DSTAR

Distribution R&D for Today's Utility Environment

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http://www.dstar.org/

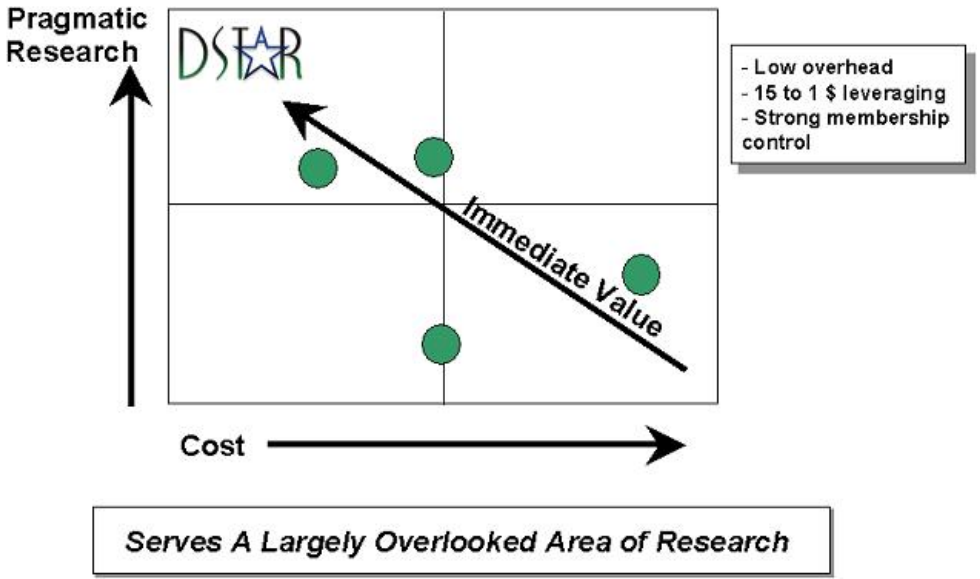
What is DSTAR?

DISTRIBUTION SYSTEMS TESTING, APPLICATION, AND RESEARCH

DSTAR is a consortium of utilities organized to cooperatively sponsor practical distribution systems research. http://www.dstar.org

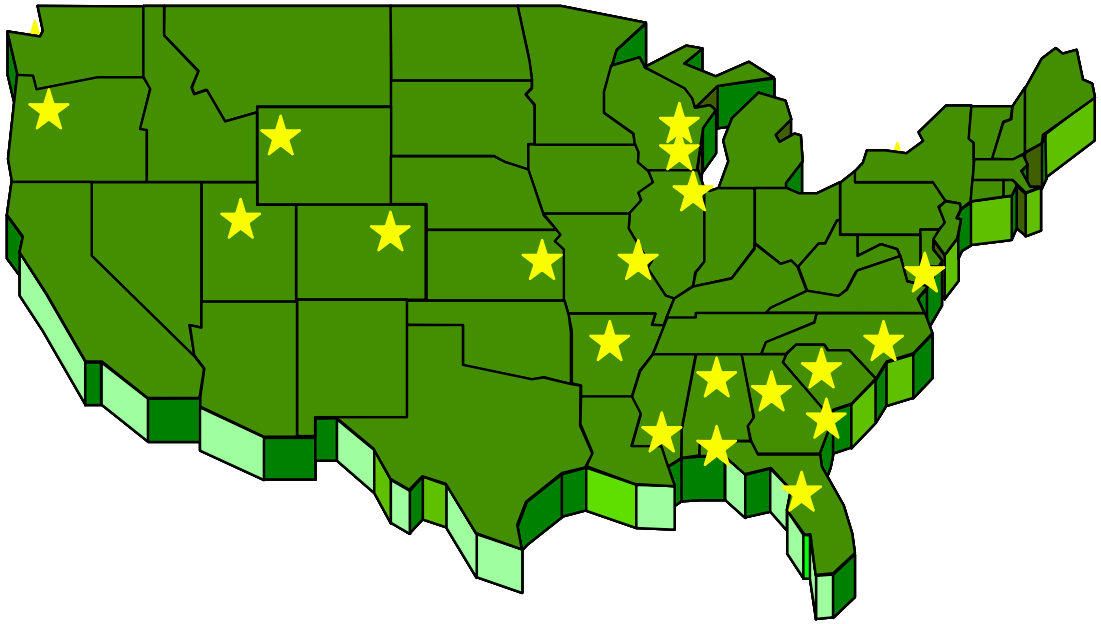
What Distinguishes DSTAR?

- Practical, near-term distribution focus
  - Equipment testing and product evaluation
  - Niche software for standards and engineering support
  - Whitepapers and reports on pressing industry issues
- Responsive, intimate, direct control by members
  - Members select, prioritize and direct project execution
  - Program members own an undivided share of IP
- Low overhead, efficiently managed organization



Active Member Utilities

Program 11, 12, and 13



Ameren Corporation

Aquila/KCP&L

Duke Energy

NRECA

PacifiCorp

Progress Energy

South Carolina Electric & Gas

Southern Company

We Energies

Wisconsin Public Service

DSTAR Program Structure

- Research project bundling
  - multiple topics in each “Program”
  - meets diverse needs of member utilities
- Membership in a Program provides all R&D fruits of projects in Program
- Program duration 1.5 - 2 years
- Member contribution is $40k or $90k per program (depending on size)
- Utilities can obtain retroactive membership for prior programs to secure results and deliverables
- Planning meeting twice per year
- GE Energy’s EA&SE group provides program management and administration services

Same Structure Since Inception in 1986

Some Research Area Examples

Engineering and economic productivity tools

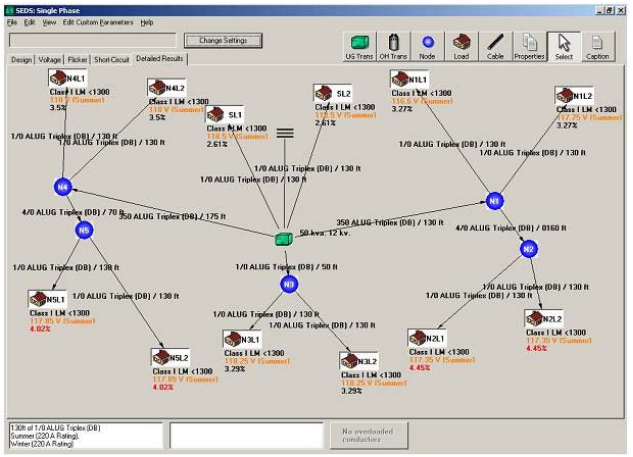
- Engineering design and analysis software
- Total owning cost & economic analysis tools

System protection, operating safety, and reliability

- Ferroresonance guidelines
- URD overvoltage protection
- Padmount transformer fault withstand

Engineering guidelines and industry perspectives

- Distribution engineering eHandbook
- DG interconnection white paper
- Storm response best practices white paper



Program	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Economic Analysis	○	○	○	○	◑	◑	◑	◑	◑	◔	◔	◑
Engineering Analysis Software	○	○	○	○	●	●	●	●	●	●	●	◑
Engineering Guidelines	◑	◑	●	●	◑	●	◑	●	◑	●	◑	◑
Equipment Testing/Evaluation	●	●	●	●	●	◑	◑	○	○	◑	◔	○
Industry Perspectives / White Papers	○	○	○	○	○	○	◔	◑	○	●	◑	◑
Operational Efficency	○	○	○	○	◔	◔	○	○	○	○	◑	●
Power Quality	○	○	◑	○	○	○	○	○	○	○	◔	○
System Protection	◑	◑	◔	◔	◑	○	○	◔	○	◔	○	◑
System Reliability	◔	◔	◔	◔	○	○	○	○	◔	◑	◑	●

Program 11 Projects

Program 11 was recently completed

1. Anchor Corrosion detection white paper
2. Voltage flicker issues related to large new residential loads
3. Electronic distribution data handbook (ehandbook) expansion
4. Secondary Electrical Design Software (SEDS) - optimization feature and other enhancements
5. Implications of Communications Equipment Mounted in the Electric Space on Distribution Poles
6. Best practices for storm response white paper
7. Harmonic load calculator
8. Transformer DOE standards evaluation
9. Solid blade switch testing
10. Distribution automation whitepaper

Program 12 Projects

Program 12 is wrapping up

1. Software maintenance and website update activities
2. SEDS Enhancements – loss optimization, lighting design
3. Electronic Data handbook (eHandbook) expansion
4. Improving energy efficiency of utility systems
5. Impact of non-wood poles on reliability
6. Changing nature of loads and the impact on utilities
7. Guidelines for current-limiting fuse application
8. Capacitor control guidelines: choosing optimal type and settings

Program 13 *Potential* Projects

Program 13 is kicking off – now is the time to join!

1. Commercial load estimation tool
2. Best practices for equipment inspection, maintenance, and thermal imaging
3. Single-phase and three phase SEDS enhancements
4. Conservation voltage reduction (CVR) - testing, methods, and results
5. 3rd harmonic issues, impact, mitigation
6. Smart grid impact on distribution reliability
7. Arrester comparative testing, and justification of normal duty arresters
8. Centralized vs. distributed feeder automation and impacts on distribution performance
9. Impact of photovoltaic generation on distribution systems
10. Getting added value from scada and remote sensors
11. Smart grid technologies and data requirements for transformer health assessment
12. Integration of reliability information with system operations planning
13. Best practices for demand side management using dynamic pricing

Back-Up Material

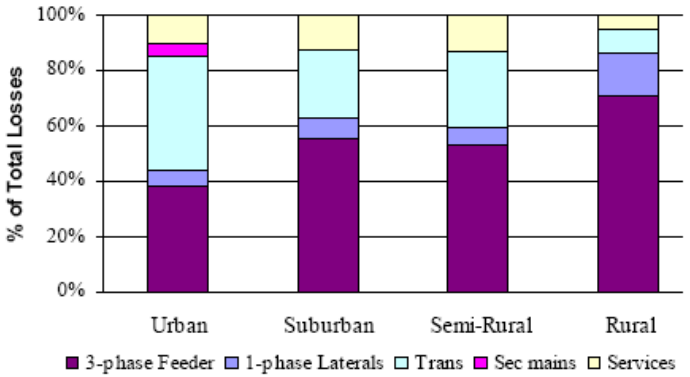
Selected Smart Grid-Related Projects

Improving Energy Efficiency of Utility Systems

Project Overview

Develop system models that accurately reflect the losses at each level of the distribution system

- Primary
- Service transformer
- Secondary and service



Develop loss contribution factors for each system component

- Determine how much typical equipment contributes to distribution system losses
- Recommend and evaluate distribution design practices to reduce losses

Changing Nature of Loads and Impact on Utilities

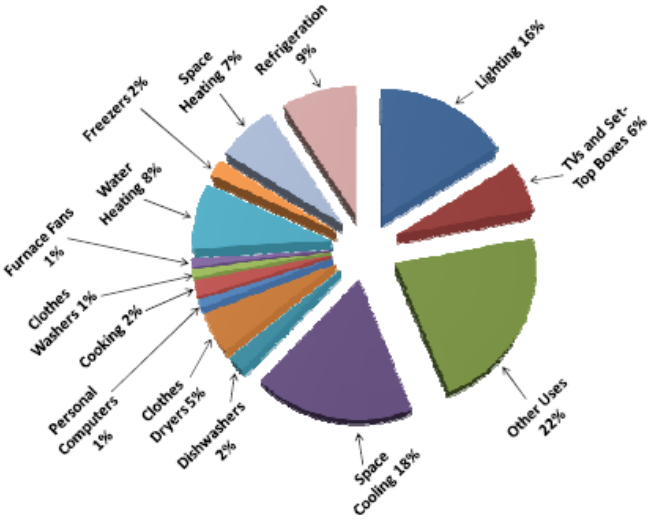
Project Overview

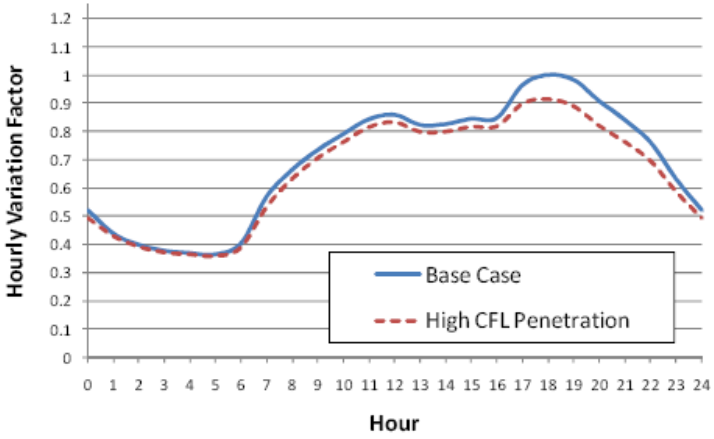
Determine relevant “new” and existing loads, trends and expected growth

Investigate how nature of aggregate utility load changed by “new” load types and penetrations

Analyze and discuss impact on conventional utility planning practices

- power quality and reliability concerns
- load control and DSM programs
- peak shaving strategies
- conservation voltage reduction, loss reduction, volt/var support
- other planning and operation issues





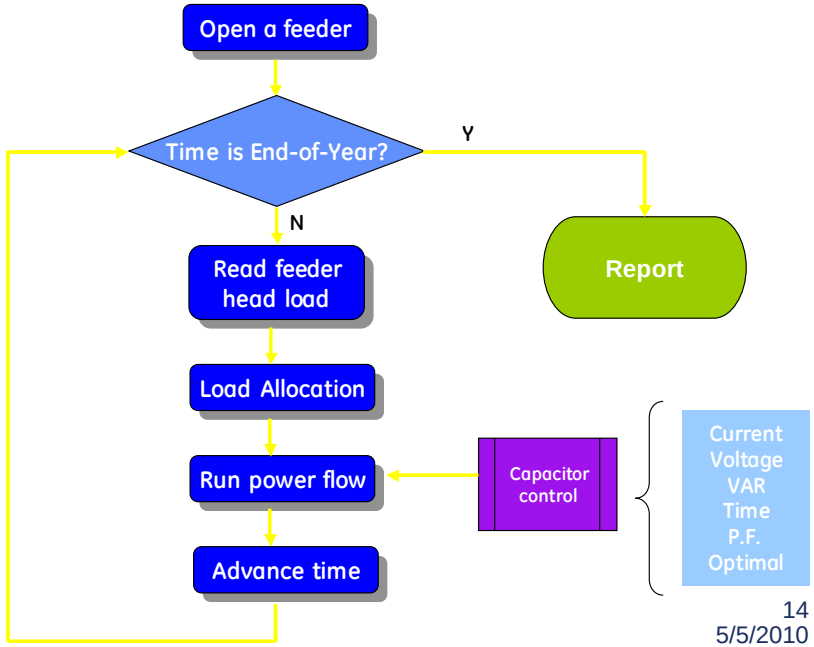
Optimal Capacitor Control Guidelines

Project Overview

Literature search to determine how much has been done in this area and survey on cap controls and interviews with manufacturers.

Develop guidelines for “optimal” control of capacitors under various situations

- Construct example (prototype) feeders for rural, urban and suburban systems
- Apply various load profiles
- Solve the loadflow problem with various cap control type/settings,
- Compute losses and energy savings
- **Determine optimal control strategy**



Selected Operating Safety and Protection Projects

Investigations to Determine Ferroresonance Avoidance Guidelines

Full-scale field testing

Wye-wye padmounts

- low-loss silicon steel
- amorphous metal transformers
- stacked (laminated) core

Delta-primary padmounts

12.47, 24.9, 34.5 kV

Wide range of cable lengths

Applied loads

Ferroresonance Avoidance Guidelines

Risk-Averse Critical Cable-Length Guidelines for Ferroresonance Avoidance

Grounded-Wye Padmounts on 5-Leg Wound Steel Cores

Primary Voltage (kV): 12.47 **kVA:** 150

Core Loss, in Watts, if known (0 if unknown): 0

Cable Size AWG or MCM	Cable Capacitance (pf/ft)	Critical Cable Lengths (ft) V < 1.6 pu Maximum	Critical Cable Lengths (ft) V < 1.25 pu Sustained
175 mil 15 kV XLP Cable			
#4	49	Censored!	Censored!
#2	56		
#1	60		
1/0	66		
2/0	71		
3/0	78		
4/0	84		
250	89		

Easy-to-use guidelines developed for DSTAR

Arrester Ferroresonance Duty

Common belief that ferroresonance will instantly fail an MOV arrester

- ferroresonance produces overvoltages well in excess of 2 p.u., lasting for as long as open phase exists
- arrester TOV is < 2 p.u. for just a few cycles!

Extensive DSTAR tests

- riser and heavy duty distribution arresters
- elbow arresters
- under-oil arresters
- 12.47 and 34.5 kV

Arrester Survivability Guidelines

Guidelines for:

short duration exposure (< 5 minutes)

long duration (indefinite)

Maximum Cable Lengths for Arrester
Short-Duration Ferroresonant Overvoltage Tolerance

Primary Line-Neutral Voltage (kV):	7.2
Arrester Duty-Cycle Rating (kV):	10

Cable Size AWG or MCM	Cable Capacitance (pf/ft)	Suggested Maximum Cable Lengths (ft)			
		Elbow Arrester	Porcelain RP & Dist Arrester	Polymer RP & Dist Arrester	Under-Oil Arrester
175 mil 15 kV XLP Cable					
#4	49				
#2	56				
#1	60				
1/0	66				
2/0	71				
3/0	78				
4/0	84				
250	89				
300	95				
350	102				
400	108				
500	118				
600	126				
750	139				
1000	157				

DSTAR Investigation; Padmount Fault Withstand

Many utilities apply current-limiting fuses

- often applied on padmounts using poletop criteria
- are CLFs necessary in most of these applications?

DSTAR testing performed on a number of padmounted transformers

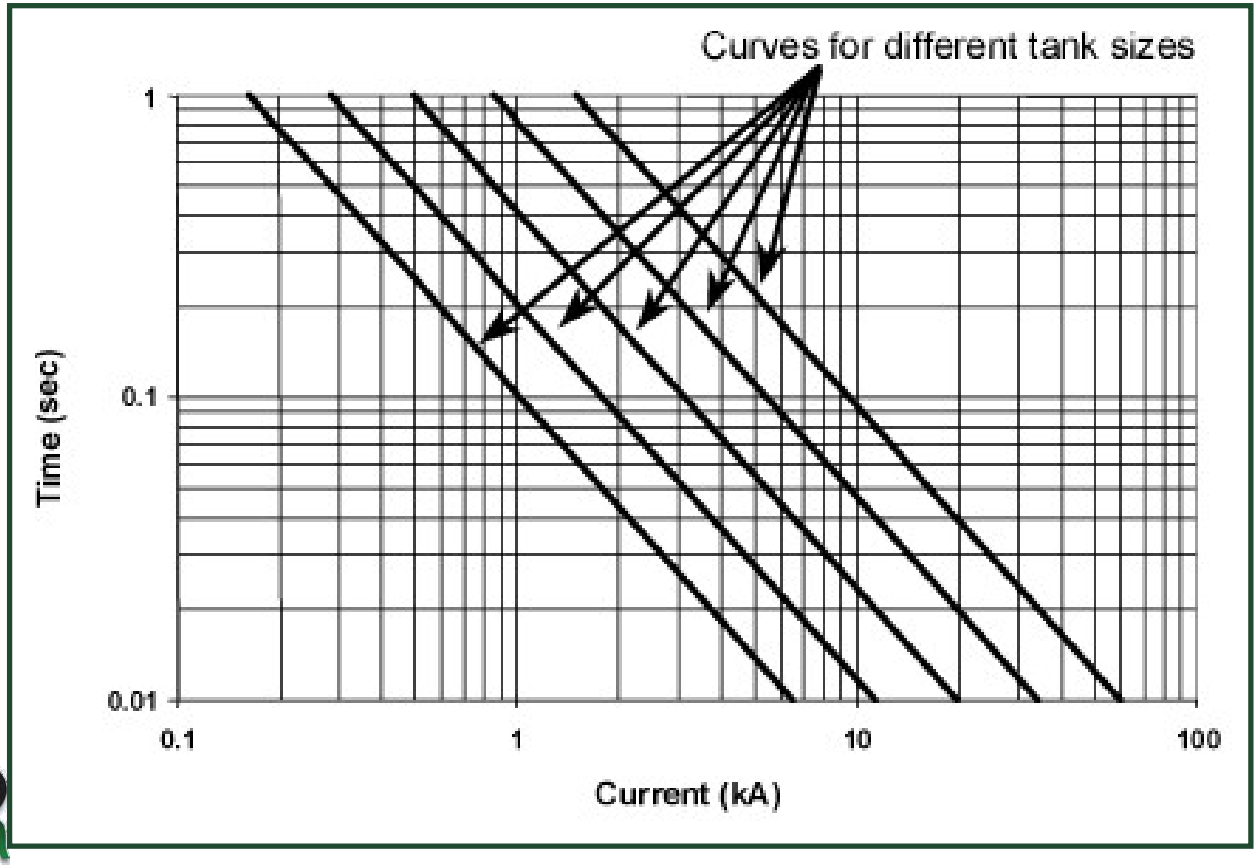
- 8 single-phase, 50 - 100 kVA
- 6 three-phase, 150 kVA

2” arc created deep under oil

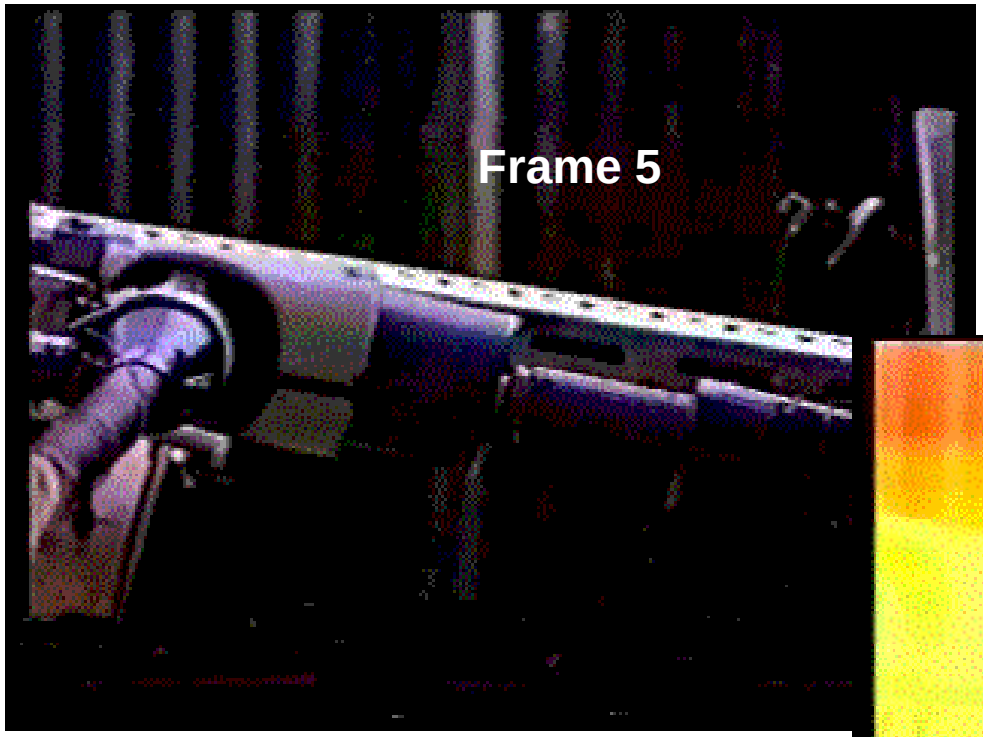
Test to threshold of tank failure

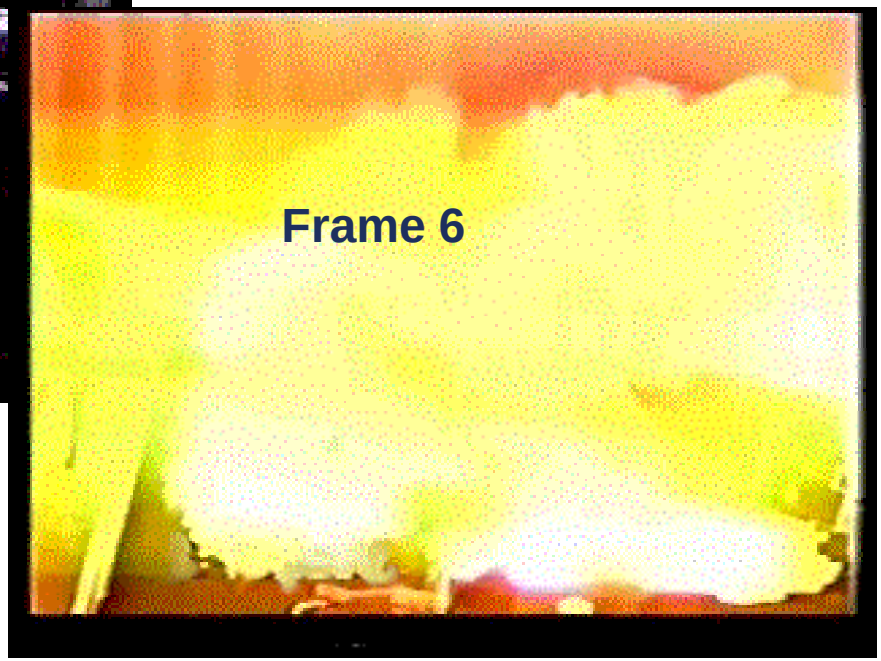
DSTAR Padmount Fault Withstand Guidelines

Fault withstand correlated to a simple tank characteristic



Loadbreak Elbow No-Load Flashover Problem





Widespread elbow flashover problem at 25 and 35 kV during no-load cable switching operations

This flashover occurred well after partial vacuum dissipated

DSTAR Projects Covering URD Overvoltage Protection

P1-1	***URD Overvoltage Protection***
P1-2	***URD Overvoltages Considering Transformers and Grounding***
P1-3	***Fast and Slow Surges***
P2-2	***Semi-Conductive Jacketed Cable Investigation***
P2-3	***Switching Surges in Underground Distribution Systems***
P3-1	***Supplemental Cable Tests and Improved System Grounding***
P5-3	***Gapped MOV Arrester Characteristics***

DSTAR Projects Addressing Transformer Overvoltage Protection and Ferroresonance

P2-4	***Ferroresonance Guidelines for Modern Transformer Applications***
P4-1a	***Ferroresonance Guidelines for Additional Padmound Transformer Types***
P4-1b	***Survivability of MOV Arresters Subjected To Ferroresonance Overvoltages***
P4-1c	***Ferroresonance Survivability of Under-Oil Arresters***
P4-3	***Secondary Surge Guidelines***
P5-2	***Floating Wye-Delta Overhead Bank Overvoltages***
P5-6	***Service Entrance Protection Coordination***

DSTAR Projects Covering Operating Safety

P5-1	***Investigations of Elbow and Insulated Cap Flashovers***
P6-1	***Investigations of Elbow and Insulated Cap Flashovers***
P3-4	***Padmount Transformer Tank Fault Withstand Capability***

Selected Projects with Potential Reliability Impact

CFO Calculator

CFO Calculator

- Scope
  - Calculates pole system CFO
  - Determines best arrester spacing for CFO, shielding, and keraunic level
- System reliability impact
  - Reduce line flashovers
  - Potentially reduce number of arresters and, as such, reduce potential for arrester failure-related outages
- Reliability indices affected
  - SAIFI

Elbow and Overhead Arrester Testing

Elbow and Overhead Arrester Testing

- Scope
  - Consumer report-like testing
  - Tracking wheel and seal integrity testing
  - Tested Cooper, Hubbell, Elastimold, and Joslyn
- Reliability and Operational impacts
  - Potentially reduce the number of arrester field failures
  - Improved intelligence for arrester procurement
- Reliability indices affected
  - SAIFI

Transformer Fault Withstand Testing

Transformer Fault Withstand Testing

- Scope
  - 8 single-phase, 50 - 100 kVA
  - 6 three-phase, 150 kVA
  - 2” arc created deep under oil
  - Test to threshold of tank failure
- Reliability and Operational impacts
  - Reduce the number of applications using CLF’s and , therefore, inherent system reliability
  - Fault withstand correlated to a simple tank characteristic

Wildlife Protection Guide

Animal-Caused Outages Manual

- Scope
  - Assess the reliability benefit of animal protection programs
  - Discuss habits and impact of various wildlife on T&D systems
  - Review of protection measures and effectiveness
- System reliability impact
  - Reduce incidents of wild-life related outages by recommending best practices and devices
  - Enable cost-effective planning and analysis of measures
- Reliability indices affected
  - SAIFI
  - MAIFI

Best Practices for Storm Response

Best Practices for Storm Response

- Scope
  - Discuss storm preparation, system hardening, early warning, planning and organization
  - Identify best-in-class mobilization, staging, operation, damage assessment, communication
  - Review post-event ramp down, data analysis, lessons learned
- System reliability impact
  - Improve response during major events, reduced downtimes
  - More efficient use of resources
  - Improved customer relations

Transient Current in Capacitor Fuses

Transient Current in Capacitor Fuses

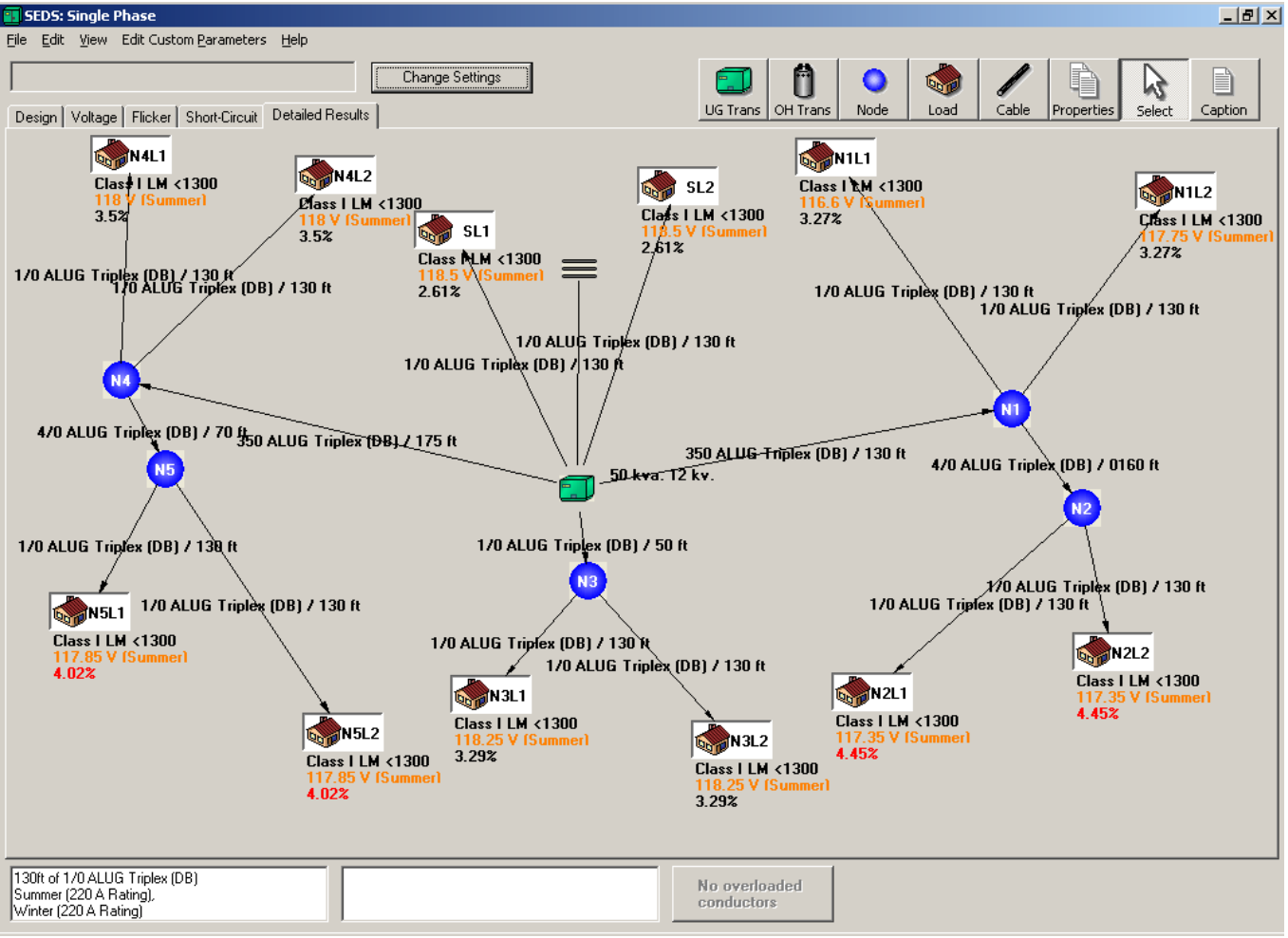
- Scope
  - Evaluate nuisance field fuse failures
  - Analyze typical switching transient fuse duty
  - Analyze typical lightning transient fuse duty
  - Evaluate typical harmonic duty
- Reliability and Operational impacts
  - Guidelines for avoiding nuisance fuse operation
  - Improved system operation due to fewer nuisance fuse operations
  - Improved system reliability
- Reliability indices affected
  - SAIFI

DSTAR Software Tools

DSTAR Software Applications

Software Application	Target User	Description
e-Handbook	All	An electronic handbook covering a variety of distribution engineering and planning topics
TOCS	Central engineering/Planning	Detailed economic and loss of life calculations for transformers according to ANSI standard C57.91-1995
TLA	Field office technician	Calculates transformer life for given loading conditions according to ANSI standard C57.91-1995
CEPS	Central engineering/Planning	Calculates a variety of cable characteristics
SOCCS	Central engineering/Planning	Assist user in the economics calculation of underground versus overhead construction
EOCS	Central engineering/Planning	Detailed economic analysis of overhead conductor total owning cost with re-conductoring and without re-conductoring
GTA	Field office technician	Calculates guy wire and guy anchor tensions for dead-end and angle distribution poles
VDROP	Field office technician	Calculates voltage drop and flicker for three-phase loads fed radially from a transformer
CPA	Field office technician	Calculates cable pulling tensions and sidewall pressures for a given layout.
SEDS	Field office technician	Calculates secondary electrical parameters including cable loading, service voltages, voltage flicker, and service-entrance
GSVIC	Field office technician	Calculates secondary voltage imbalance on three-phase services.
CLPUS	Field office technician	Calculates cold load pick-up current for a feeder or circuit following a power outage.
TSRDS	Field office technician	Assists users in making the decision to scrap or repair a distribution transformer.
X-Derate	Central engineering/Planning	Calculates interference temperatures (ampacity) for a limited set of field conditions
OCS	Field office technician	Calculates ruling span, conductor construction sag & blowout, and conductor span length for given pole loading
CFO	Central engineering/Planning	Calculates the CFO of an overhead pole structure using CFO-added methods
Harmonic	Central engineering/Planning	Calculates THD at point of common coupling for small industrial and large commercial loads

Secondary Electrical Design Software



For single-phase and three-phase secondary design

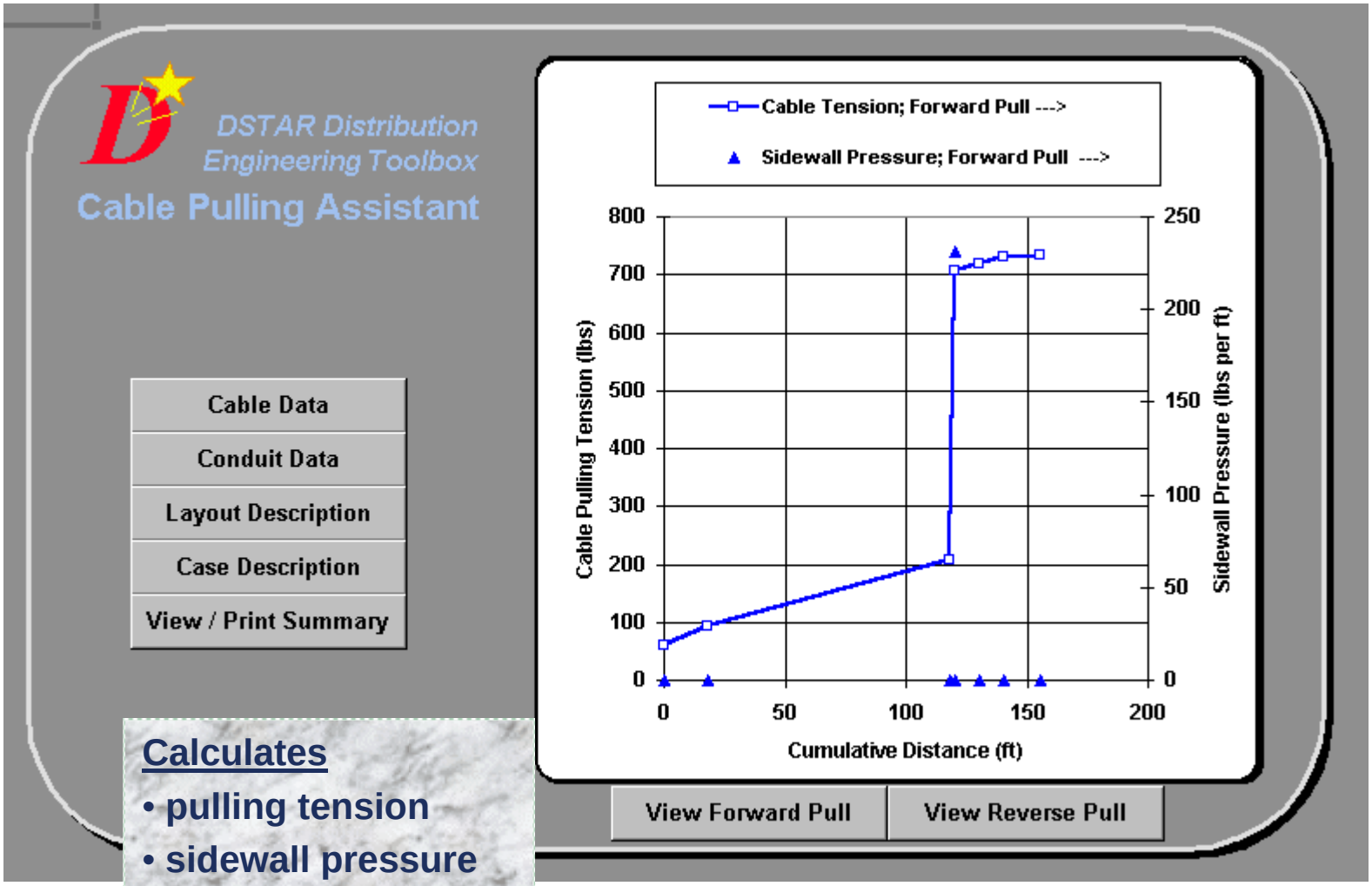
Calculates

- voltage drop
- flicker
- short circuit
- xfmr loading
- cable loading

Optimizes design based on total cost

Convenient graphic interface

Cable Pulling Assistant

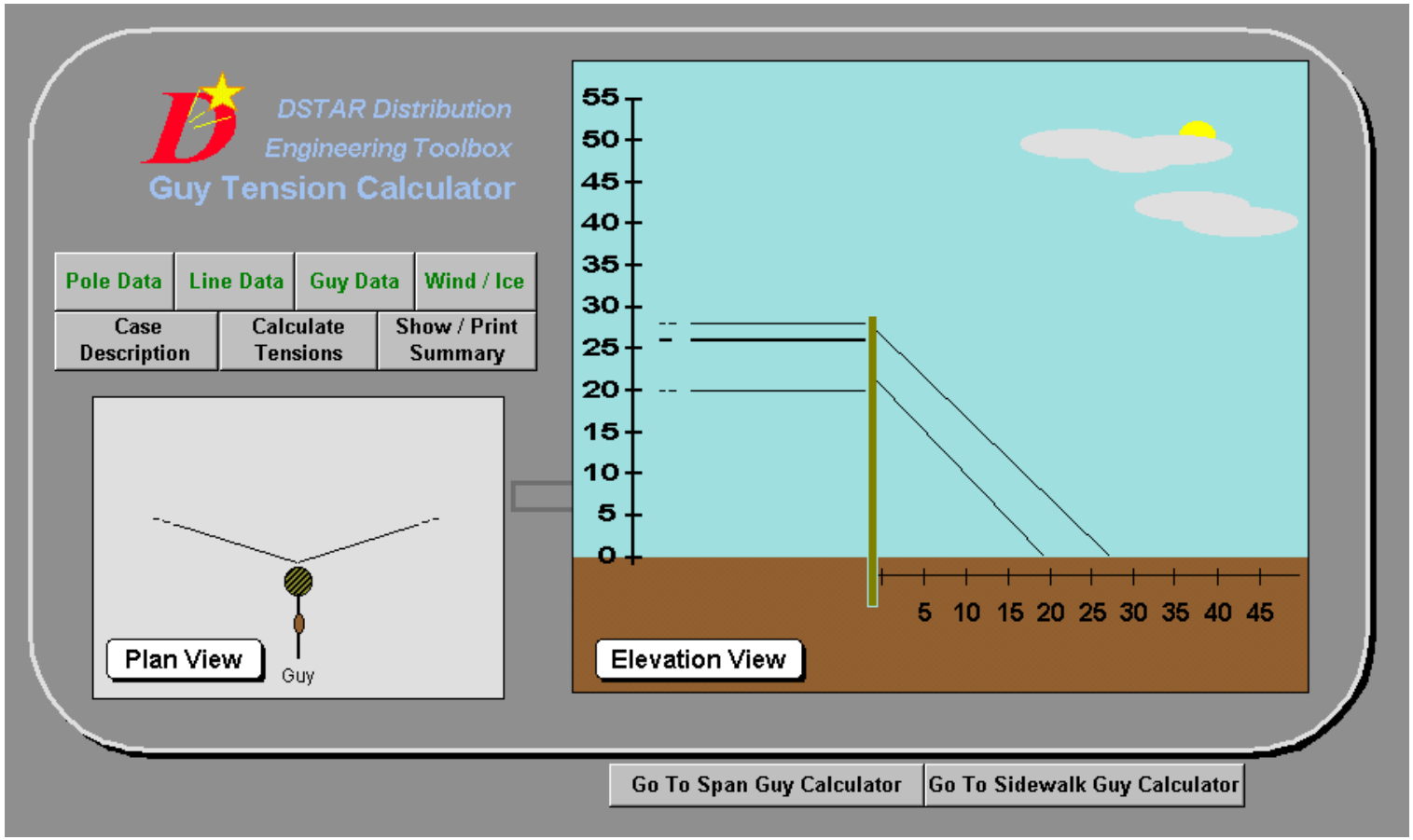


Calculates

- pulling tension
- sidewall pressure
- jam ratio
- fill and clearance

Calculates pulls in both directions

Guy Tension Analyzer



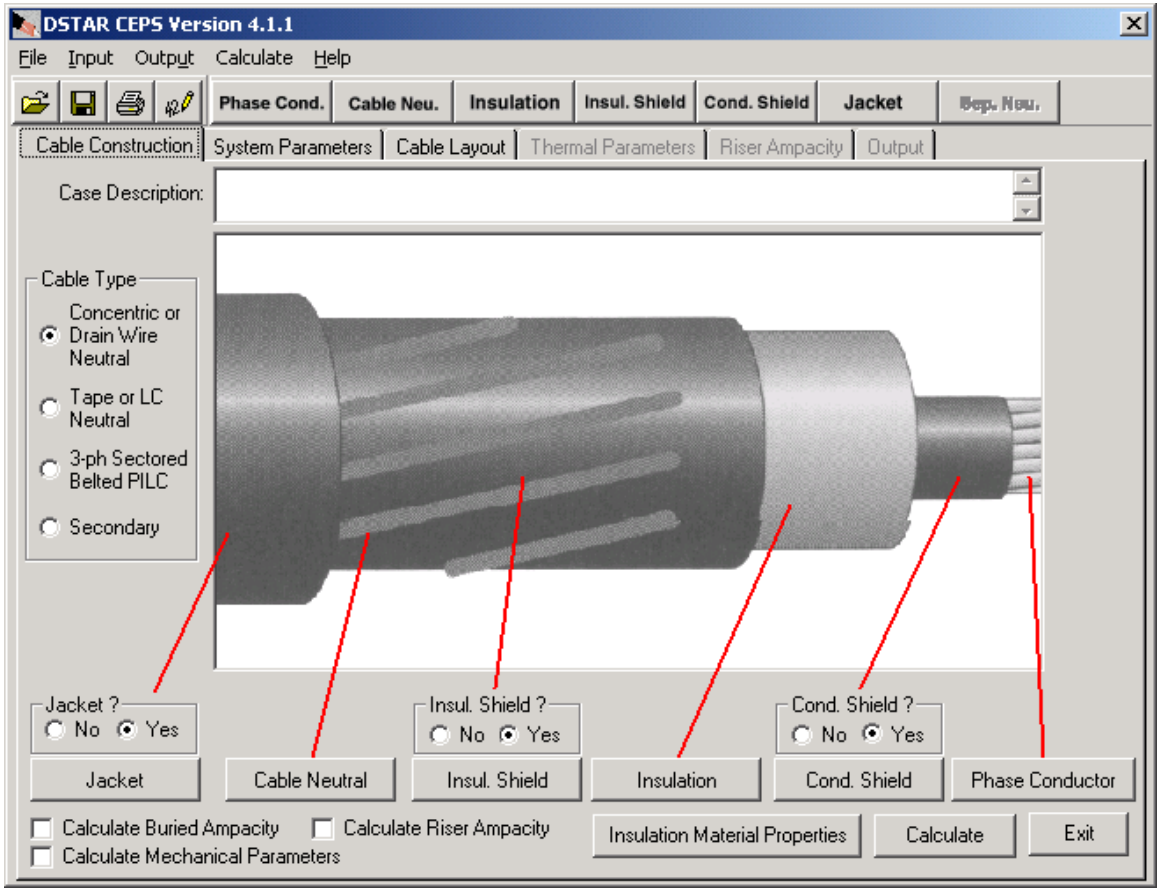
Standard, span guy, and sidewalk guy calulations

Easy-to-use graphic interface

Cable Electrical Parameters Software

Calculates:

- dimensions
- areas
- resistances
- sequence impedances
- capacitance
- conductor and dielectric losses
- voltage regulation
- short-circuit withstand
- Riser and normal ampacity



Thank You!

For more information, contact DSTAR

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