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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

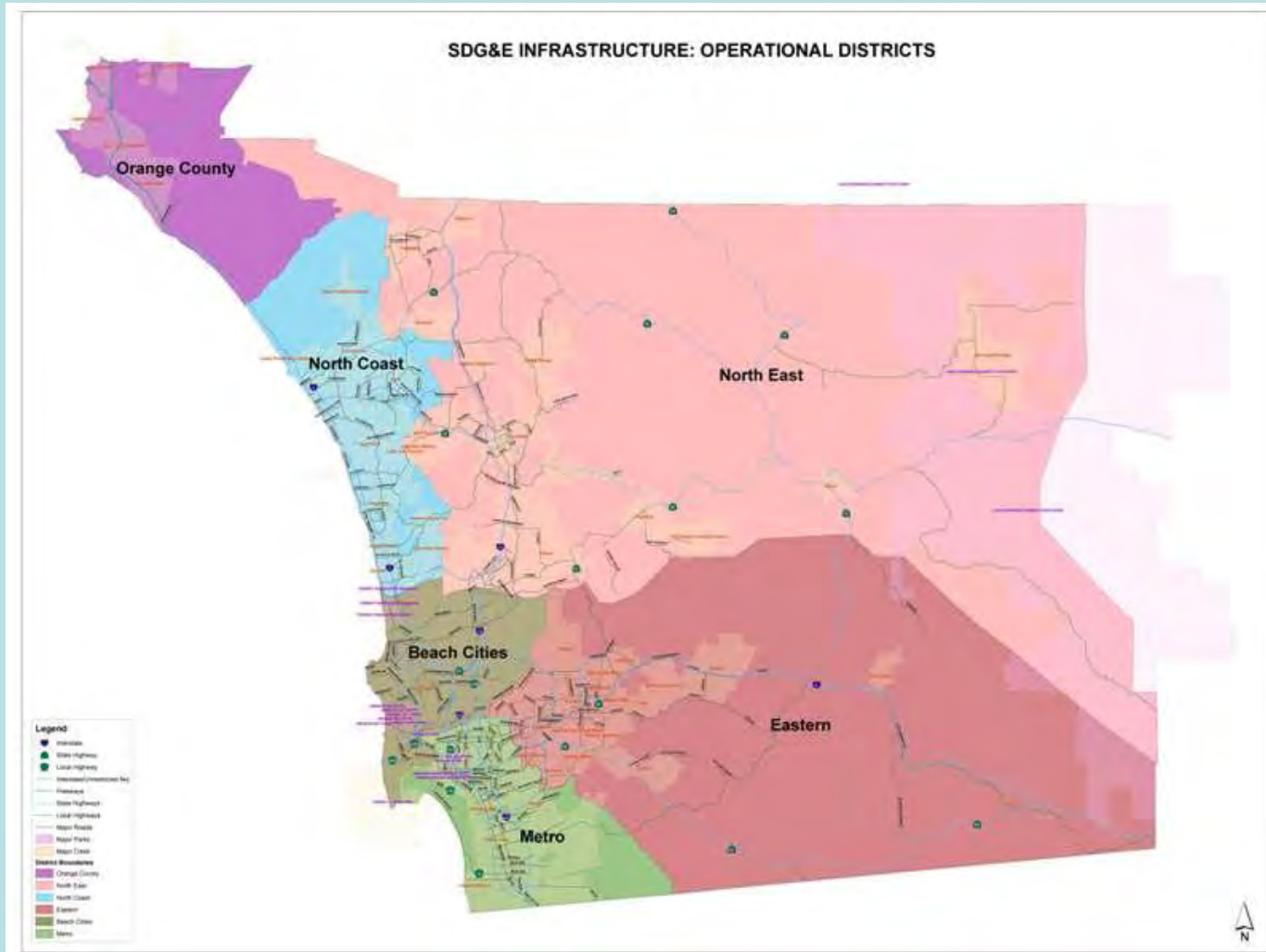




Topics to be Discussed

- 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

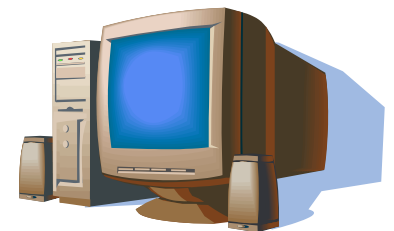


In-service cable environment



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



Engineering Data Warehouse



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Equipment Failure/Problem Report

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C & O Center: **Beach Cities**

Submitter Employee ID:

Submitter Name: **Donna E Johnson**

Manual EFRID: **Leave blank if you want the system to assign the number.**

Failure Date: - - New In Service An Outage Occurred as an immediate result of failure

Outage Id: Environment Inland Coastal Environment Cond: Dry Wet Hold for Claims

Cable (UG) Unjacketed Information

Circuit: Structure(1): Structure(2):

Station #: SCADA Site #:

Serial #: Stock #: Switch ID:

Cable Size: Other Size: Insulation Type:

The following three rows are for EDE only.

Nbr Conductor: Insulation Thickness:

Feeder Feet: Lateral Feet:

Installed Type: Installed Work Order: Installed Mo/Yr: /

Manufacturer: Other Mfg:

Manufactured Mo/Yr: /

Cable Failure Reporting



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Equipment Failure/Problem Report - Browse

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EFR ID: 501486	C & O Center: Orange County	(Electric Distribution Engineer)
Submitter ID: 65733	Name: William M Parrott	Failure Date: 01/13/2010
District Engineer ID: 00957	Name: Denis Kambale Katatcha	Date: 01/14/2010
Equipment Engineer ID:	Name:	Date:
Equipment Category: Cable (UG) Unjacketed	Status: In Service	QDN Nbr.:
Outage as a result of failure: Yes	Outage Id: 100113E5002	
Environment location: Inland	Env. Condition: Wet	Hold for Claims:
Circuit: 562	Structure(1): D5511656091	Structure(2): D5510656114
Operating District: OC	Station Nbr: 562-70	Switch ID:
SCADA Site ID:	Serial Nbr:	Stock Nbr:
Cable Size: #2 Al PID	Insulation Type: XLPE	Insulation Thickness: 175
Nbr Conductor: 1	Feeder Feet:	Lateral Feet: 395
Installed Type: Conduit	Installed Work Order: 5536140	Installed Mo/Yr: 09 / 1979
Manufacturer: General	Mfg Month/Year: / 1977	
Equipment location:		
Description of Failure/Comments: CABLE FAILURE		
Possible Cause: OLD CABLE		

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Cable Classification

Feeder cable

350 Al

4/0 Cu

500 Cu

750 Al

1000 Al & Cu

Lateral cable

4 Cu

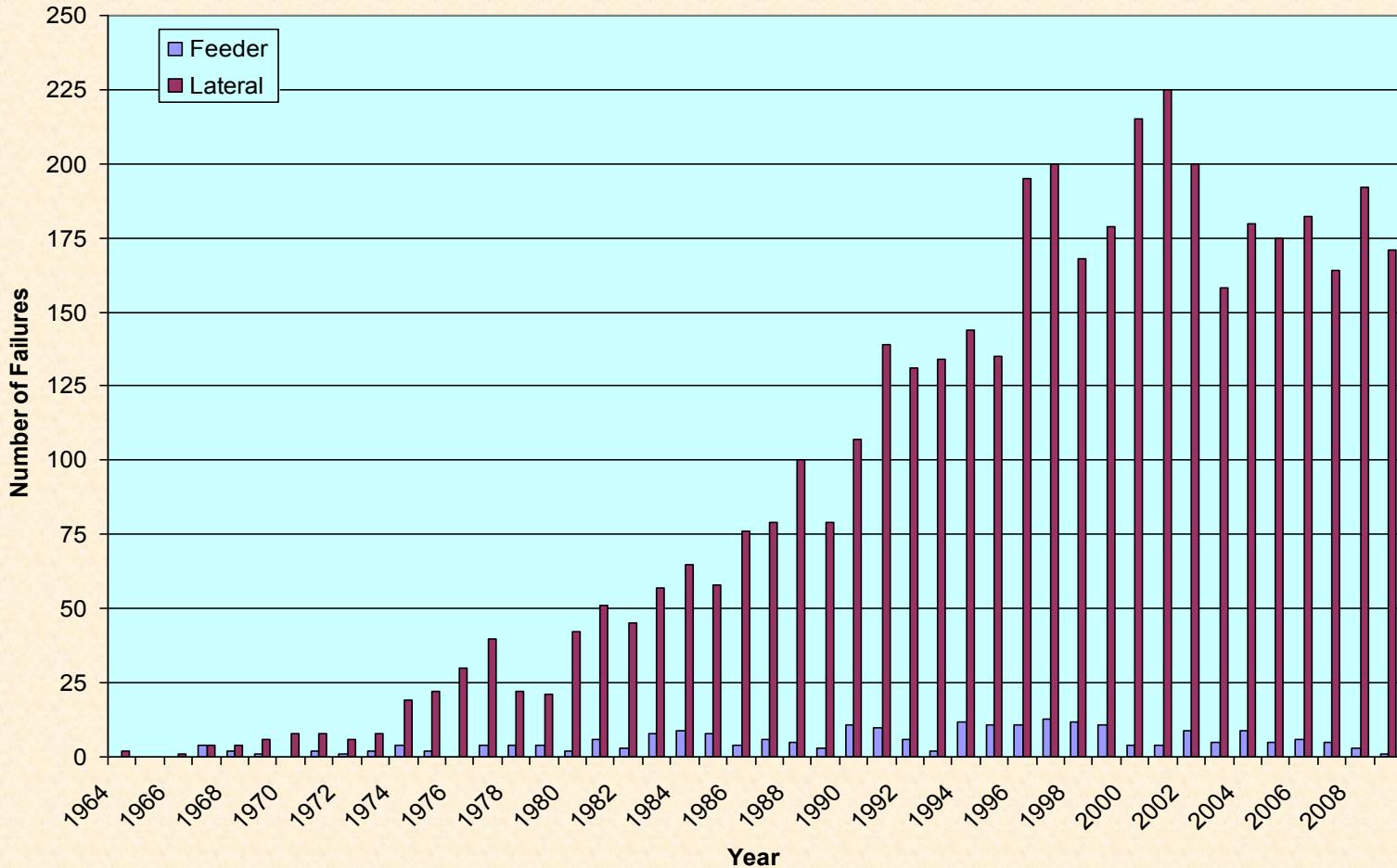
2 Cu

2 Al

2/0 Al

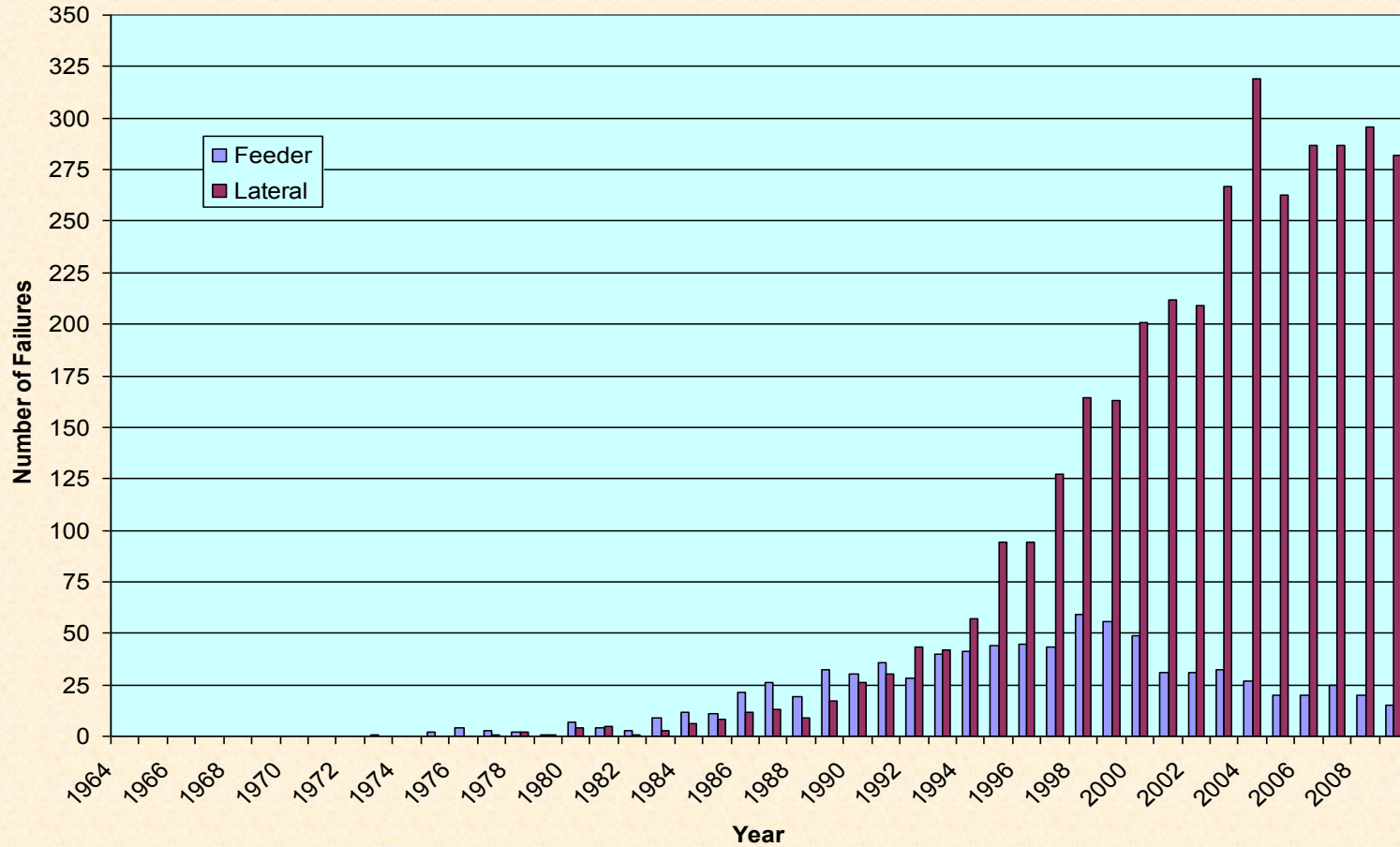
HMWPE Unjacketed Cable Failures

Historical Cable Failures - HMWPE (Unjacketed)



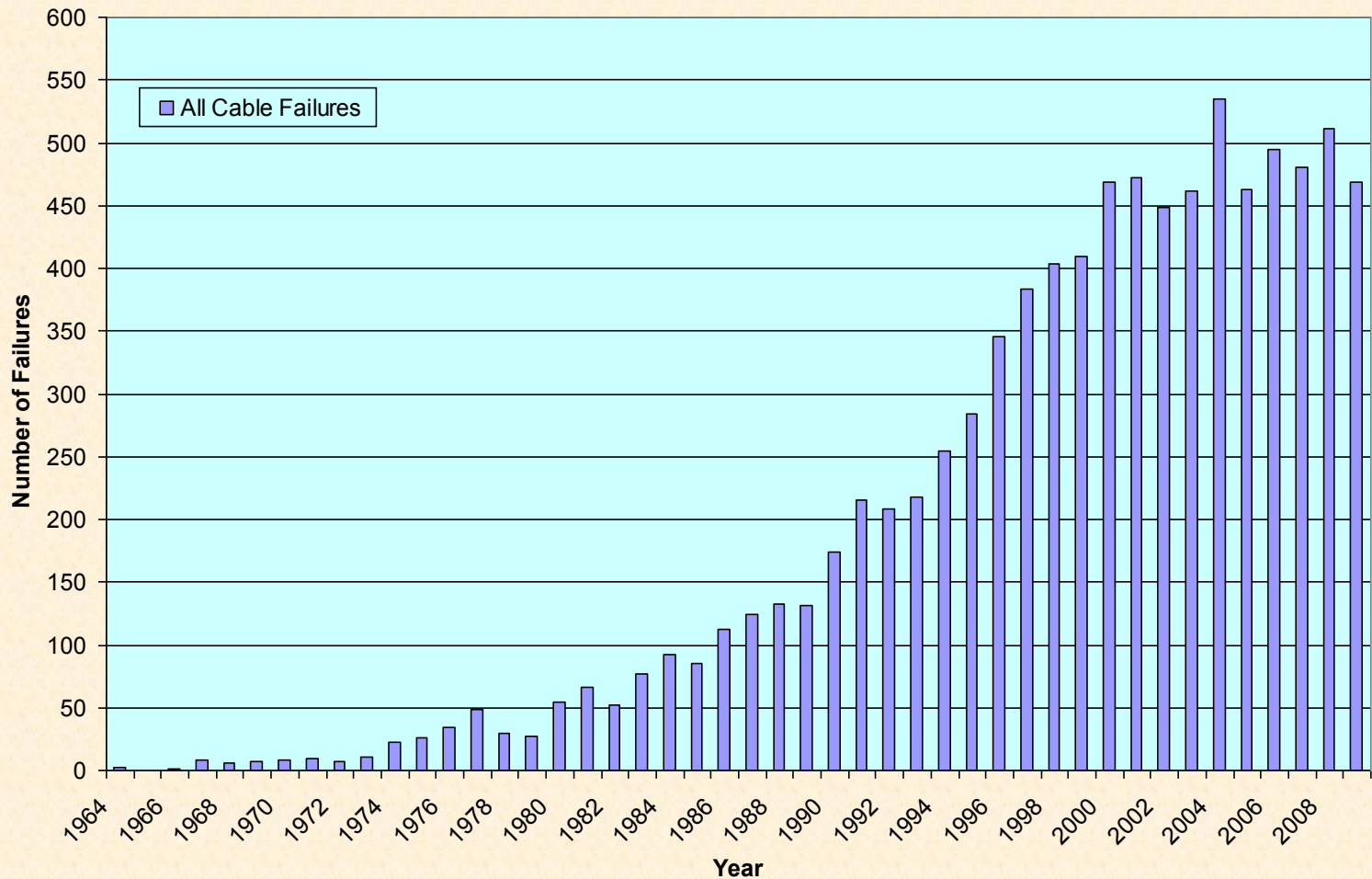
XLPE Unjacketed Cable Failures

Historical Cable Failures - XLPE (Unjacketed)



All Unjacketed Cable Failures

Historical Cable Failures Unjacketed (1964 - 2009)



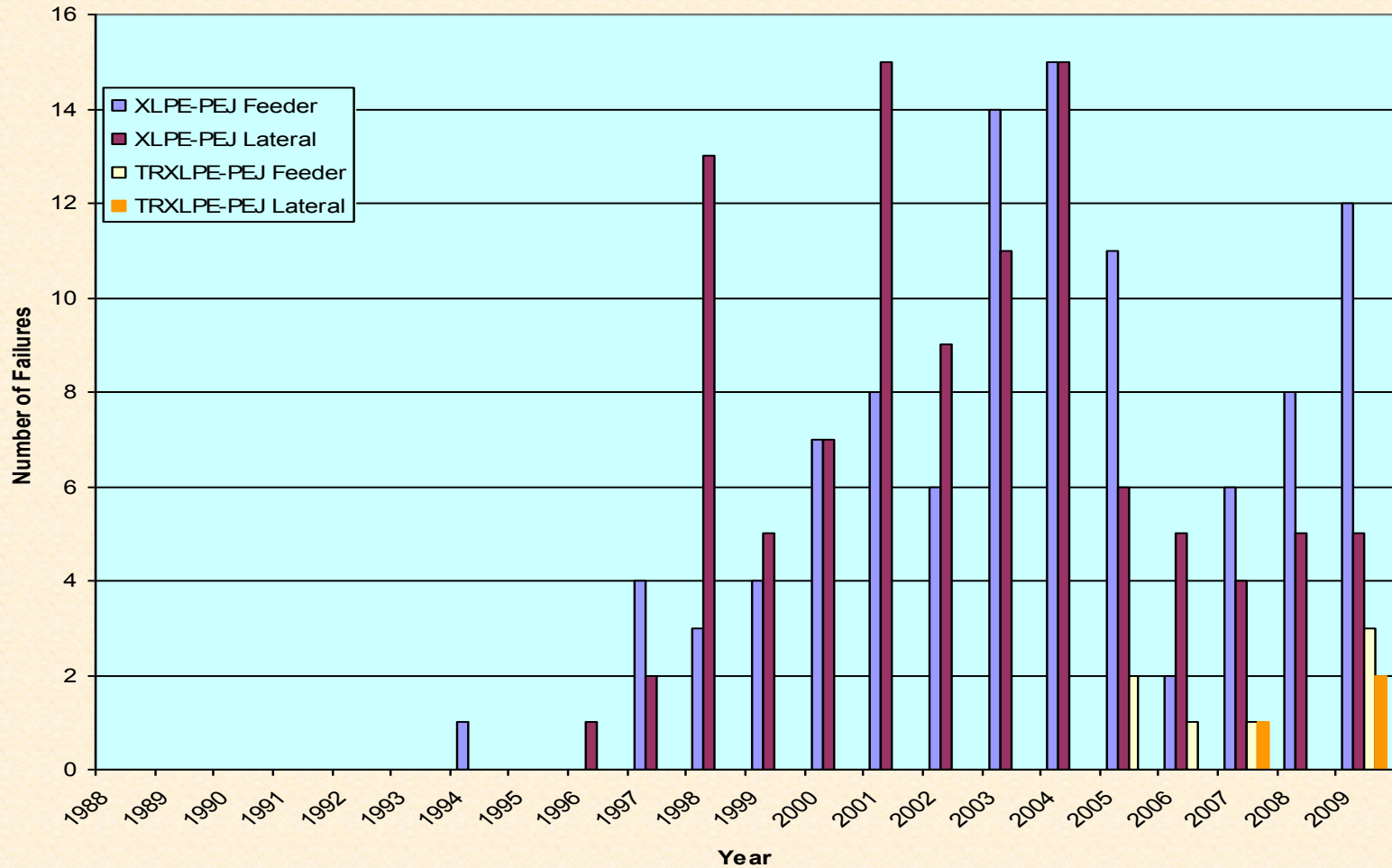
Poor Performing Vintages

<u>Rank</u>	<u>Year</u>
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

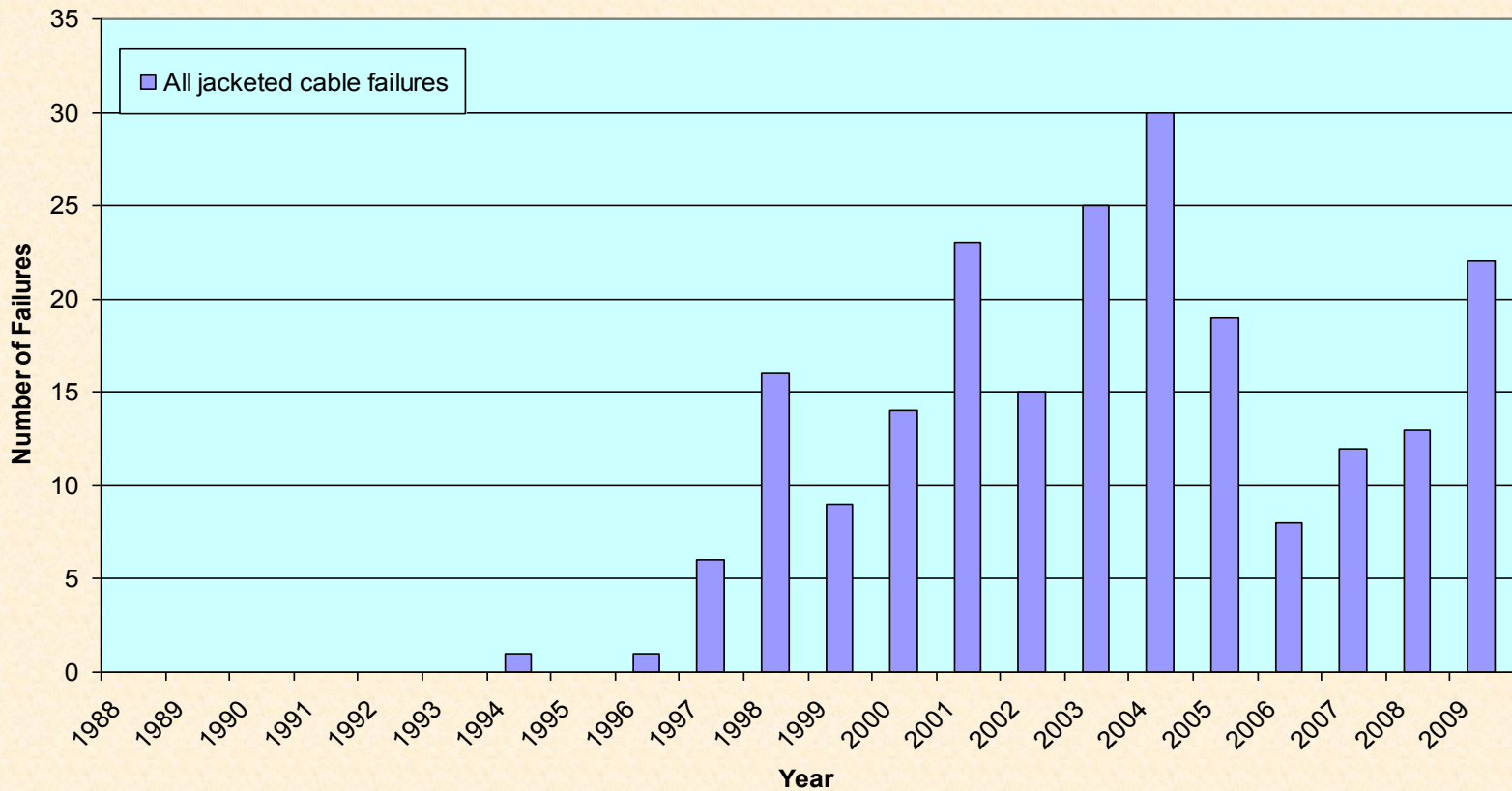
Jacketed Cable Failures

Historical Cable Failures - Jacketed Cable



Jacketed Cable Failures

Historical Jacketed Cable Failures - Combined (1988 to 2009)

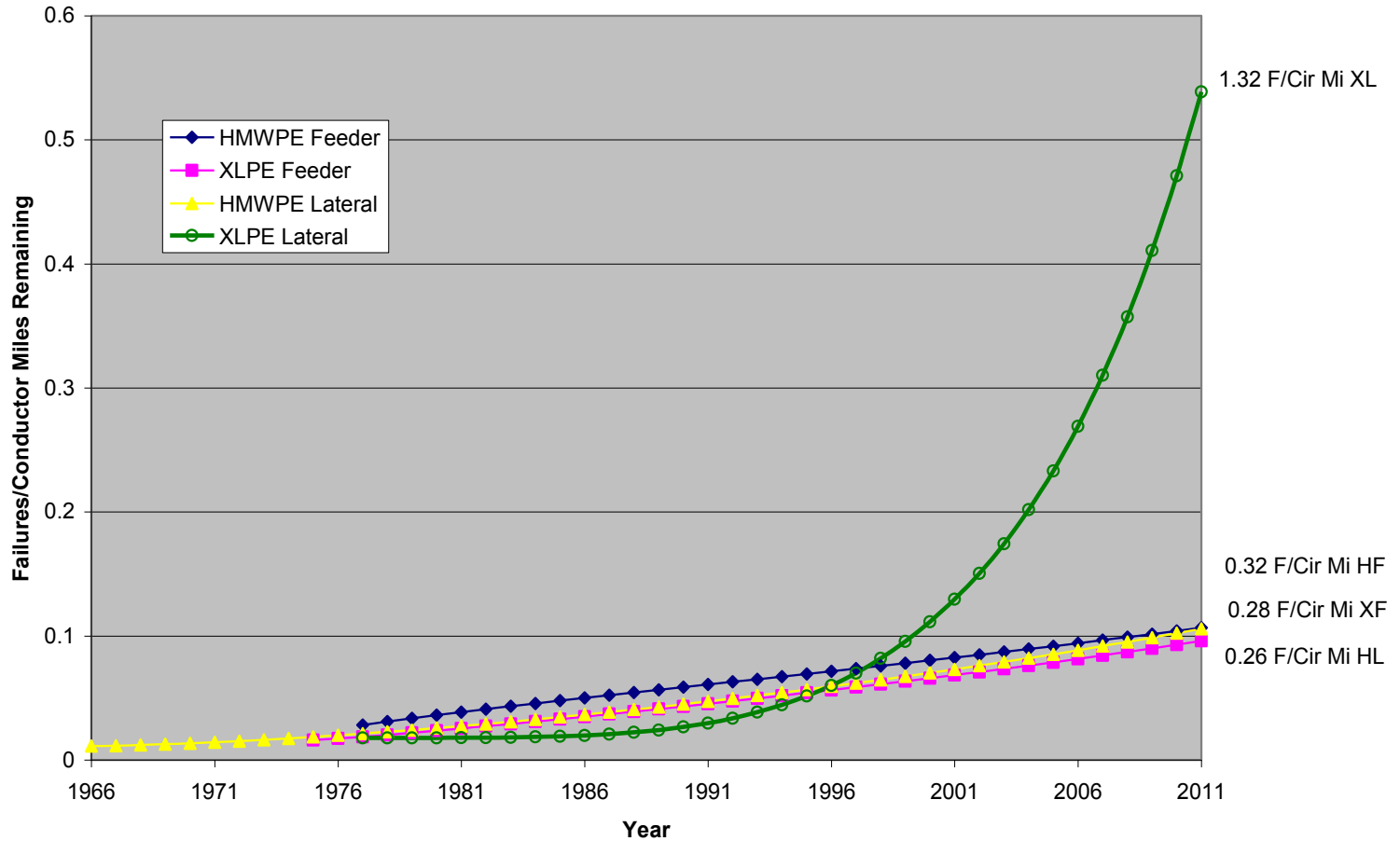


Summary of All Cable Failures

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

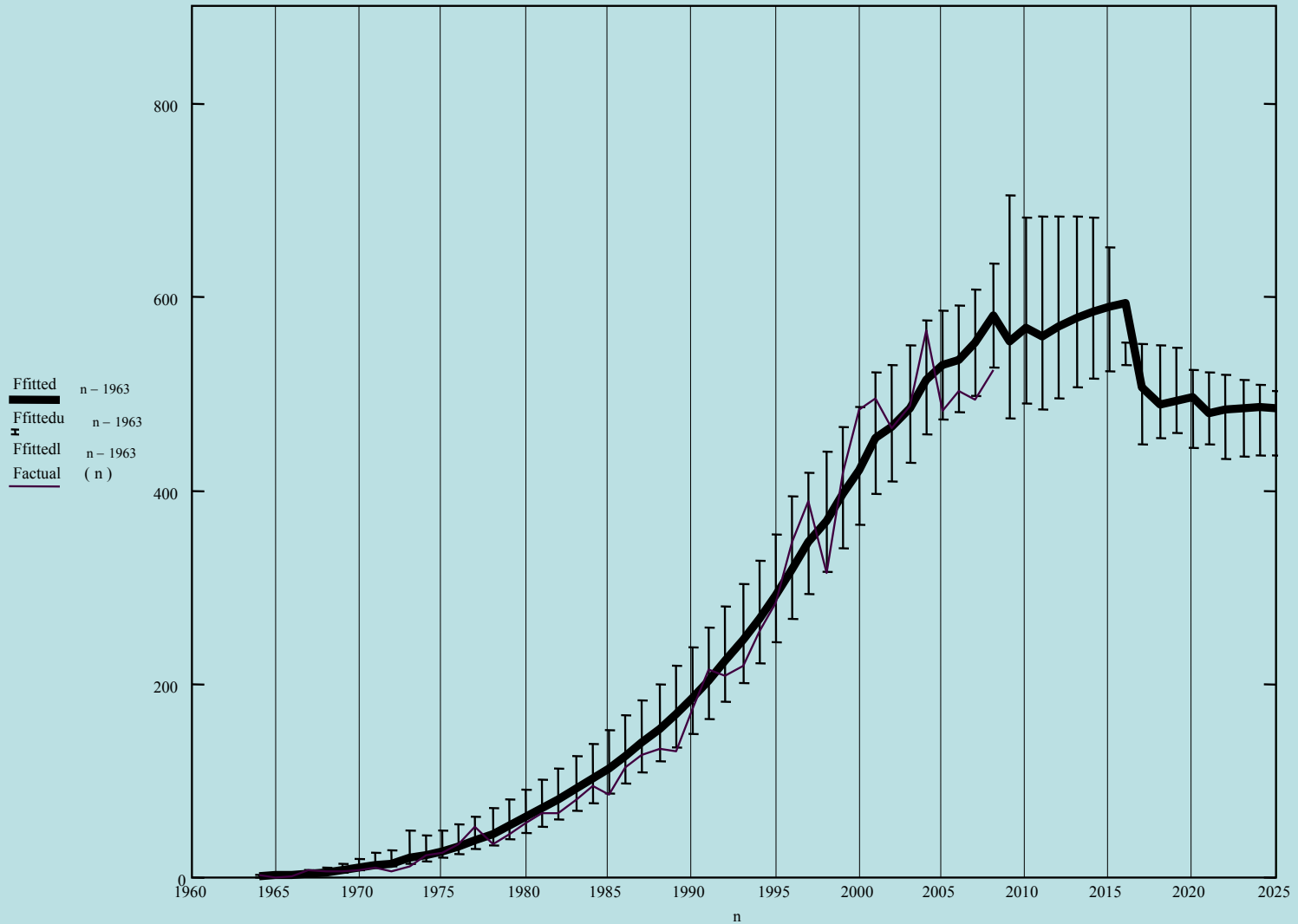
Cable Failure Rates

Summary of HMWPE, XLPE Feeder & Lateral UG Cable Failure Rate (Upper 90% CL) YE 2006



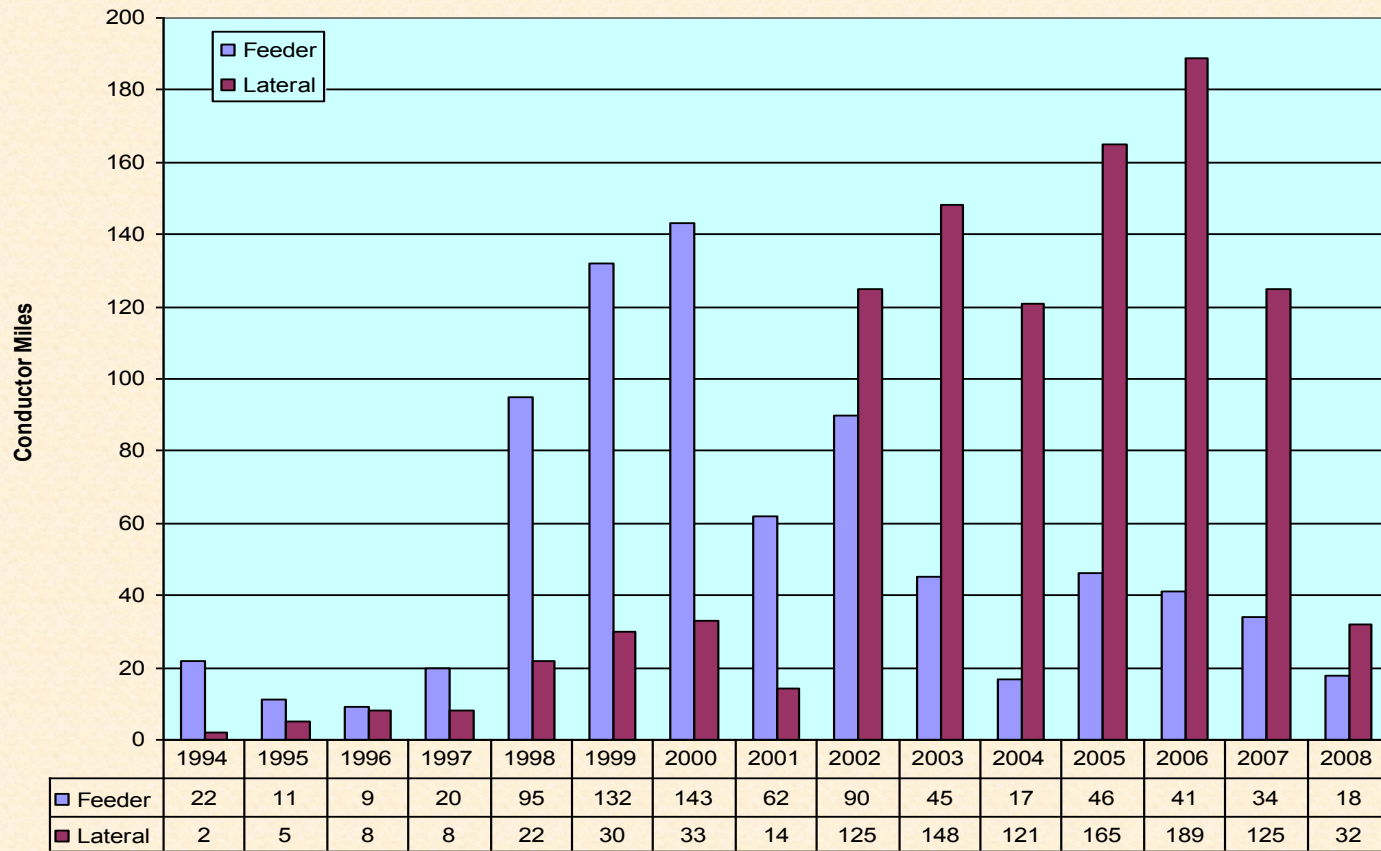
Cable Failure Projections

Historical and Predicted Cable Failures with Confidence Bounds



Proactive Cable Replacement

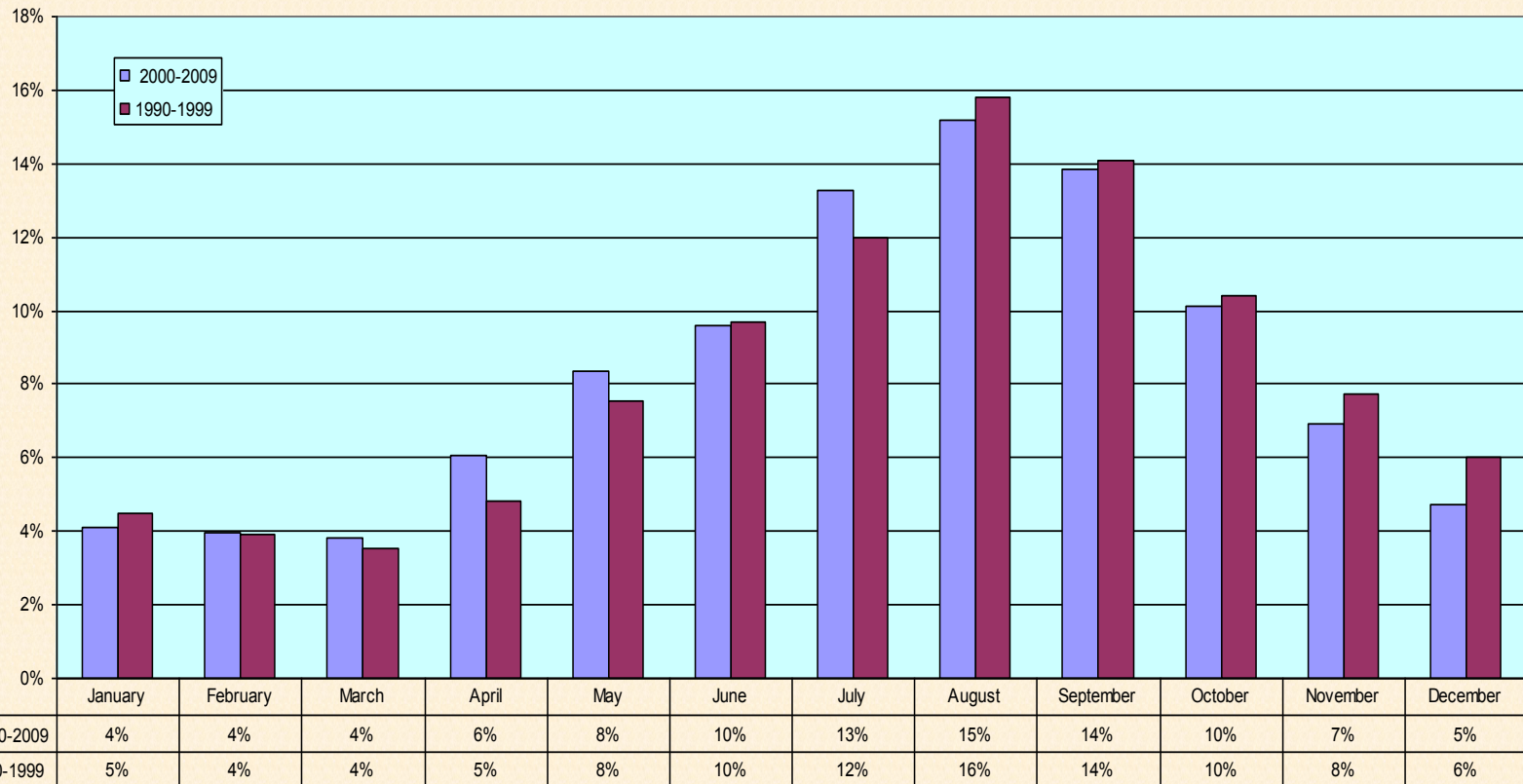
Proactive Cable Replacement



Year/Conductor Miles

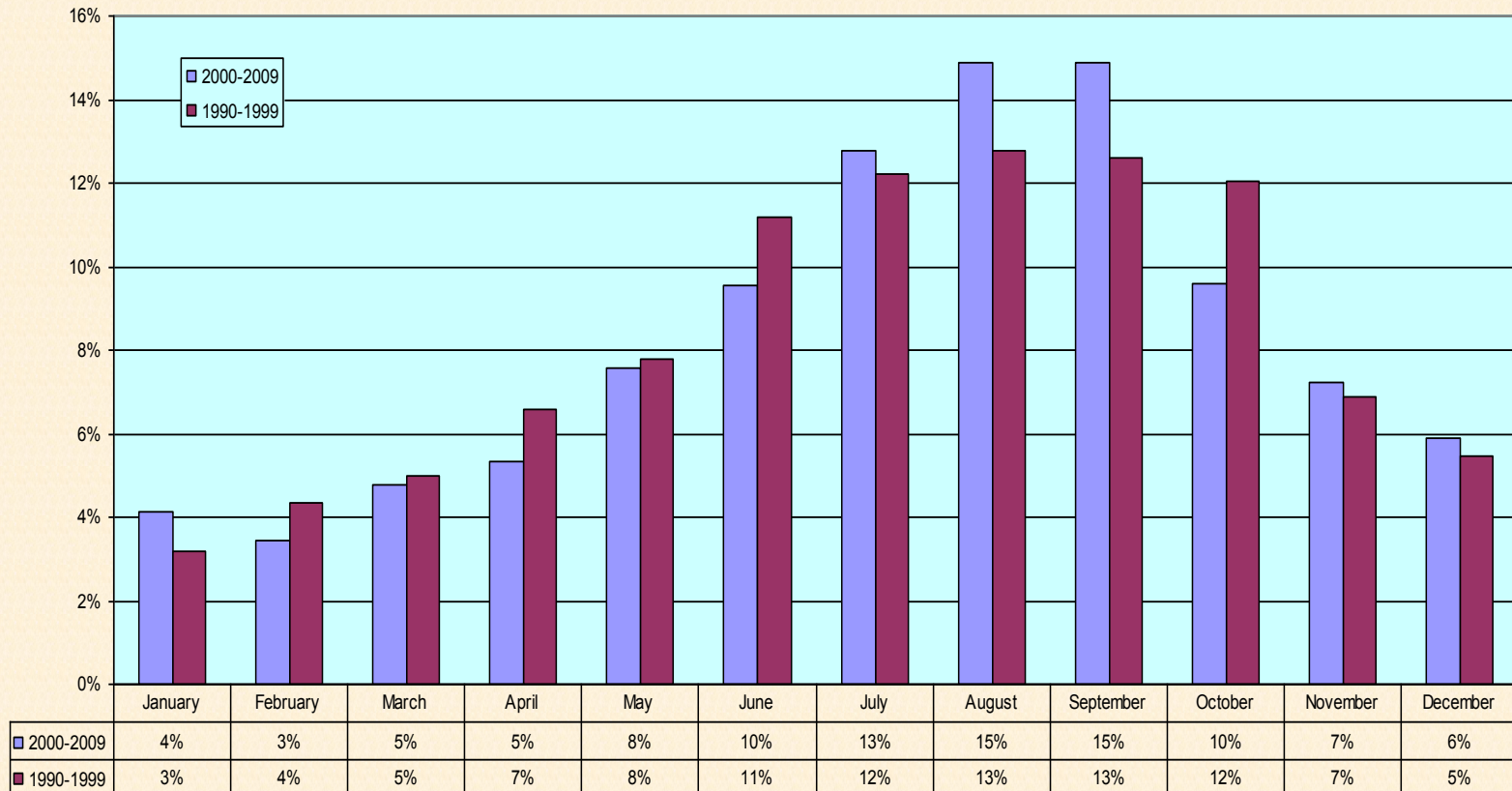
Seasonal Failures – Unjacketed HMWPE

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



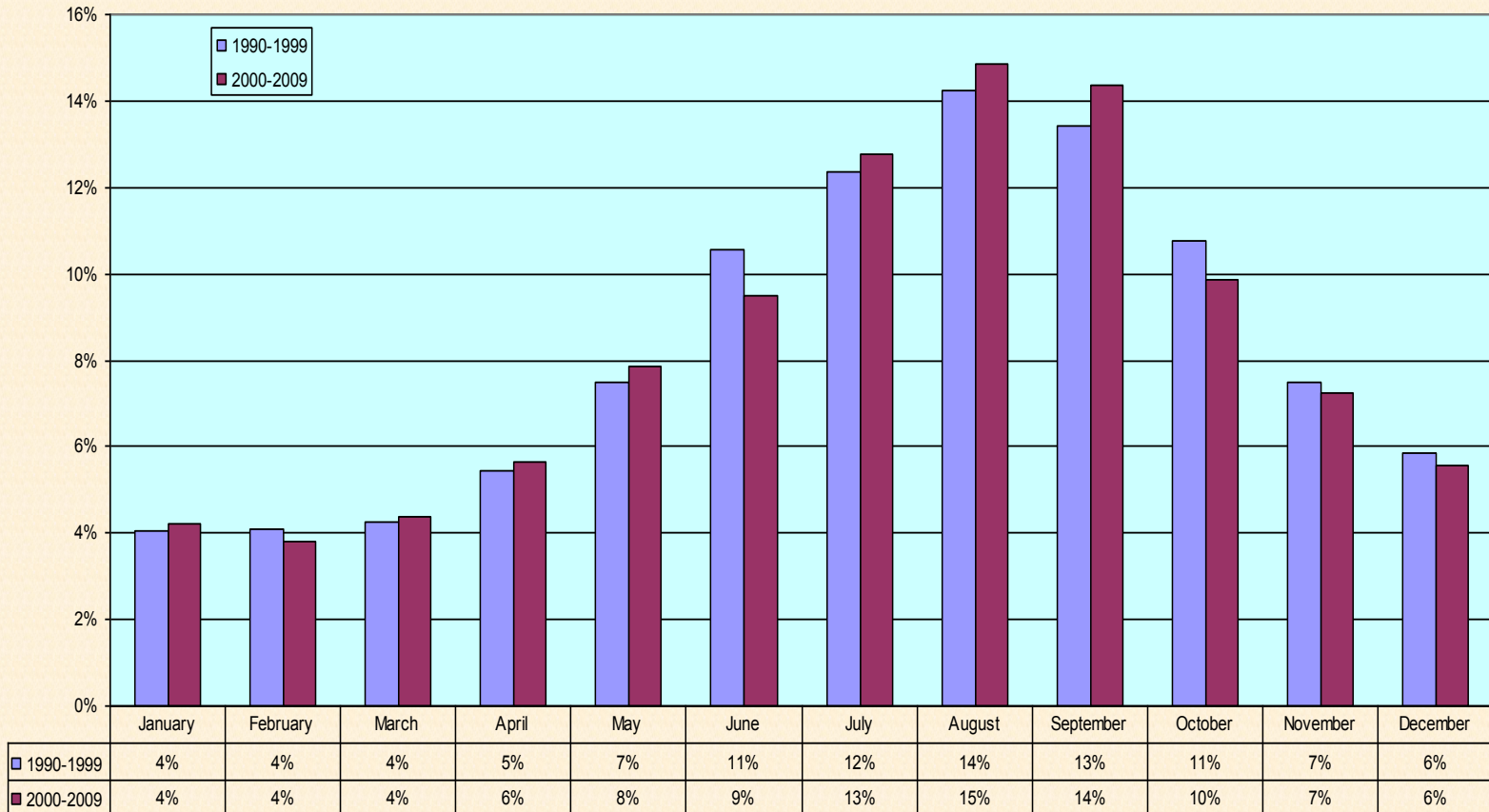
Seasonal Failures – Unjacketed XLPE

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



Seasonal Failures – All cables

Seasonal Failures - Combined Lateral and Feeder
(expressed as a % of all failures)



Thanks for your attention

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Questions?

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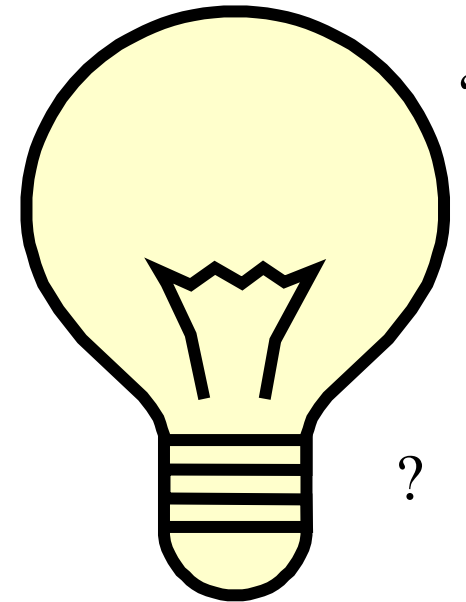
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