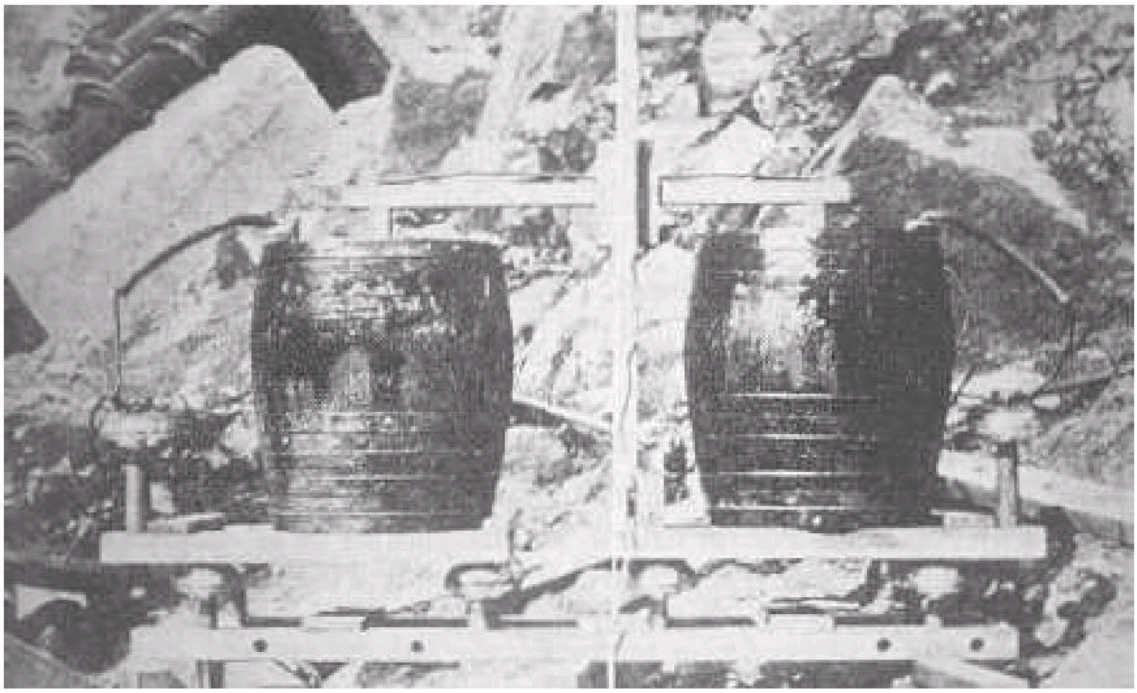
CIGRE WG A3.06

Reliability of High Voltage Equipment

Final Results Circuit Breakers

WG A3.06 Reliability of High Voltage Equipment

Final Results CIRCUIT BREAKERS



„First“ High Voltage Circuit Breaker 1847

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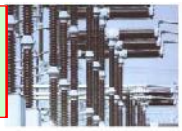
Final Results **CIRCUIT BREAKERS**



1974-77	First enquiry performed **1981 First enquiry published**
1988-91	Second enquiry performed **1994 Second enquiry published**
2004-07	Third enquiry performed **2011 Third enquiry published**

Only SF6 single pressure technology !

Historical background

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Final Results CIRCUIT BREAKERS

Progess regarding reliability ?

High Voltage Circuit Breakers / Modern Design

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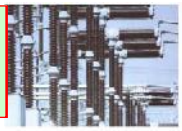
Final Results **CIRCUIT BREAKERS**



Population data

Old Survey 1988-91

70.708 CB years

22 countries

New Survey 2004-07

69.085 CB / 2004
69.127 CB / 2005
70.996 CB / 2006
71.884 CB / 2007

281.090 CB years

26 countries

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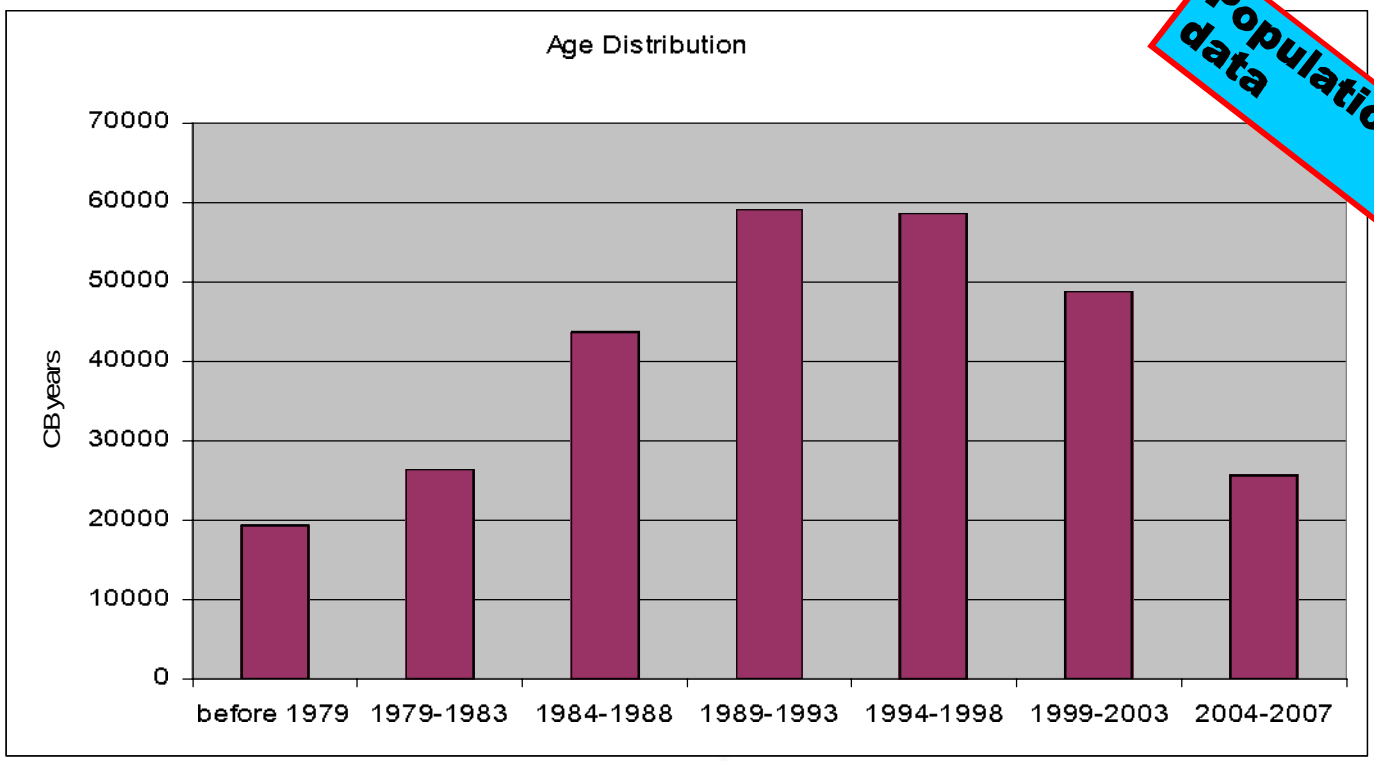
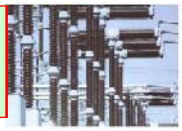
Final Results **CIRCUIT BREAKERS**

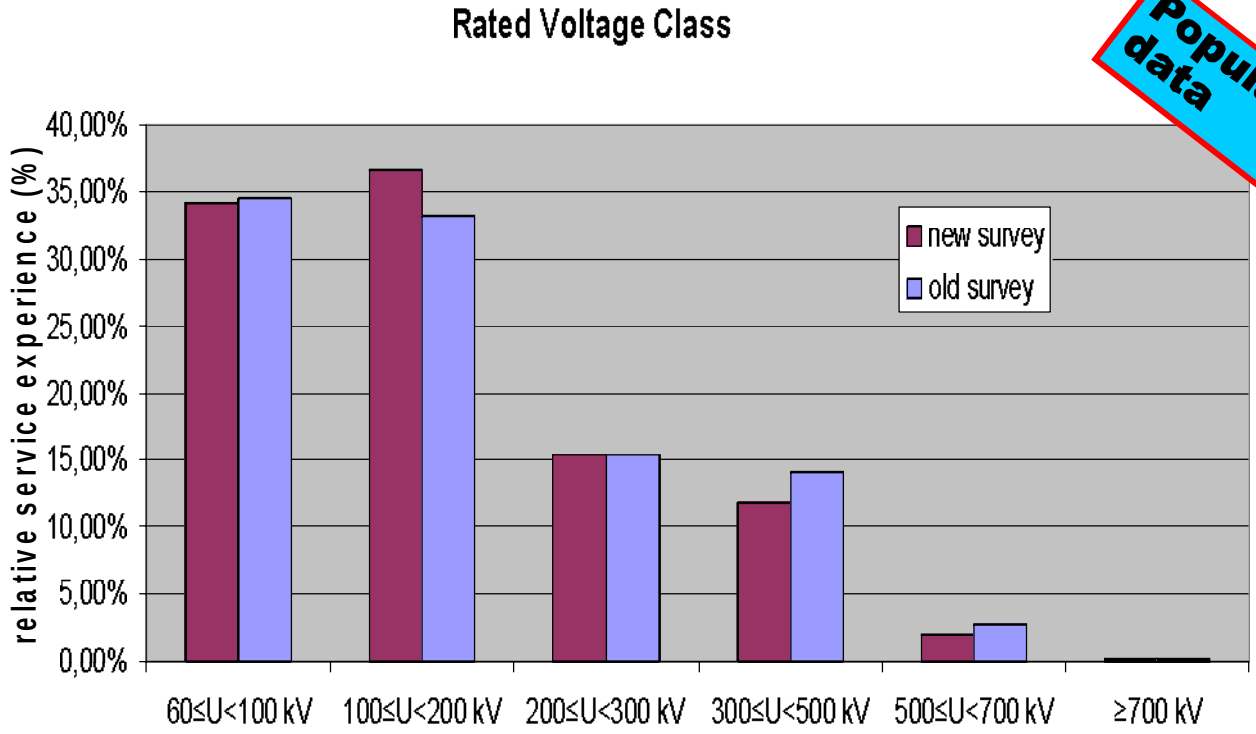
Population data



Age Distribution



Population data



Voltage distribution

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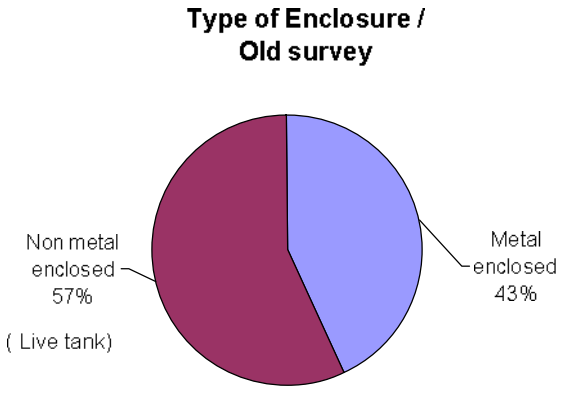
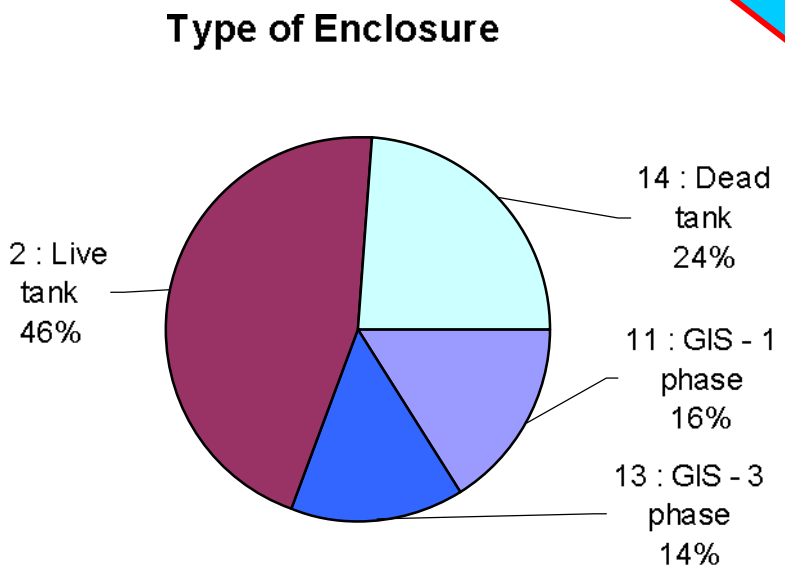
Final Results CIRCUIT BREAKERS

Population data





Type of enclosure

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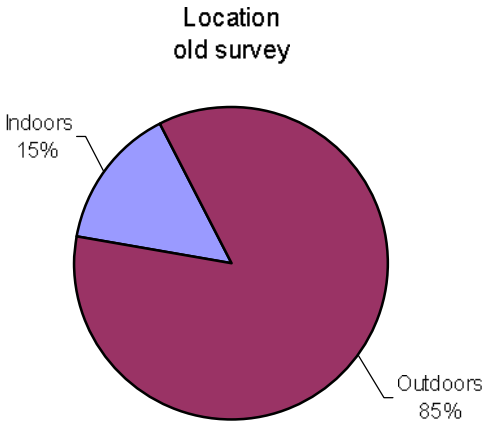
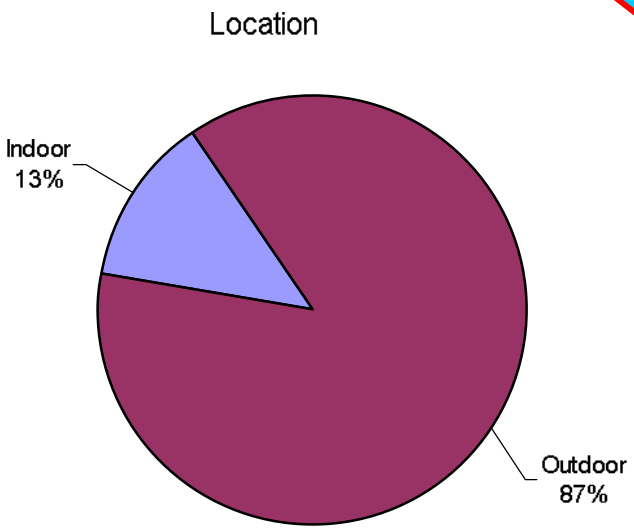
Population data





Location

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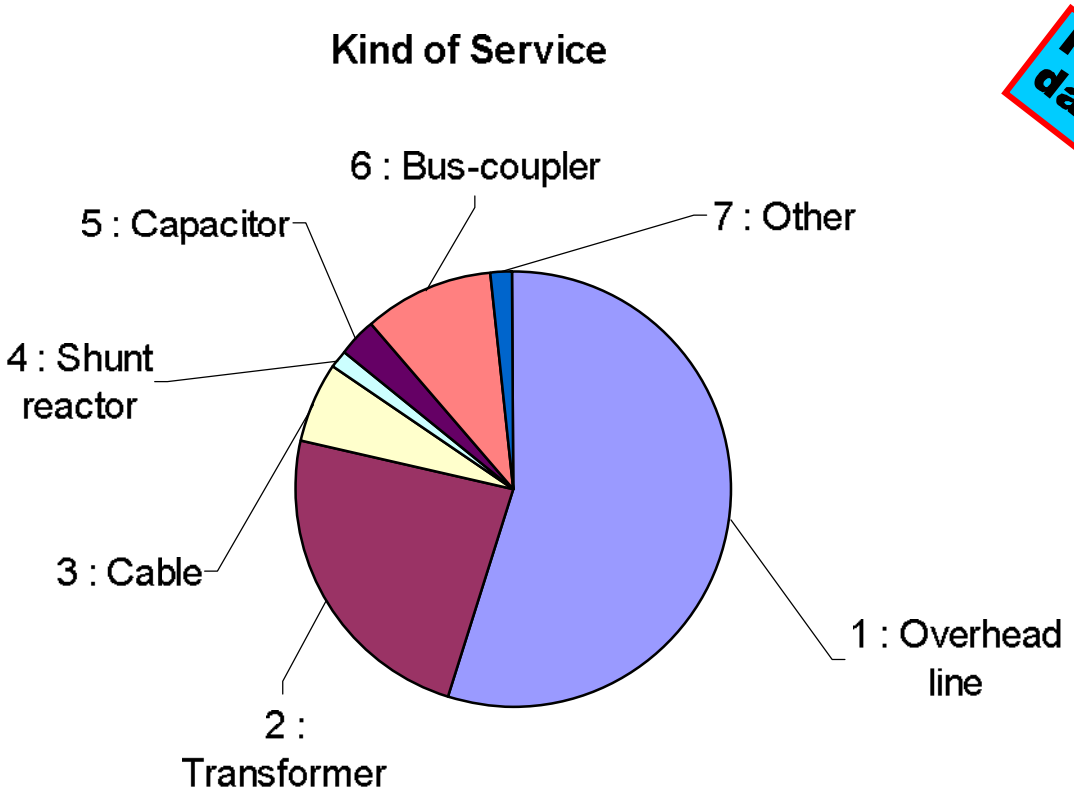
Final Results CIRCUIT BREAKERS

Population data



Kind of service

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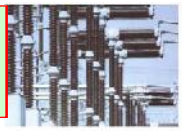
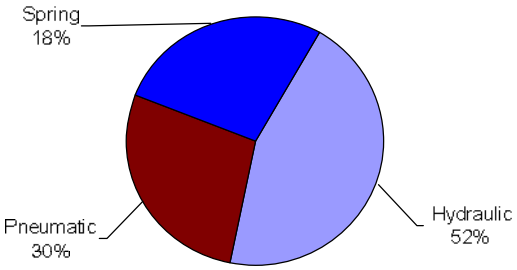
Final Results CIRCUIT BREAKERS

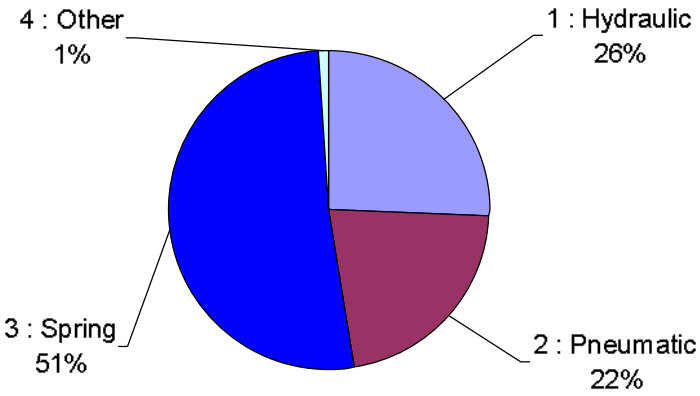


Population data

Type of Operating Mechanism
old survey



Type of Operating Mechanism



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Type of operating mechanism

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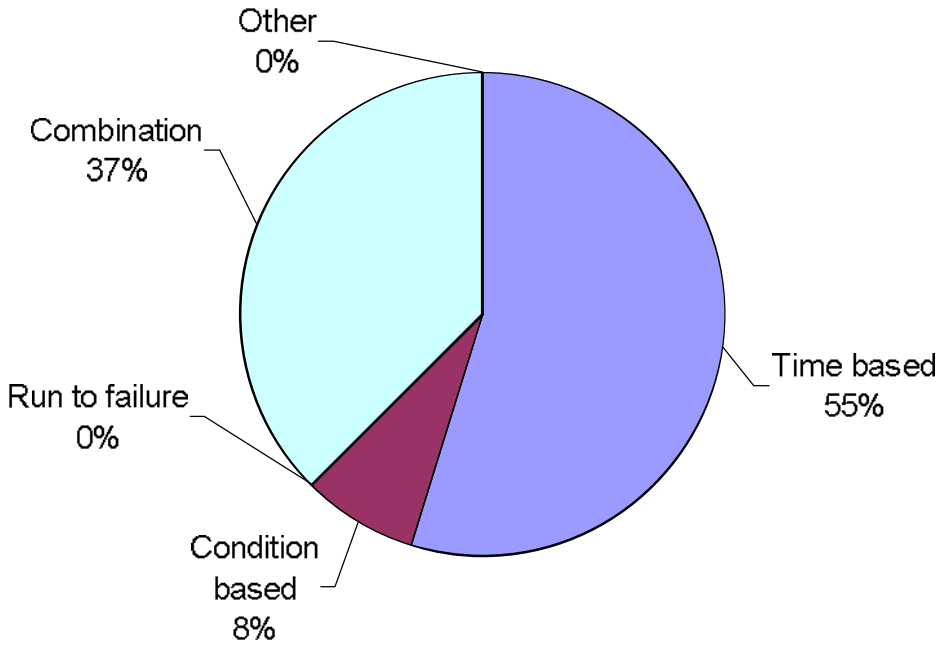
Final Results CIRCUIT BREAKERS

Population data

Maintenanance Philosophy



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Maintenance philosophy

Failure Distribution

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Final Results CIRCUIT BREAKERS

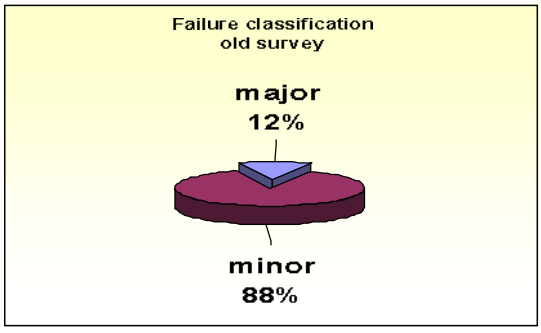
Failure data

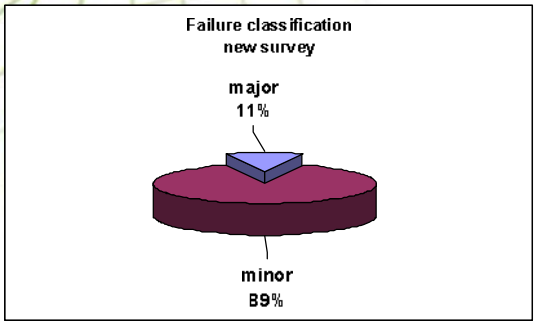
Old Survey
1988-1991

Minor:	3358
Major:	475

New Survey
2004 - 2007

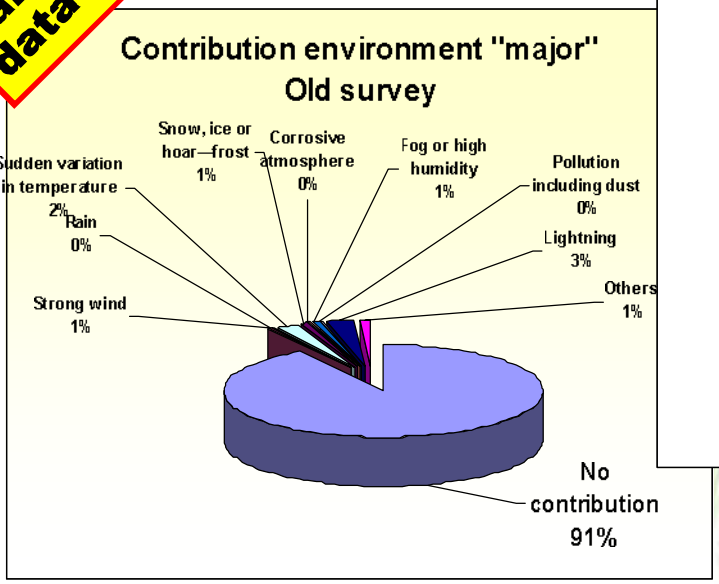
Minor:	6655
Major:	840

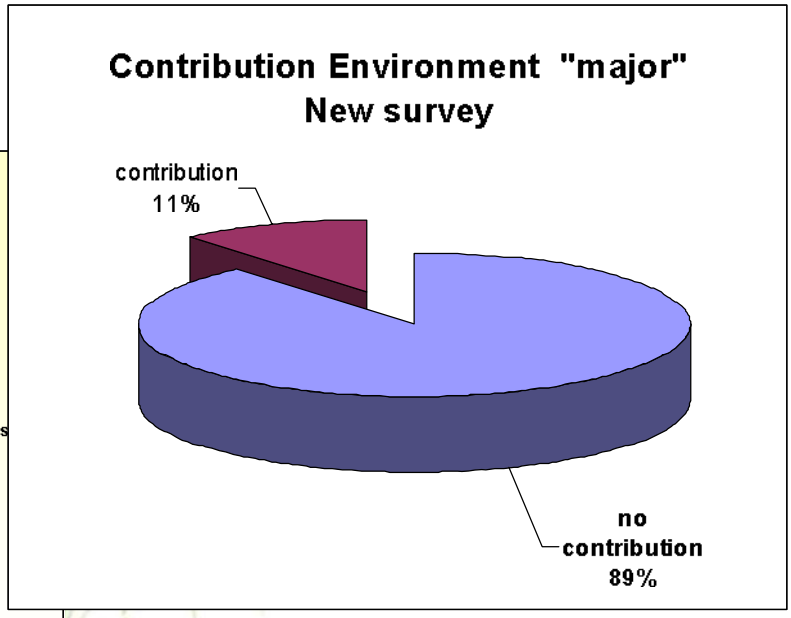




Failure classification

Failure data





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Contribution of environment

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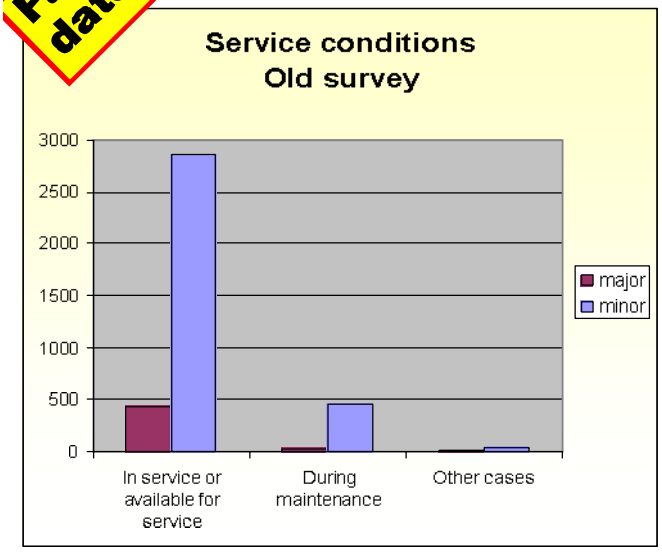
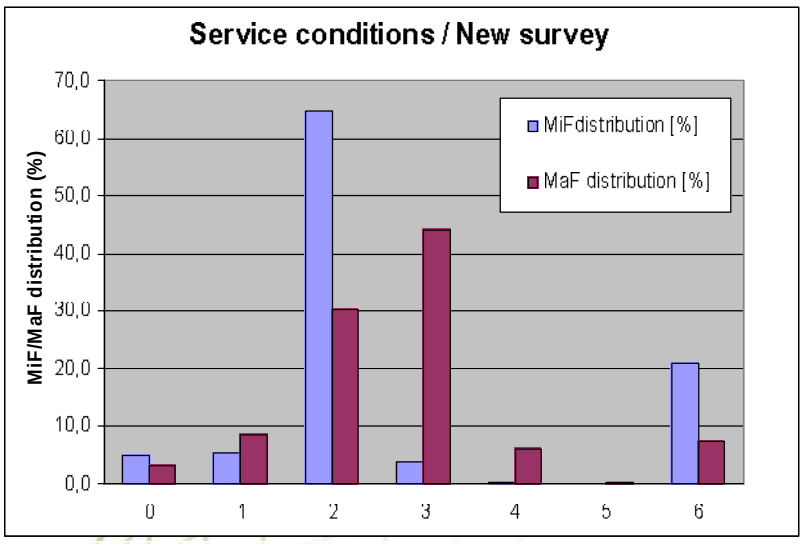
Final Results CIRCUIT BREAKERS

Failure data





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

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Service conditions

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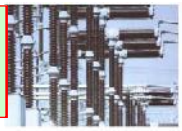
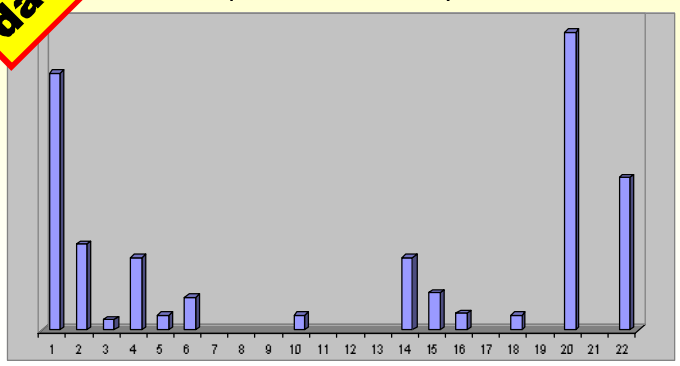
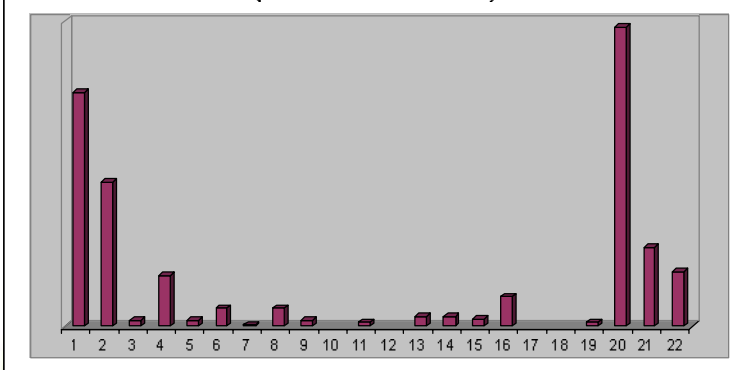
Final Results **CIRCUIT BREAKERS**



Failure data





1+2 Does not close / open on command

20 Locking in open or closed position by the control system

21 Loss of mechanical integrity

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Major failure modes

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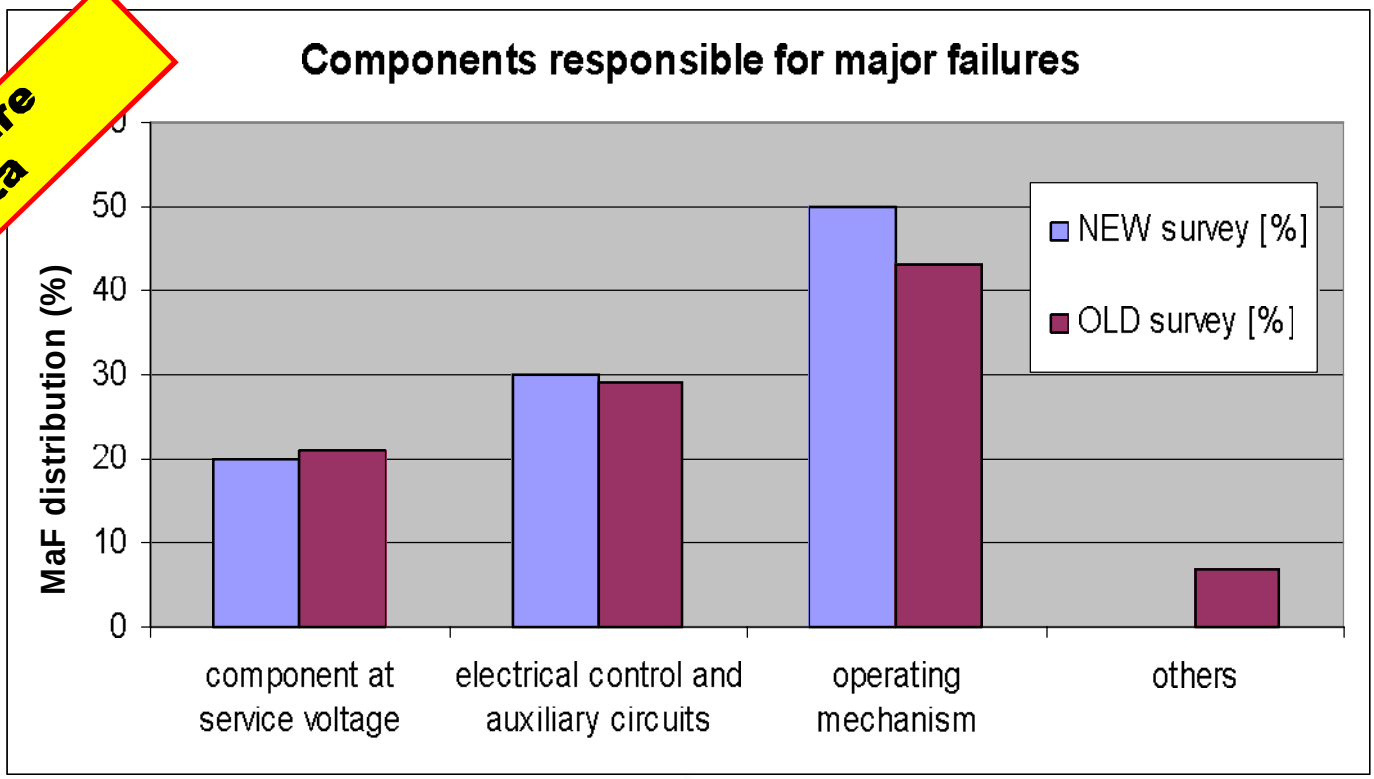
Final Results **CIRCUIT BREAKERS**

Failure data



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Components responsible

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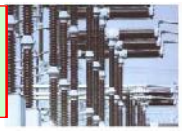
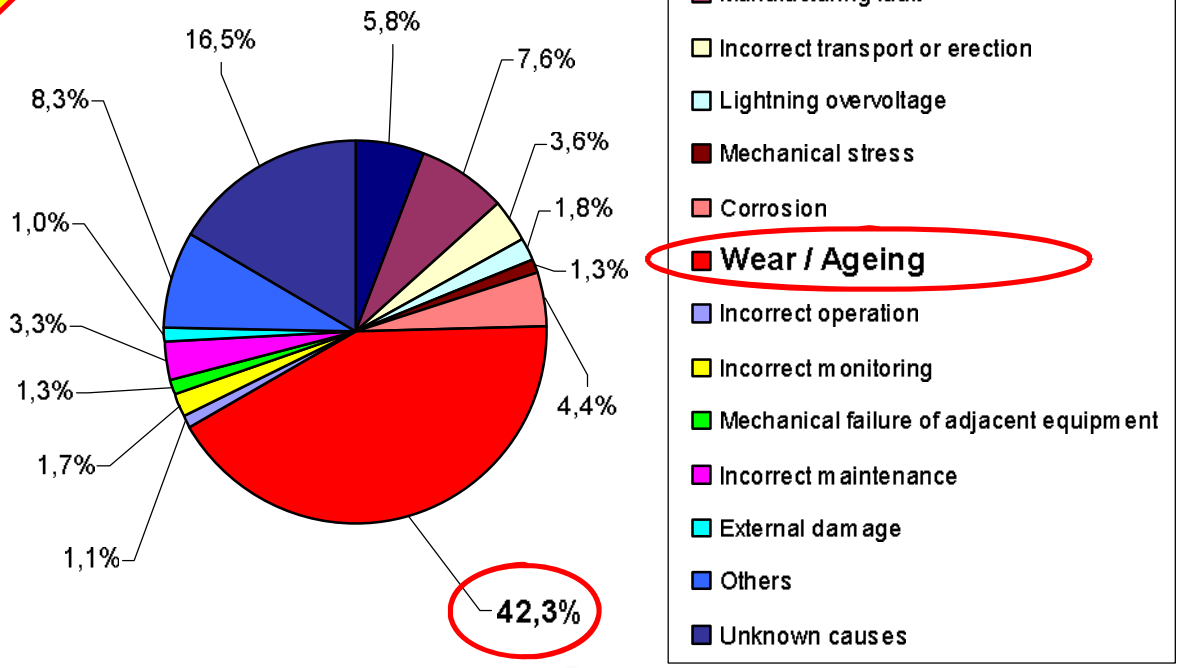
Final Results **CIRCUIT BREAKERS**



Failure data

Primary Cause of major failures



Primary cause

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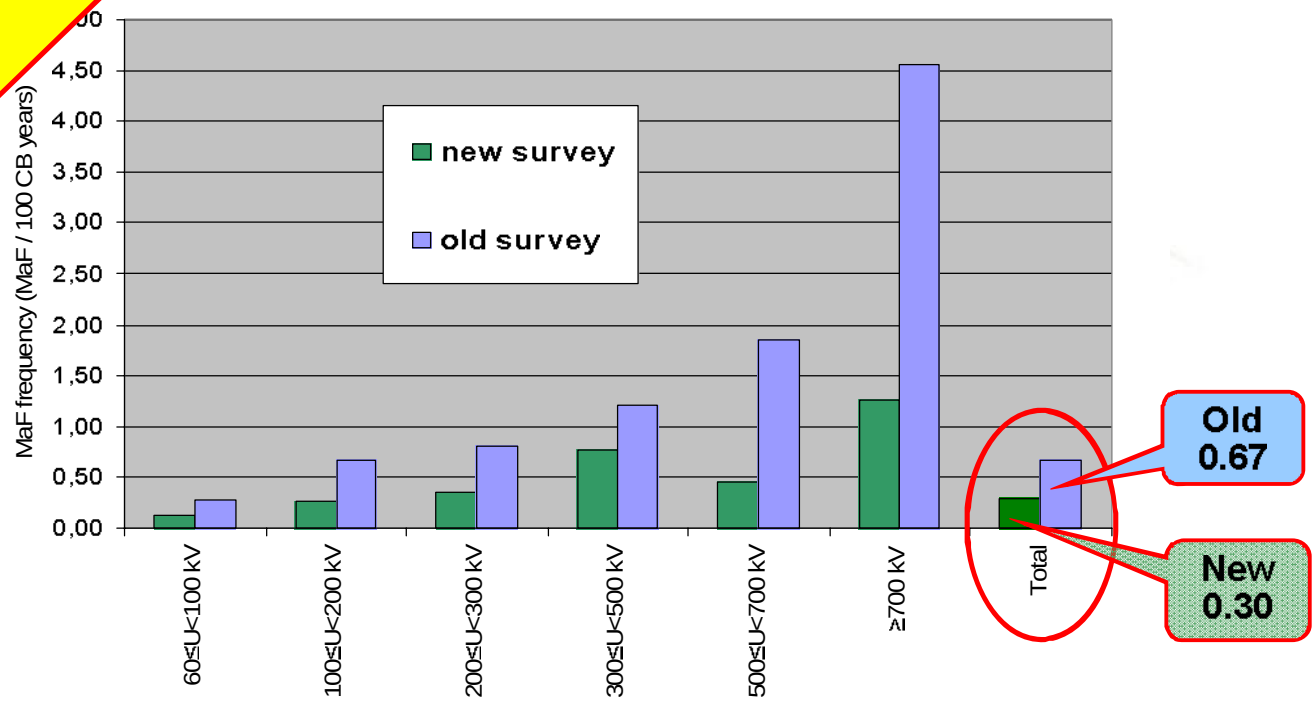
Final Results **CIRCUIT BREAKERS**

Failure data

Failure frequencies major failures/ Rated Voltage Class



Major failure frequency

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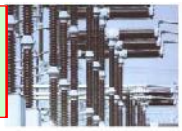
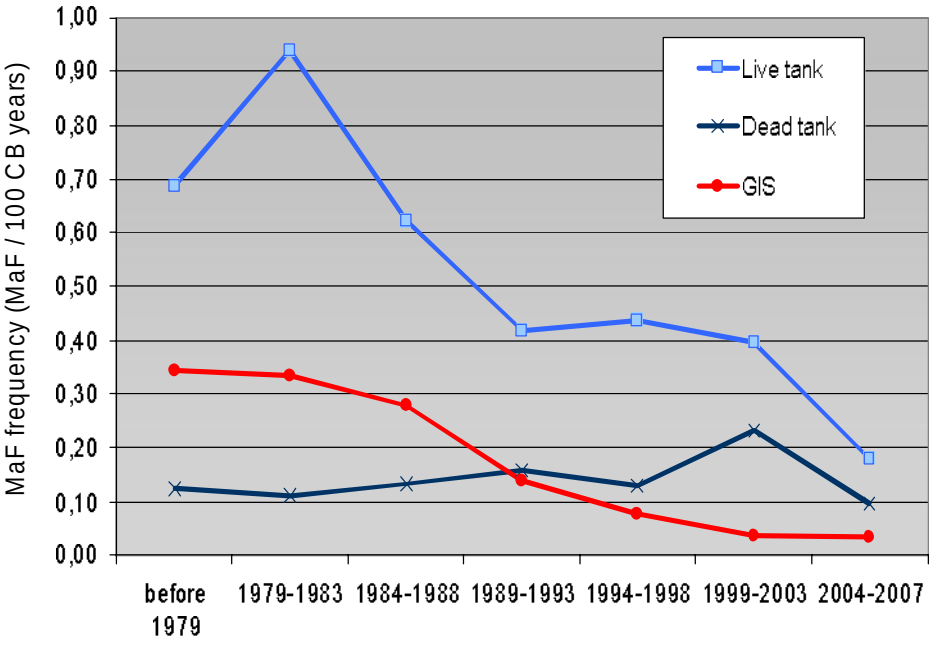
Final Results **CIRCUIT BREAKERS**

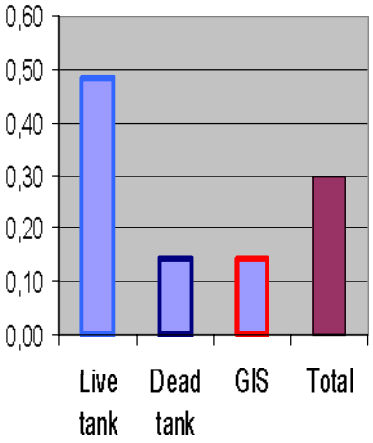


Failure data

Major failure frequencies / manufacture period



Major failure frequencies Type of Enclosure



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Major failure frequency

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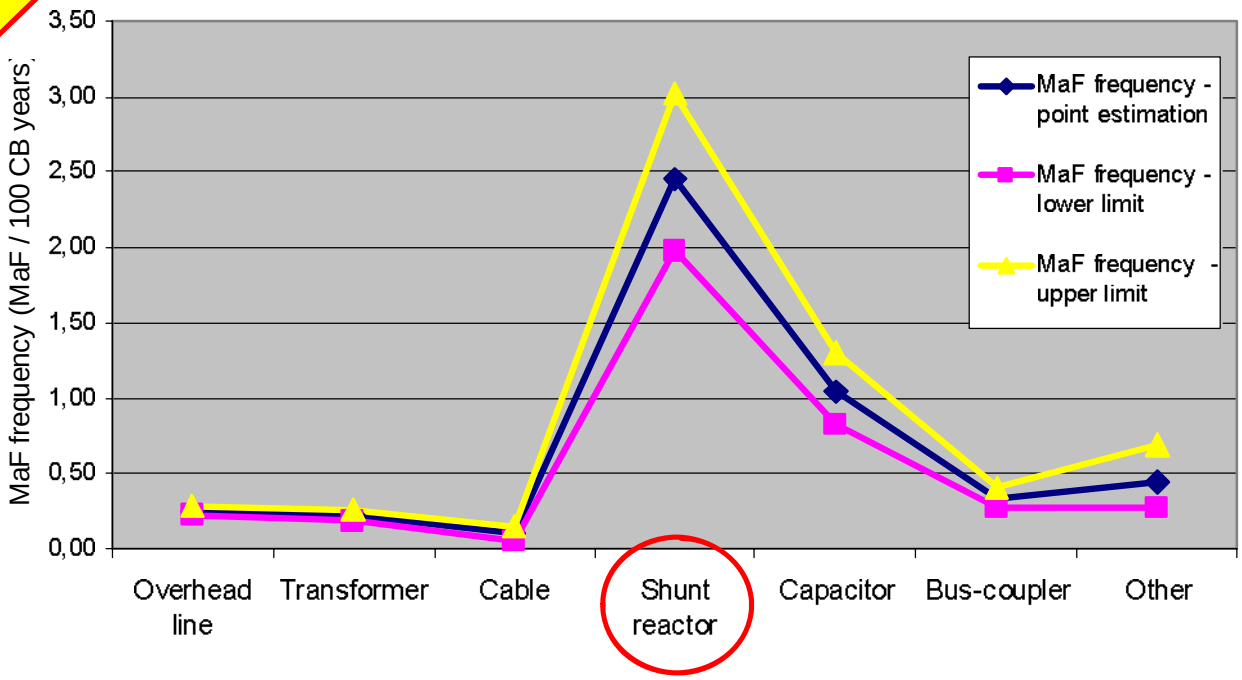
Final Results **CIRCUIT BREAKERS**

Failure data

Major failure frequencies / Kind of Service



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Major failure frequency

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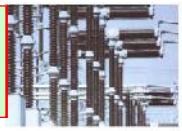

Failure data

Population 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
- Failure frequencies have decreased to around half compared to the previous survey
- Live tank breakers have 3 times higher rates than GIS or Dead Tank breakers
- Shunt reactor breakers are the most unreliable kind of CB´s
- The majority of the failures 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 major failures
- The most reported cause for failures is „wear/aging“

But getting better!

Main Conclusions

WG A3.06 Reliability of High Voltage Equipment
Final Results CIRCUIT BREAKERS

Thank you for your kind attention!

High Voltage

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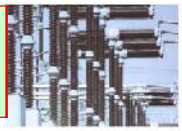

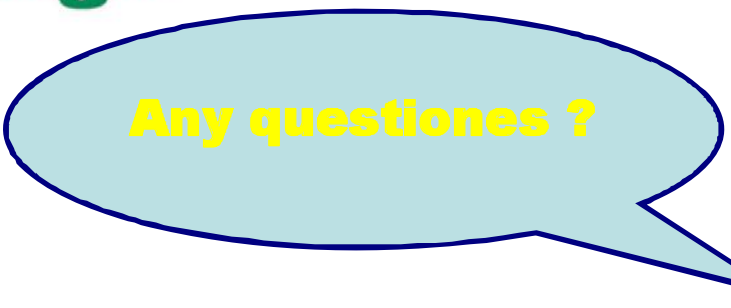

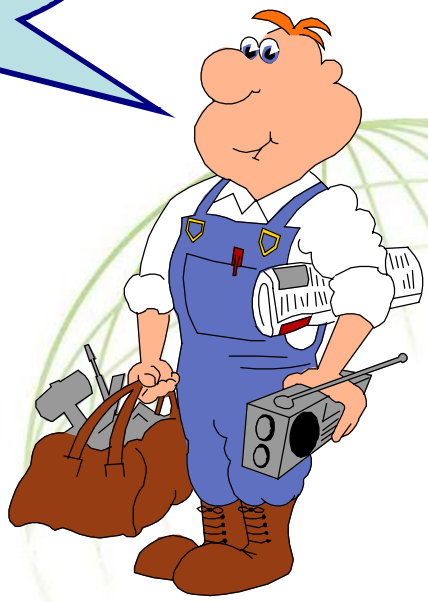

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CIGRE WG A3.06
Final Results
Circuit Breakers

WG A3-06
September 2011
Vienna

Task Force Circuit Breakers:

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Antoni Hyrczak, Kresimir Mestrovic,
Manuel Lopez Cormenzana,
Antonio Carvalho, Bob Sweeney