	U_T	SIM	U_T	SIM	U_T	SIM/ACPD		U_T	SIM	U_T	SIM	U_T	SIM	U_T	SIM/ACPD

ZL = zero load (zero heating), HL = high load (continuous heating), LC = load cycle,

SIM = Superimposed switching and lighting impulse voltage test,

SIM/ACPD = AC partial discharge measurement at U_{ac} followed by SIM test.

x6

- Long DC phase
- Superimposed SI/LI voltage test



Subsequent tests

Step	Test	Conditions	Load
1.	DC PD measurement	Pre-stress at $\pm U_{dcpre}$; PD measurement with $\pm U_{dcpd}$.	ZL
2.	Lightning impulse test	LI voltage U_{TP}	ZL
3.	Switching impulse test	SI voltage U_{TS}	ZL
4.	AC PD measurement	Pre-stress at U_{acpre} ; PD measurement at U_{acpd} .	ZL



Test parameters

Test parameters	Value	Unit
Test DC voltage U_T	$\pm \text{min. } 385 \text{ (min. } 1.1 U_r)$	kV_{dc}
DC PD pre-stress (1 min) test voltage U_{dcpre}	$\pm 525 \text{ (} 1.5 U_r)$	kV_{dc}
DC PD test voltage (2 h) U_{dcpd}	$\pm 420 \text{ (} 1.2 U_r)$	kV_{dc}
AC PD pre-stress (1 min) test voltage U_{acpre}	$372 \text{ ((} 1.5 \times U_r)/\sqrt{2})$	kV_{rms}
AC PD (1 min) test voltage U_{acpd}	$297 \text{ ((} 1.2 \times U_r)/\sqrt{2})$	kV_{rms}
Test LI withstand voltage U_{TP}	$\pm 840 \text{ (} 0.8 \times U_p)^*$ $\pm 940 \text{ (PROMOTioN)}^{**}$	kV_{peak}
Test superimposed LI withstand voltage U_{TP} / U_r	$\pm 840^* / \pm 350$ $\pm 940 / \pm 350 \text{ (PROMOTioN)}^{**}$	$\text{kV}/\text{kV}_{\text{dc}}$
Test SI withstand voltage U_{TS}	$\pm 760 \text{ (} 0.8 \times U_s)^*$	kV_{peak}
Test superimposed SI withstand voltage U_{TS} / U_r	$\pm 760^* / \pm 350$	$\text{kV}/\text{kV}_{\text{dc}}$
Test AC heating current I_{eqac}	4000	A_{rms}
*: 80 % impulse voltages site tests of IEC 62271-203 [7]; **: higher PROMOTioN values, related to an LI rating of 1175 kV ($0.8 \times 1175 = 940$).		



Status

- Installation and commissioning of test object [completed]
- Pre-tests [ongoing]
- Long-term voltage test: expected end of 2018
- Subsequent tests: expected end of 2019



PROMOTioN – HVDC GIS

HVDC GIS demonstrator



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APPENDIX

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