Working Group I17
Transmission System Relay Performance Comparison

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Background

- Measuring criteria developed 1999
- Several companies participated initially
- Easy to use
- Views performance from a high level
- Directed to transmission only
- This report covers years 2000-2003
- 4 companies participated all 4 years
- 5 companies partially participated

Misoperation Formula

$$\% \text{ Misoperations} = \frac{\text{All misoperations}}{\text{Total \# of events + K}} \text{ X } 100$$

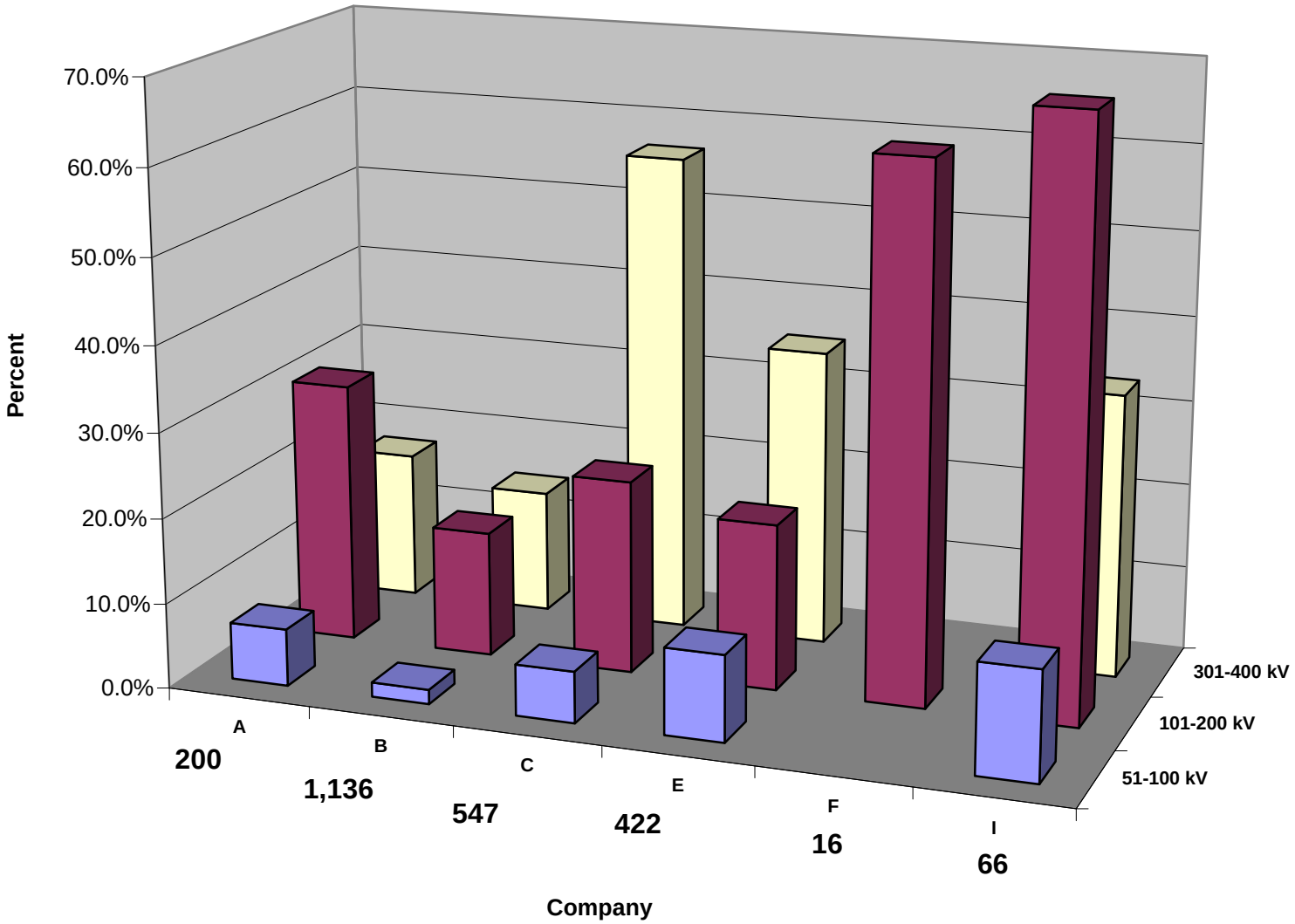
Utility: **Time Period:** **Jan. - Dec. 2004**

Voltage:	Dependability			Security		System Restoration	Total Misoperations
138 kV	**Failure to Trip**	**Failure to Interrupt**	**Slow Trip**	**Unnecessary Trip During Fault**	**Unnecessary Trip Other Than Fault**	**Failure to Reclose**	
Relay System	2	0	19	18	5	7	51
Circuit Breaker	1	1	0	0	3	2	7
Total Protective System	3	1	19	18	8	9	58
Percent Incorrect Operation Relay System	0.5%	0.0%	4.7%	4.5%	1.2%	1.7%	12.7%
Percent Incorrect Operation Circuit Breaker	0.3%	0.3%	0.0%	0.0%	0.8%	0.5%	1.8%
Percent Incorrect Operation Protective System	0.7%	0.2%	4.7%	4.5%	2.0%	2.2%	14.4%

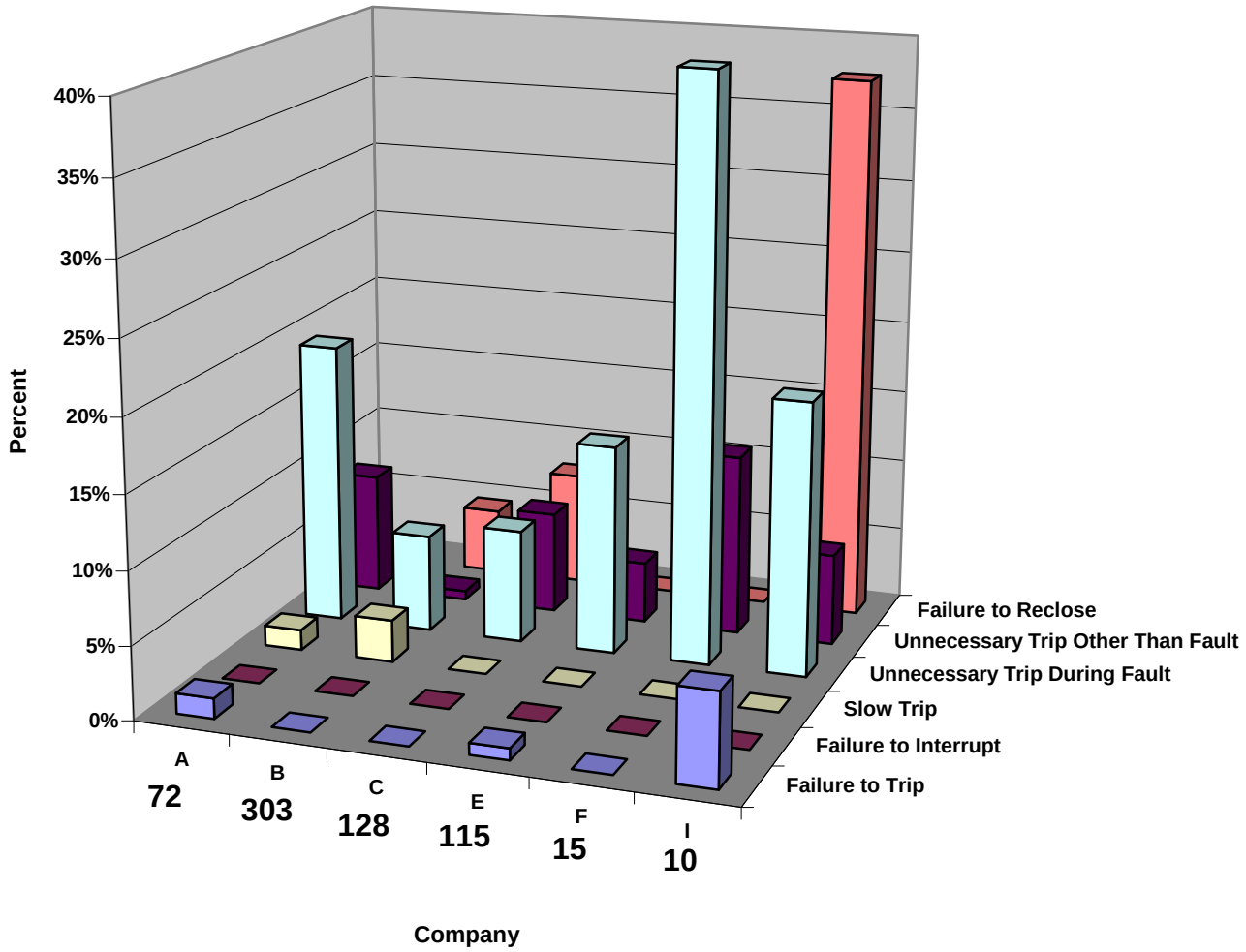
138 kV	**Relay K =**	5
	Breaker K =	0
	Total Operations:	397

% INCORRECT OPERATIONS, YEAR 2003												
Company	Total Events	K Factor	Relay Misoperations		Voltage	Failure to Trip	Failure to Interrupt	Slow Trip	Unnecessary Trip During Fault	Unnecessary Trip Other Than Fault	Failure to Reclose	Total Misoperations
A					Above 400							
B												
C	3	0	1			0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	33.3%
D												
E												
F												
H												
I												
A	23	0	4		301 - 400	0.0%	0.0%	0.0%	8.7%	8.7%	0.0%	17.4%
B	136	2	20			0.7%	0.0%	1.4%	5.1%	2.2%	5.1%	14.5%
C	22	1	13			0.0%	0.0%	0.0%	13.0%	39.1%	4.3%	56.5%
D												
E	16	4	7			0.0%	0.0%	0.0%	0.0%	0.0%	35.0%	35.0%
F	1	0	0			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
H												
I	9	0	3			0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	33.3%
A					201 - 300							
B												
C	9	1	2			0.0%	0.0%	0.0%	0.0%	20.0%	0.0%	20.0%
D												
E	1	0	0			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
F												
H												
I												
A	72	0	22		101 - 200	1.4%	0.0%	1.4%	19.4%	8.3%	0.0%	30.6%
B	303	9	46			0.0%	0.0%	2.9%	6.7%	0.6%	4.5%	14.7%
C	128	0	29			0.0%	0.0%	0.0%	7.8%	7.0%	7.8%	22.7%
D												
E	115	3	23			0.8%	0.0%	0.0%	14.4%	4.2%	0.0%	19.5%
F	15	1	10			0.0%	0.0%	0.0%	50.0%	12.5%	0.0%	62.5%
H												
I	10	6	11			6.3%	0.0%	0.0%	18.8%	6.3%	37.5%	68.8%
A	105	0	7		51 - 100	1.0%	0.0%	0.0%	4.8%	0.0%	1.0%	6.7%
B	697	1	12			0.0%	0.0%	0.0%	1.1%	0.0%	0.6%	1.7%
C	397	1	24			0.3%	0.0%	0.0%	2.8%	0.8%	2.3%	6.0%
D												
E	291	5	30			0.7%	0.0%	0.3%	6.4%	1.0%	1.7%	10.1%
F												
H												
I	47	0	6			0.0%	0.0%	2.1%	4.3%	4.3%	2.1%	12.8%

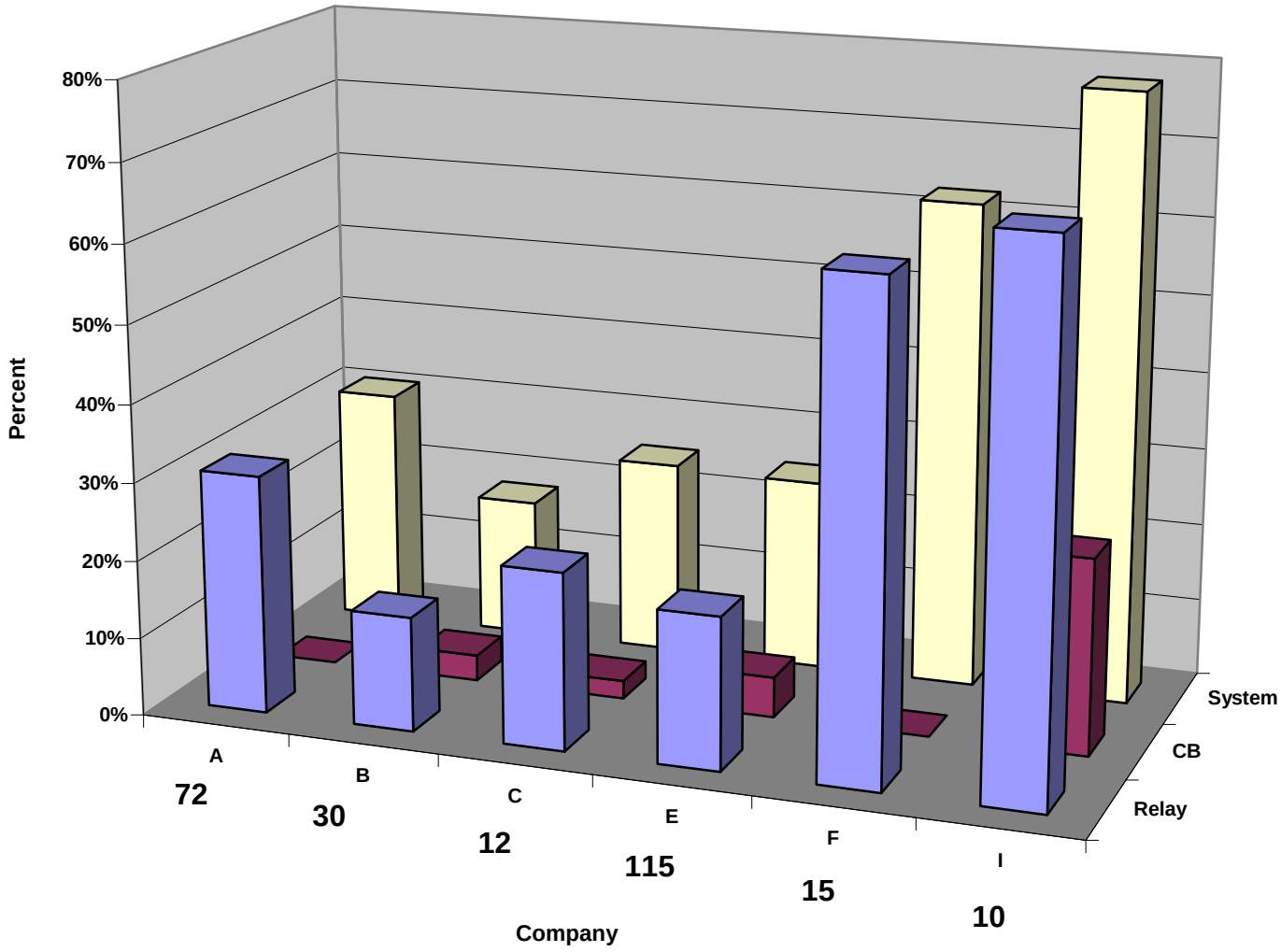
2003 Total % Misoperations By Voltage Class

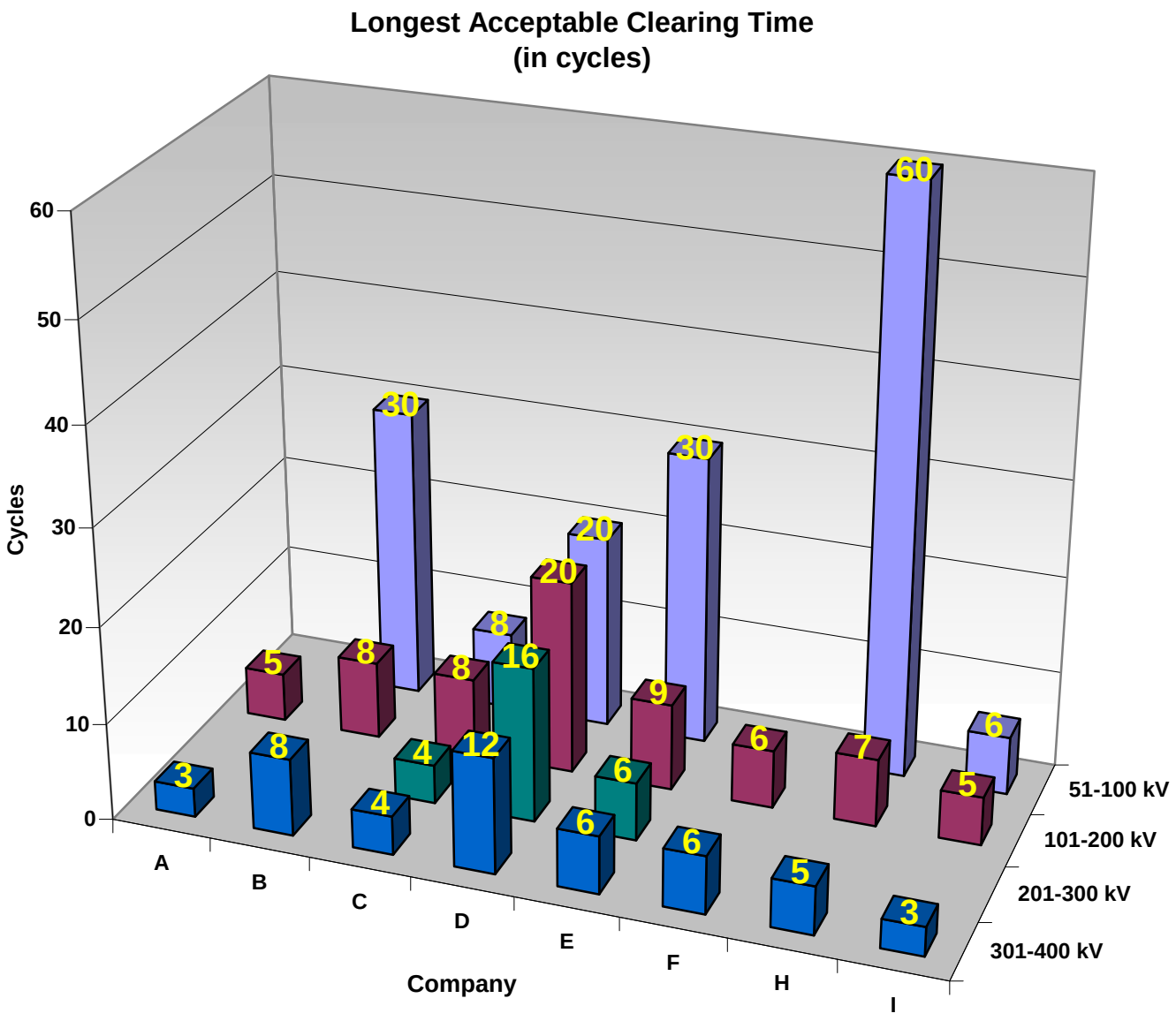


2003 Transmission % Relay Misoperations By Type
100-200 kV

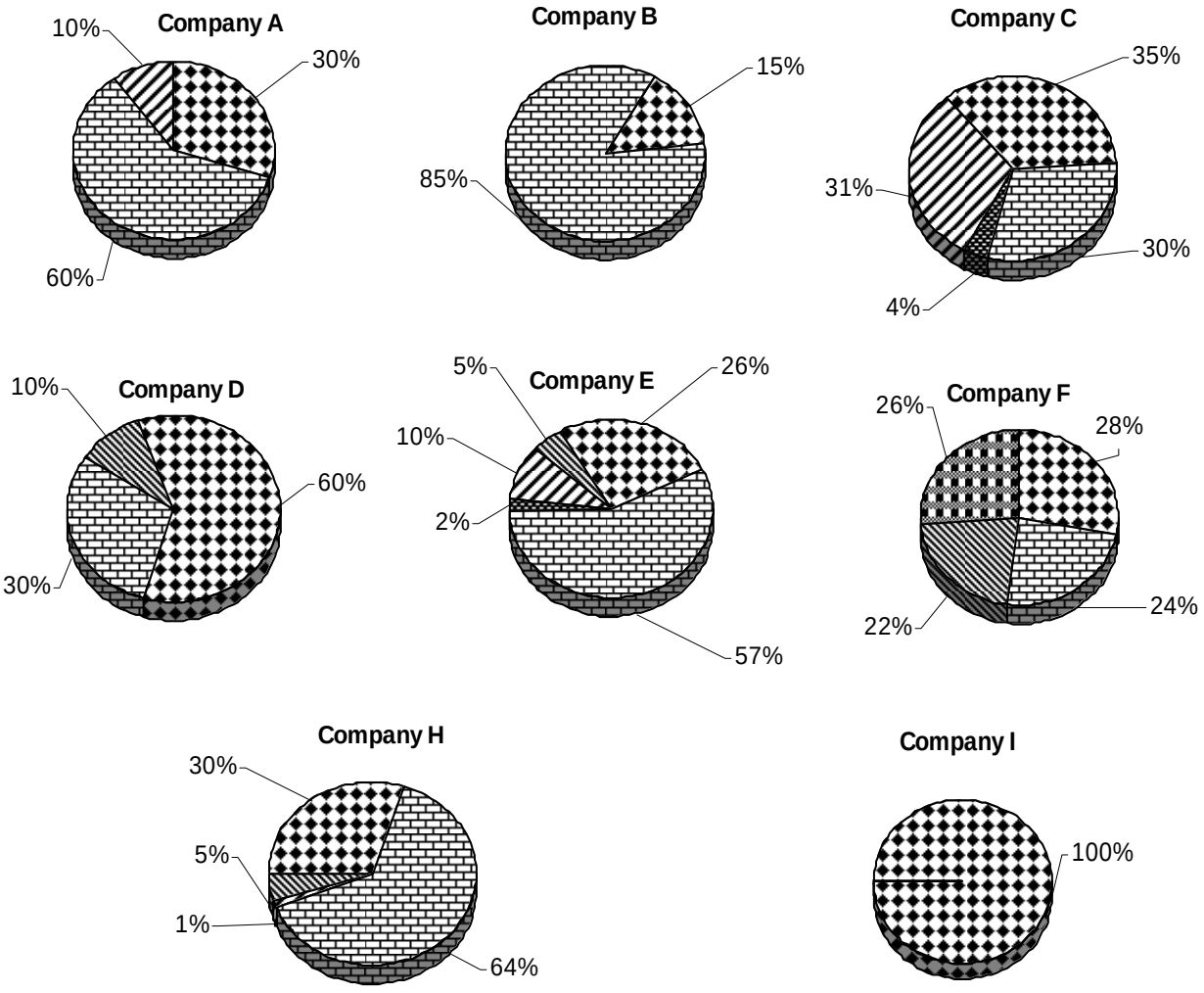


2003 Total % Incorrect Operations at 100-200 kV

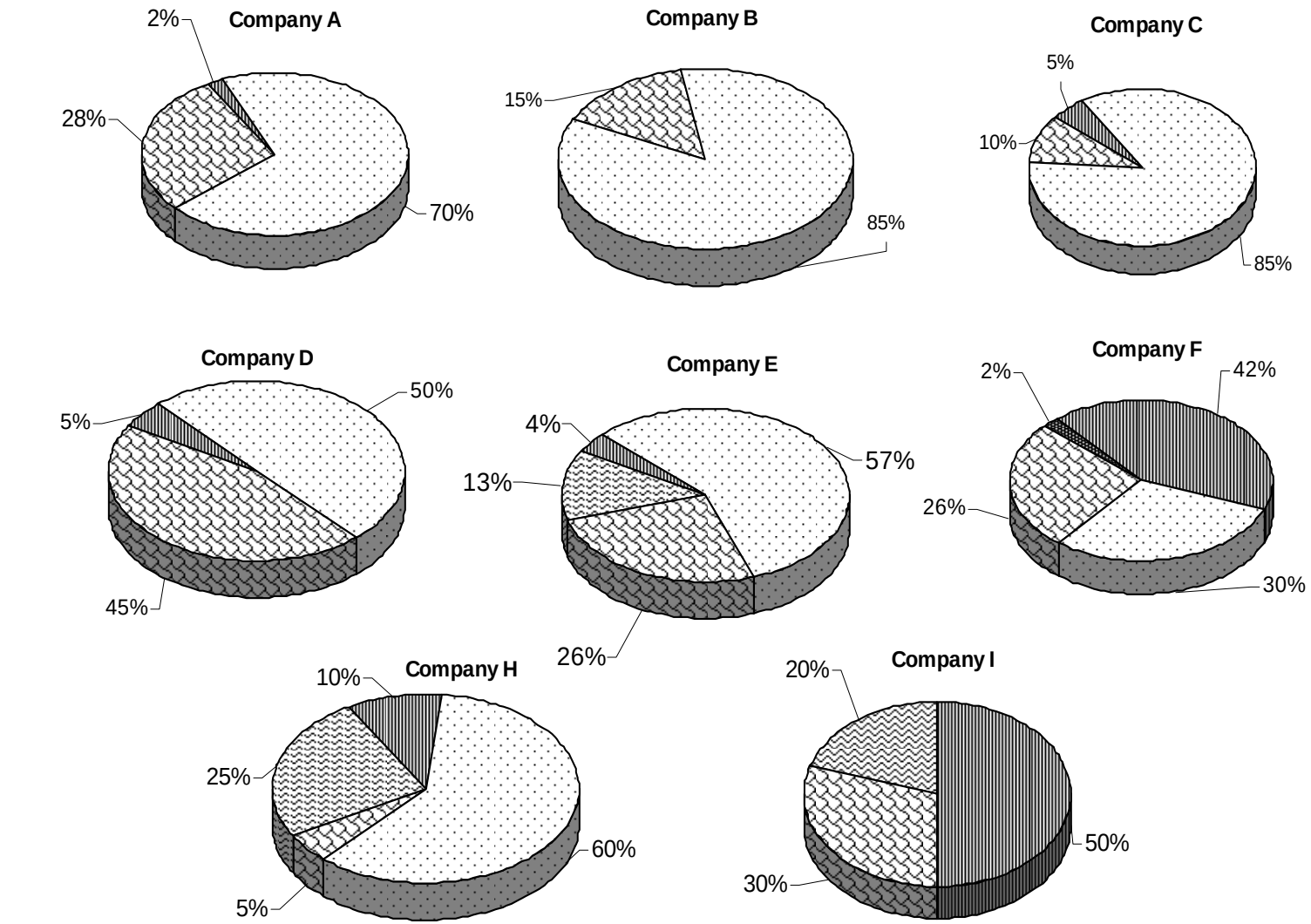



Longest Acceptable Clearing Time
(in cycles)
Cycles
60
50
40
30
20
10
0
A
B
C
D
E
F
H
I
Company
51-100 kV
101-200 kV
201-300 kV
301-400 kV
3
8
4
12
6
6
5
3
5
8
8
16
20
9
6
7
5
6
30
8
20
30
60

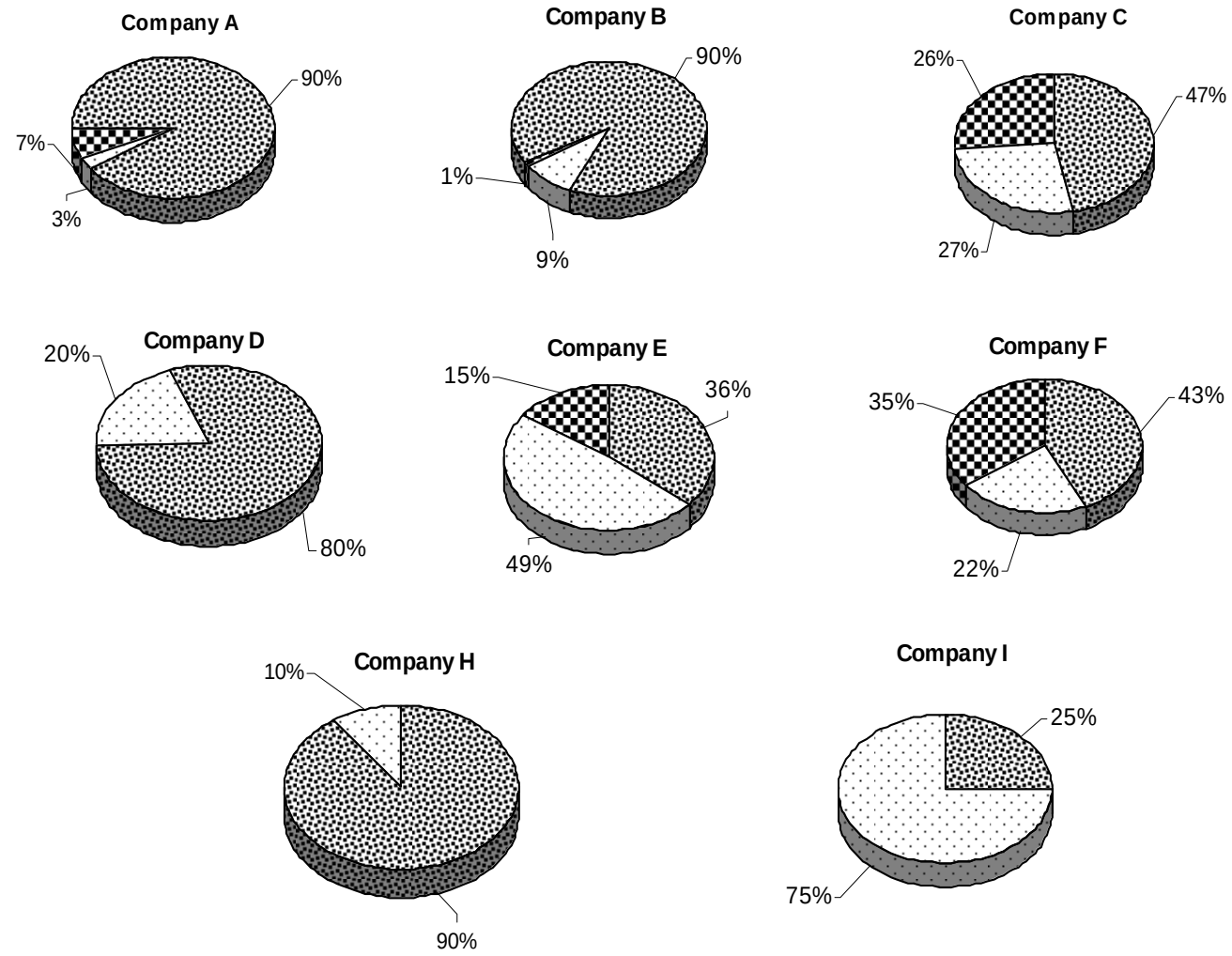
Type Communication Assisted Scheme: 100 - 200kV



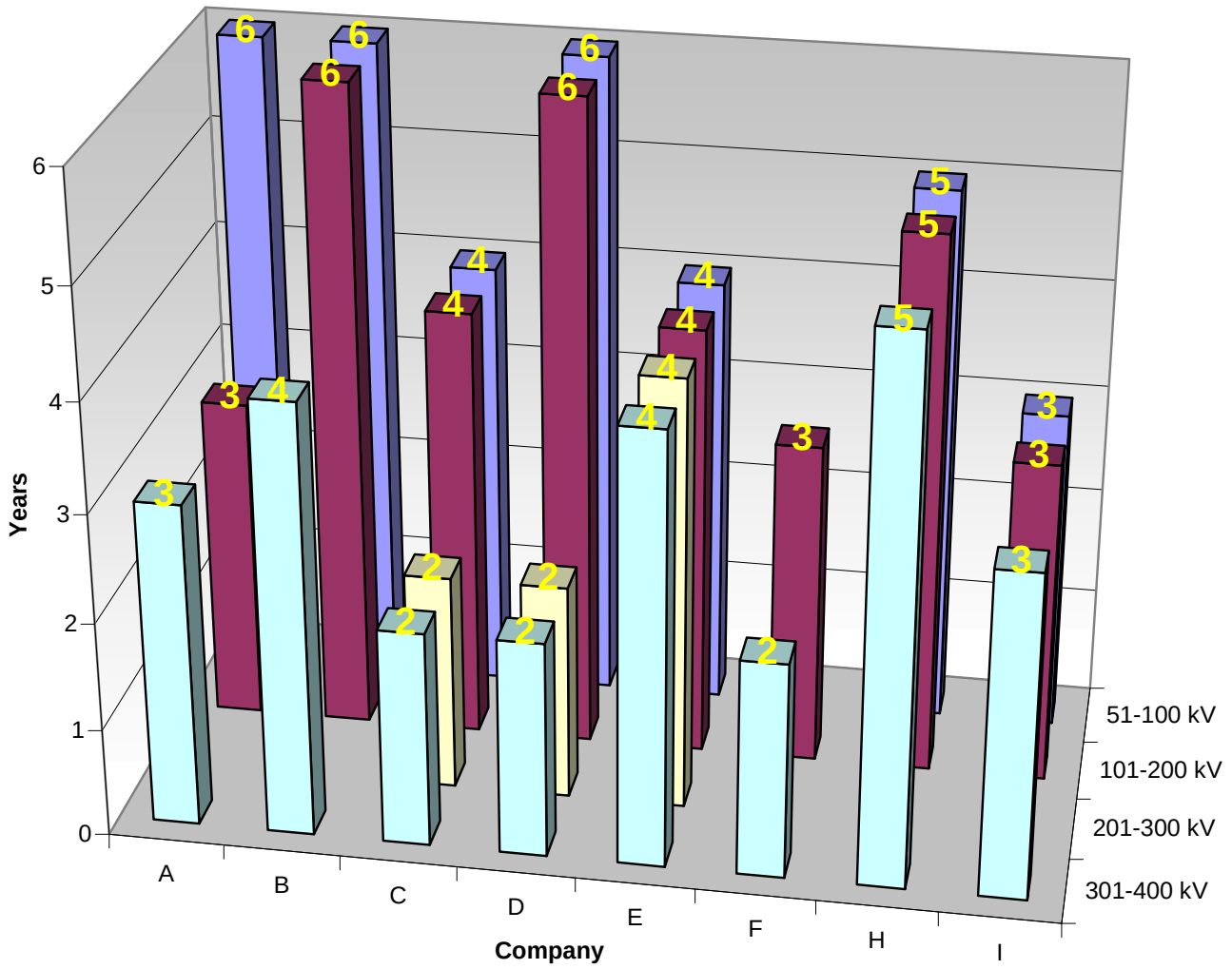
Communication Medium: 100 - 200kV



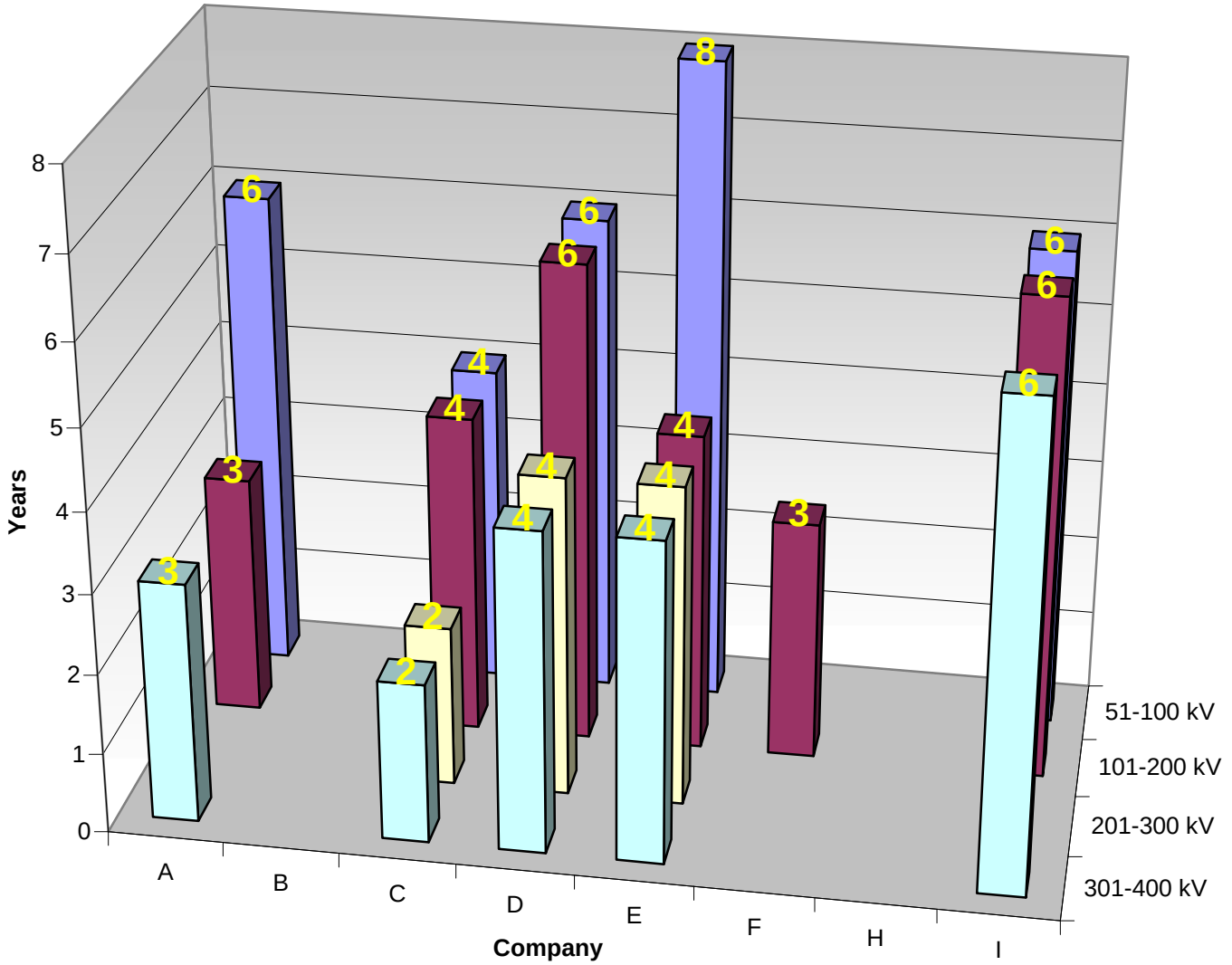
Type Relaying: 100 - 200kV



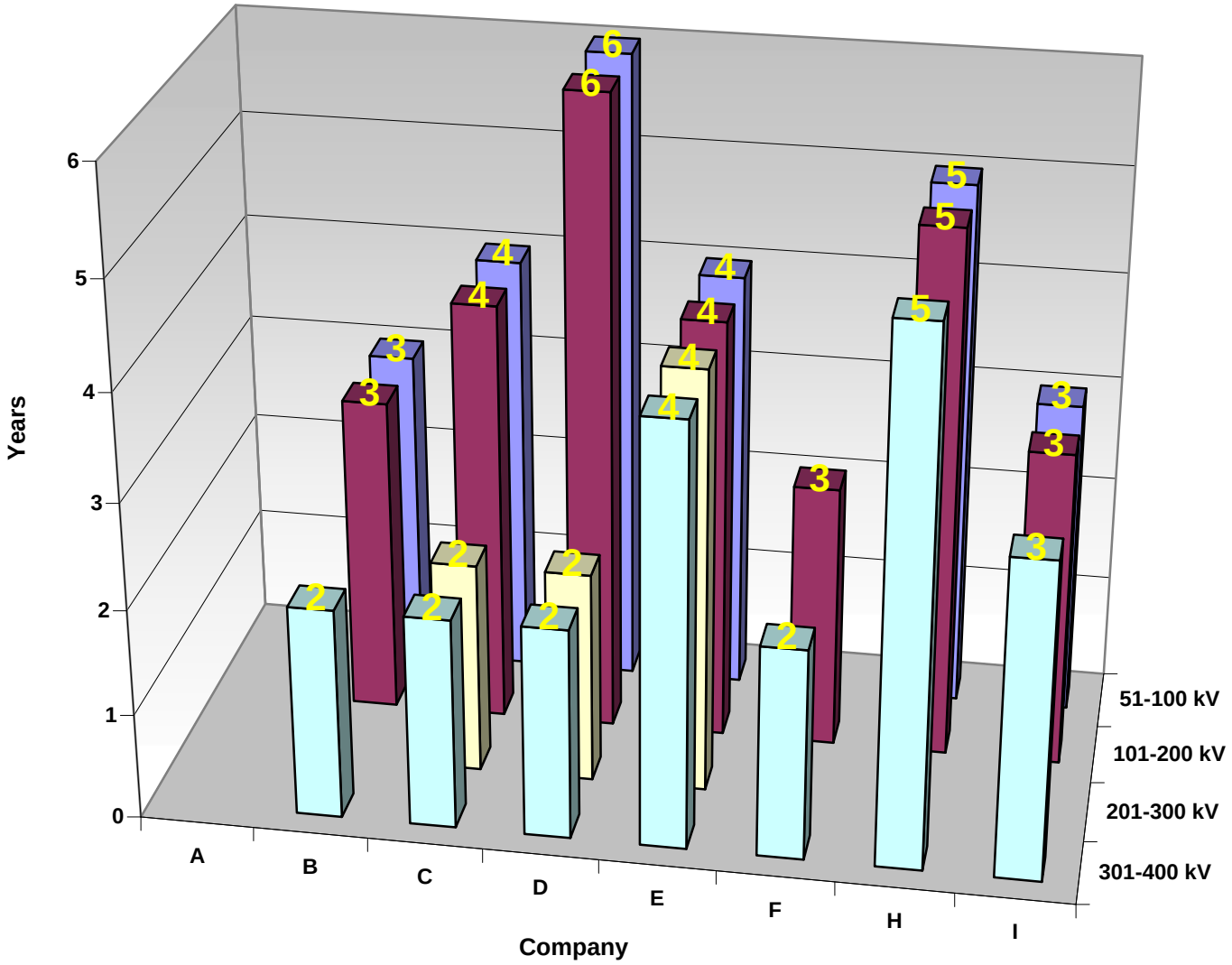
Calibration Test Interval for Electromechanical Relays



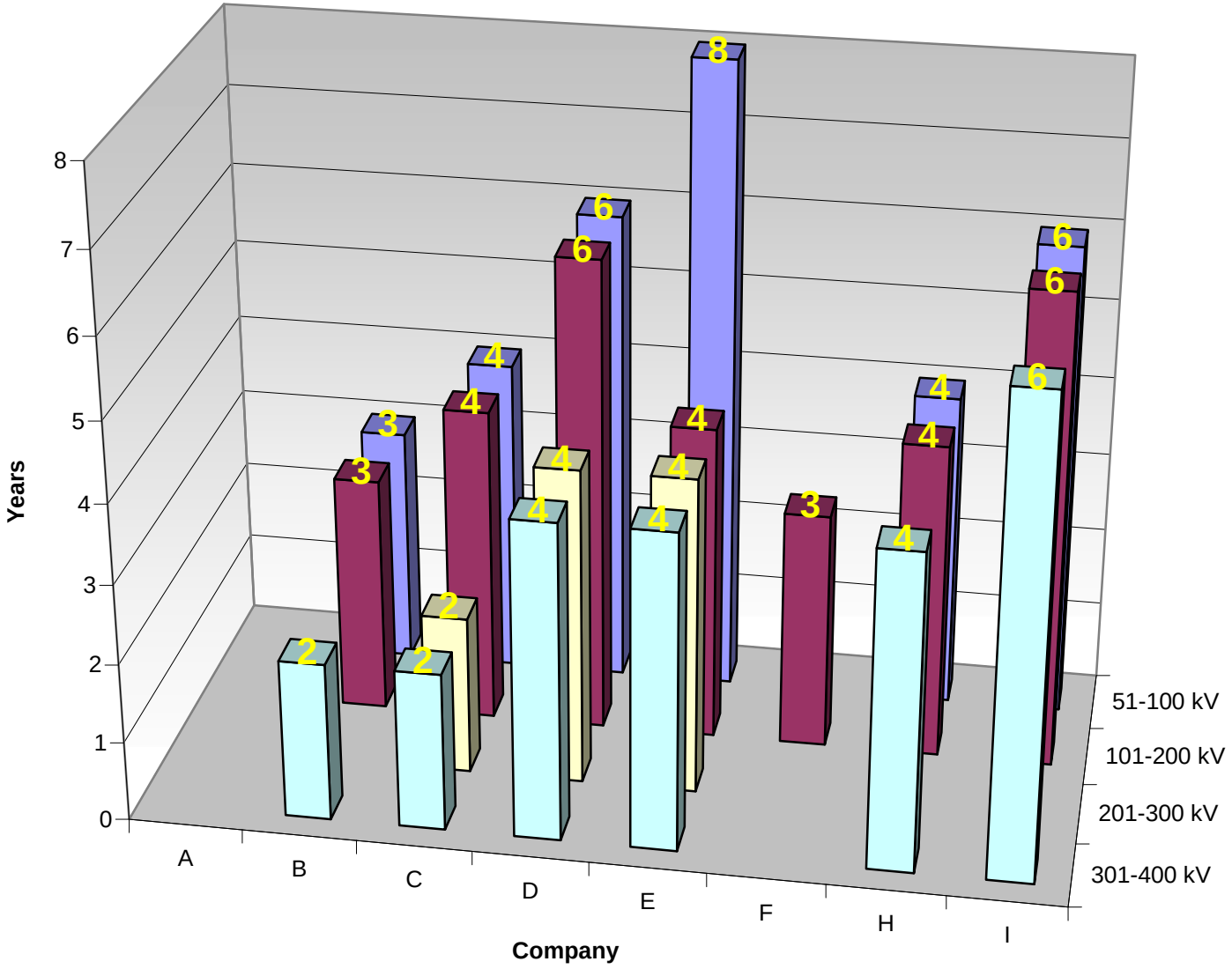
Calibration Test Interval for Microprocessor Relays



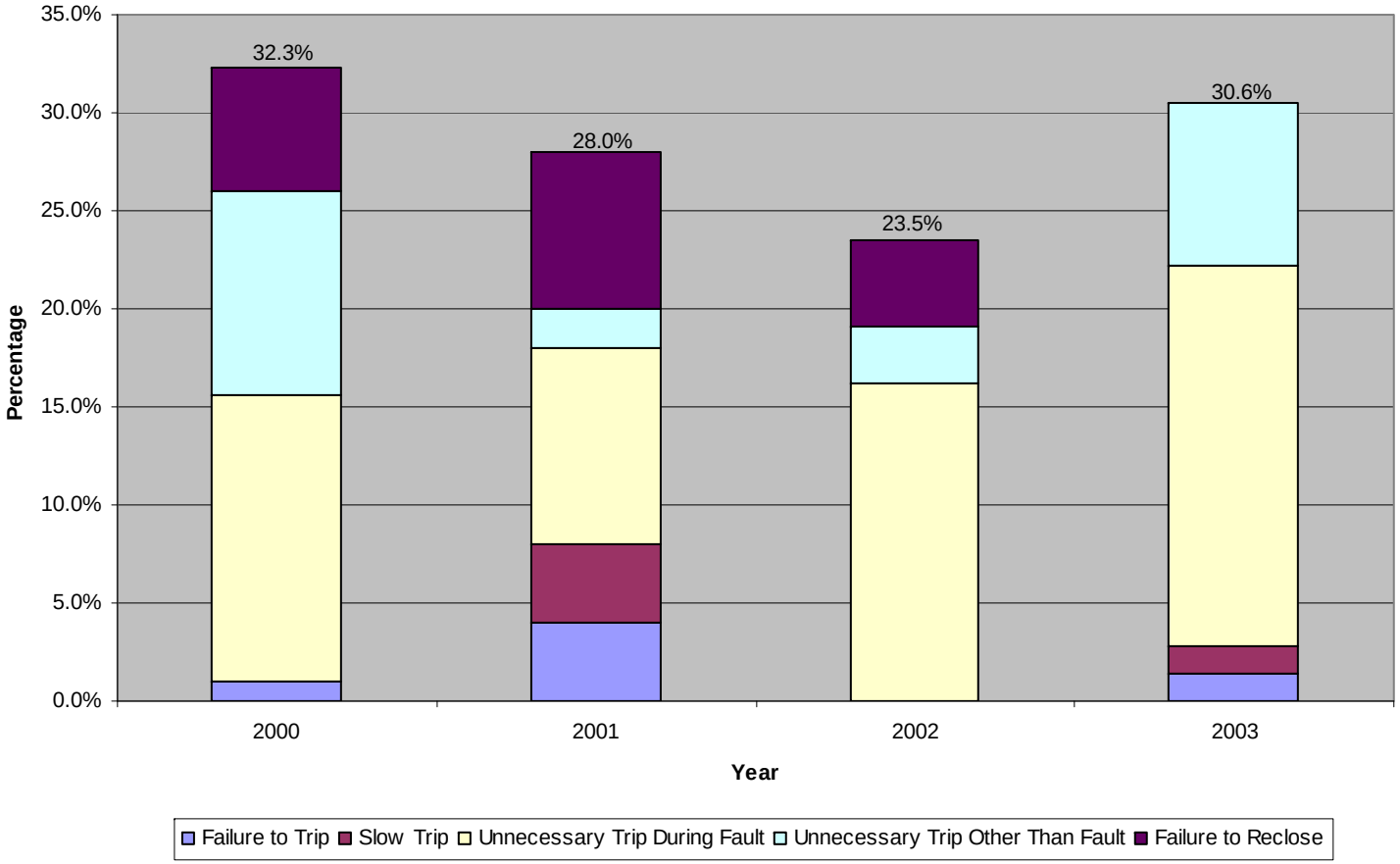
Functional Test Interval for Electromechanical Relays



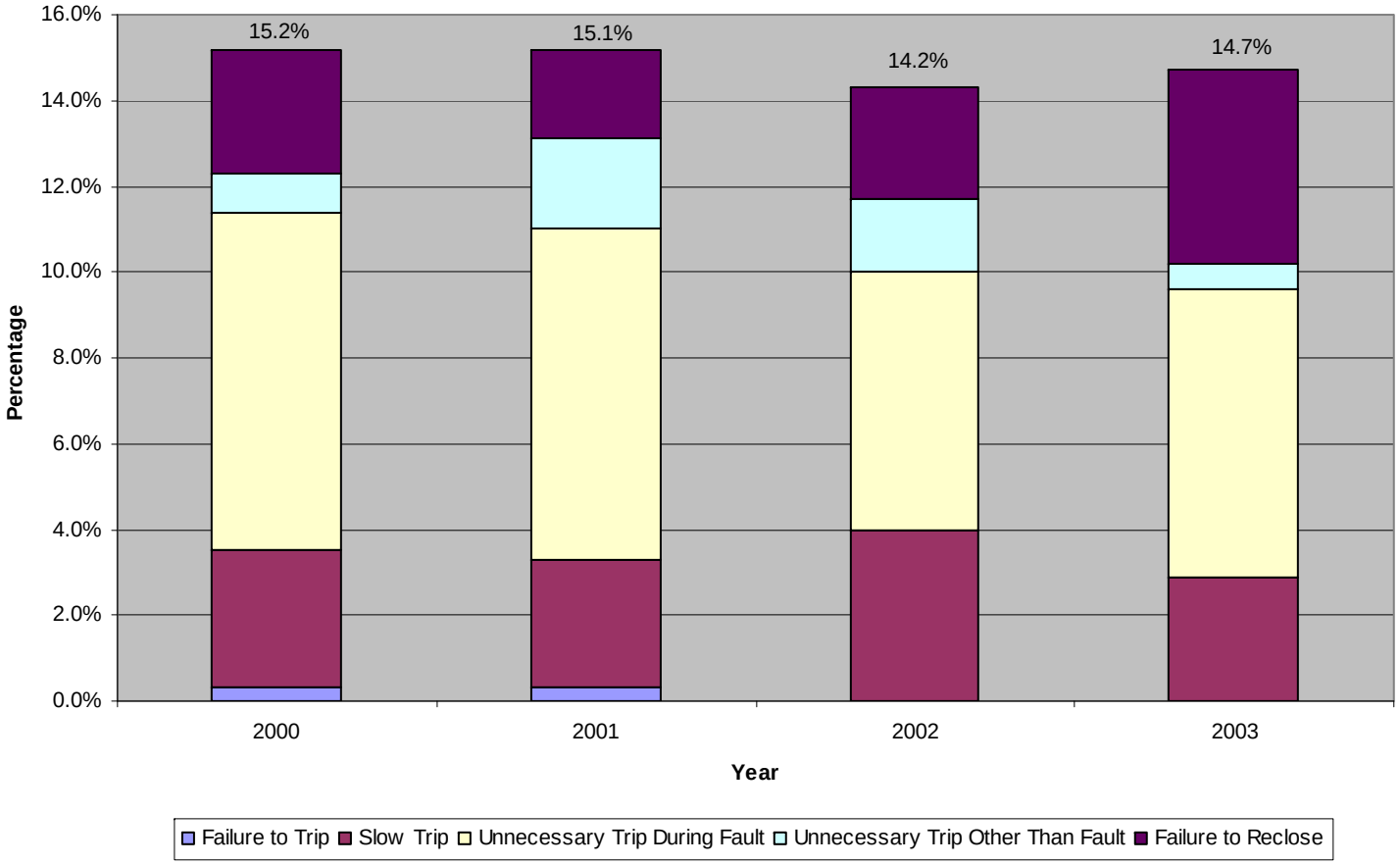
Functional Test Interval for Microprocessor Relays

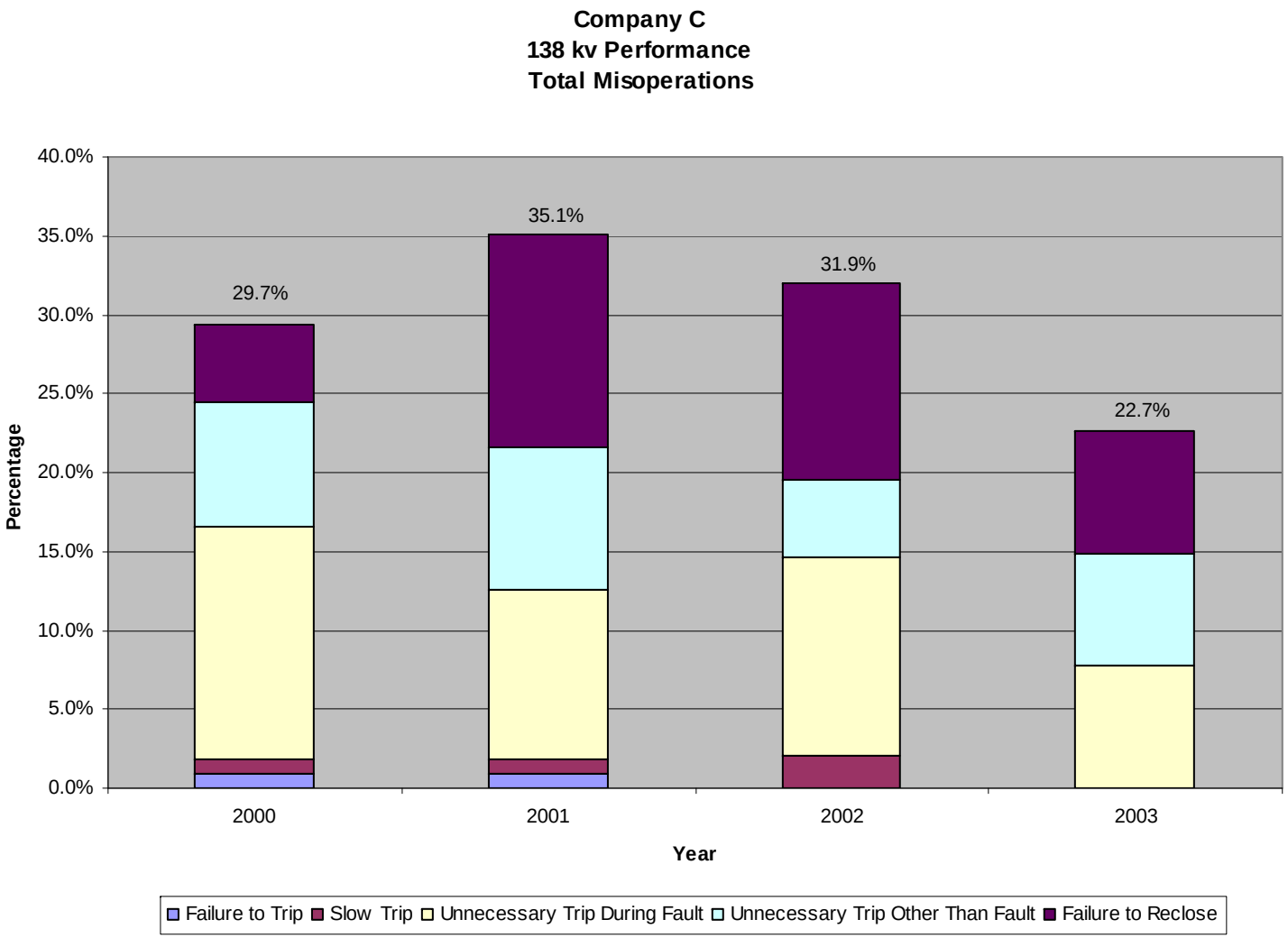


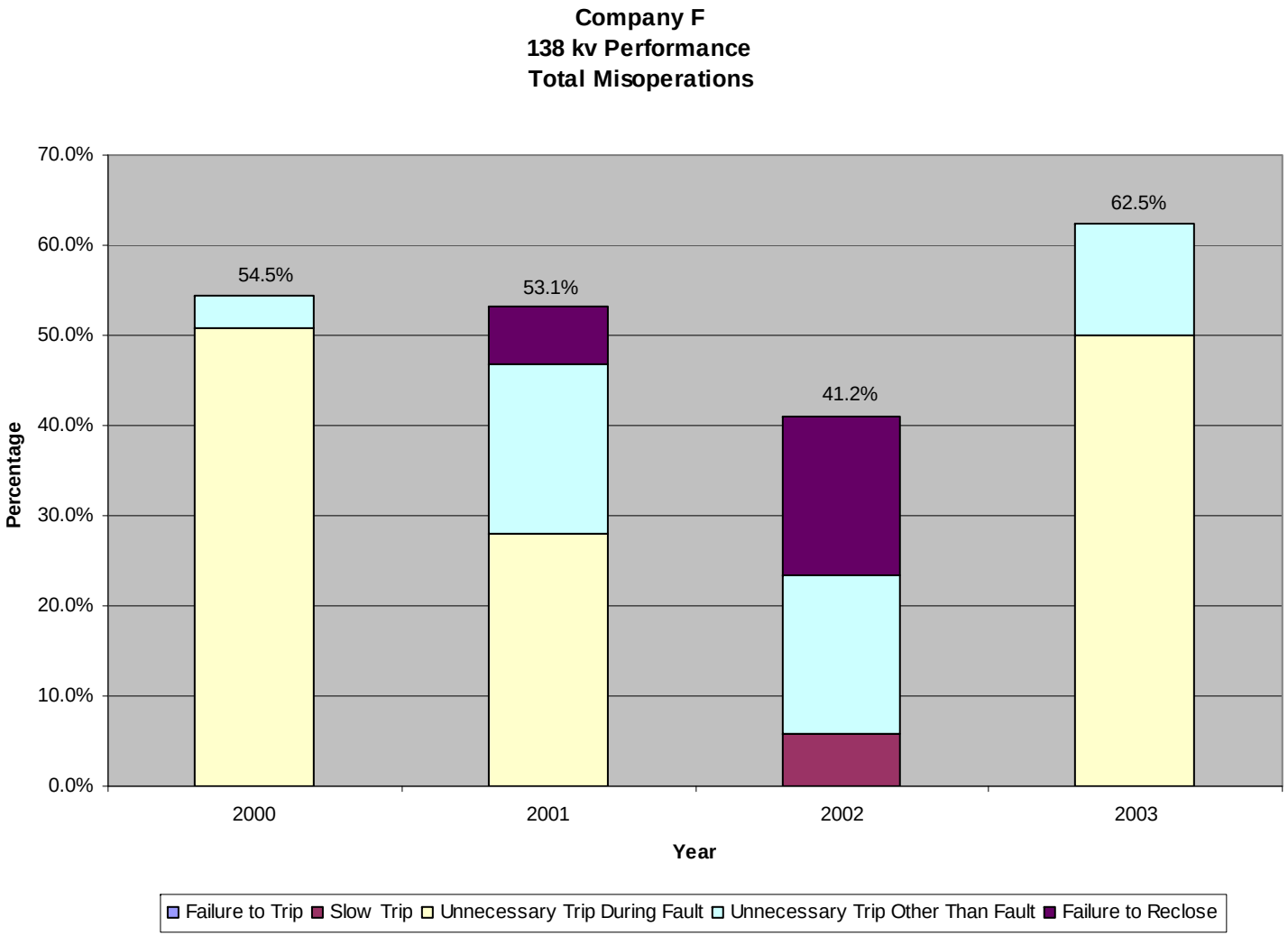
Company A
138 kv Performance
Total Misoperations



Company B
138 kv Performance
Total Misoperations




Company C
138 kv Performance
Total Misoperations
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
Percentage
29.7%
35.1%
31.9%
22.7%
2000
2001
2002
2003
Year
Failure to Trip
Slow Trip
Unnecessary Trip During Fault
Unnecessary Trip Other Than Fault
Failure to Reclose


Company F
138 kv Performance
Total Misoperations
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Percentage
54.5%
53.1%
41.2%
62.5%
2000
2001
2002
2003
Year
Failure to Trip
Slow Trip
Unnecessary Trip During Fault
Unnecessary Trip Other Than Fault
Failure to Reclose

Closing Comment

- Data gives a representative sample of present performance
- May become beneficial as performance based oversight matures
- ERCOT presently requires its use
- Fairly good benchmarking tool
- Can track performance vs. activity over time

Questions?