Cigre WG A3-06 "HV Equipment Reliability"

Gas Insulated Substations (GIS) Reliability Results

Participation in the survey (2004-2007):

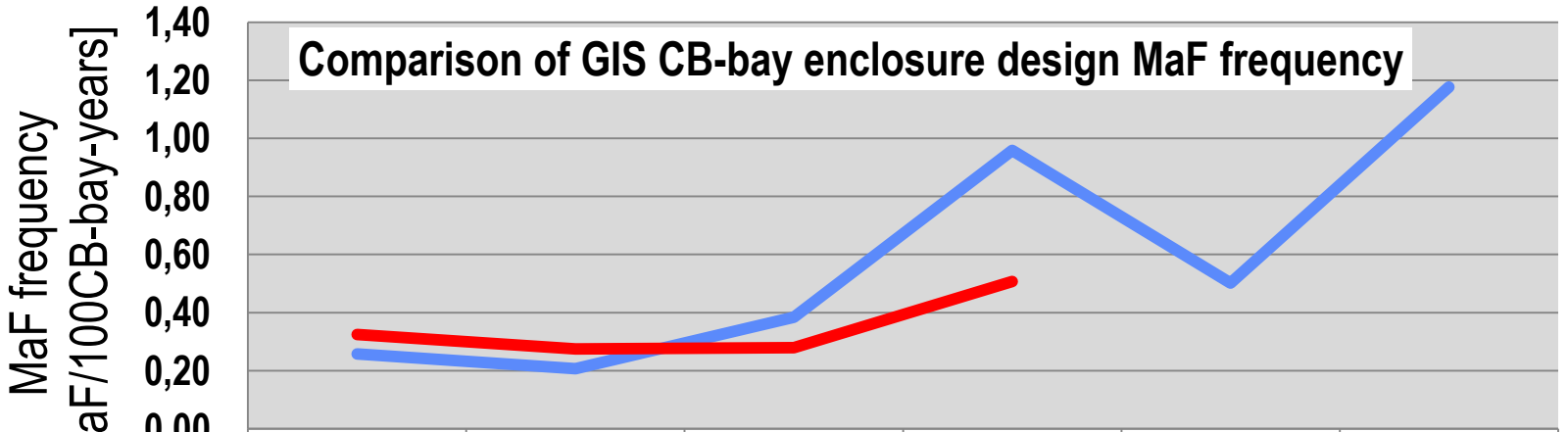
24 countries, 55 utilities

∅ annual reported population 22240 CB-bays

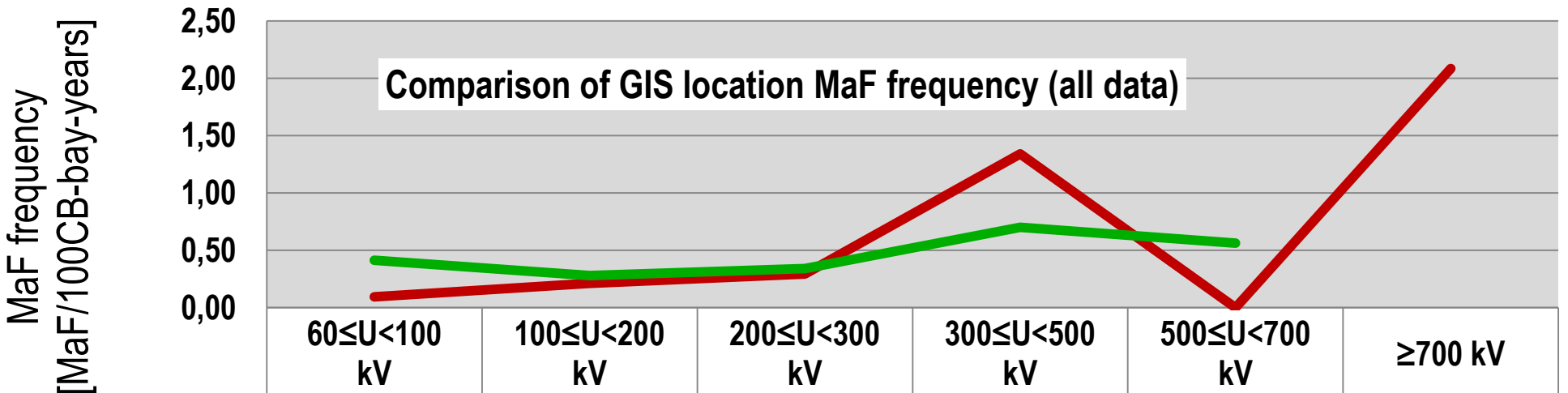
Evaluation made for 2 datasets:

	Service experience [CB-bay-years]	Number of major failures MaF	Number of minor failures MiF
All data	88948	326	1505
Without countries 14 and 23	7158	102	970

WB A3.06 - Reliability of HV equipment – GIS failure rates



	60≤U<100 kV	100≤U<200 kV	200≤U<300 kV	300≤U<500 kV	500≤U<700 kV	≥700 kV
CB-bay 1-phase (all data)	0,26	0,21	0,38	0,96	0,50	1,18
CB-bay 3 phase (all data)	0,32	0,27	0,28	0,51		



	60≤U<100 kV	100≤U<200 kV	200≤U<300 kV	300≤U<500 kV	500≤U<700 kV	≥700 kV
Indoor GIS (all data)	0,09	0,21	0,29	1,34	0,0	2,08
Outdoor GIS (all data)	0,41	0,28	0,34	0,70	0,56	

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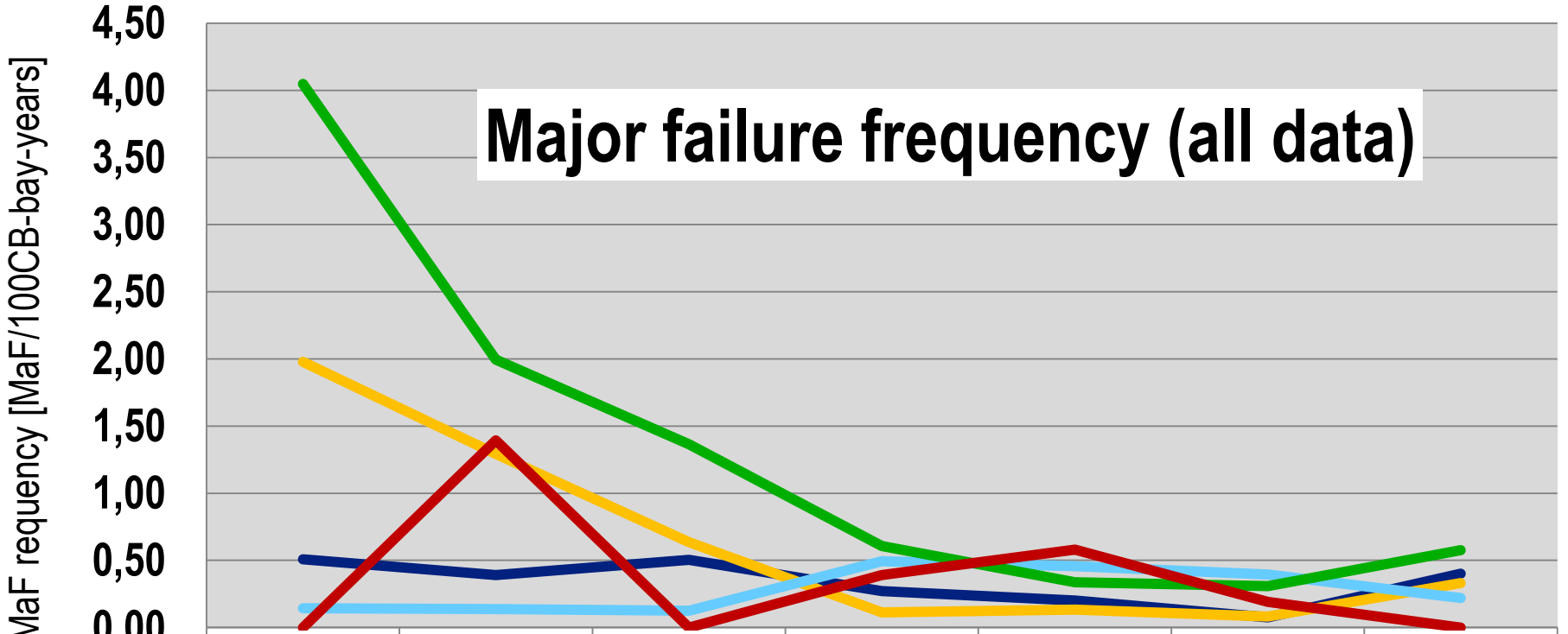
Voltage class	Outdoor GIS Major failure frequency [MaF/100 CB-bay-years] all data			Result of null and alternate hypothesis test with indoor GIS data results
	Point estimation	Lower limit	Upper limit	
60≤U<100 kV	0,41	0,34	0,50	Indoor better than outdoor
100≤U<200 kV	0,28	0,18	0,41	equal
200≤U<300 kV	0,34	0,20	0,53	equal
300≤U<500 kV	0,70	0,52	0,92	Indoor worse than outdoor
500≤U<700 kV	0,56	0,32	0,91	equal
Total	0,43	0,38	0,49	Indoor better than outdoor

Statistic calculations for 95% of confidence level and null and alternate hypothesis tests for comparisons

Voltage class	[MaF/100 CB-bay-years]		Test of null and alternate hypothesis	[MaF/100 CB-bay-years]		Test of null and alternate hypothesis
	2nd survey indoor GIS	3rd survey indoor GIS		2nd survey outdoor GIS	3rd survey outdoor GIS	
60≤U<100 kV	0,08	0,09	equal	0,03	0,51	3rd worse than 2nd
100≤U<200 kV	0,78	0,22	3rd better that 2nd	0,12	0,29	3rd worse than 2nd
200≤U<300 kV	1,12	0,33	3rd better that 2nd	0,46	0,34	equal
300≤U<500 kV	3,09	1,34	3rd better that 2nd	2,36	0,71	3rd better that 2nd
500≤U<700 kV	2,20	0,00	3rd better that 2nd	0,16	0,56	3rd worse than 2nd
≥700 kV	6,00	2,08	3rd better that 2nd	0,21	0,49	3rd worse than 2nd
Total	0,79	0,28	3rd better that 2nd	0,03	0,51	3rd worse than 2nd

WB A3.06 - Reliability of HV equipment – GIS failure rates



	before 1979	1979-1983	1984-1988	1989-1993	1994-1998	1999-2003	2004-2007
60≤U<100 kV	0,51	0,39	0,50	0,27	0,20	0,08	0,40
100≤U<200 kV	1,98	1,29	0,64	0,11	0,13	0,08	0,33
200≤U<300 kV	0,14	0,14	0,13	0,49	0,46	0,40	0,22
300≤U<500 kV	4,05	1,99	1,36	0,61	0,34	0,31	0,58
500≤U<700 kV	0,00	1,39	0,00	0,39	0,58	0,19	0,00

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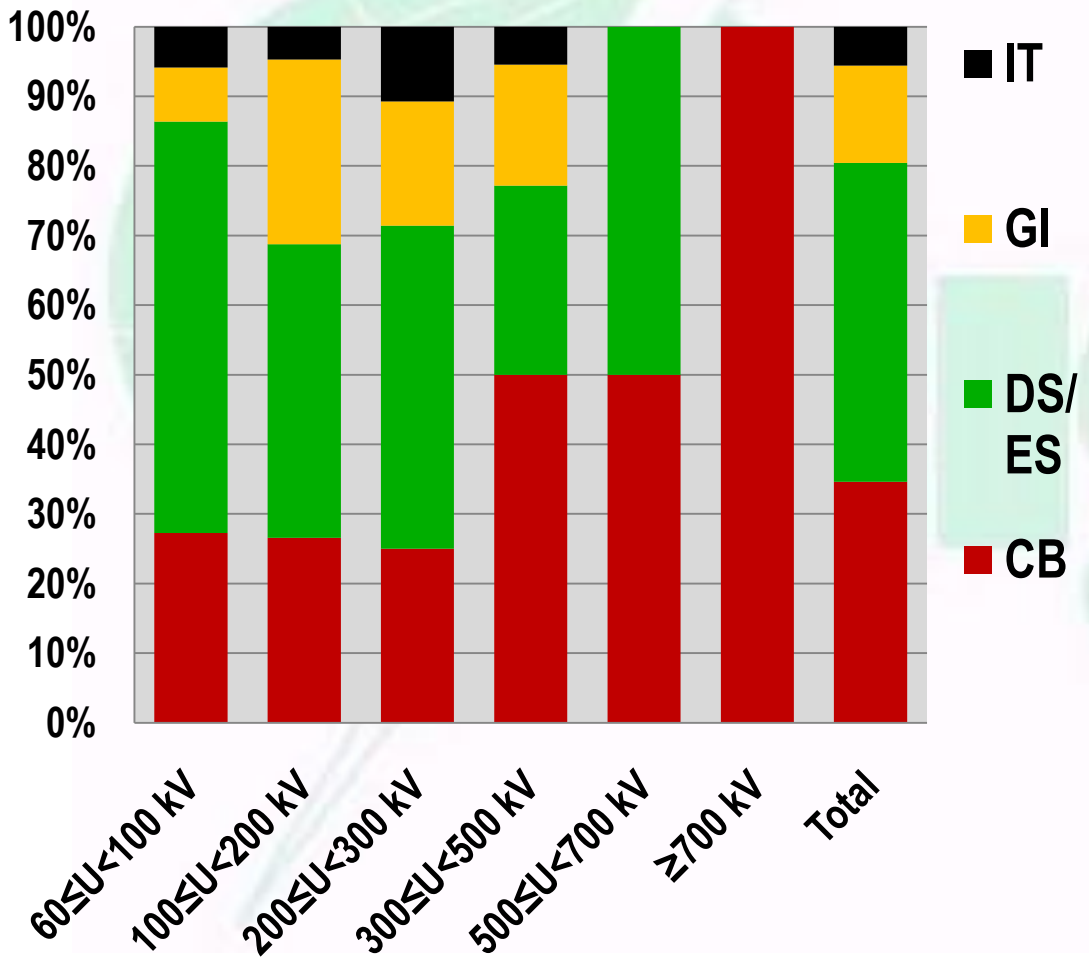
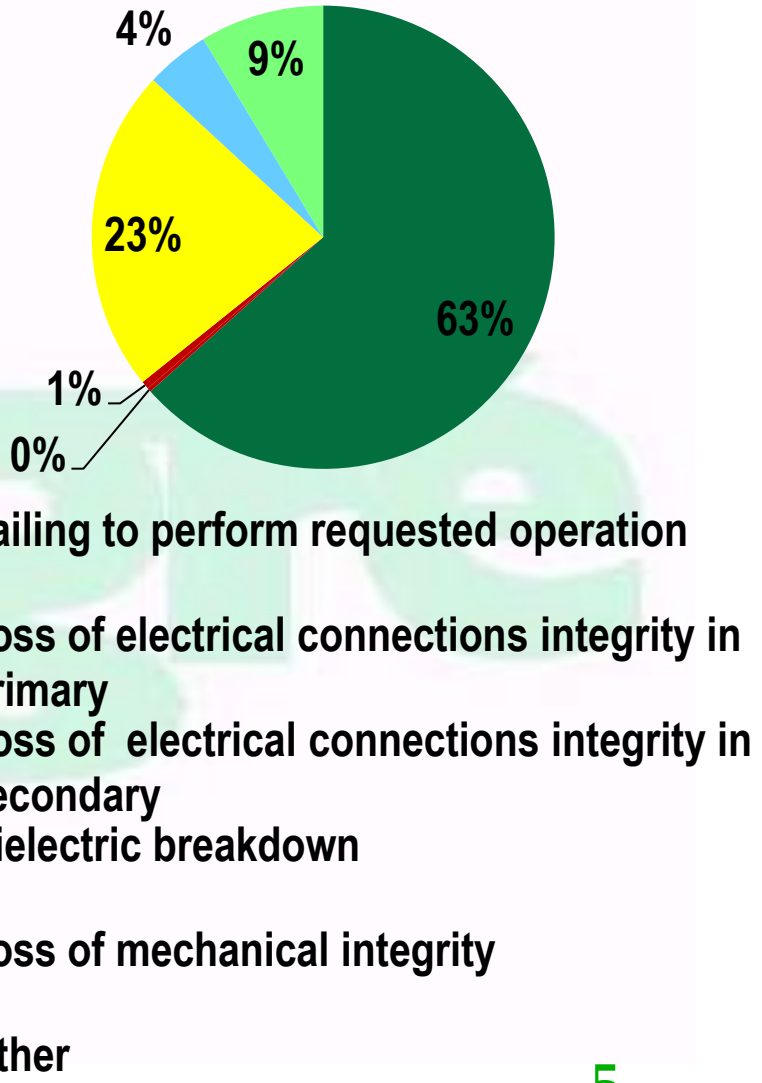
GIS equipment major failures (MaF) voltage classes distribution (all data)



Major failure mode (all data)



WB A3.06 - Reliability of HV equipment – GIS survey brochure

GIS analysis content (tables, graphs, comparison with 1995 survey results, findings and commentary):

- Population, major and minor failures, major failure rates per 100*CB-bay-year for GIS location, type of enclosure and design (GIS, MTS) per voltage classes and age
- Failure characteristics (component, failure mode, failed subassembly, service circumstances, origin, primary cause, environmental contribution, repair, consequential measures and their correlations) per age, location resp.
- Individual GIS equipment failure rates (CB, DS/ES, IT, other parts as bushings, busbars, busducts, SA)
- GIS practices and strategies (on-site HV testing, monitoring and diagnostics, specific service problems, major maintenance ,extension, new technologies, functional spec. and turnkey projects experience)

Brochure will be published in 2011