ICC Educational Program 600 Volt Secondary Underground Cable Survey

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Overview

- Survey
  - conducted for ICC Educational Program
  - questionnaire focused on:
    - cable purchase specifications and installation methods
    - cable failure data
    - reducing cable failures
- Surveyed IOU's, REA's and Canadian utilities
- 37 responses received mainly from IOU's

Participating Utilities Ranked

Miles of Underground Secondary Cables Installed Annually

Rank	Utility
1	Duke Power
2	Progress Energy
3	PacifiCorp
4	TXU Electric Delivery
5	Dominion
6	Xcel Energy
7	Georgia Power Company
8	Commonwealth Edison
9	Arizona Public Service
10	Ameren

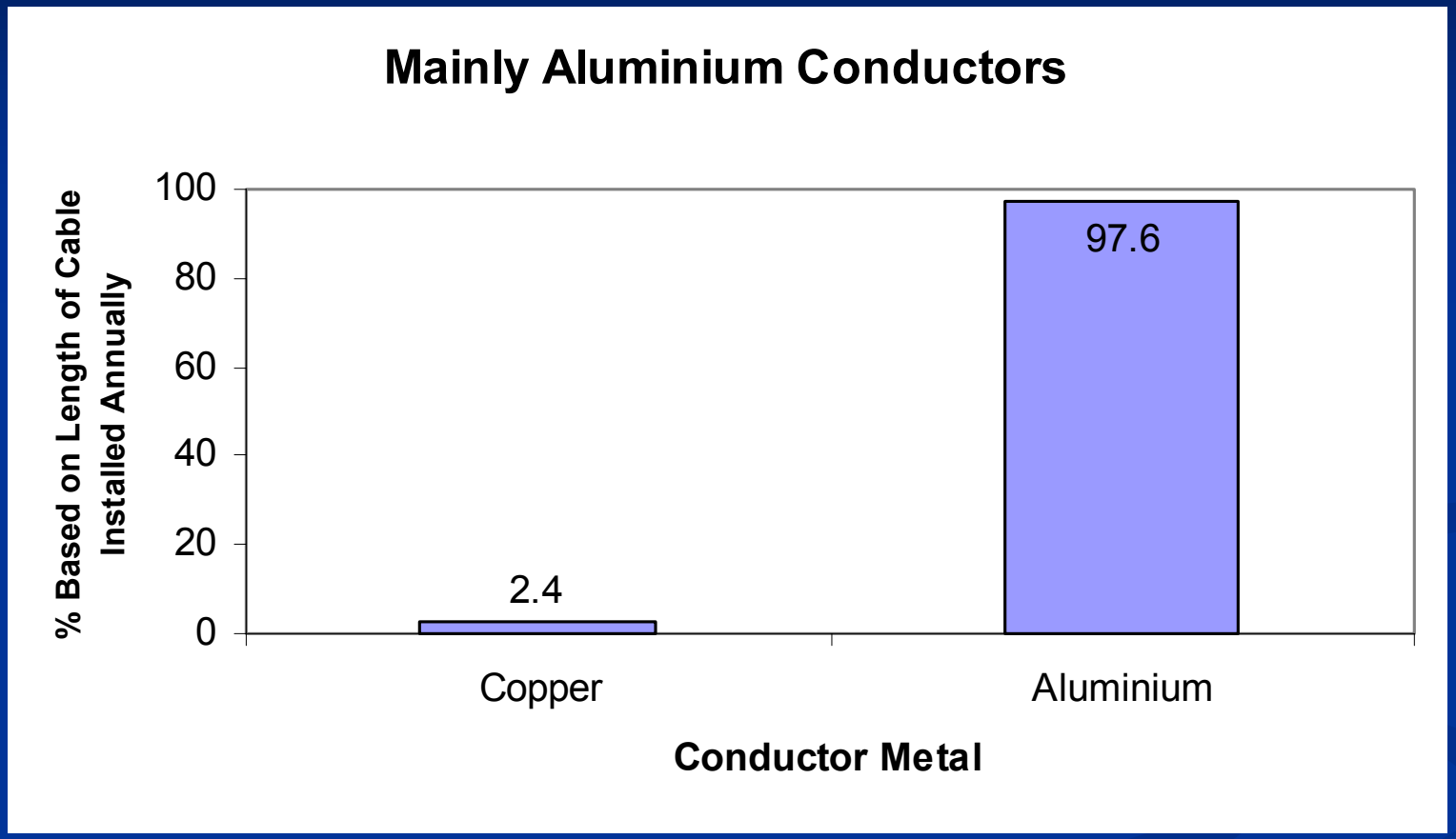
33 utilities that responded install over 20,500 miles underground secondary cables annually
Top 10 utilities install over 70% of total miles

Variety of Cable Designs

Example - Cable Designs Used by a Utility

Conductor Metal	Conductor Size AWG/kcmil	Number of Layers (insulation)	Cable Construction
Al	2#6	2	Ruggedized
Al	3#4	2	Ruggedized
Cu	3#2 (CIC)	1	Non-Ruggedized
Al	3#4 (CIC)	1	Non-Ruggedized
Al	2#6 (CIC)	1	Non-Ruggedized
Al	4/0-4/0-2/0	2	Ruggedized
Al	350-350-4/0	2	Ruggedized

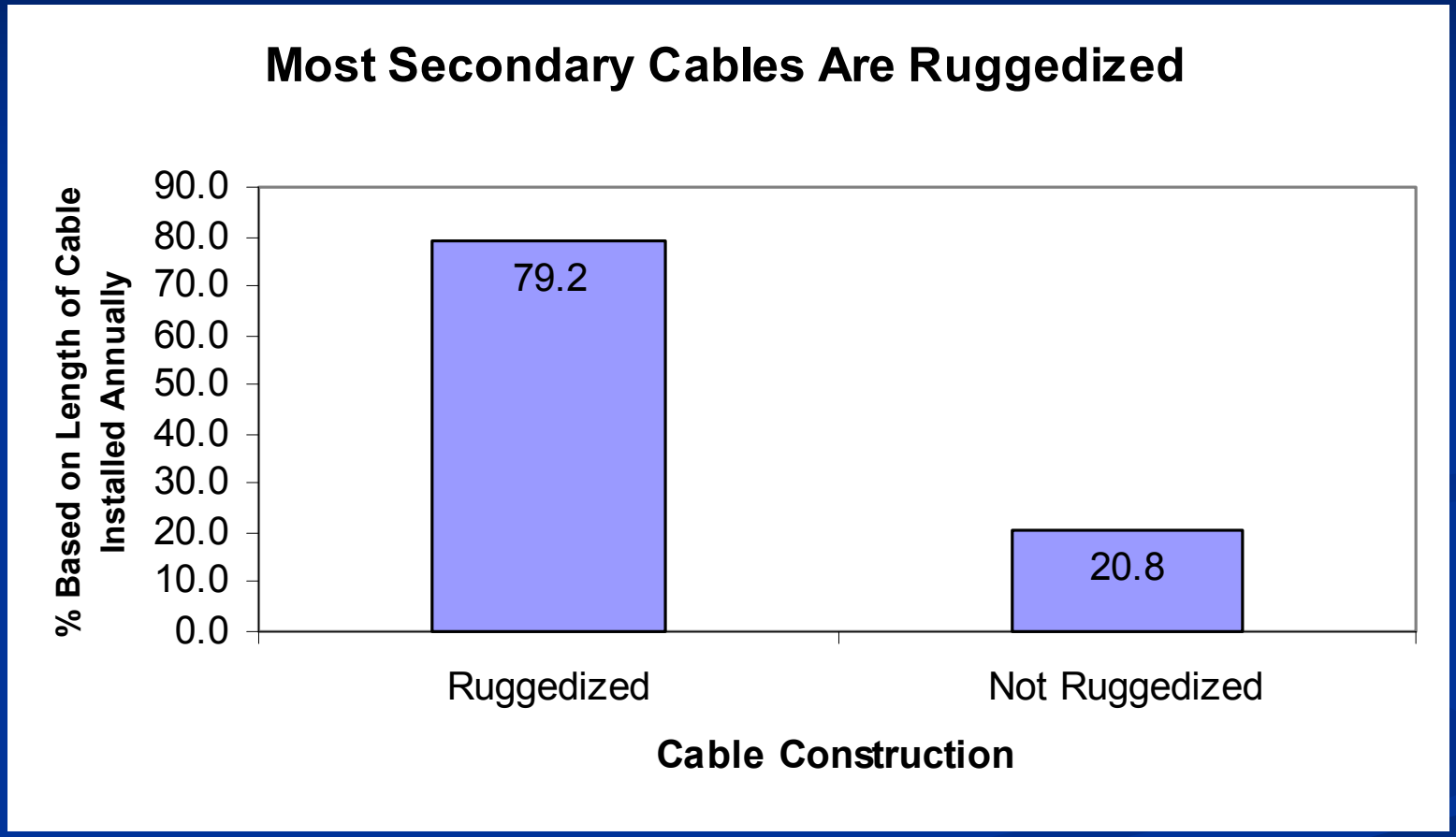
Secondary Cable Conductors



72% of utilities surveyed specify only Al conductor
17% Al+Cu
6% Cu only
6% no response

Secondary Cable Designs

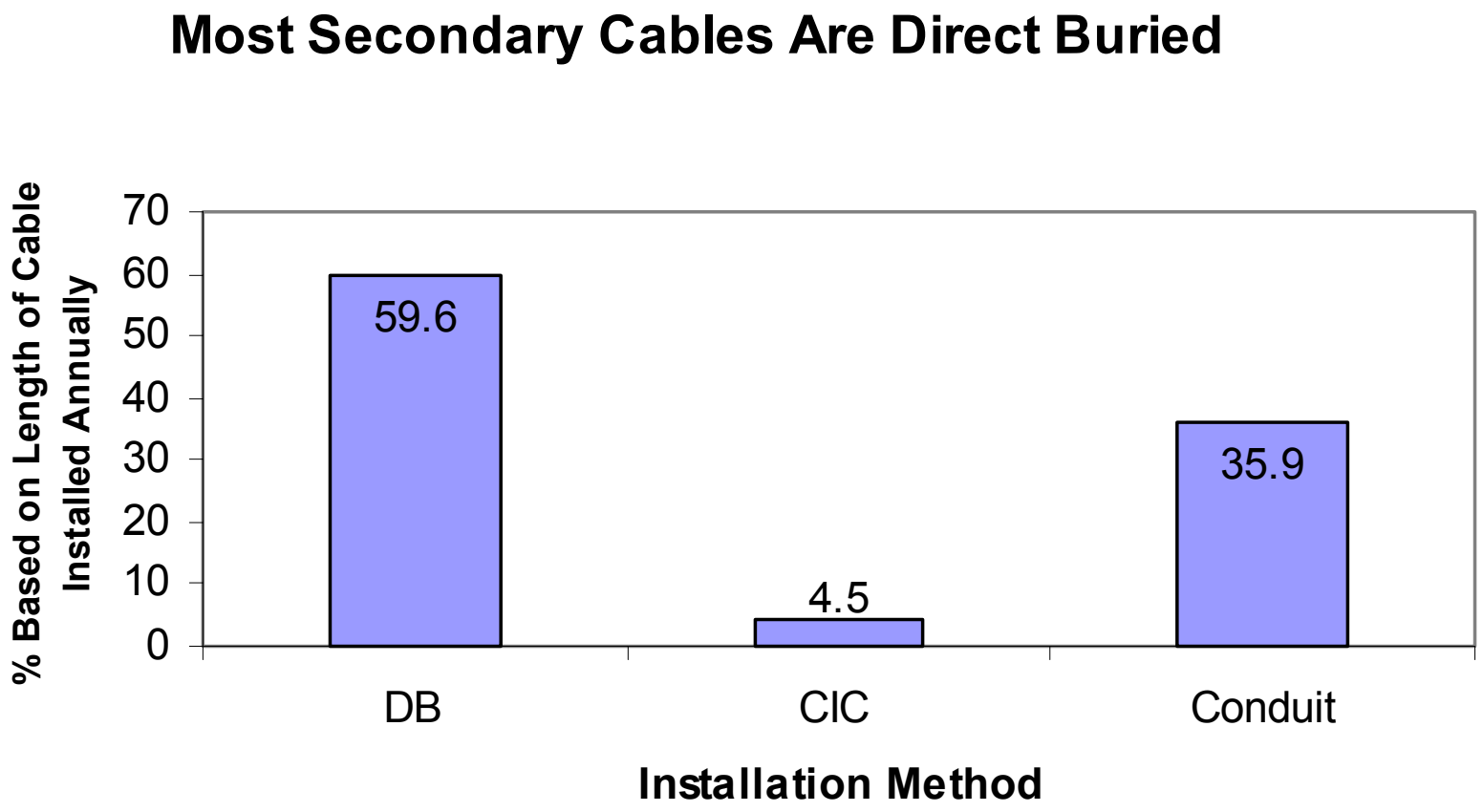
Mostly 90°C Rated*



86% Ruggedized cables specified are 2 layer design

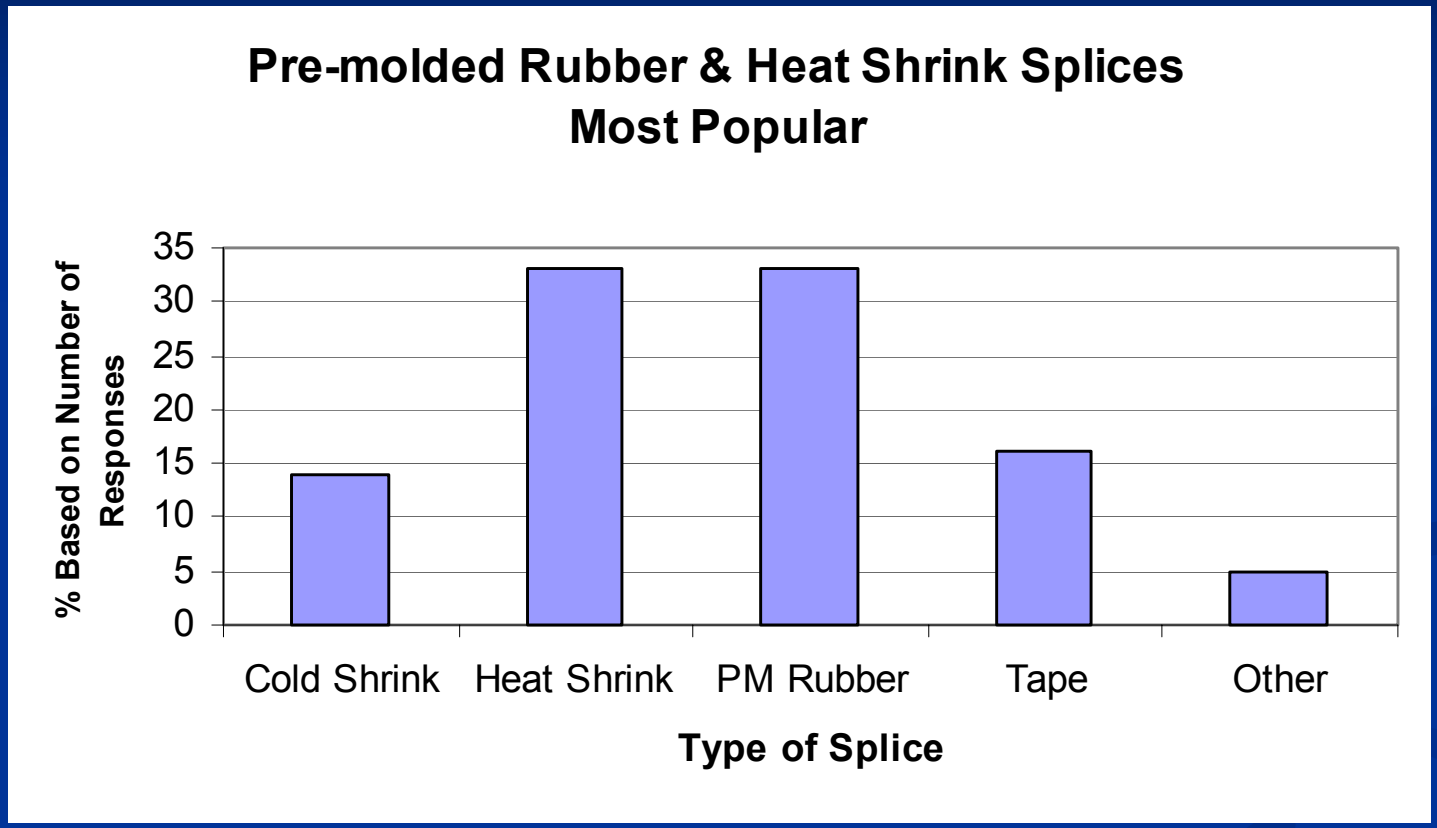
*All utilities except 1 small co-op specify 90°C rated cables

Secondary Cable Installation



DB direct buried
CIC cable purchased in conduit
Conduit cable installed in previously installed conduit

Types of Splices Used



Cable Failures

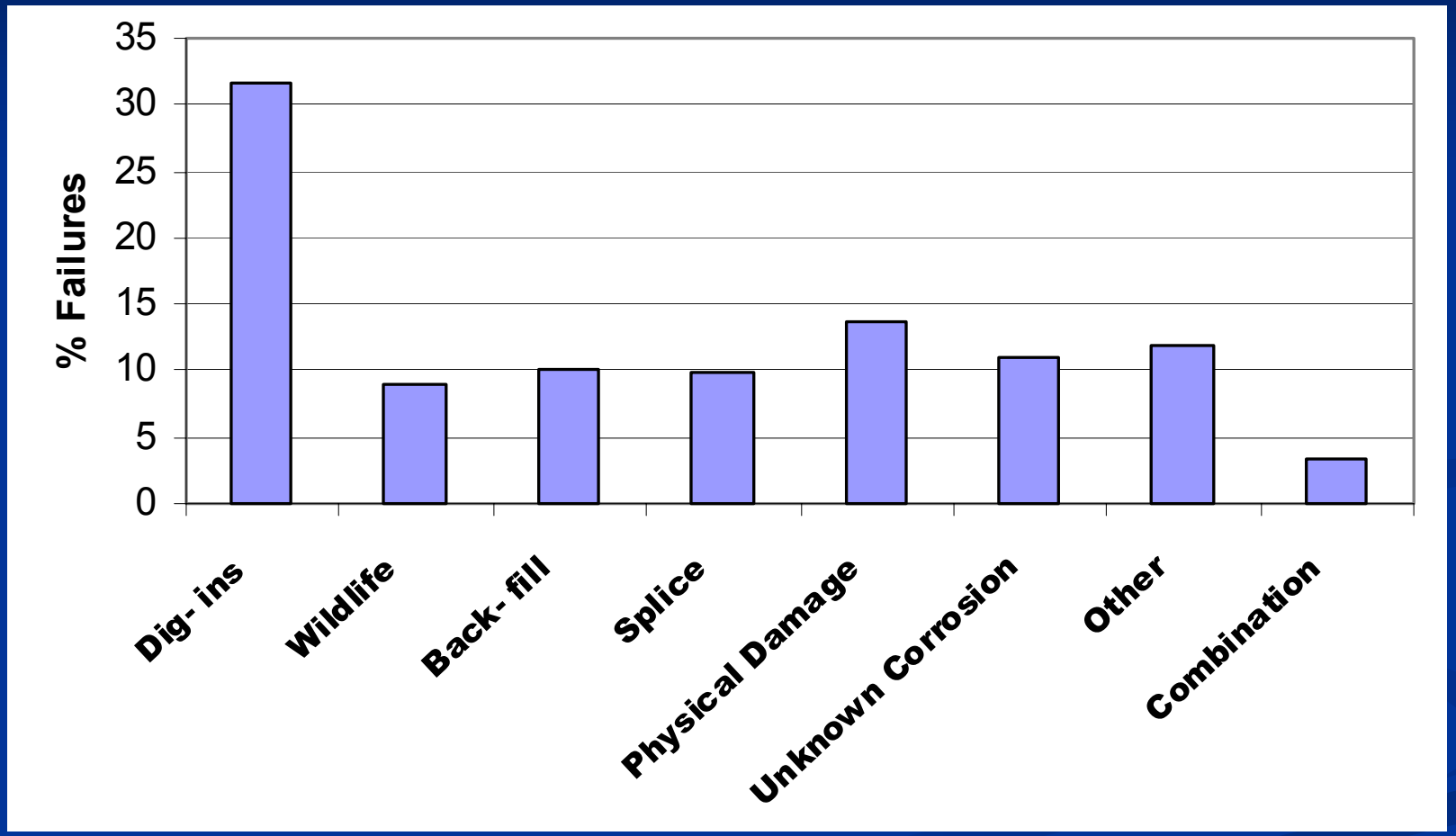
Underground secondary cable failures

- tracked by 18 (or 49%) of utilities surveyed
- at 13* utilities annual cost $16.6 million
- average annual cost $1.15 million per utility

  (range of $4.2 million for large IOU to $16,000 for small Co-op)
- average cost $1092 per failure
  - (range of $3222 - $320)

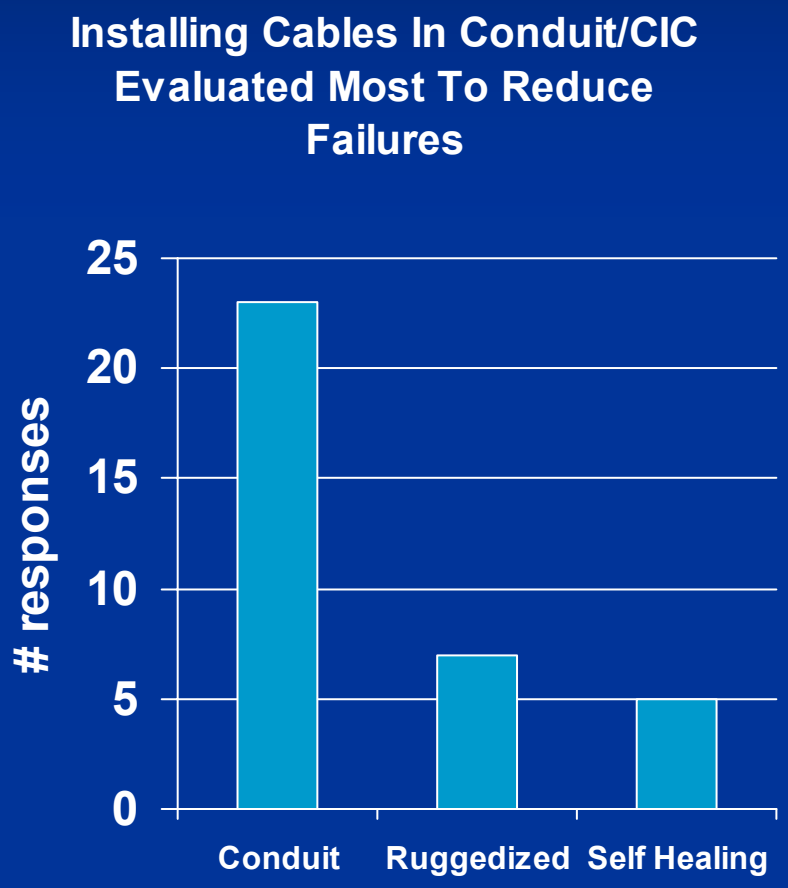
*Only 13 utilities provided cost of failure data

Mechanical Damage Causes Most Underground Secondary Cable Failures



Responses based on best estimates

Solutions Evaluated
To Mitigate Secondary Cable failures



***Successful in mitigating secondary cable failures*:**

- Conduit/CIC at 22 utilities
  - 1 utility: too expensive
- Ruggedized at 4 utilities
  - Unsuccessful at 2 utilities
  - Moderately successful at 1
- Self Healing successful at 2 utilities
  - Still being evaluated by 3 others

Selected Comments
Solutions Evaluated To Mitigate Cable Failures

Solutions evaluated	Was solution successful?
Conduit/CIC	Yes
Conduit/CIC	Too expensive
Select backfill	No- contractor controls
Cleaner backfill	Yes
Ruggedized cable	Yes- standard since 1980
Ruggedized cable	No- large boulders tougher
One call system/state law	Yes- dig-ins greatly reduced
Copper	Yes- no corrosion if damaged
Thermal imaging	Yes- reveals poor connections

Future Plans

To Mitigate Underground Secondary Cable Failures

Utility plans to reduce underground secondary cable failures:

62%	no plans (mainly those satisfied with conduit)
16%	self-healing cable
8%	conduits

Evaluation of Self Healing Cables
Evaluated by 18 (49%) Utilities

* stated would not specify self heal in future

Comments
Evaluations of Self-Healing Cables

Results were concluded as:

- **unknown**
  - cable handling difficult within meter sockets
  - hopefully can specify in future
- **indeterminate**
  - may specify in future
- **unsuccessful**
  - not sure why not pursued & no plans to specify
- **unsuccessful**
  - most of our failures are with dig-ins and this is not the solution

Comments
Evaluations of Self-Healing Cables Continued

- **successful**
  - decided it cost too much
  - 90% installed in conduits, 6% CIC
- **successful**
  - self-healing not used because cables in conduit
- **not evaluated because all 600 volt cables installed in conduit**
  - stopped all damage from hand dig-ins, bad backfill, etc., (including kind of damage self-healing can handle)
  - still have dig-ins from power equipment that cut cable in 2 & self-healing cannot handle that

Utilities Future Plans To Specify Self-Healing Cable

- 57% do not plan to specify
- 26% may specify
- 14% no comment
- 3% will be allowable

Conclusions

- Typical 600 volt underground secondary cable is:
  - 90°C rated dual layer ruggedized with Al conductor
  - direct buried but significant quantity installed in conduits
- Mechanical damage responsible for most failures
- Conduits used successfully by most utilities to reduce cable failures
- Self-healing cables are still under evaluation as a possible solution to reduce cable failures