Historical Performance of Medium Voltage Polyethylene Cable in a Conduit System

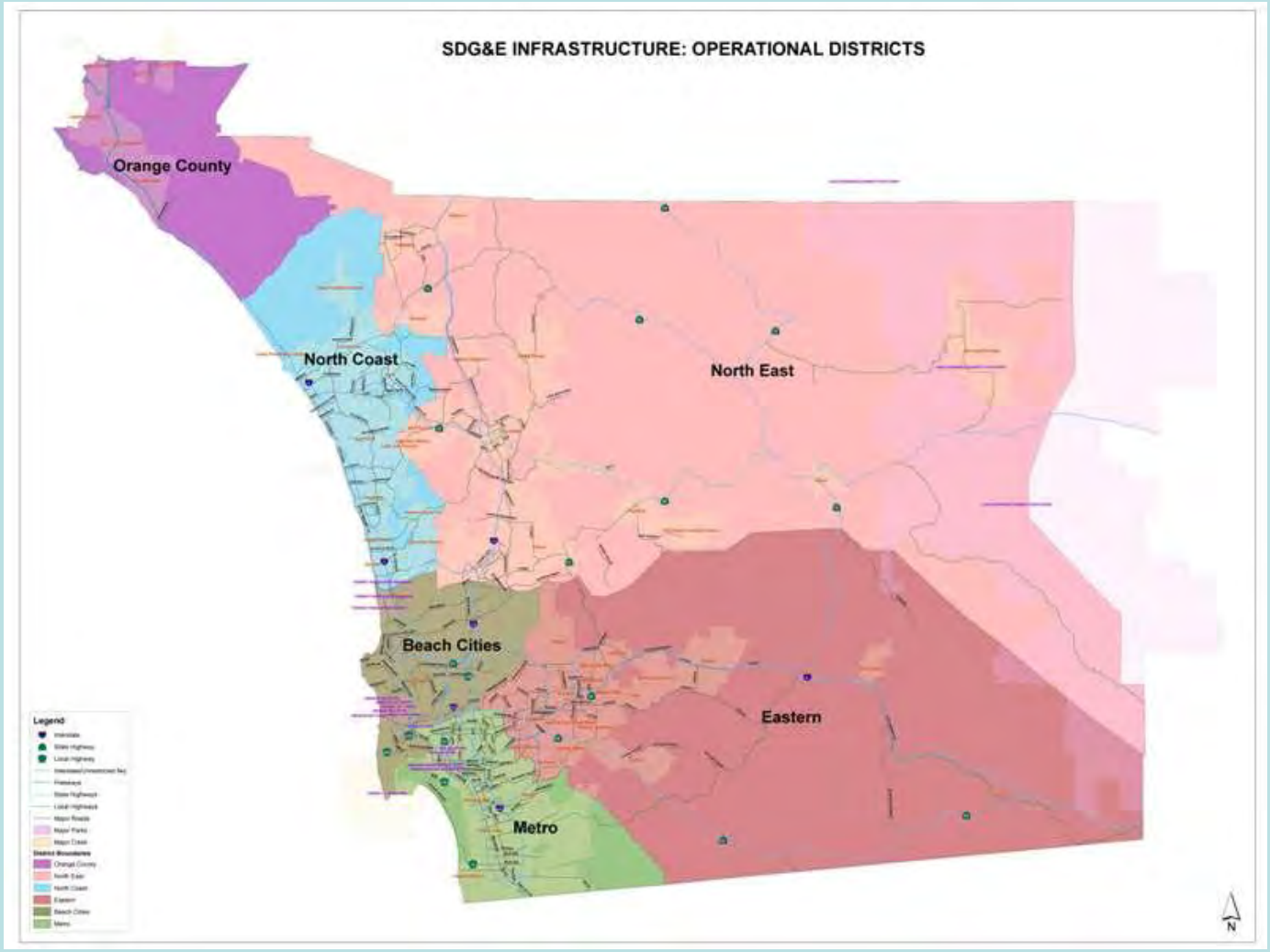
Presented by Jon Erickson, Senior Engineer, San Diego Gas & Electric

ICC Subcommittee C March 23, 2010

Topics to be Discussed

- Overview of SDG&E service territory
- History of cables purchased
- Data collection process
- Cable failure history
  - HMWPE – unjacketed
  - XLPE – unjacketed
  - XLPE – jacketed
  - TRXLPE – jacketed
- Poor performing vintages
- Cable failure rates
- Cable failure projections
- Proactive cable replacement
- Seasonal variations in failures for last 20 years

SDG&E Service Territory



SDG&E Electric System
2009 Totals

- Number of electric customers – 1,400,000
- Number of electric distribution circuits – 991
  - 4 kV circuits – 226
  - 12 kV circuits – 765
- All time system peak load – 4,636 MW (Sept 2007)
- Underground cable circuit miles – 10,033
- Underground cable conductor miles – 26,735

SDG&E Electric System (cont).

- Unjacketed HMWPE conductor miles installed – 3,700
  - Installed 1963 – 1979 – copper conductor – 220 mil insulation
  - Installed 1974 – 1976 – aluminum conductor – 175 mil insulation
  - Remaining HMWPE conductor miles – 2,618

- Unjacketed XLPE conductor miles installed – 3,400
  - Installed 1968 – 1985 – aluminum conductor – 175 mil insulation
  - Remaining XLPE conductor miles – 2,147

- Jacketed XLPE/TRXLPE conductor miles – 21,729
    - XLPE conductor miles – 11,226
    - TRXLPE conductor miles – 10,503
  - Installed XLPE 1978 – 1999 – aluminum conductor – 175 mil insulation
  - Installed TRXLPE 1998 to present – aluminum and copper conductor – 175 mil insulation

- Jacketed EPR conductor miles – 101

- PILC conductor miles - 140

SDG&E Electric System (cont).

- 60 % of system is underground
- 99+ % of cable in conduit
- Cable failure replacement – all cables in conduit replaced

Cable removed from field

In-service cable environment

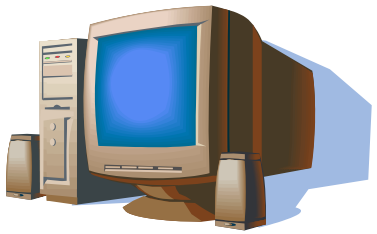
In-service cable environment

In-service cable environment

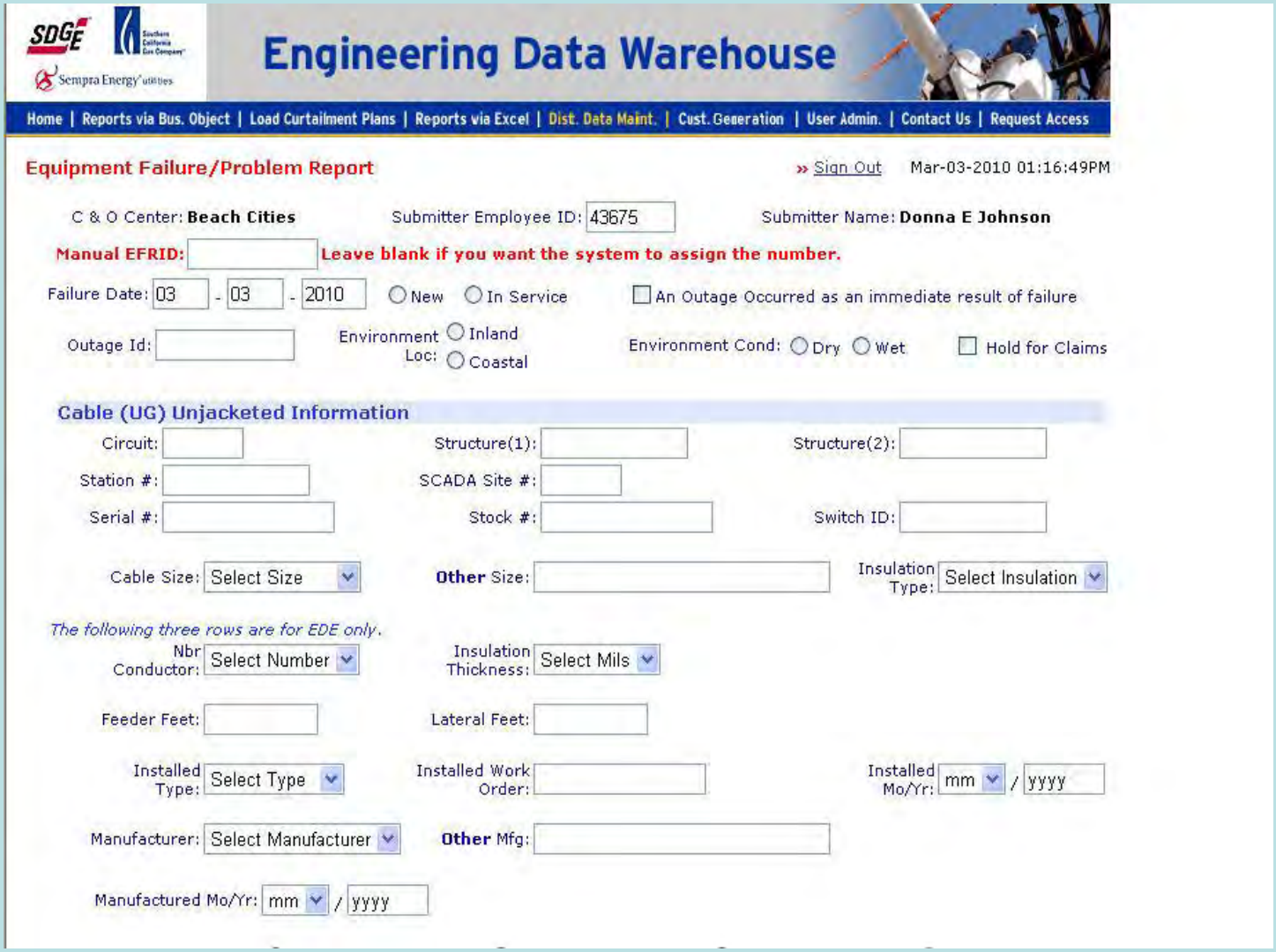
In-service cable environment

Data Collection for Cable Failure Rates

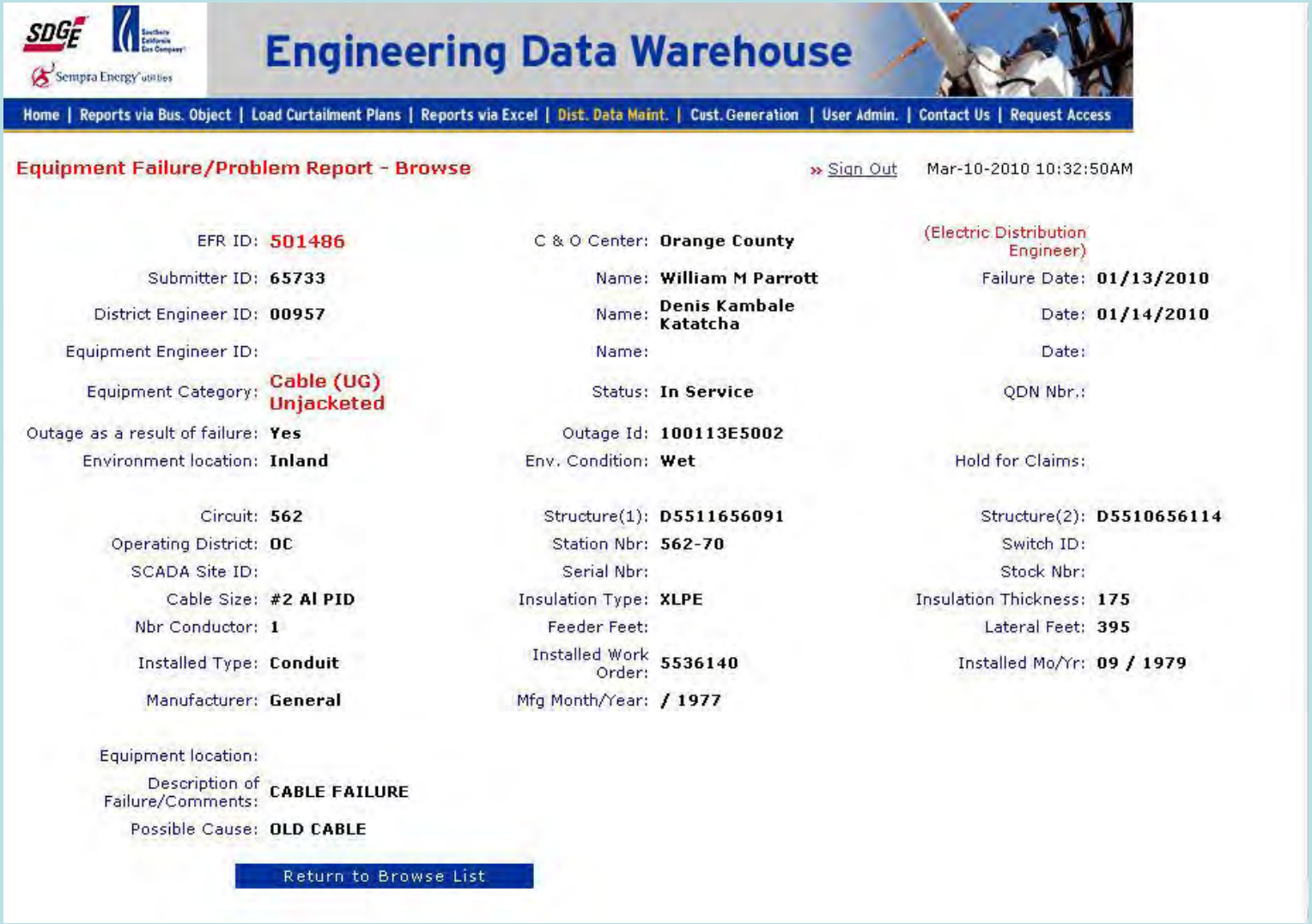
- Need to develop a simple method for collecting cable failure data.
- Maintain an outage database (Access database)
- Utilize paper or electronic data forms.
- Need to convince operating people of importance of collecting cable failure information.
- Utilize statistical software (i.e. Weibull ++) to determine best fit for your data.



Cable Failure Reporting



Cable Failure Reporting



Cable Classification

Feeder cable

350 Al

4/0 Cu

500 Cu

750 Al

1000 Al & Cu

Lateral cable

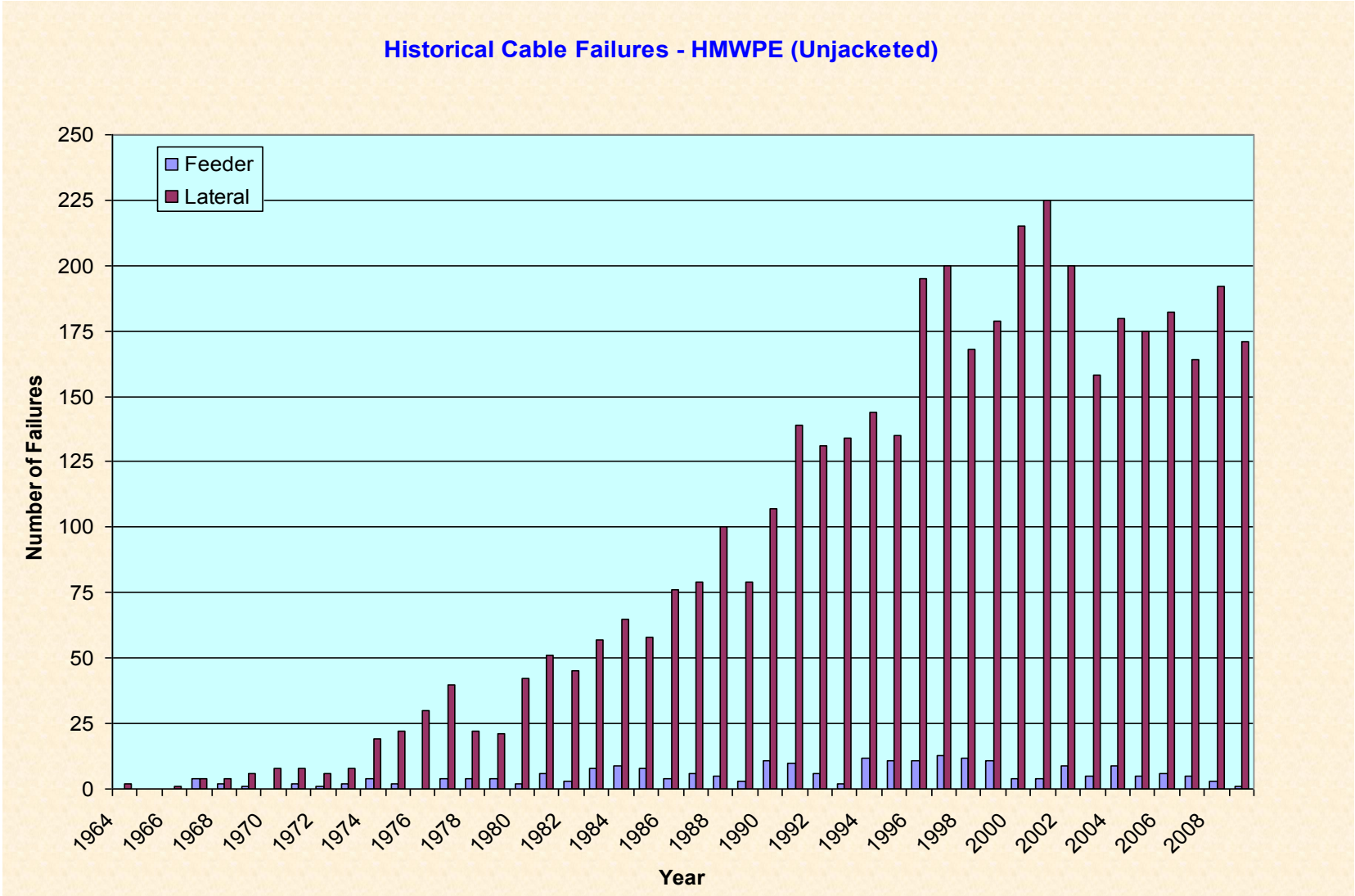
4 Cu

2 Cu

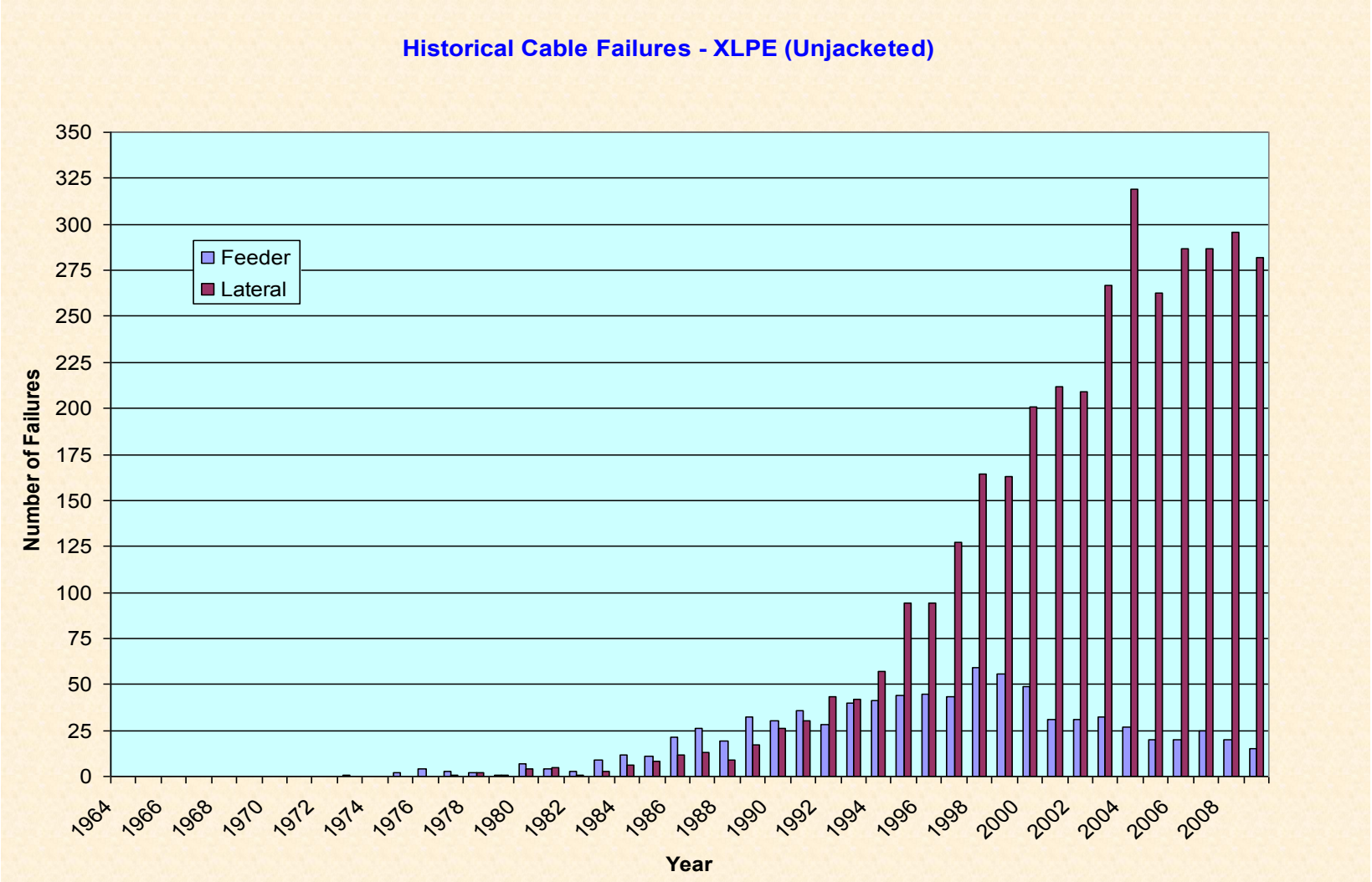
2 Al

2/0 Al

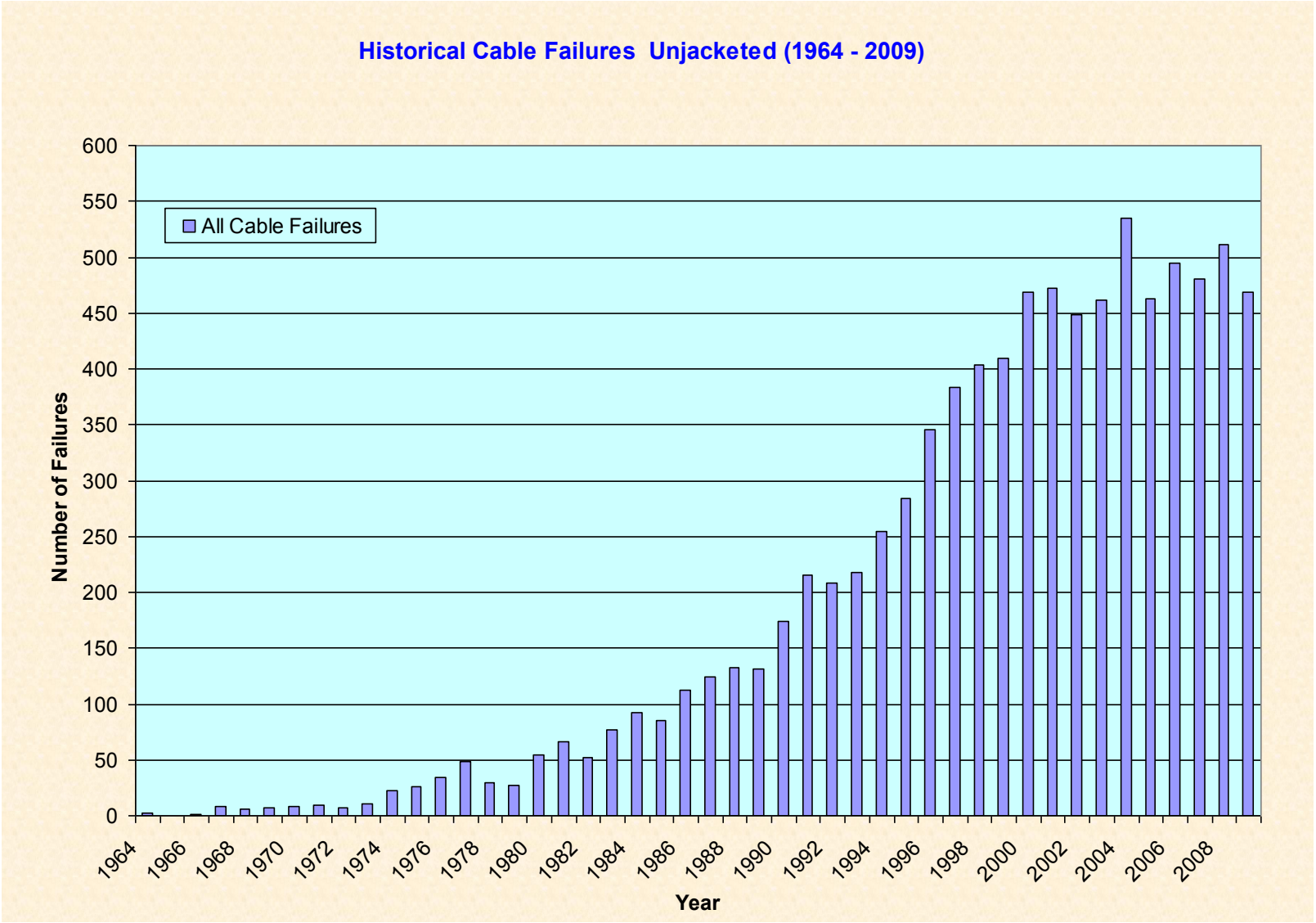
HMWPE Unjacketed Cable Failures



XLPE Unjacketed Cable Failures



All Unjacketed Cable Failures

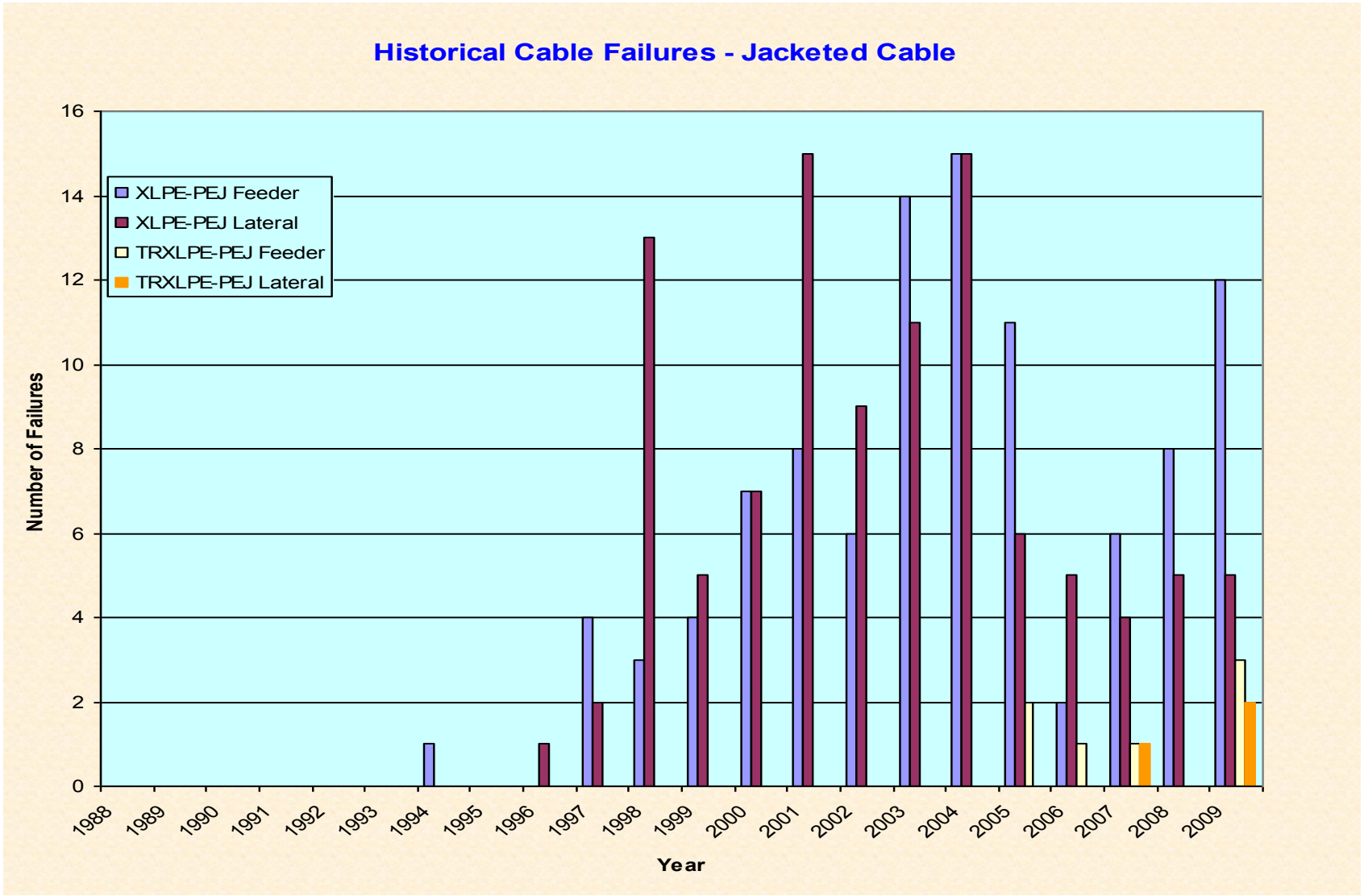


Poor Performing Vintages

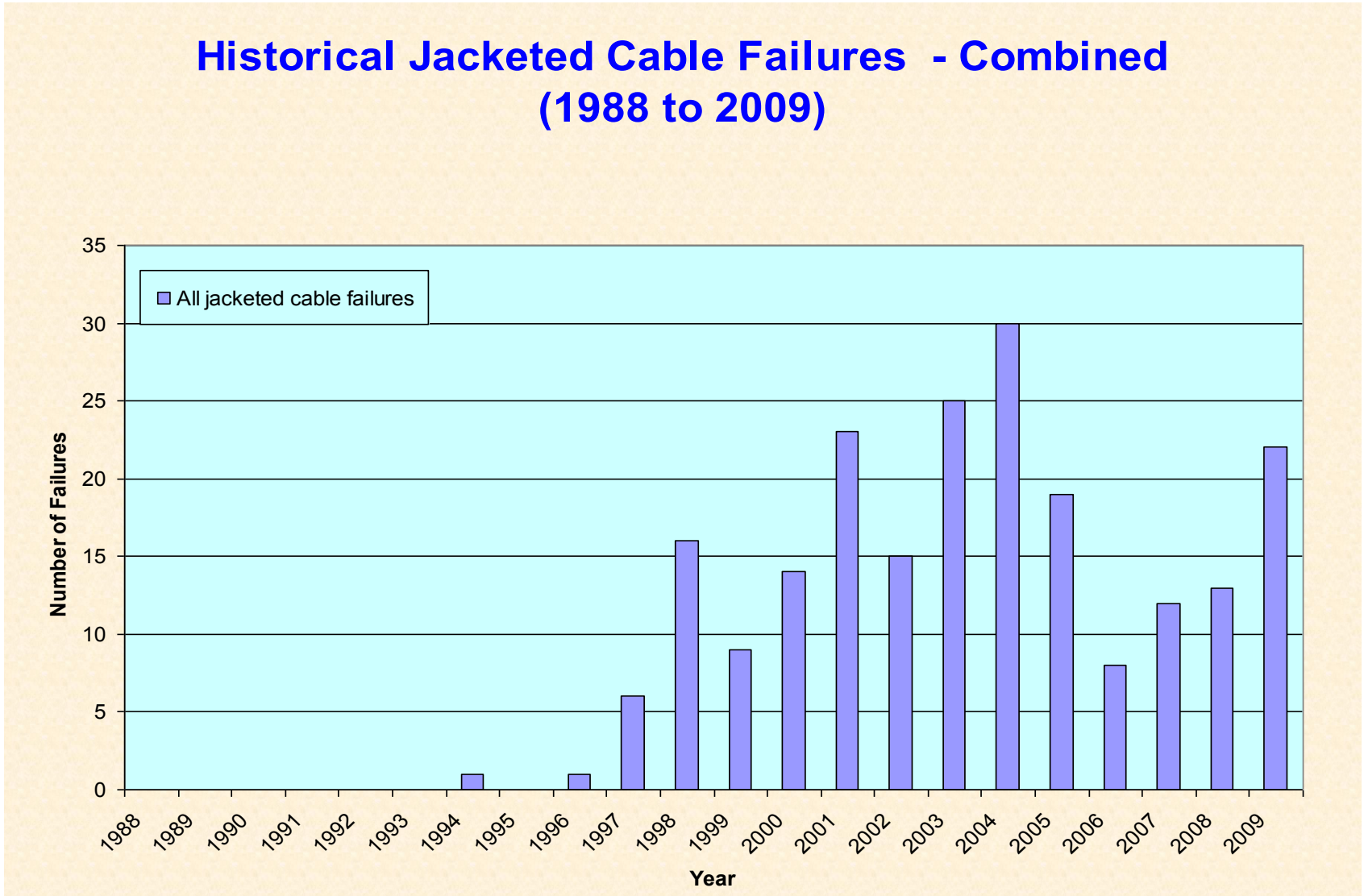
Rank	Year
1	1981
2	1983
3	1977
4	1978
5	1980
6	1982
7	1979

- All cable is aluminum unjacketed 175 mil insulation XLPE
- The use of cable failure data has allowed SDG&E to identify these poor performing vintages which can then be targeted for proactive cable replacement

Jacketed Cable Failures



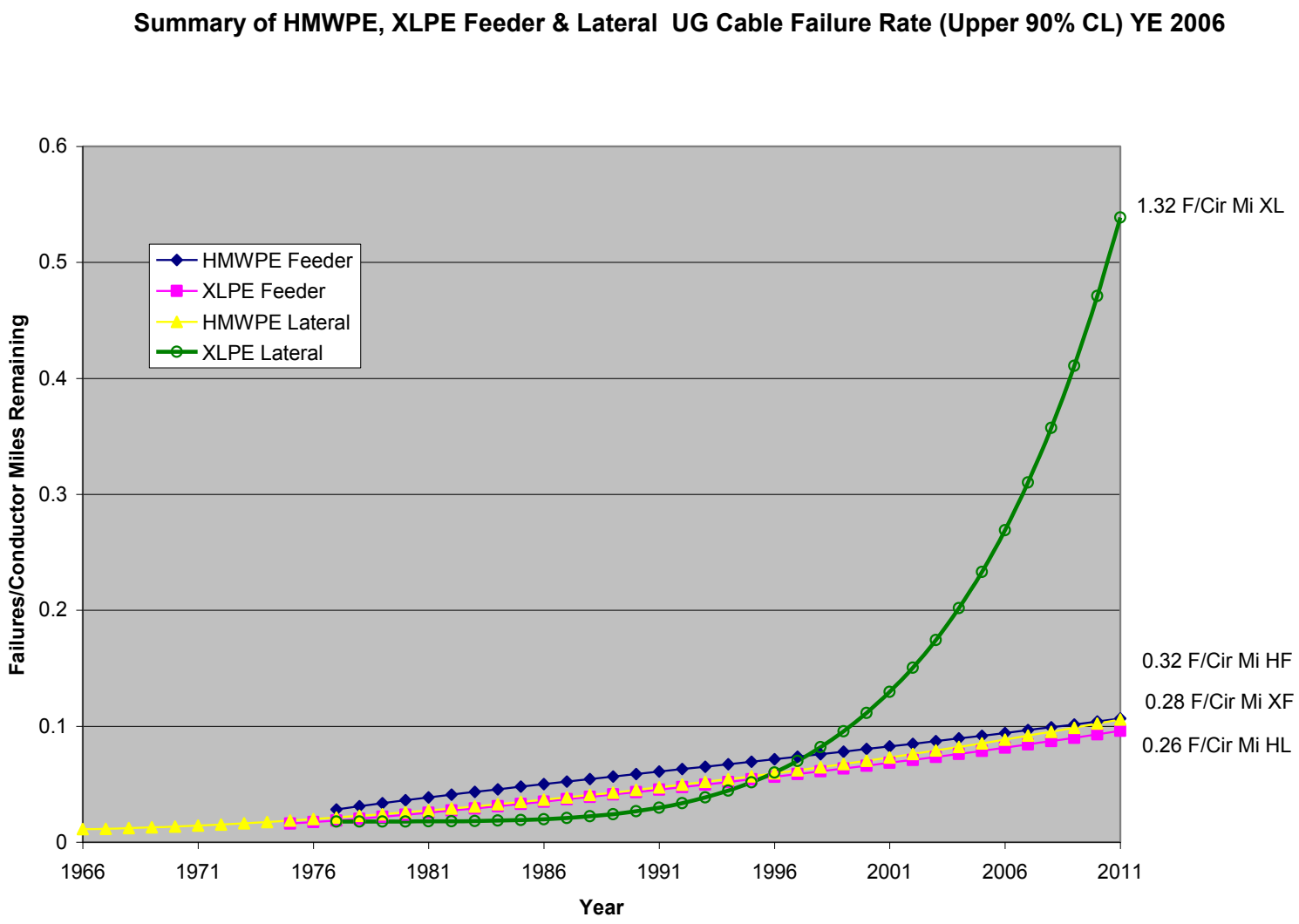
Jacketed Cable Failures



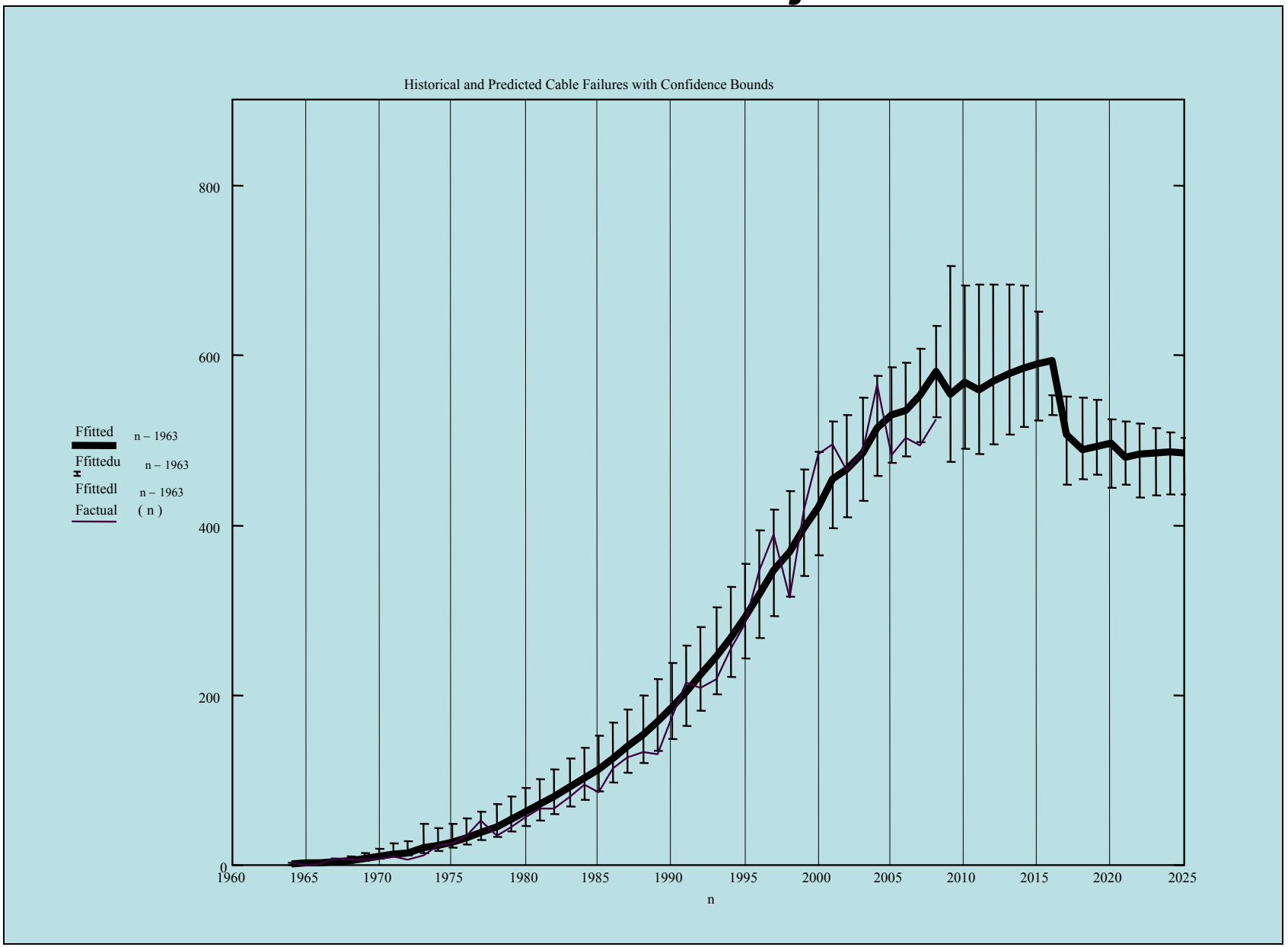
Summary of All Cable Failures

Cable Failure Summary							
		1964-69	1970-79	1980-89	1990-99	2000-09	Total
HMWPE	Feeder	7	23	54	99	51	**234**
	Lateral	17	184	652	1532	1862	**4247**
XLPE	Feeder	0	13	144	422	270	**849**
	Lateral	0	4	78	840	2623	**3545**
XLPE-PEJ	Feeder	0	0	0	12	89	**101**
	Lateral	0	0	0	21	82	**103**
TRXLPE	Feeder	0	0	0	0	7	**7**
	Lateral	0	0	0	0	3	**3**
		24	**224**	**928**	**2926**	**4987**	**9089**

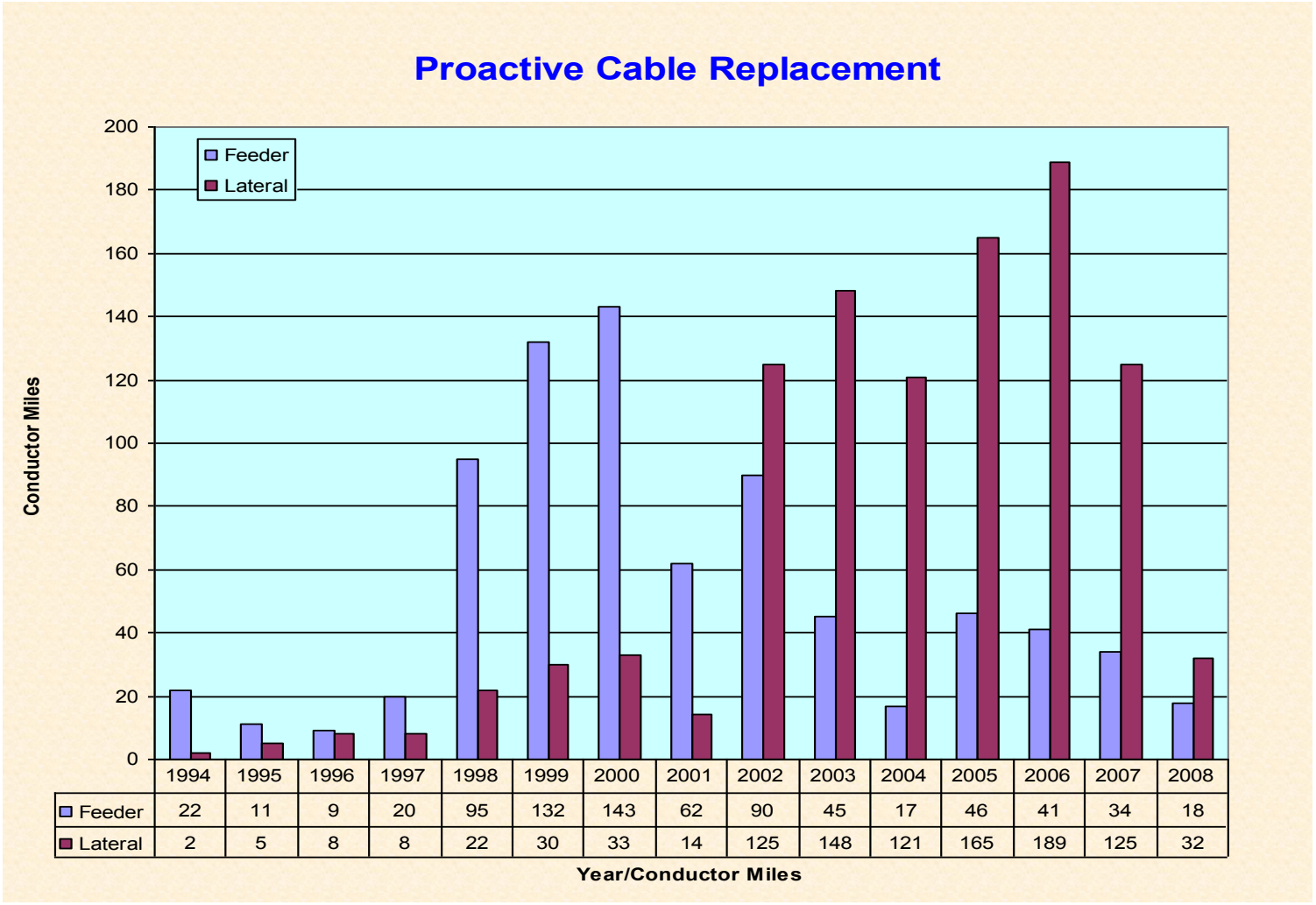
Cable Failure Rates



Cable Failure Projections

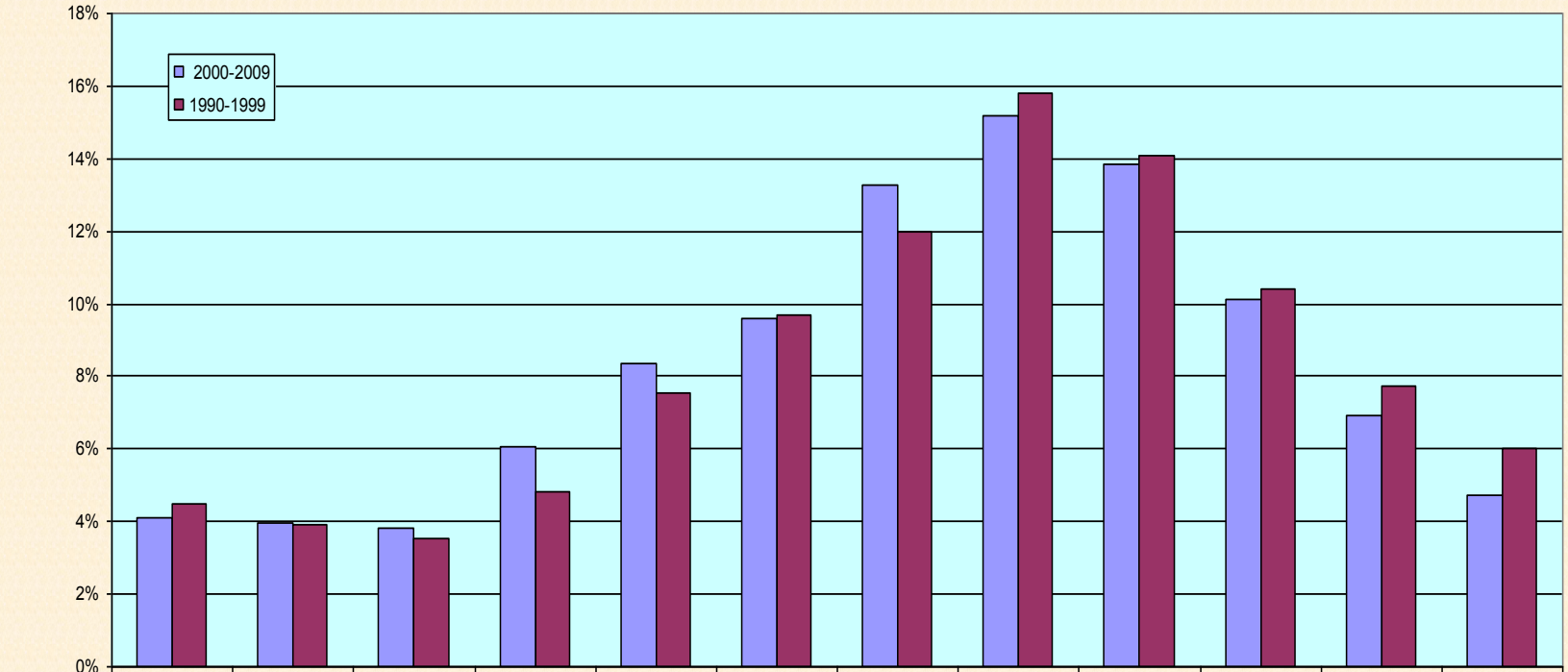


Proactive Cable Replacement



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Feeder	22	11	9	20	95	132	143	62	90	45	17	46	41	34	18
Lateral	2	5	8	8	22	30	33	14	125	148	121	165	189	125	32

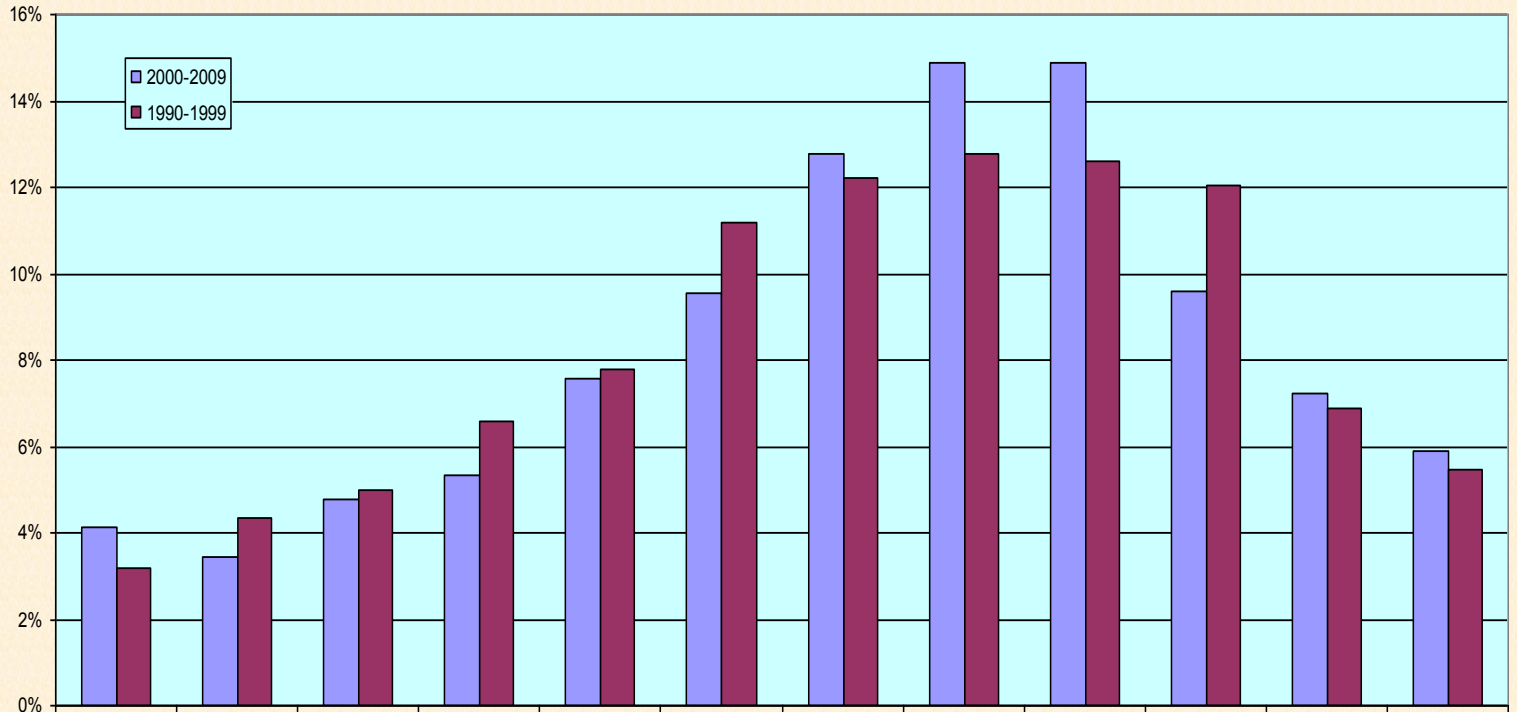
Seasonal Failures – Unjacketed HMWPE



	January	February	March	April	May	June	July	August	September	October	November	December
2000-2009	4%	4%	4%	6%	8%	10%	13%	15%	14%	10%	7%	5%
1990-1999	5%	4%	4%	5%	8%	10%	12%	16%	14%	10%	8%	6%

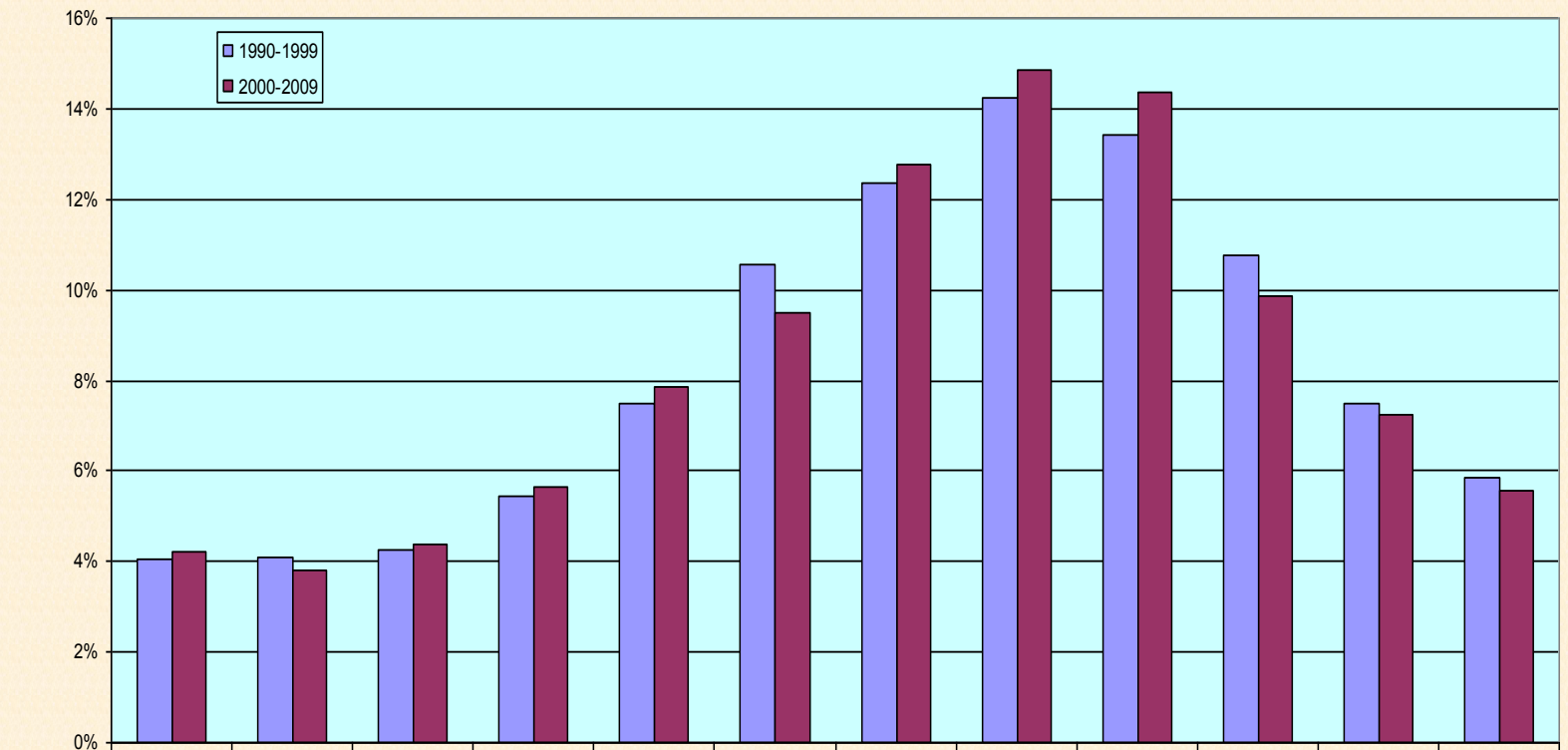
Seasonal Failures – Unjacketed XLPE

Seasonal Cable Failures - XLPE (Unjacketed) Combined Lateral and Feeder
Expressed as a % of Total failures



	January	February	March	April	May	June	July	August	September	October	November	December
2000-2009	4%	3%	5%	5%	8%	10%	13%	15%	15%	10%	7%	6%
1990-1999	3%	4%	5%	7%	8%	11%	12%	13%	13%	12%	7%	5%

Seasonal Failures – All cables



	January	February	March	April	May	June	July	August	September	October	November	December
1990-1999	4%	4%	4%	5%	7%	11%	12%	14%	13%	11%	7%	6%
2000-2009	4%	4%	4%	6%	8%	9%	13%	15%	14%	10%	7%	6%

Thanks for your attention

Questions?