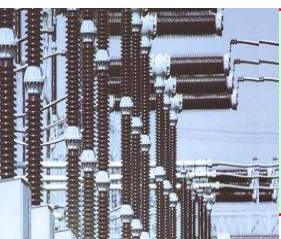


CIGRE WG A3.06

Reliability of High Voltage Equipment

Intermediate Results Circuit Breakers



CIGRE WG A3.06 Reliability of High Voltage Equipment

Intermediate Results

CIRCUIT BREAKERS

Old Survey 1988-91

70.708 CB years

22 countries

**Population
data**

New Survey

55.088 CB / 2004

46.470 CB / 2005

6.329 CB / 2006

14.763 CB / 2007

122.650 CB years

21 countries

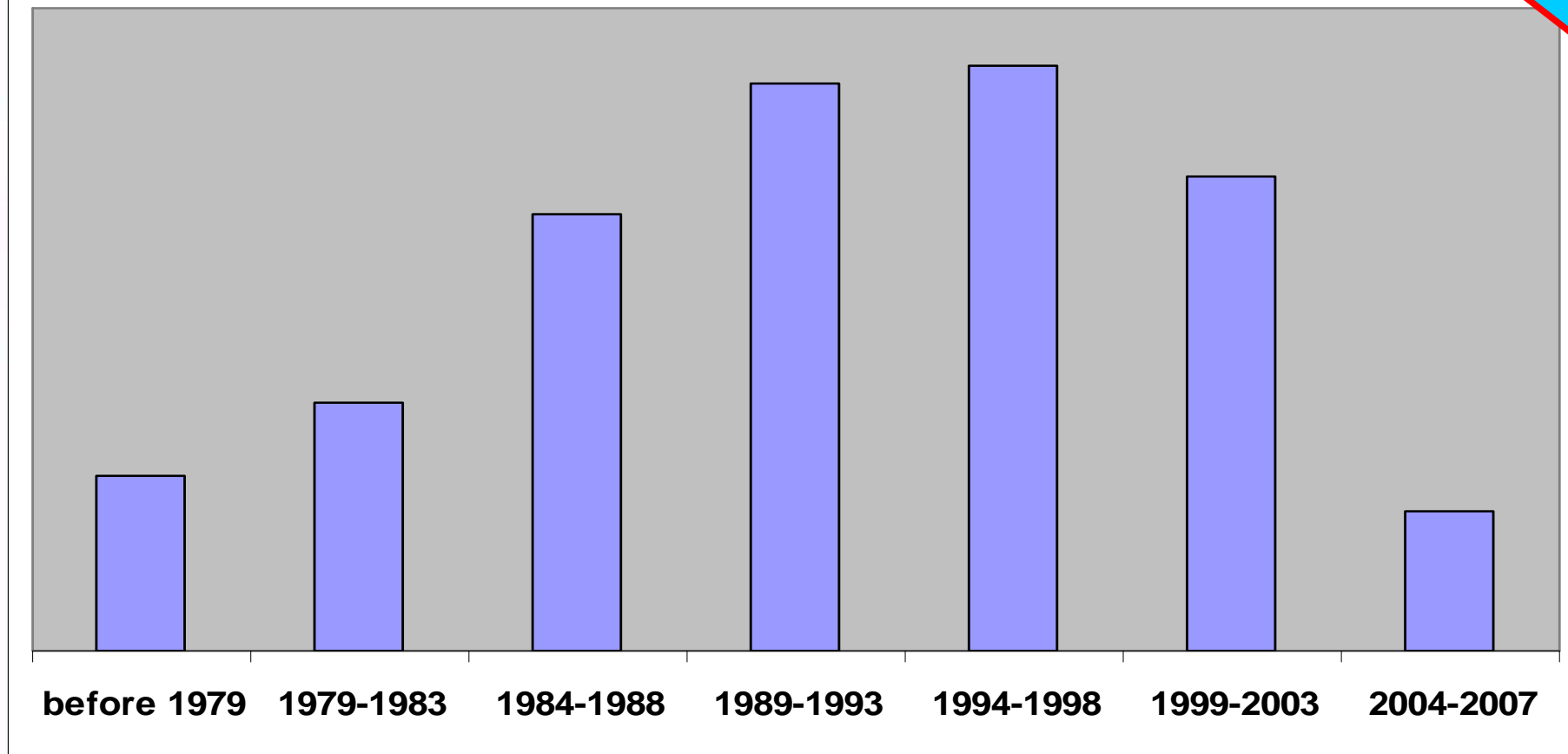
CIGRE WG A3.06 Reliability of High Voltage Equipment

Intermediate Results

CIRCUIT BREAKERS

Age Distribution
Total 122650 CB years

Population
data



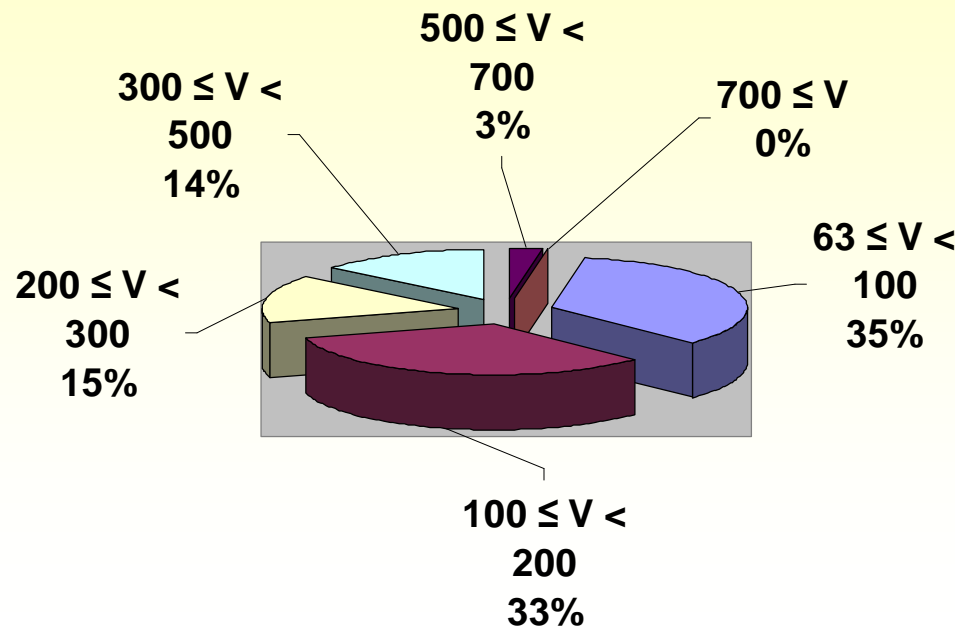
CIGRE WG A3.06 Reliability of High Voltage Equipment

Intermediate Results

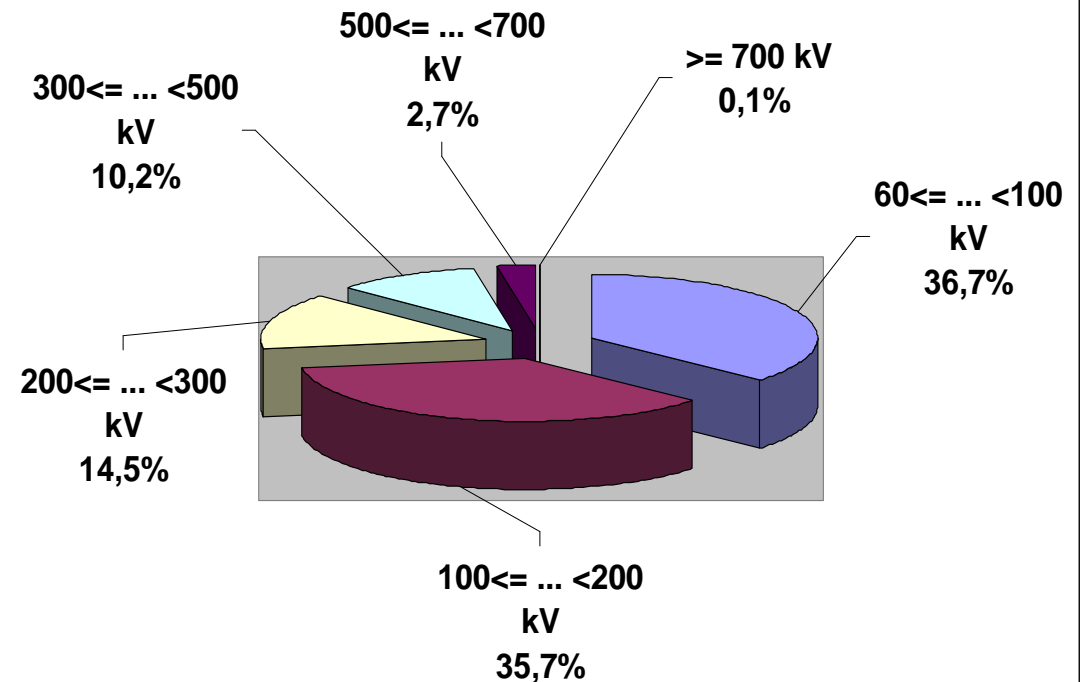
CIRCUIT BREAKERS

Population data

Voltage distribution
Old survey



Voltage distribution
New survey



Voltage distribution

CIGRE WG A3.06 Reliability of High Voltage Equipment

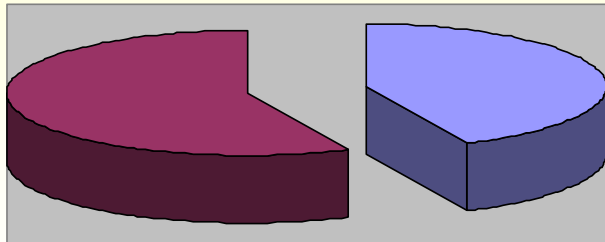
Intermediate Results

CIRCUIT BREAKERS

Population
data

Type of enclosure
Old survey

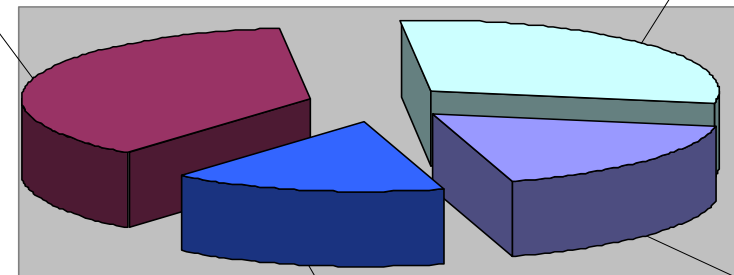
Non metal
enclosed
57%



Metal
enclosed
43%

Type of enclosure
New survey

Non metal
enclosed
38%



Dead tank
29%

GIS -
3 phase
15%

GIS -
1 phase
18%

Type of enclosure

CIGRE WG A3.06 Reliability of High Voltage Equipment

Intermediate Results

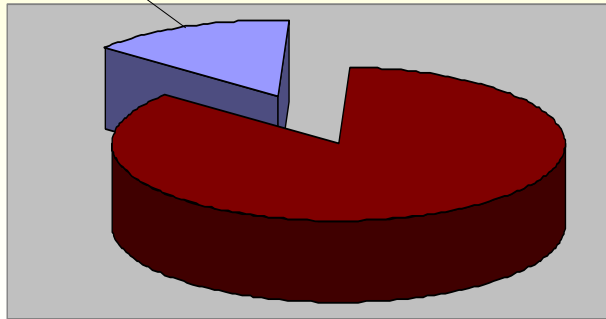
CIRCUIT BREAKERS

Population
data

Location
Old survey

Indoors
15%

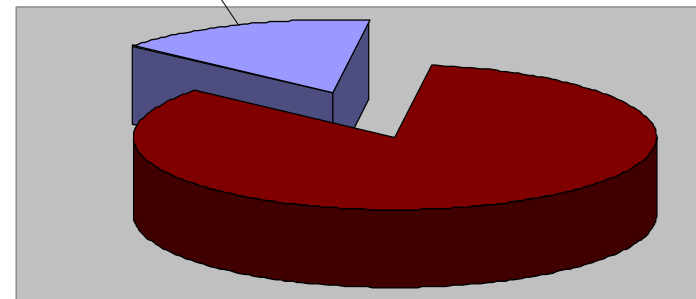
Outdoors
85%



Location
New survey

Indoor
16%

Outdoor
84%

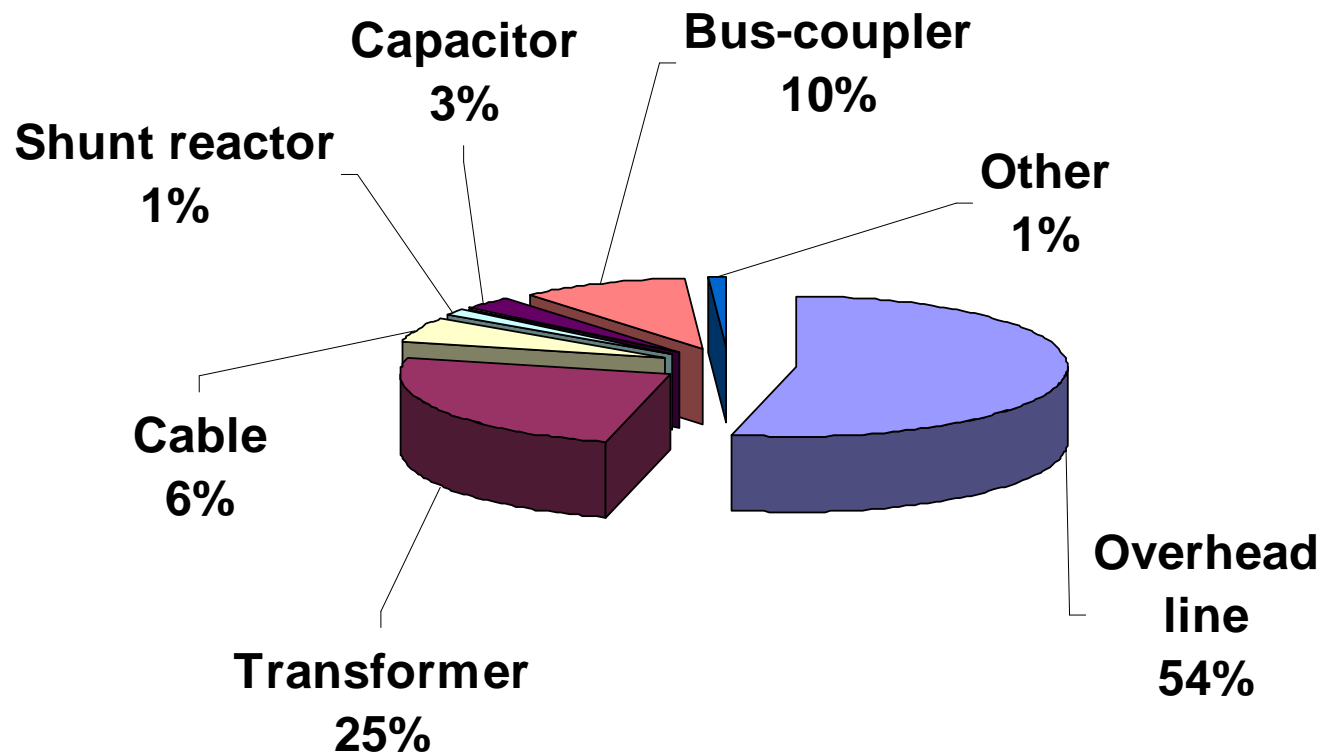


CIGRE WG A3.06 Reliability of High Voltage Equipment

Intermediate Results

CIRCUIT BREAKERS

Kind of service



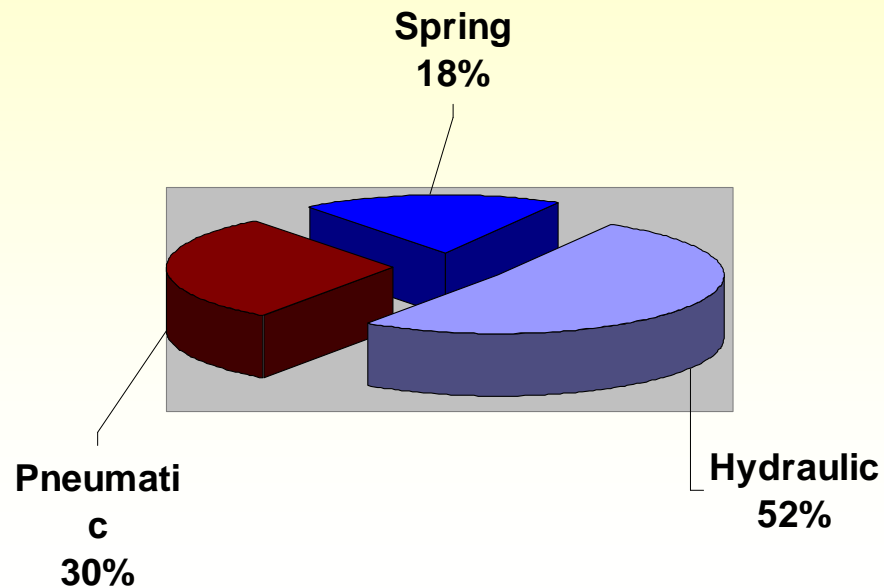
Population
data

CIGRE WG A3.06 Reliability of High Voltage Equipment

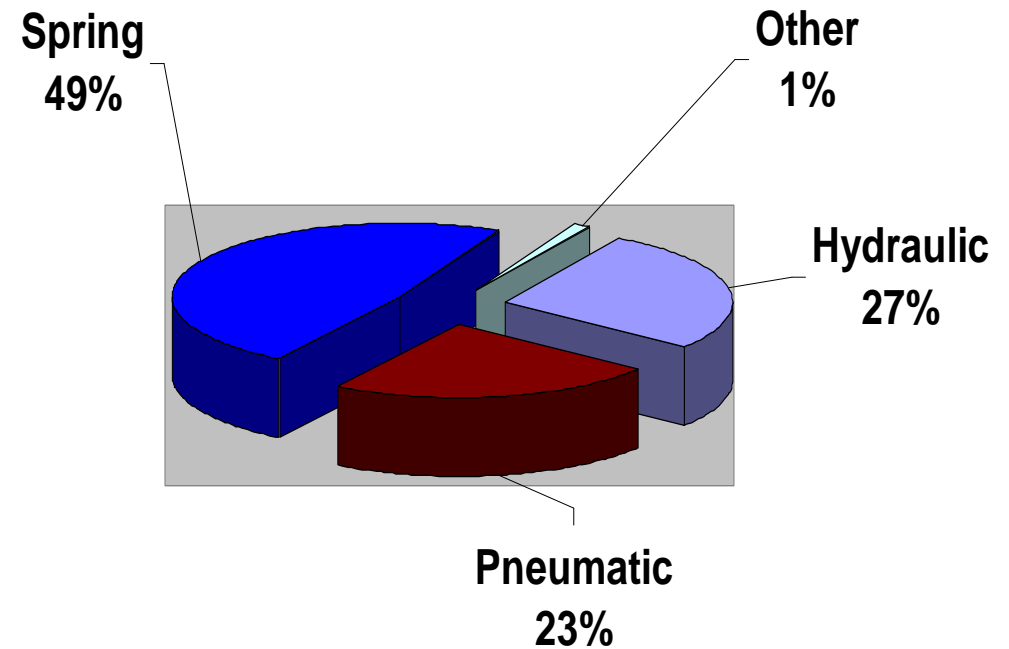
Intermediate Results

CIRCUIT BREAKERS

Type of operating mechanism
Old survey



Type of operating mechanism
New survey



Population
data

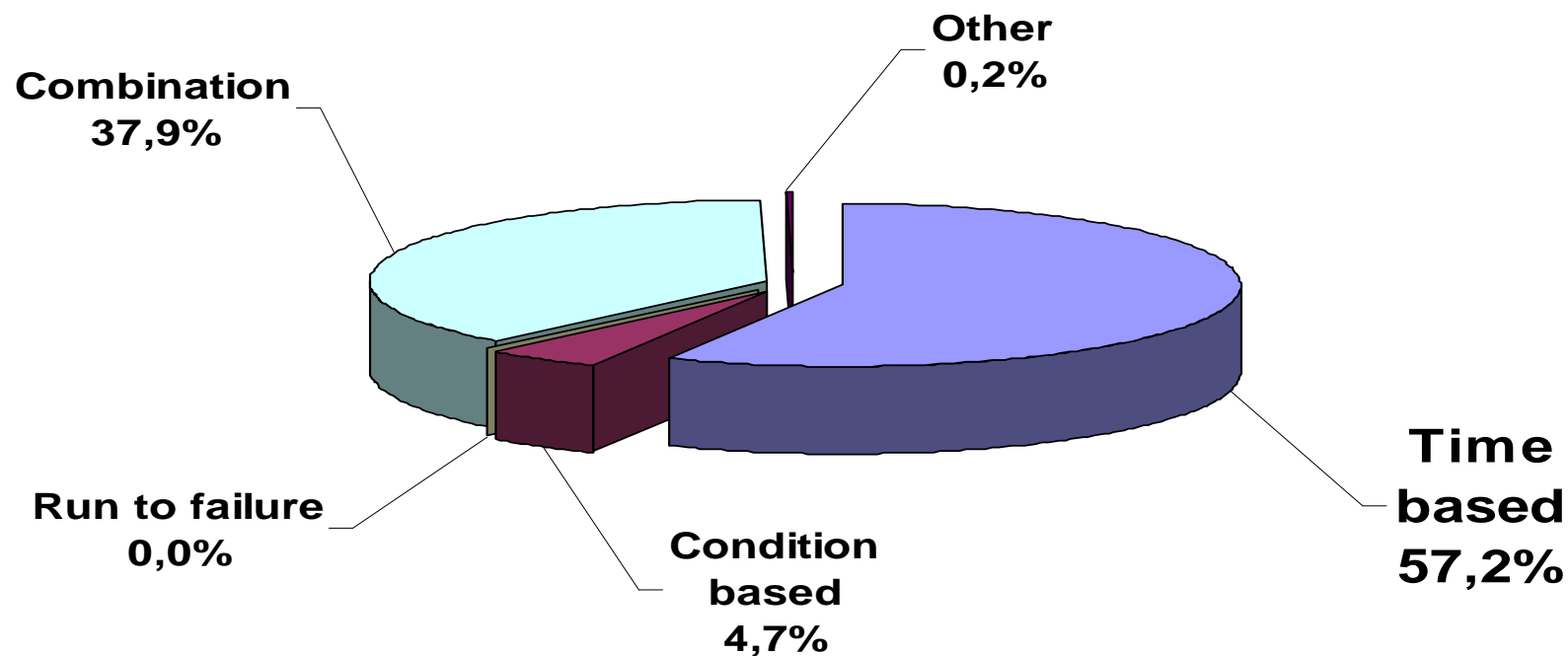
Type of operating mechanism

CIGRE WG A3.06 Reliability of High Voltage Equipment

Intermediate Results

CIRCUIT BREAKERS

Maintenance philosophy New survey



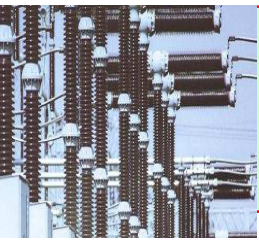
**Population
data**

Failure Distribution

CIGRE WG A3.06 Reliability of High Voltage Equipment

Intermediate Results

CIRCUIT BREAKERS



**Failure
data**

Old Survey 1988-91

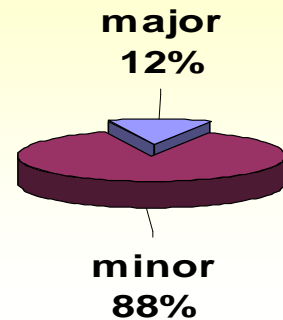
Minor: 3358

Major: 475

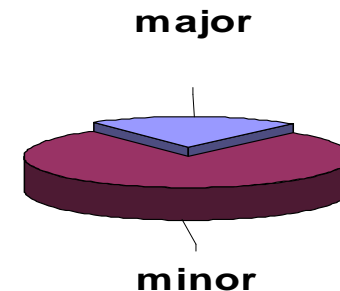
New Survey

**up to 2007:
2342 reports**

Failure classification
old survey



Failure classification
new survey



Failure classification

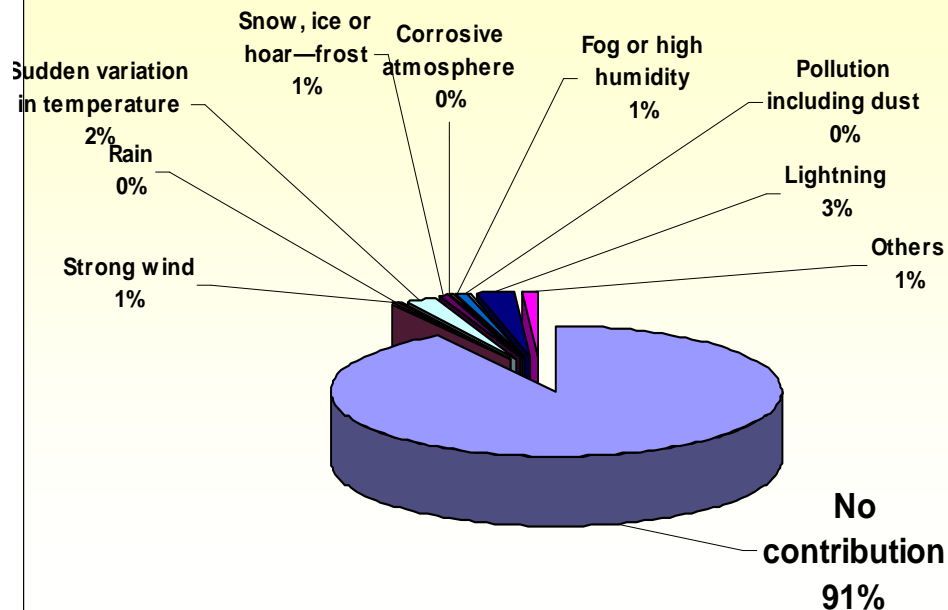
CIGRE WG A3.06 Reliability of High Voltage Equipment

Intermediate Results

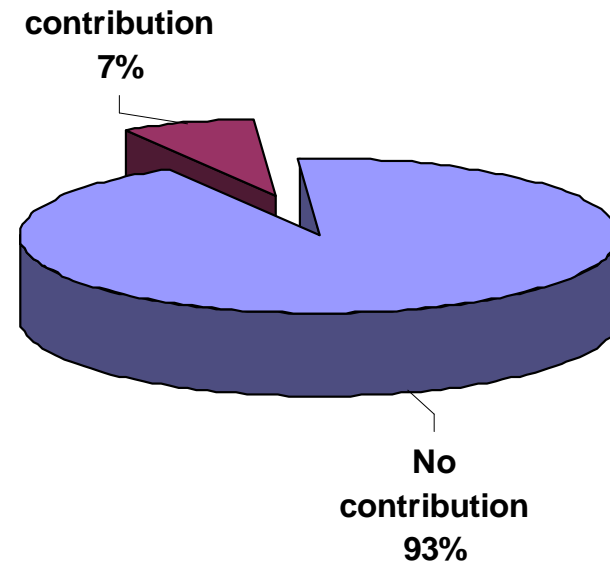
CIRCUIT BREAKERS

Failure data

Contribution environment "major"
Old survey



Contribution environment "major"
New survey



Contribution of environment

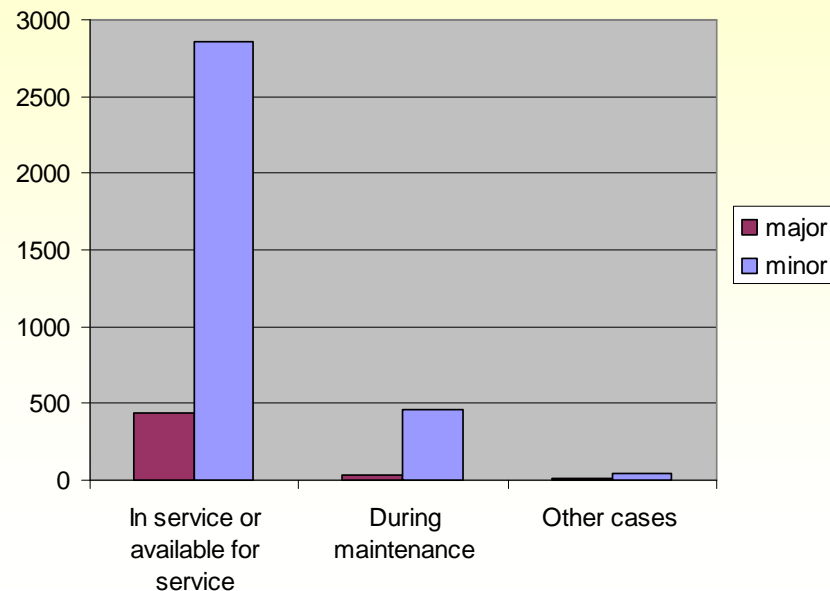
CIGRE WG A3.06 Reliability of High Voltage Equipment

Intermediate Results

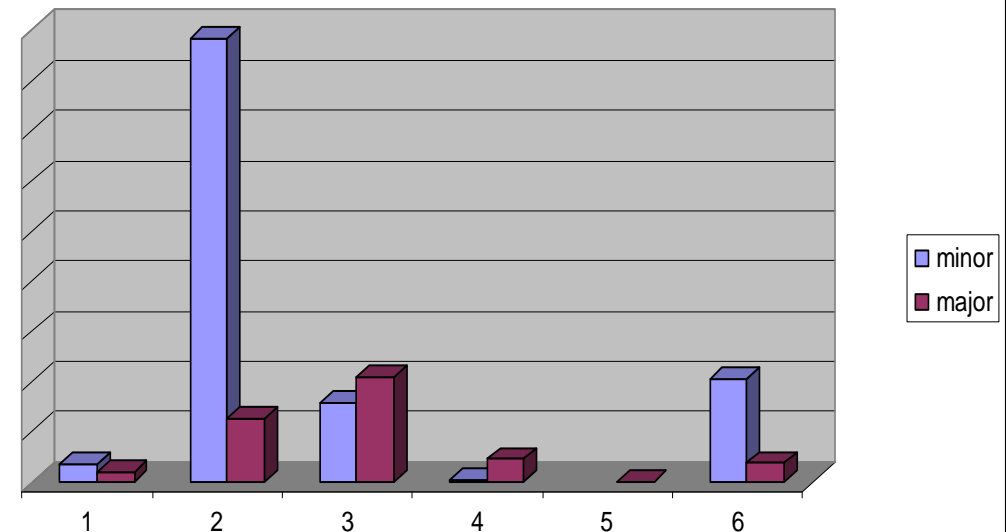
CIRCUIT BREAKERS

Failure data

Service conditions
Old survey



Service conditions / New survey



1 de-energized - Available for service

2 Normal service - no operation command

3 Normal service operation demanded

4 Fault clearing operation

5 Operation occurred without command

6 During or directly after testing / maintenance

Service conditions

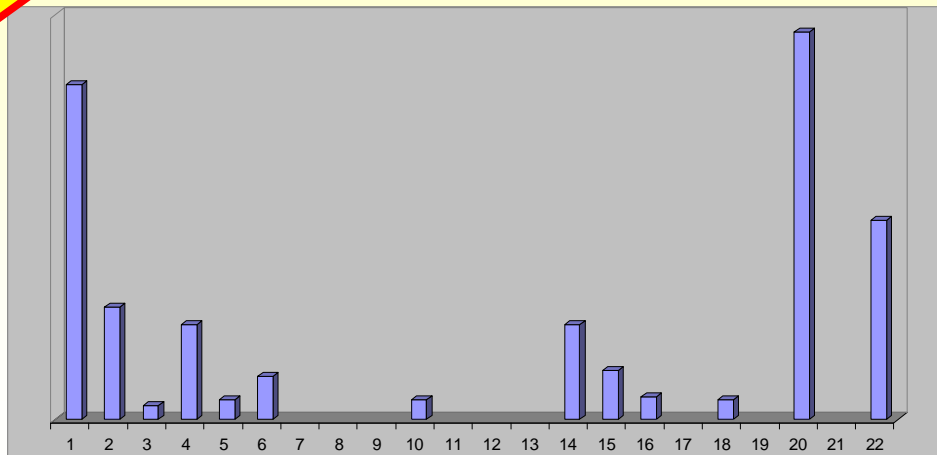
CIGRE WG A3.06 Reliability of High Voltage Equipment

Intermediate Results

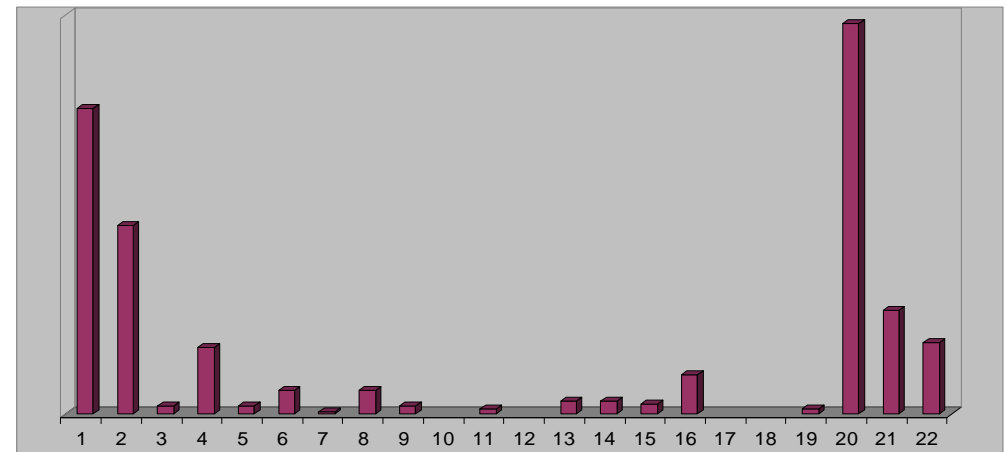
CIRCUIT BREAKERS

Failure data

Major failor mode
Old survey



Major failor mode
New survey

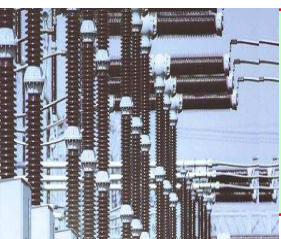


1+2 Does not close / open on command

20 Locking in open or closed position by the control system

21 Loss of mechanical integrity

Major failure modes



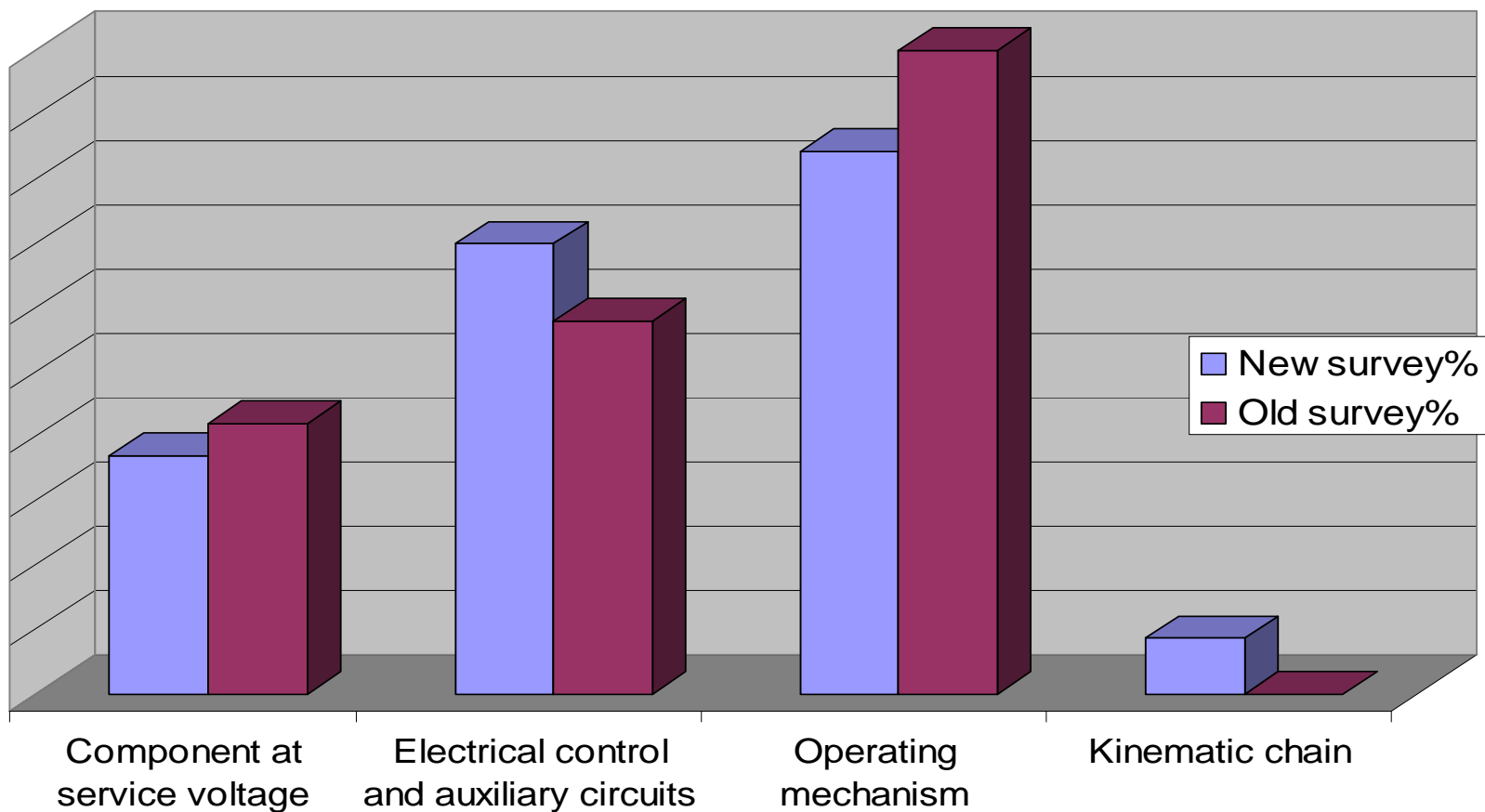
CIGRE WG A3.06 Reliability of High Voltage Equipment

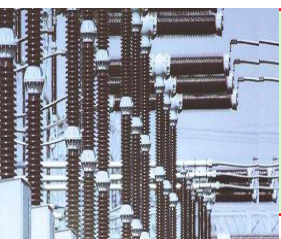
Intermediate Results

CIRCUIT BREAKERS

Failure data

Components responsible for major failures





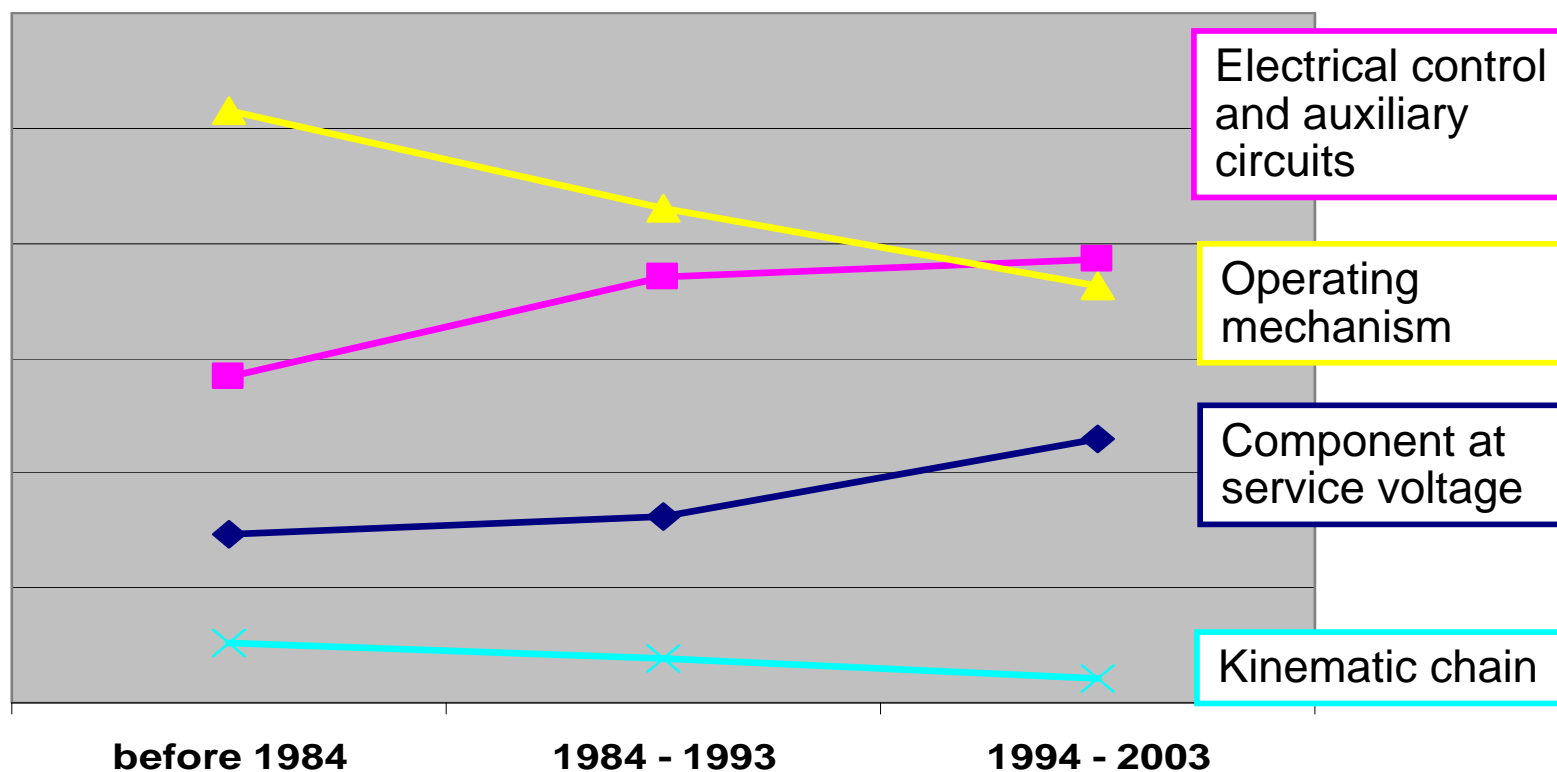
CIGRE WG A3.06 Reliability of High Voltage Equipment

Intermediate Results

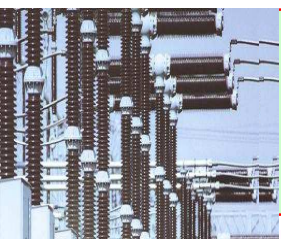
CIRCUIT BREAKERS

Failure data

Components responsible for MF dependence on age



Components responsible



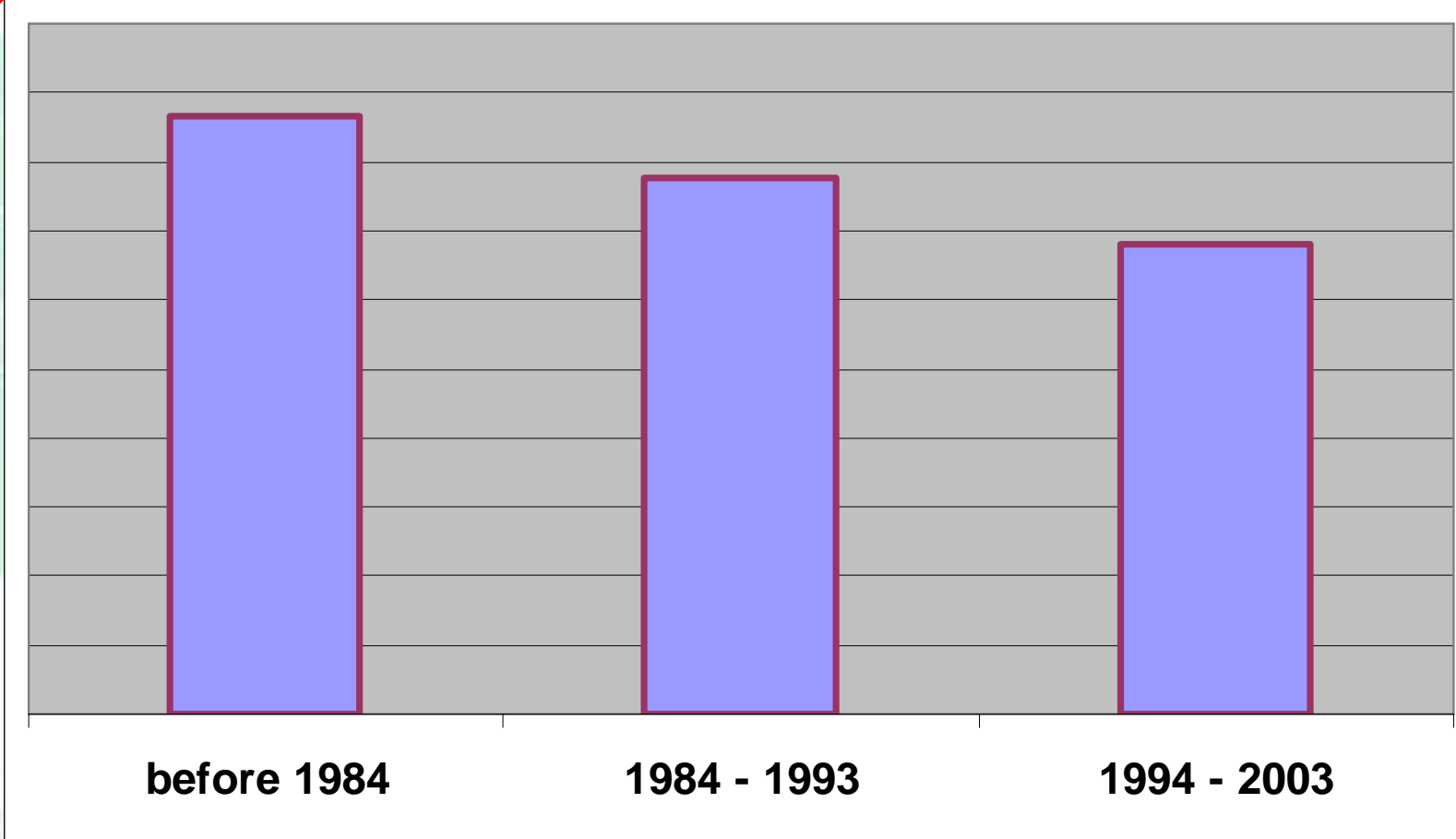
CIGRE WG A3.06 Reliability of High Voltage Equipment

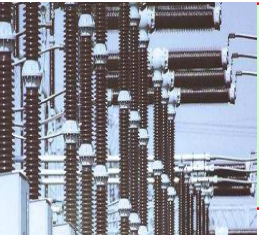
Intermediate Results

CIRCUIT BREAKERS

Failure data

Major failure rate / age





CIGRE WG A3.06 Reliability of High Voltage Equipment

Intermediate Results

CIRCUIT BREAKERS

**Failure
data**

- The majority of the CB's is used at service voltages between 60 and 200 kV
- The majority of the CB's is installed outdoors
- 54% of the CB's are used for overhead line switching
- The mainly used type of operating mechanism has changed from hydraulic to spring design
- Most of the failures seem to happen during normal service
- Leakage of SF6 or oil seems still to be a problem
- Operating mechanisms are still the most reported components responsible for mayor failures But getting better!

**Population
data**

Main Conclusions

CIGRE WG A3.06

Intermediate Results

Circuit Breakers

WG A3-06 Tutorial
October 2008
Seoul

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