

Cigre WG A3-06 “HV Equipment Reliability”

Preliminary Results from Present Cigre Survey

Gas Insulated Substations (GIS)

Population cards 2004

Failure cards 2004 and 2005 (partly)

WG A3-06 Tutorial

June 2006

Rio de Janeiro

TF GIS

D.Kopejtkova, M. Kudoke, H. Furuta

WB A3.06 - Reliability of HV equipment – GIS population (2004)

OLD SURVEY :

GIS DATA AVAILABLE UP TO 31-12-1995

No. of GIS	2115
No. of GIS CB-bays	13 696
No. of GIS CB-bay-years	118 483
No. of countries	30

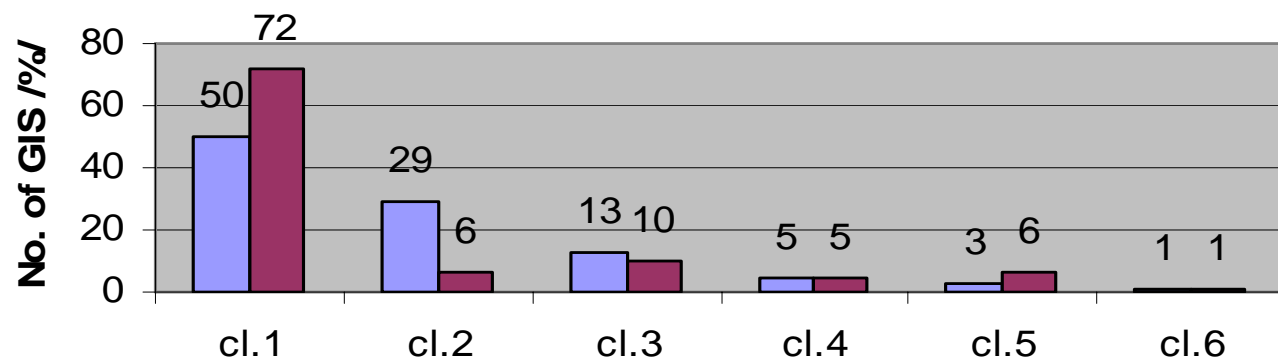
NEW SURVEY :

GIS DATA AVAILABLE UP TO 31-12-2004

No. of GIS	7515	(355%)
No. of GIS CB-bays	15 206	(111%)
No. of GIS CB-bay-years	208 691	(176 %)
No. of countries	18	(60 %)

WB A3.06 - Reliability of HV equipment – GIS population (2004)

1995 & New Survey - No. of GIS x U class



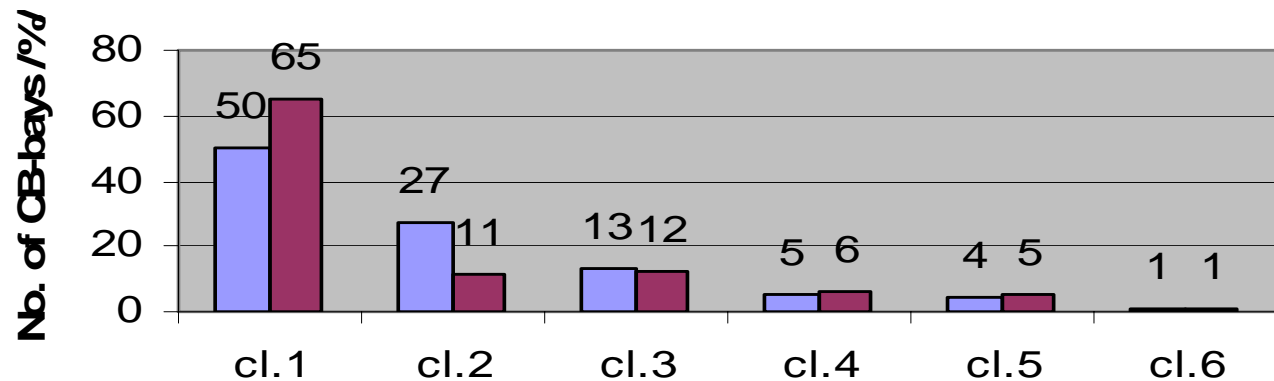
NEW SURVEY :

355% of GIS No.in 1995

111% of GIS CB-bays in 1995

Blue : 1995 Survey
Red : New Survey

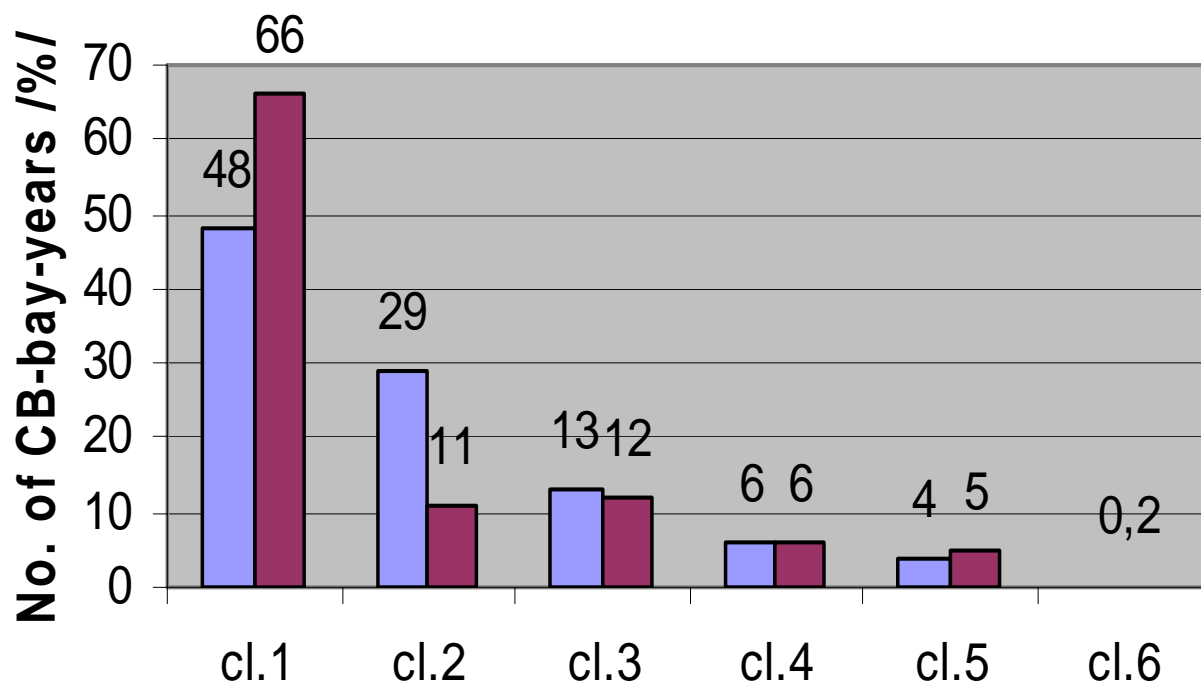
1995 & New Surveys - No. of GIS CB-bays x U class



Cl. 1 : ≥ 60 ... < 100 kV
Cl. 2 : ≥ 100 ... < 200 kV
Cl. 3 : ≥ 200 ... < 300 kV
Cl. 4 : ≥ 300 ... < 500 kV
Cl. 5 : ≥ 500 ... < 700 kV
Cl. 6 : ≥ 700 kV

WB A3.06 - Reliability of HV equipment – GIS population (2004)

1995 & New Surveys - No. of GIS CB-bay-years x U class



NEW SURVEY :

176% of GIS CB-bay-years No. in 1995

Blue : 1995 Survey

Red : New Survey

Cl. 1 : $\geq 60 \dots < 100$ kV

Cl. 2 : $\geq 100 \dots < 200$ kV

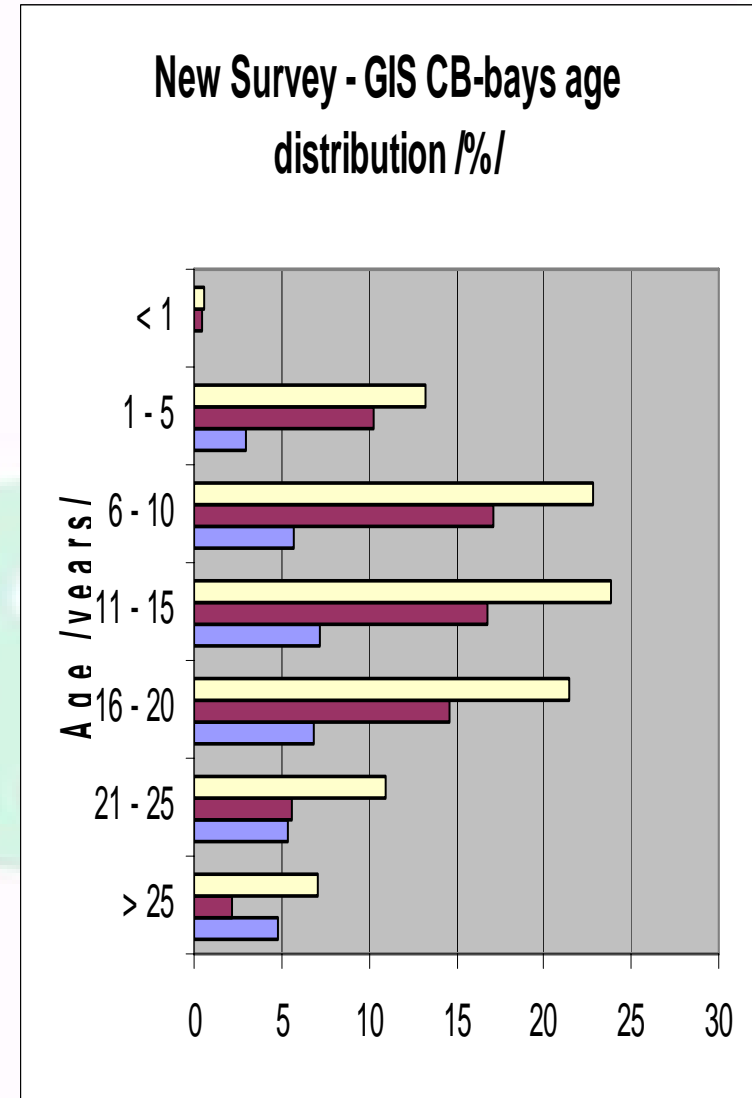
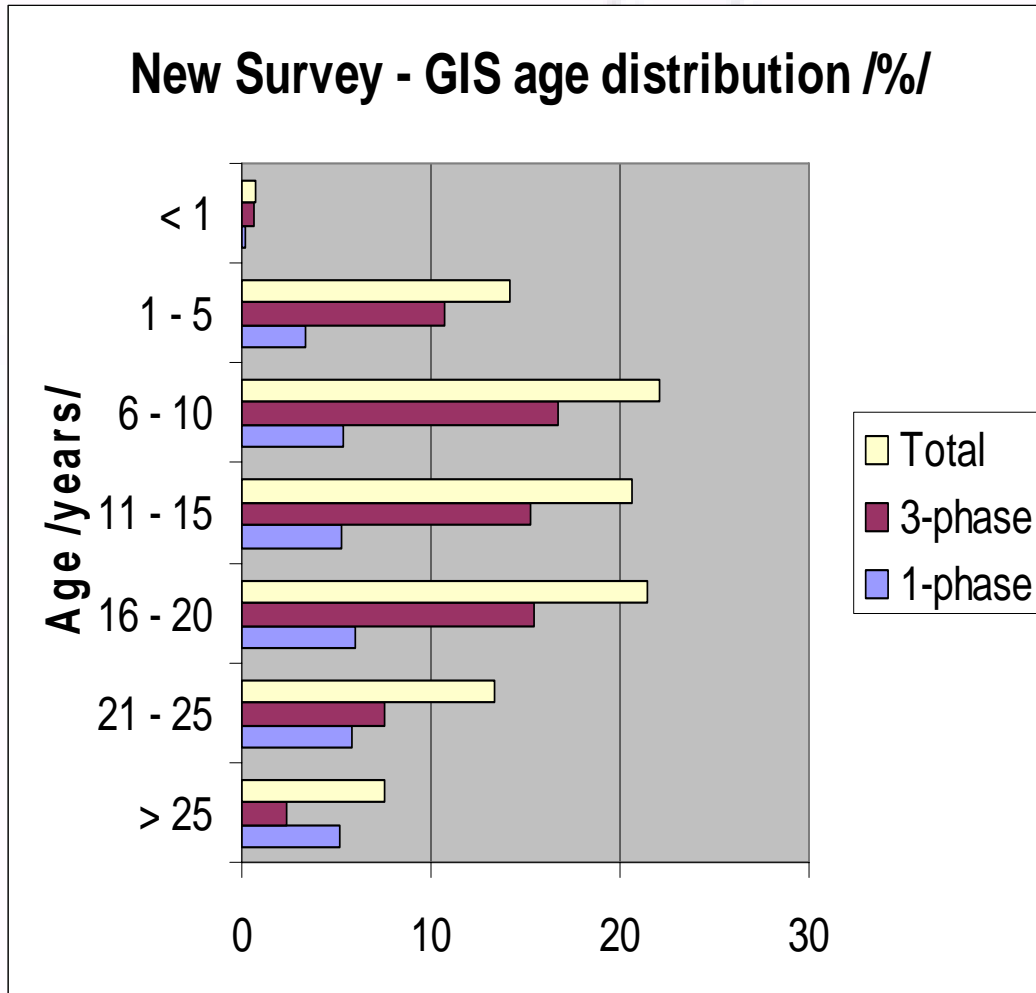
Cl. 3 : $\geq 200 \dots < 300$ kV

Cl. 4 : $\geq 300 \dots < 500$ kV

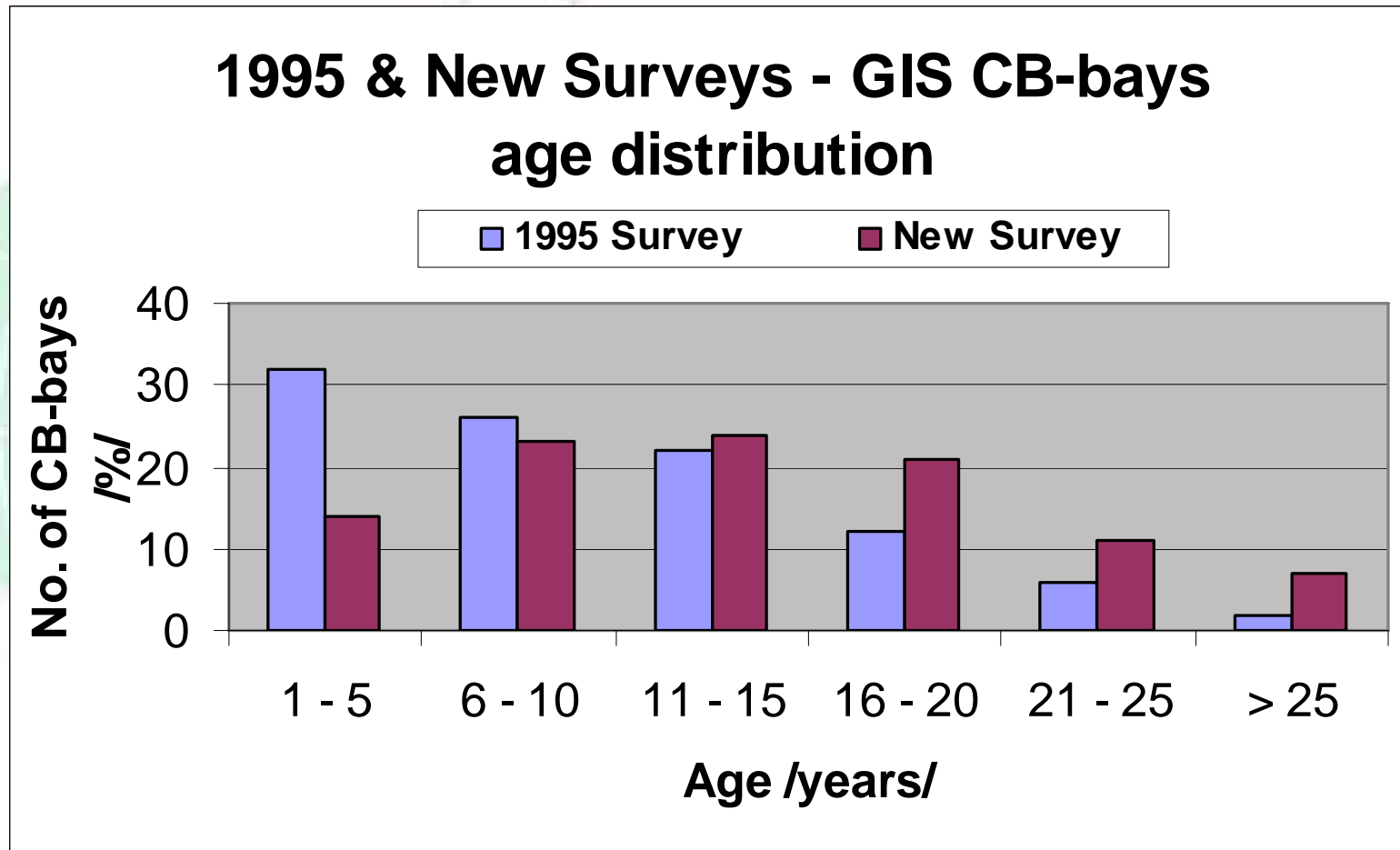
Cl. 5 : $\geq 500 \dots < 700$ kV

Cl. 6 : ≥ 700 kV

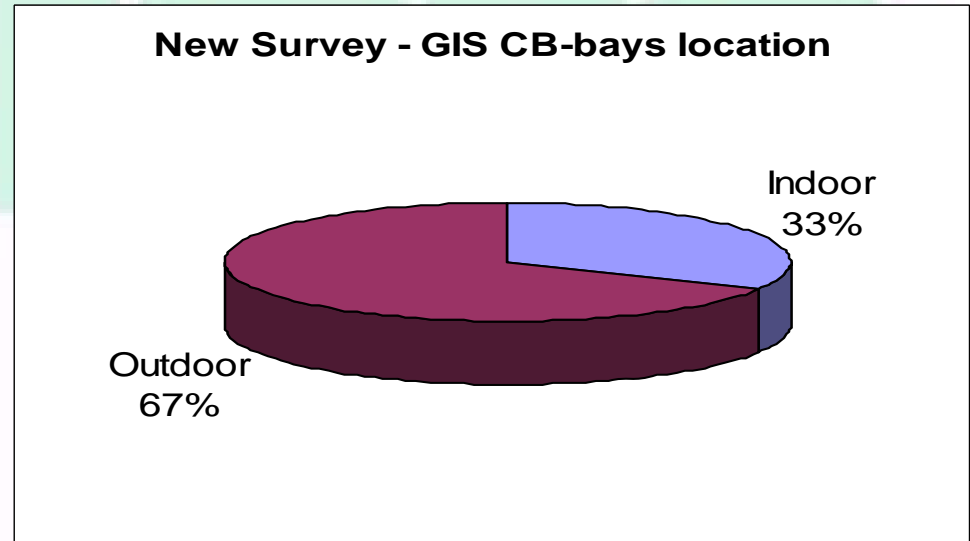
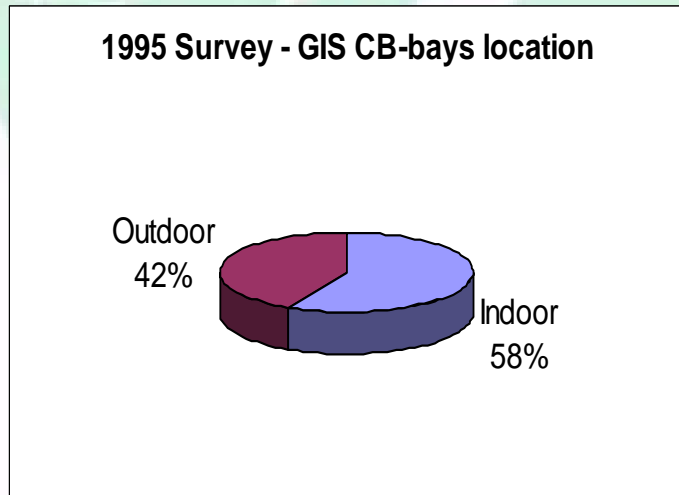
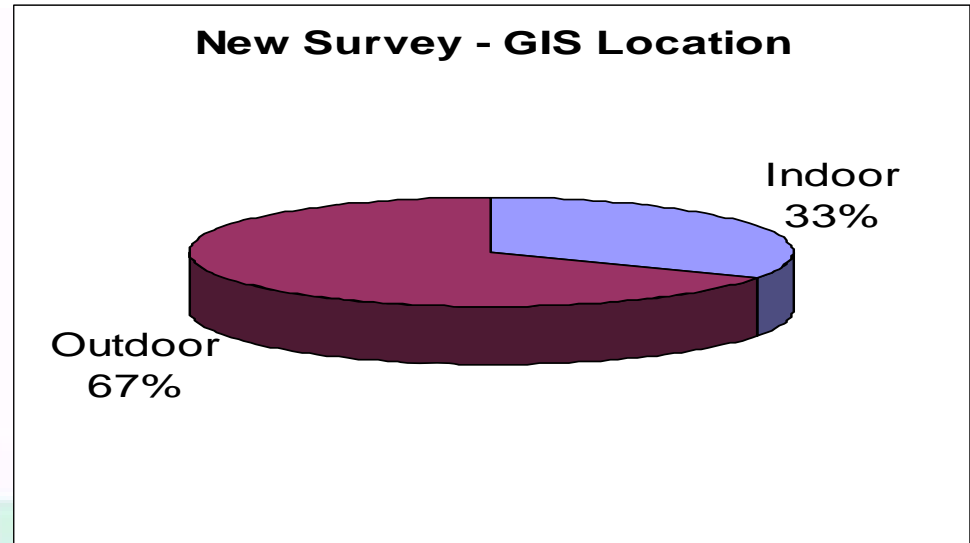
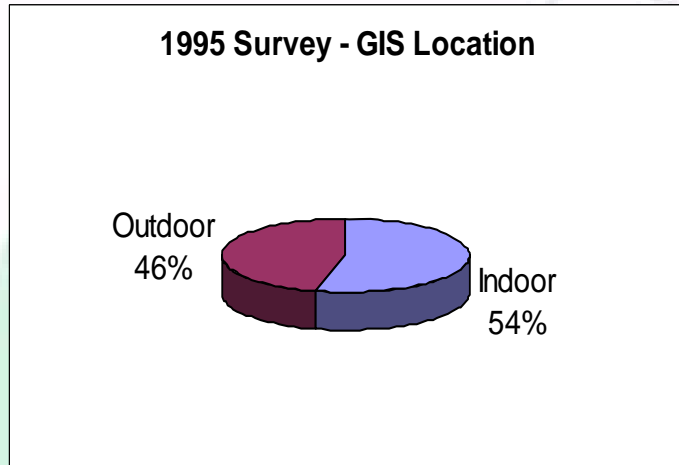
WB A3.06 - Reliability of HV equipment – GIS population (2004)



WB A3.06 - Reliability of HV equipment – GIS population (2004)

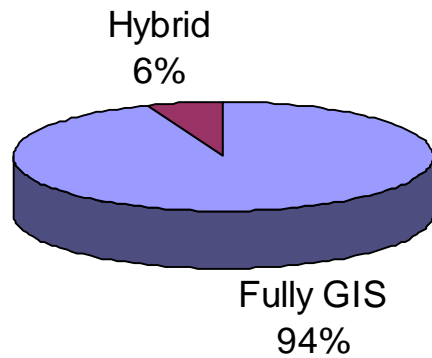


WB A3.06 - Reliability of HV equipment – GIS population (2004)

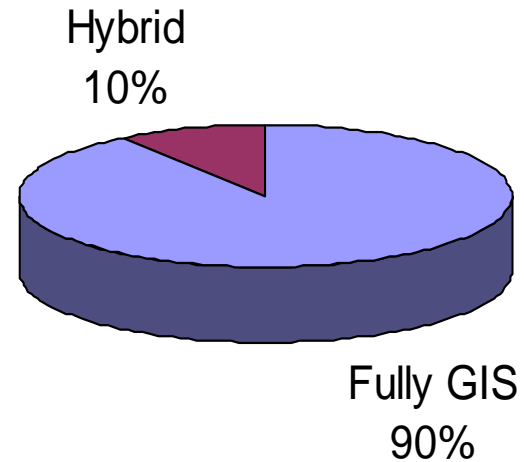


WB A3.06 - Reliability of HV equipment – GIS population (2004)

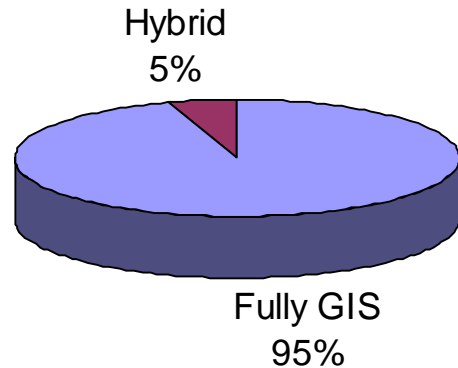
1995 Survey - GIS part extent



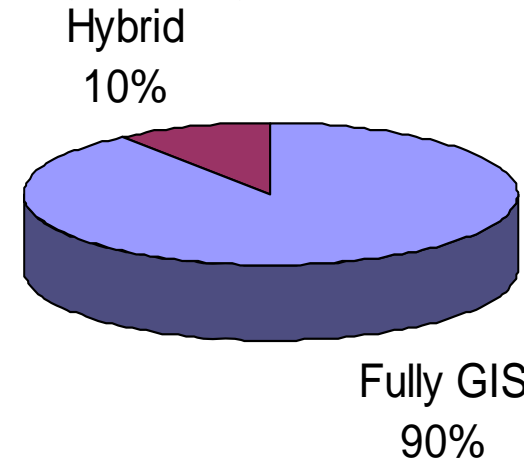
New Survey - GIS part extent



1995 Survey - CB-bays GIS part extent

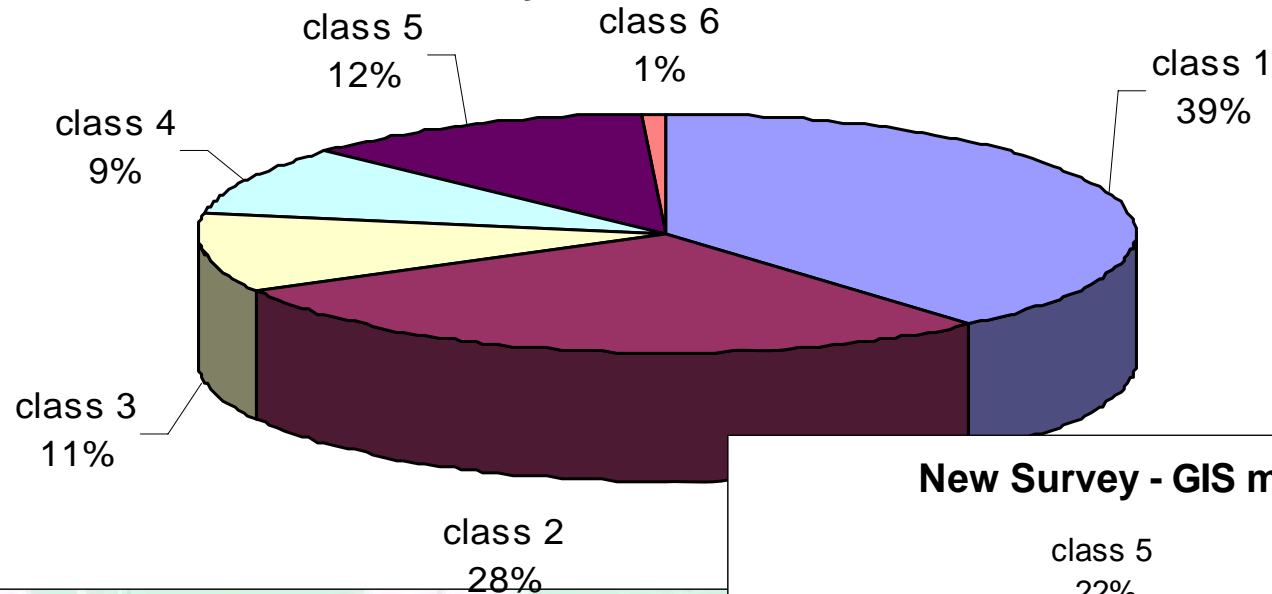


New Survey - CB-bays GIS part extent

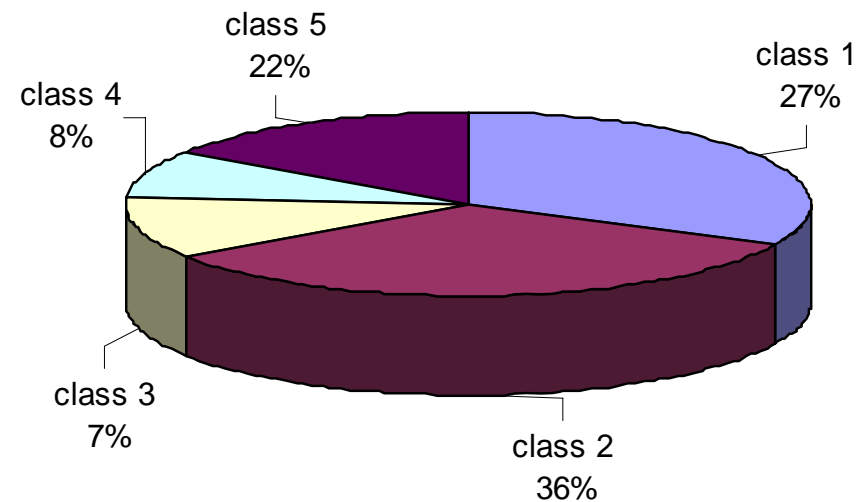


WB A3.06 - Reliability of HV equipment – GIS failures

New Survey - GIS failures x U class



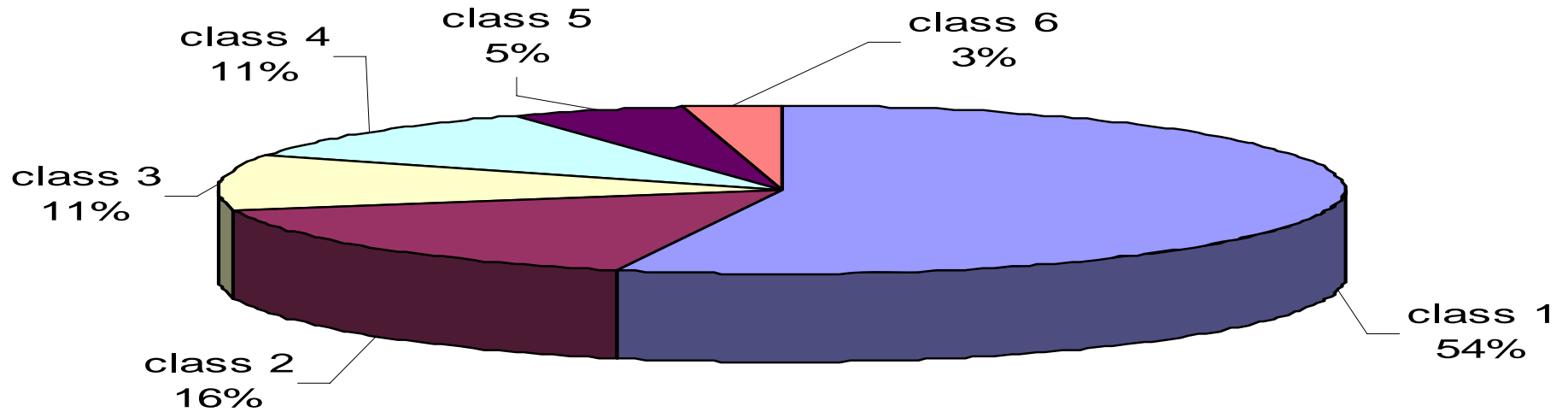
New Survey - GIS minor failures x U class



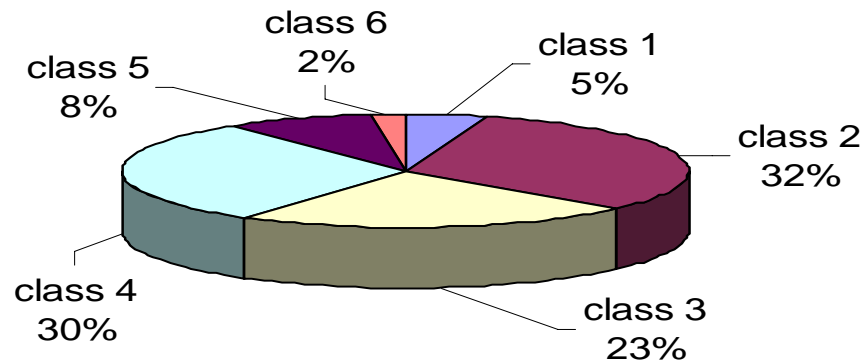
- Class 1 : $\geq 60 \dots < 100$ kV**
- Class 2 : $\geq 100 \dots < 200$ kV**
- Class 3 : $\geq 200 \dots < 300$ kV**
- Class 4 : $\geq 300 \dots < 500$ kV**
- Class 5 : $\geq 500 \dots < 700$ kV**
- Class 6 : ≥ 700 kV**

WB A3.06 - Reliability of HV equipment – GIS failures

New Survey - GIS major failures x U class



1995 Survey - GIS major F x U class

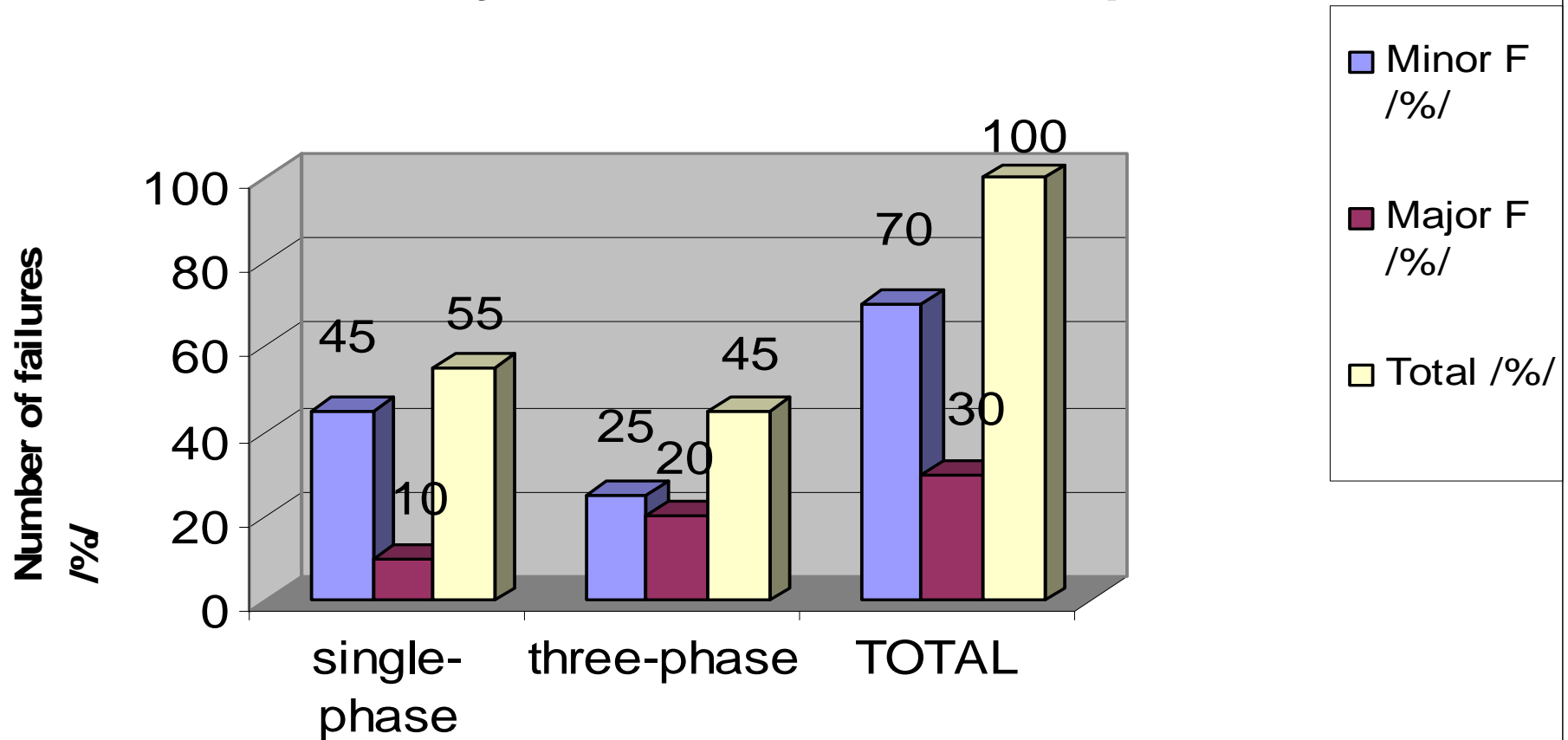


NEW SURVEY : 20% of major failures number in 1995 survey

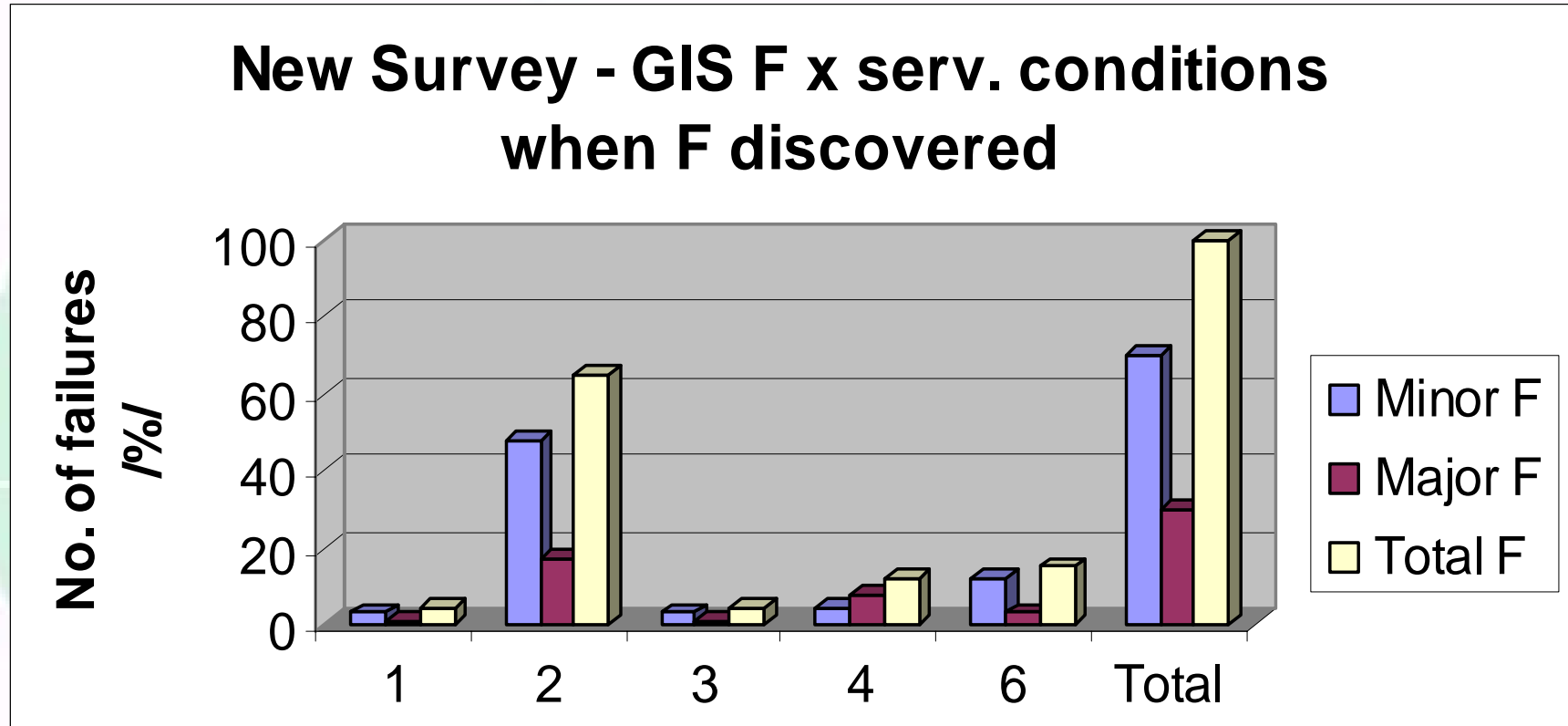
- Class 1 : $\geq 60 \dots < 100$ kV**
- Class 2 : $\geq 100 \dots < 200$ kV**
- Class 3 : $\geq 200 \dots < 300$ kV**
- Class 4 : $\geq 300 \dots < 500$ kV**
- Class 5 : $\geq 500 \dots < 700$ kV**
- Class 6 : ≥ 700 kV**

WB A3.06 - Reliability of HV equipment – GIS failures

New Survey - GIS failures x Encapsulation



WB A3.06 - Reliability of HV equipment – GIS failures



1 -De-energized - available for service

2 -Normal service - no operation command in S/S

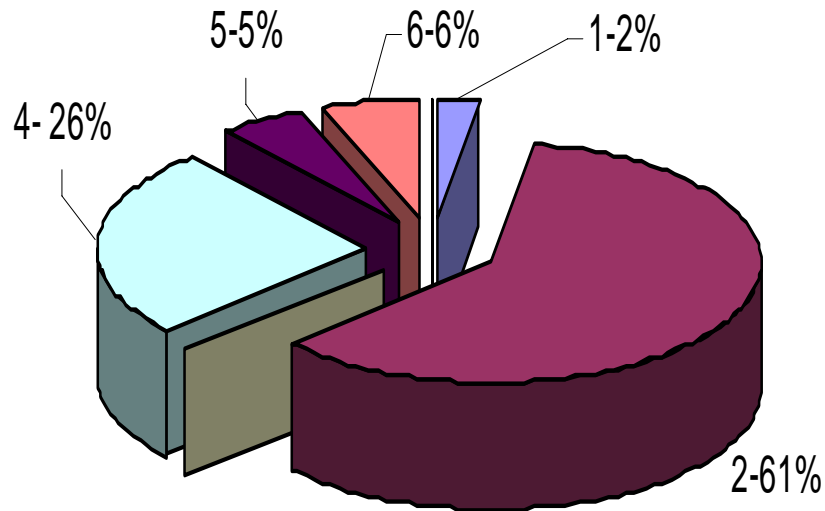
3 -During normal operation in S/S

4 -During normal switching operation (CB,DS,ES)

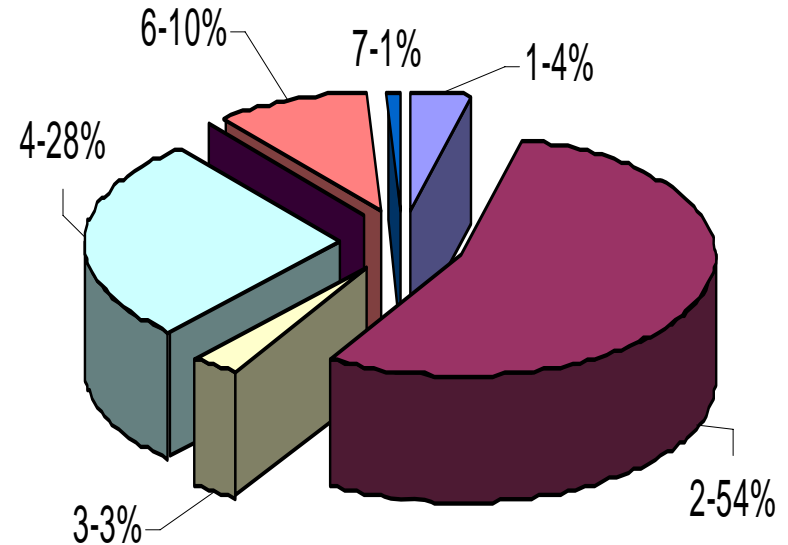
6 -During testing/maintenance

WB A3.06 - Reliability of HV equipment – GIS failures

1995 Survey - Major F x conditions when F discovered



New Survey - Major F x conditions when F discovered

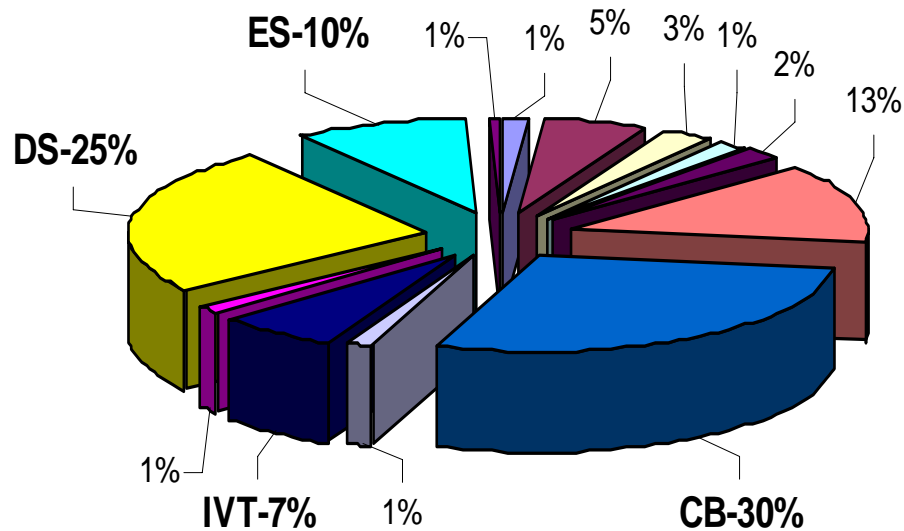


- 1 -De-energized - available for service
- 3 -During normal operation in S/S
- 5 -Fault clearing operation
- 7 -During misoperation in S/S

- 2 -Normal service - no operation command in S/S
- 4 -During normal switching operation (CB,DS,ES)
- 6 -During testing/maintenance

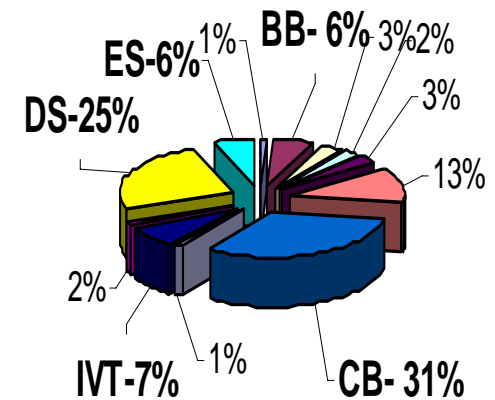
WB A3.06 - Reliability of HV equipment – GIS failures

New Survey - Failures x GIS component



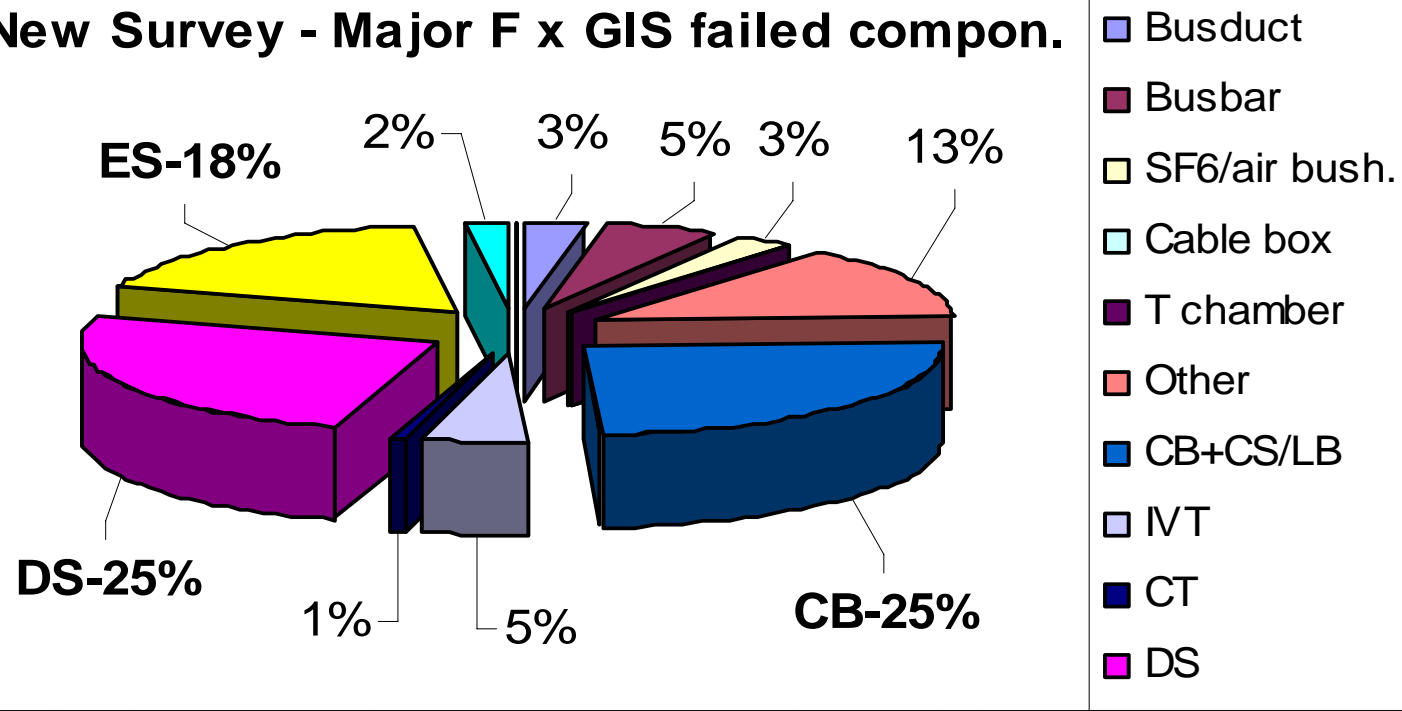
- Busduct
- Busbar
- SF6/air bush.
- Cable box
- T chamber
- Other
- CB
- CS/LB
- IVT
- CT
- DS
- ES
- CDES

New Survey - Minor F x GIS component

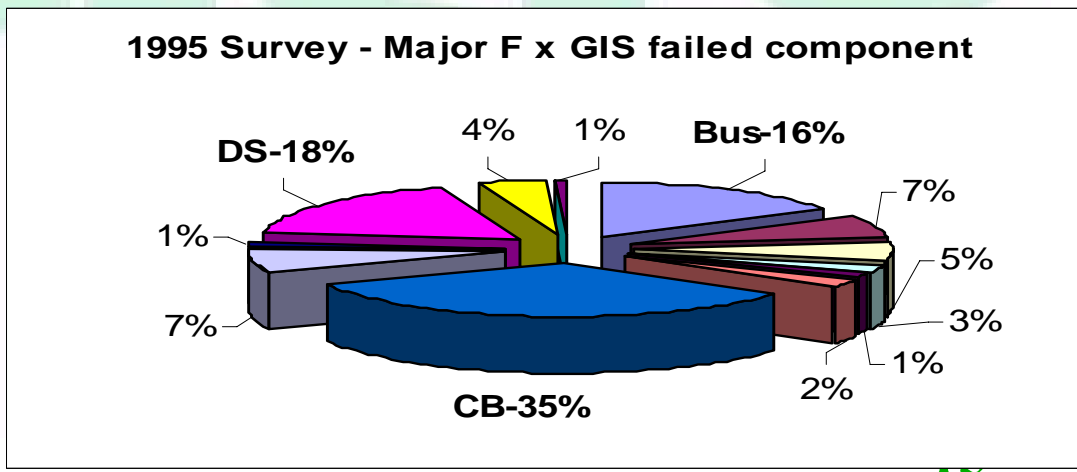


WB A3.06 - Reliability of HV equipment – GIS failures

New Survey - Major F x GIS failed compon.

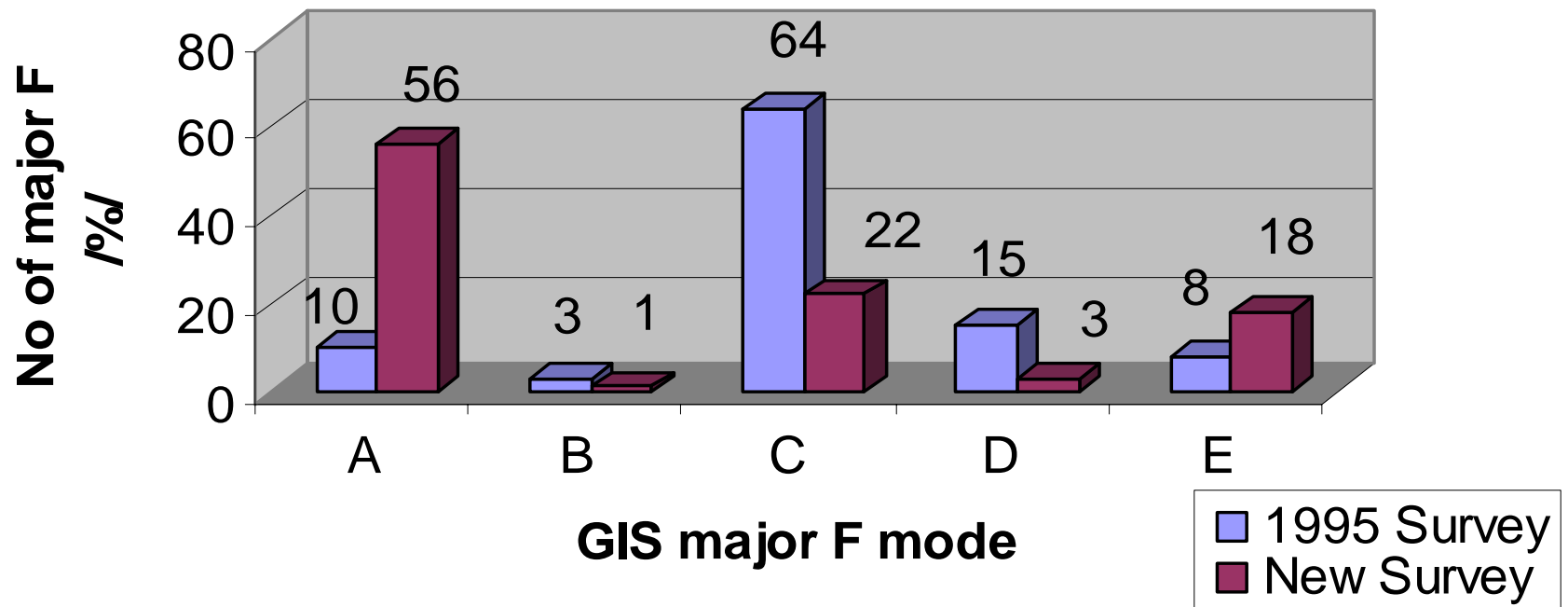


1995 Survey - Major F x GIS failed component



WB A3.06 - Reliability of HV equipment – GIS failures

1995 & New Surveys - GIS major F modes



A - Failing to perform requested operation or function resp.

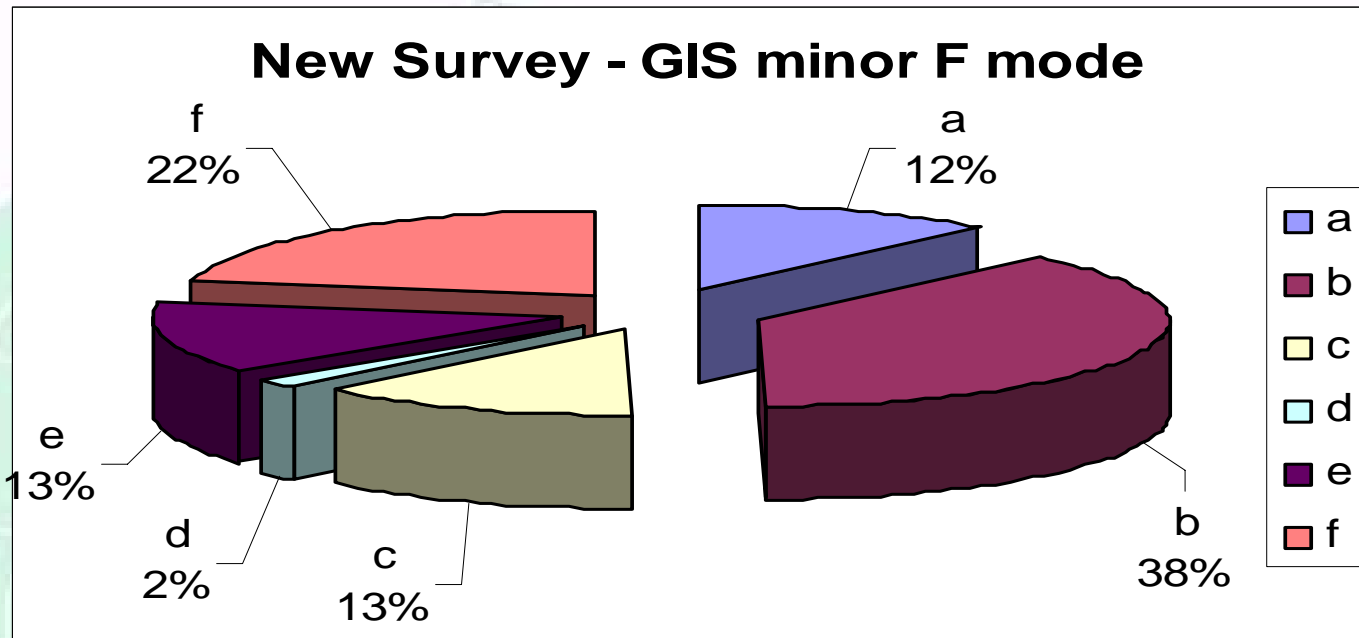
B - Loss of electrical connections integrity

C - Dielectric breakdown

D - Loss of mechanical integrity (big SF6 leakage incl.)

E- Other

WB A3.06 - Reliability of HV equipment – GIS failures



a - Mechanical weakness in operating mechanism

b - Small SF6 leakage

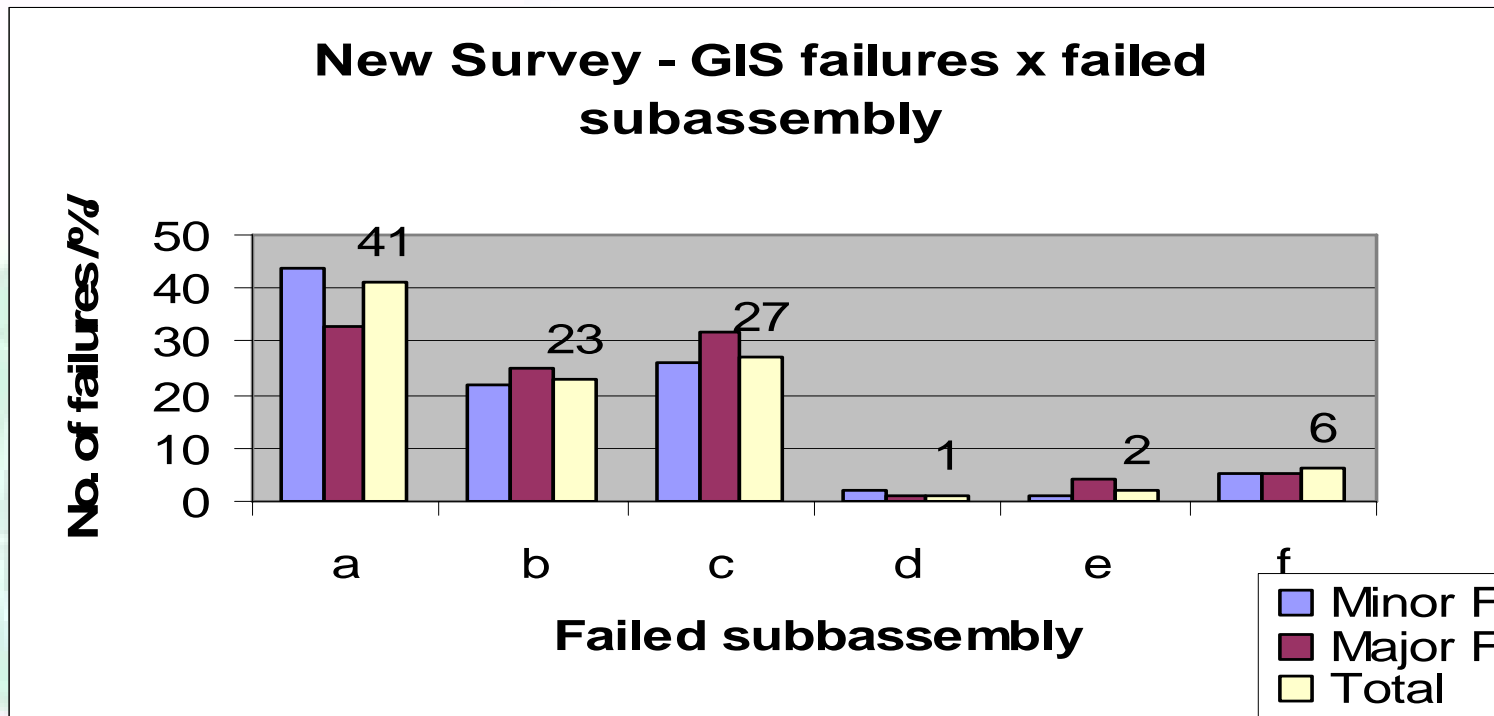
c - Mechanical weakness in primary

d - Electrical or dielectrical weakness in primary

e - Mechanical or electrical weakness in control, auxiliary and monitoring

f - Other

WB A3.06 - Reliability of HV equipment – GIS failures



a - Component in primary circuit

b - Component in control, auxiliary or monitoring circuit

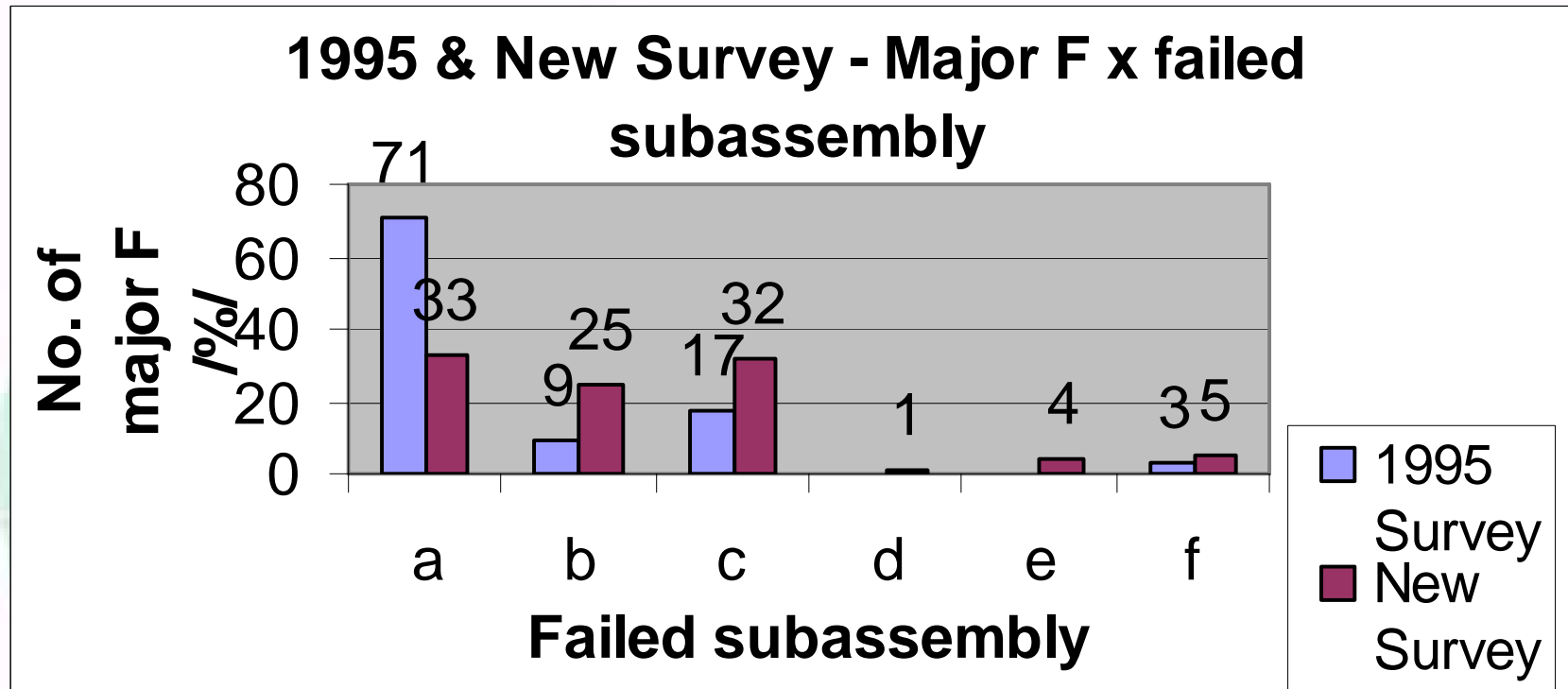
c - Component in operating mechanism

d - Component in kinematic chain

e - Component in IT secondary circuit

f - Unknown or other

WB A3.06 - Reliability of HV equipment – GIS failures



a - Component in primary circuit

b - Component in control, auxiliary or monitoring circuit

c - Component in operating mechanism

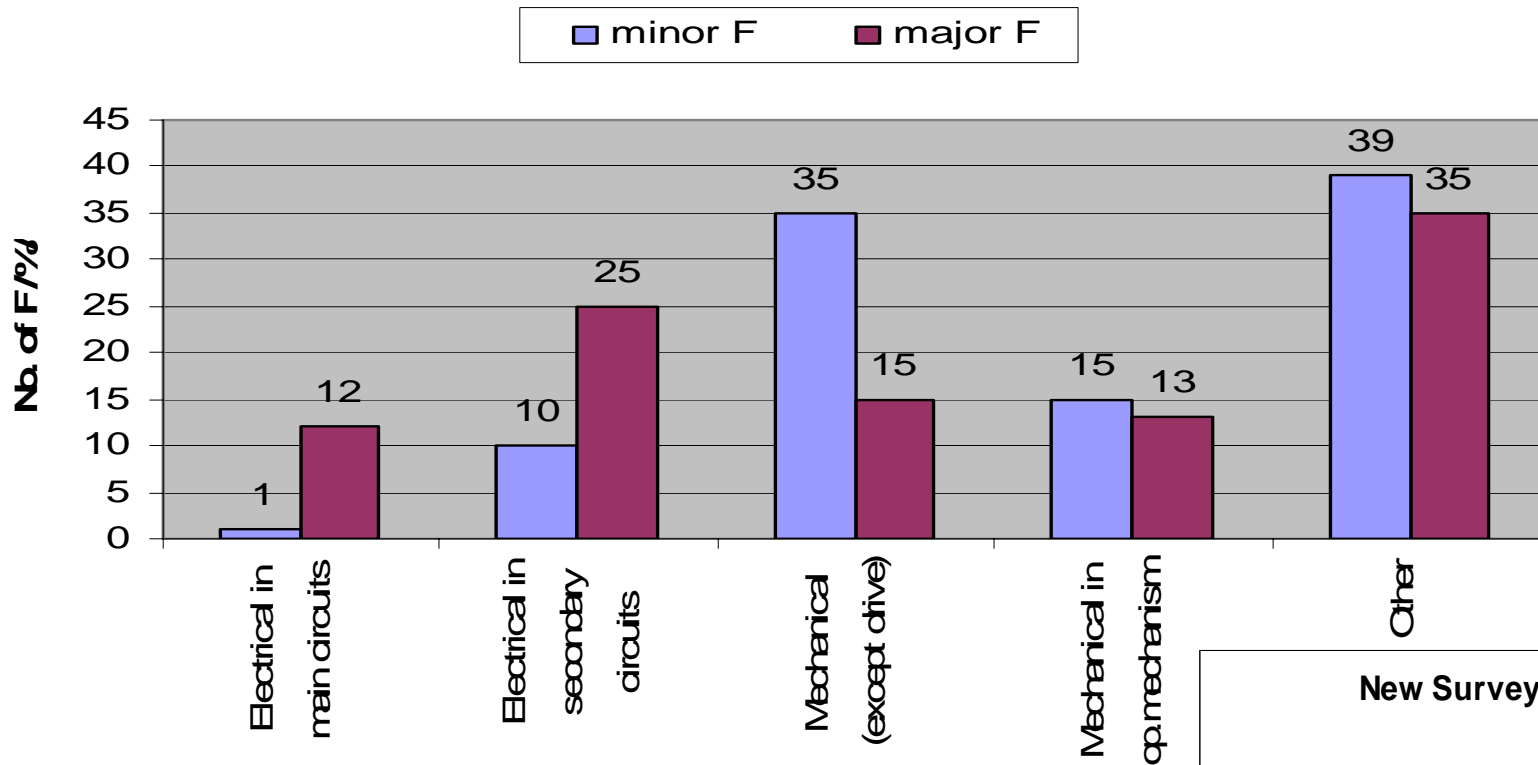
d - Component in kinematic chain

e - Component in IT secondary circuit

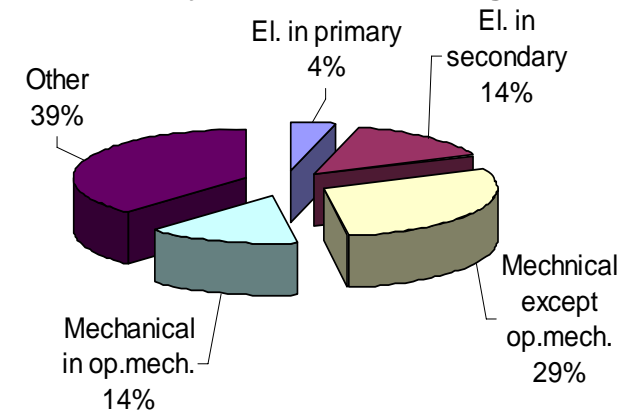
f - Unknown or other

WB A3.06 - Reliability of HV equipment – GIS failures

New Survey - Minor & Major F x origin



New Survey - GIS failures x origin



WB A3.06 - Reliability of HV equipment – GIS failures

A - Cause introduced during a period before putting into service

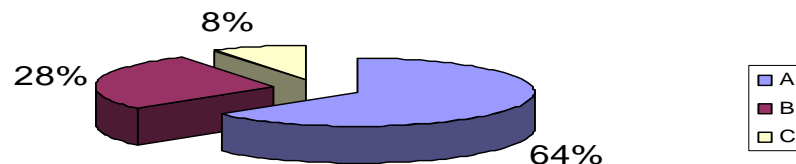
- a - Design fault (manufacturer responsibility)
- b - Engineering fault (utility responsibility)
- c - Manufacturing fault (poor quality control)
- d - Incorrect transport or erection
- e - Inadequate instructions for transport, erection, operation
- f - Other before PTS

B - Cause introduced during service

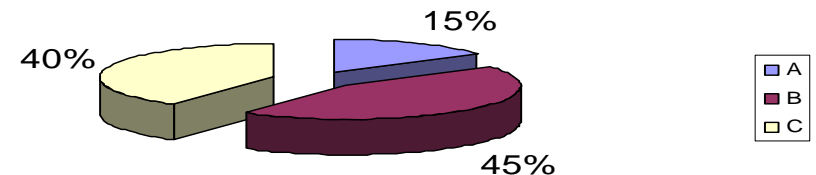
- h - Current in excess of rating
- i - Voltage at power frequency in excess of rating
- j - Switching overvoltage in excess of rating
- k - Lightning overvoltage in excess of rating
- l - Mechanical stress in excess of rating
- m - Environmental stresses (other than lightning)
- n - Corrosion
- o - Wear / Ageing
- p - Incorrect operation
- q - Incorrect monitoring
- r - Electrical failure of adjacent equipment
- s - Mechanical failure of adjacent equipment
- t - Human error
- u - Incorrect maintenance (incl. instruction)
- v - External damage caused by animals, humans etc.
- w - Other abnormal service conditions

C - Unknown other causes

1995 Survey - GIS major F x primary cause

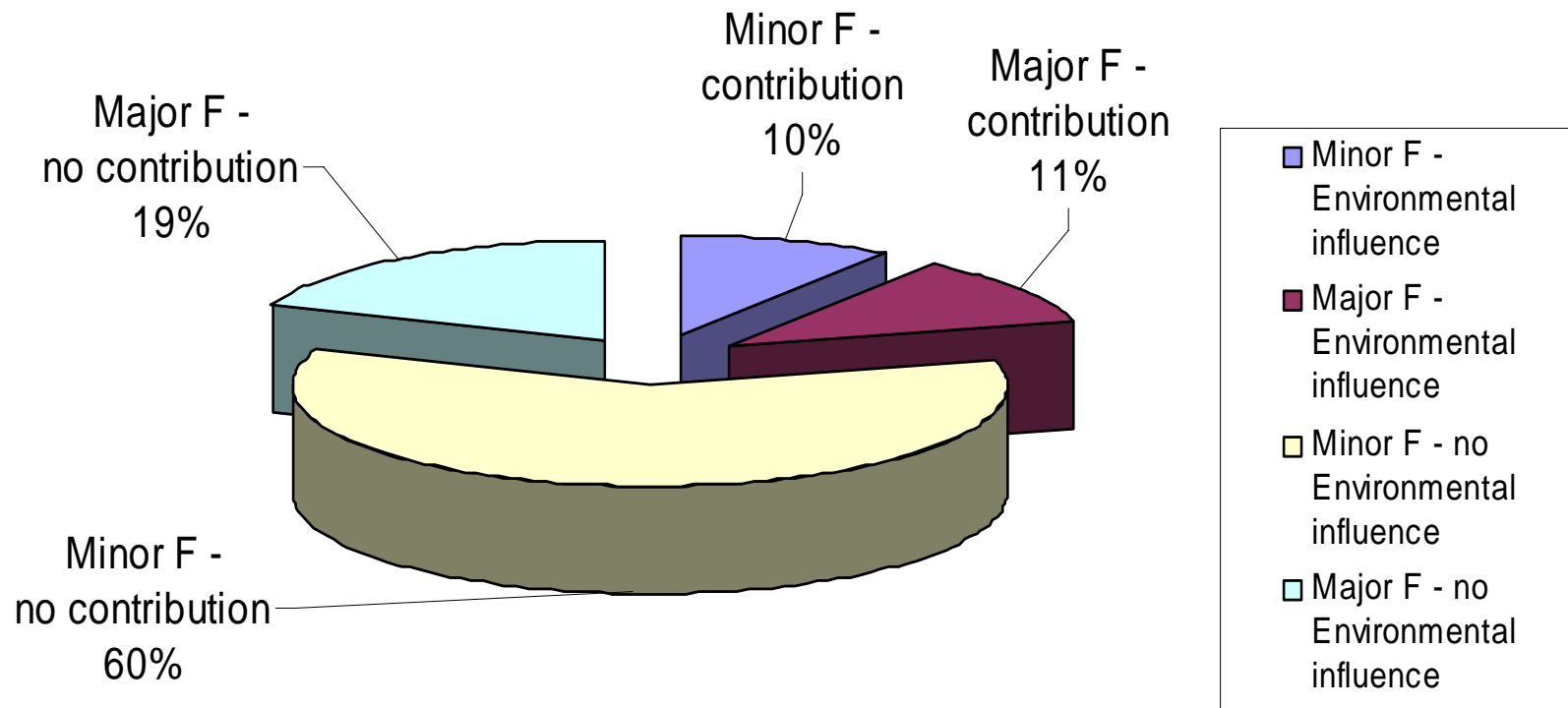


New Survey - GIS major F x primary cause



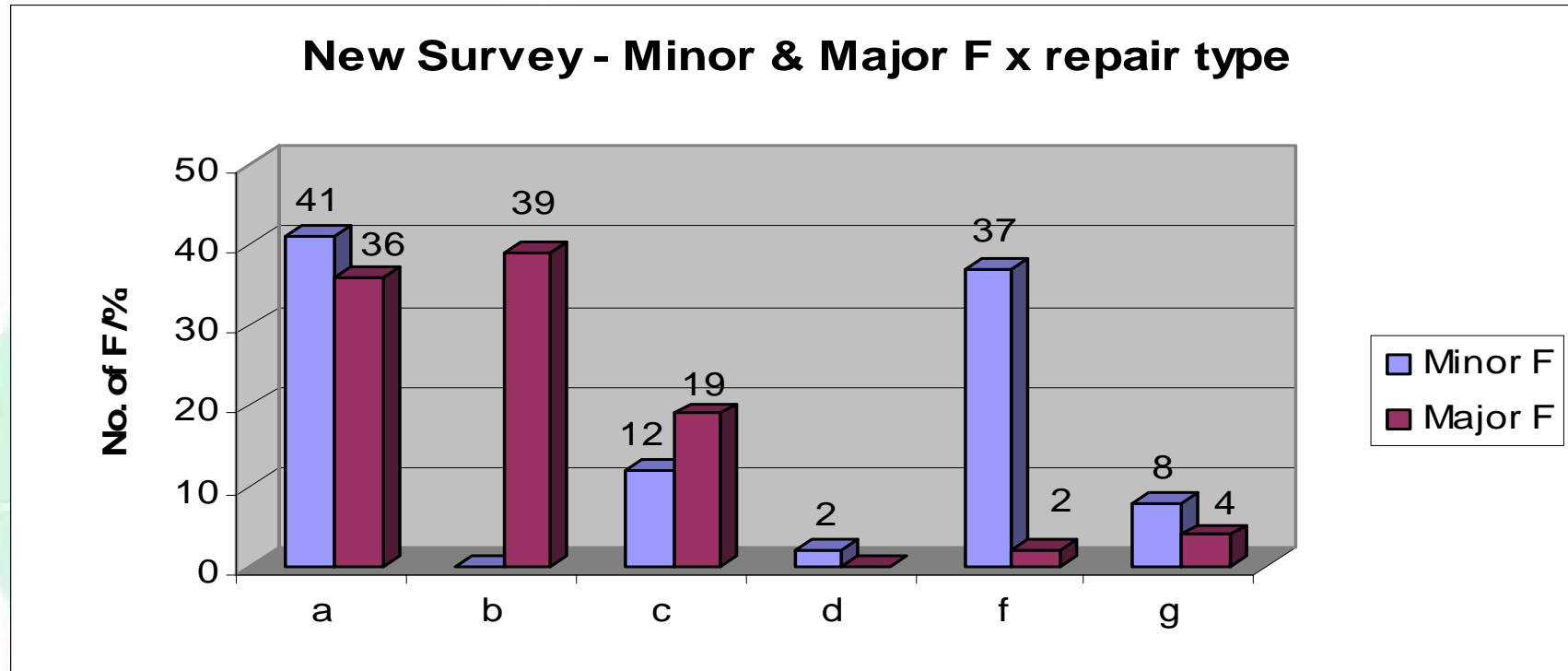
WB A3.06 - Reliability of HV equipment – GIS failures

GIS failures versus environmental contribution



Outdoor GIS failures represent 87 % of failures influenced by environment

WB A3.06 - Reliability of HV equipment – GIS failures



a - Repair of failed component on site

b - Repair in factory or shop

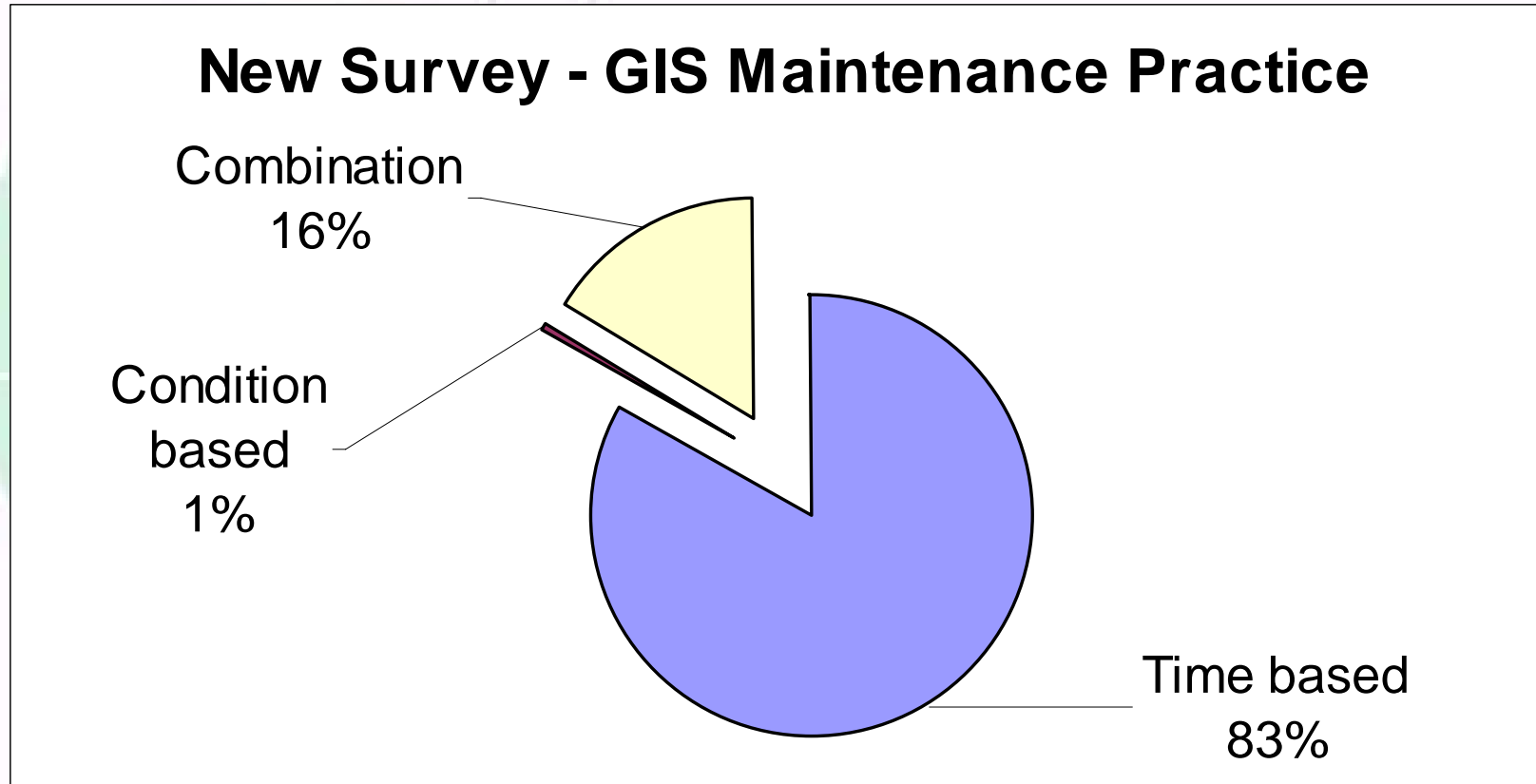
c - Replacement of failed component on site (without replacement of enclosure)

d - Replacement of failed component and its enclosure

f - Replacement of seals or refilling only

g - Placed back into service without repair

WB A3.06 - Reliability of HV equipment – GIS population (2004)



What happens when the teamwork
(engineering, design, manufacturing, transport,
erection, commissioning, service, maintenance)
does not work?

