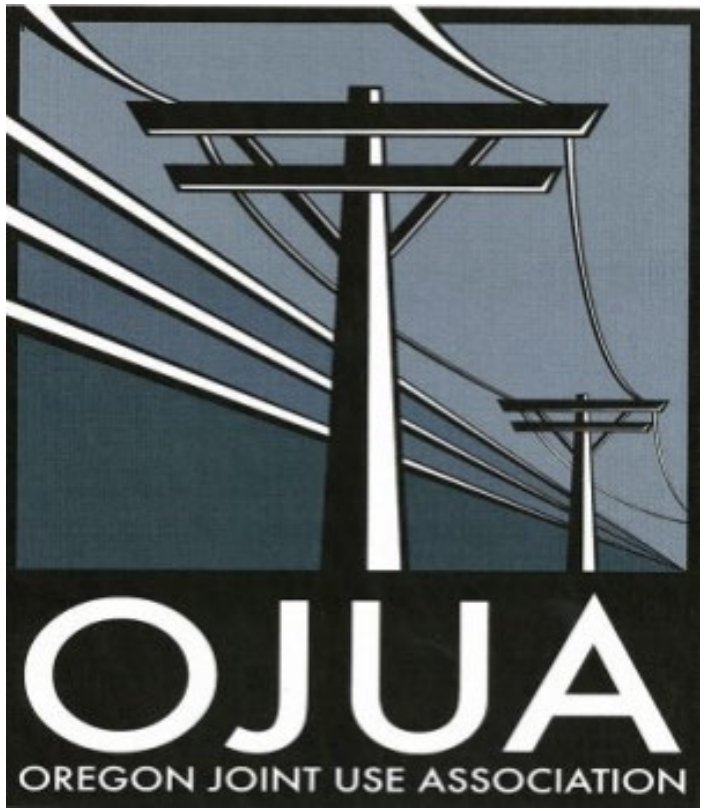
Proper Use and Application of Fiberglass and Cross Arms



Reasons to consider Fiberglass

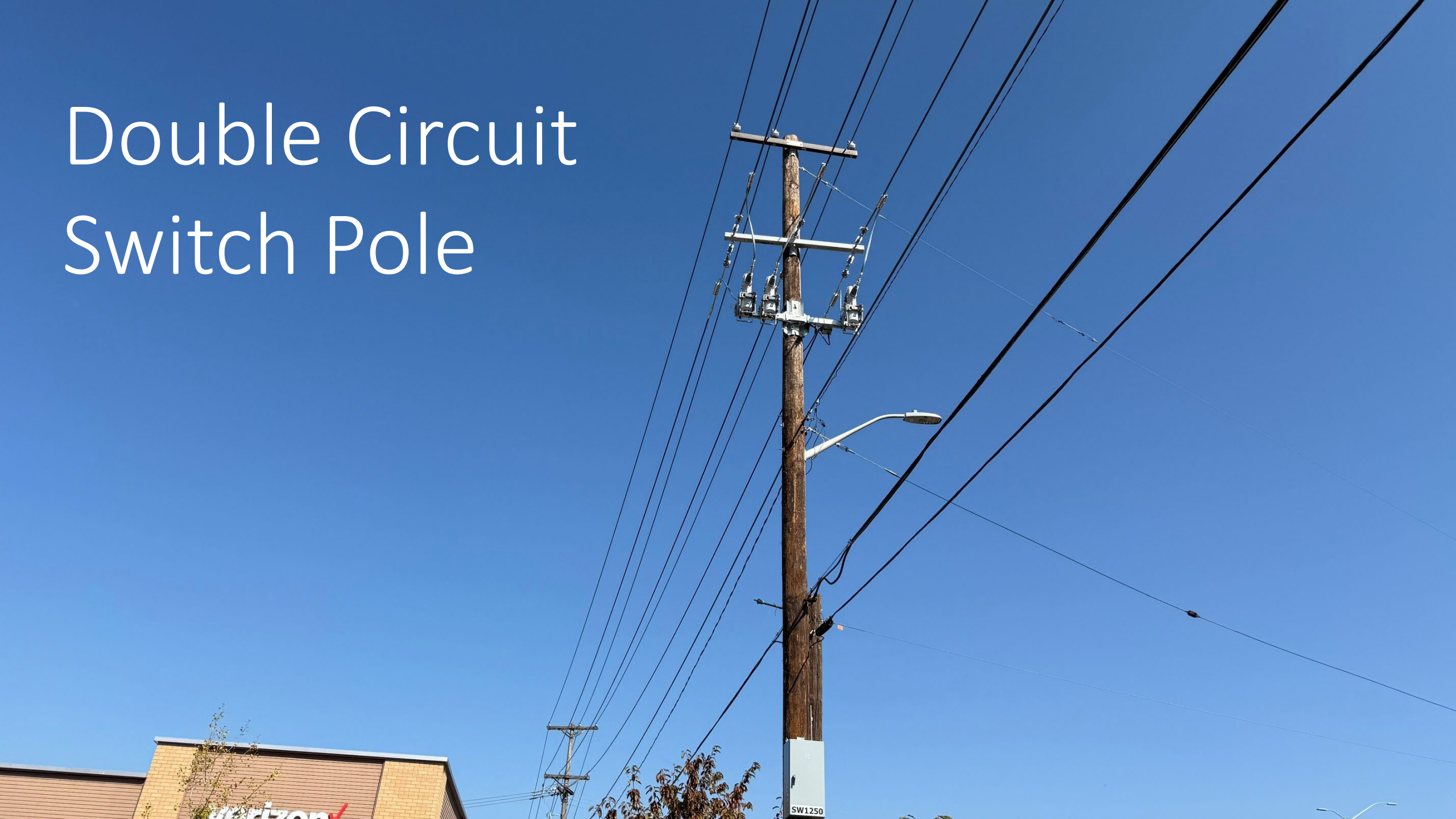
- Engineered Product
- Longevity
- Strength
- Lighter-weight
- Ease of installation
- Wildfire Hardening
- Nesting Deterrent
- Non-conductive

Power Pupi Arms

Are you jacked to know more?

Angle Framing

Double Circuit Switch Pole



Distribution Underbuild

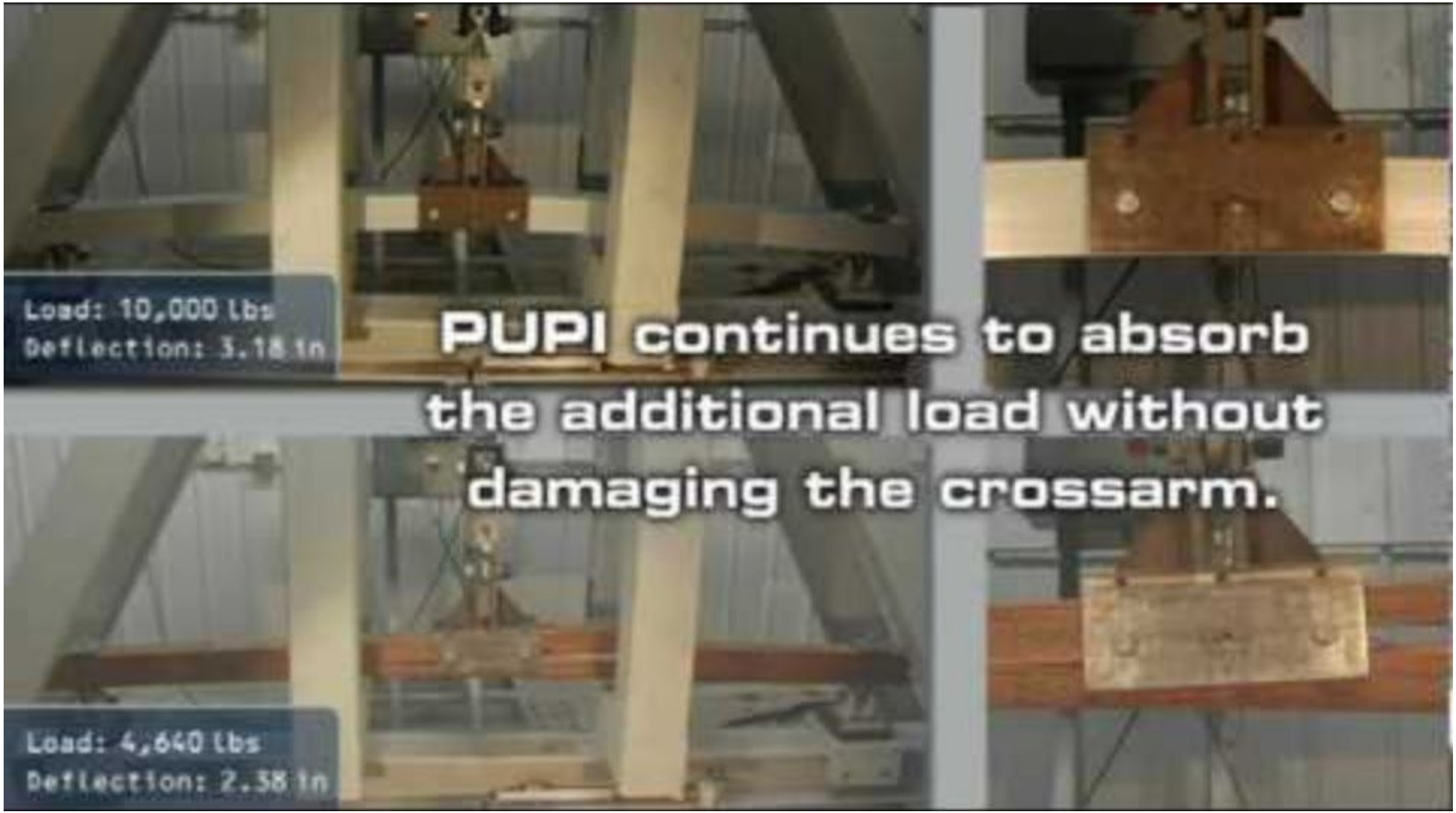
Wildlife Hazards

Wildlife Solutions

AMI Collector Antennas


Apprentice
Training Day


Is this okay?
Asking for a
friend


Load: 10,000 lbs
Deflection: 3.18 in
PUPI continues to absorb
the additional load without
damaging the crossarm.
Load: 4,640 lbs
Deflection: 2.38 in

Utility Arms

Wood cross arms(XARM)

Metal arms

Alley arms

PUPI arms

Fiberglass arms(FGA)

NESC Code to Consider

Table 238-1 Vertical Clearance between supply conductors and communications equipment, between communications and supply equipment, and between supply and communications equipment- note the rise in the FGA slides and metal braces

Table 238-2 Vertical Clearance of span wires and brackets from communications lines and equipment-40” to ungrounded luminaire and note 20” rule for **any** support arms as it relates to grounded luminaire clearances

Rule 236 Climbing Space

Consideration for pole owner arm requirements and standards should also be taken into account

Pole gain cross arm backing plate

Cross Arm Brace Measurement

Wood Cross Arm (XARM) metal Braces Down

Metal Arm
Some pole owners require metal arms

10’ long Alley arm Used to keep running line for Road widening project

PUPI Arm multiple comms can share space

PUPI Arm with bolts up and down was used for separation from other comms Splice case

Acceptable arm attachments?

Fiberglas Arm (FGA) Sometimes used to help midspan separations

Fiberglass arms (FGA) can assist with pole transfers in order to make attachments to new poles that may have been shifted

Fiberglass arm Banded and drilled Iron Pole

Fiber glass arm
base measurement


36” FGA arm has a 6” rise to the end of it. Maintain 40” from power from the end of arm.


30” FGA arm has a 4 ½ inch rise at the end of arm make sure to maintain 40” from end of arm.

Broken FGA

Look for Hazards

https://www.ojua.org/wp-content/uploads/2024/09/CURRENT-OJUA-Best-Practices-Guide_Updated-08212024.pdf

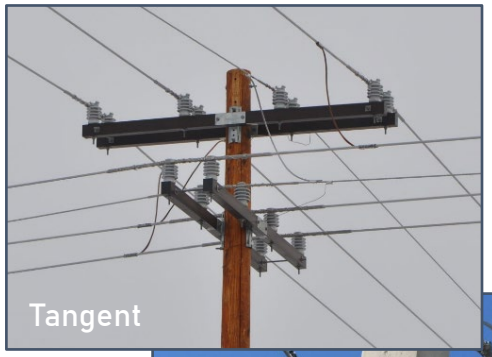
OJUA

Applications and Best Practice

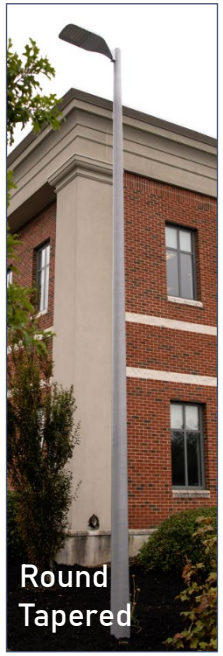
10/02/25

GEOTEK Product Lines

Crossarms: Overhead Electrical Infrastructure



Light Poles: Street and Area Lighting



Driving the use of composites technology in our respective markets.

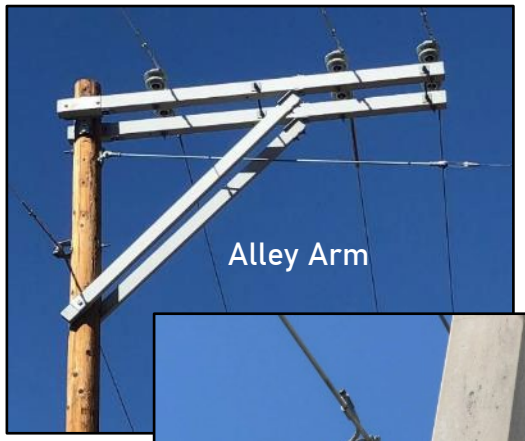
GEOTEK ISO Certified - 9001:2015

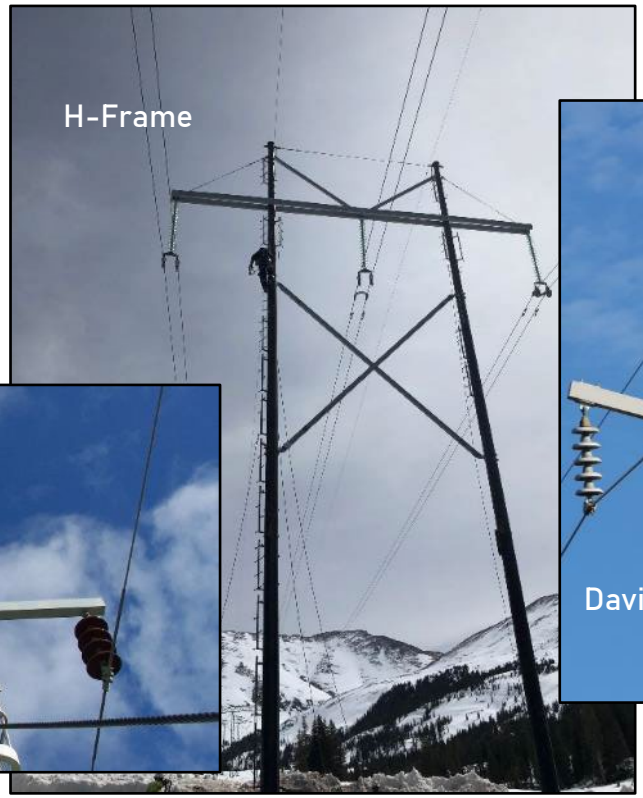
PUPI® Product Line (broadly)

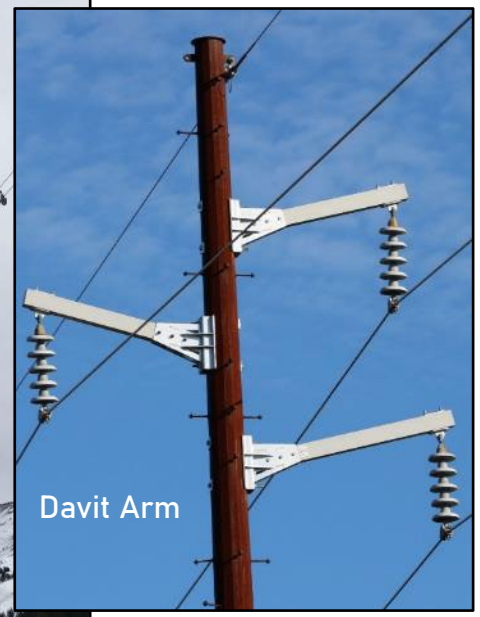
PUPI® is the market & technology leader in pultruded fiberglass crossarm solutions for overhead electrical infrastructure.

Distribution <33kV

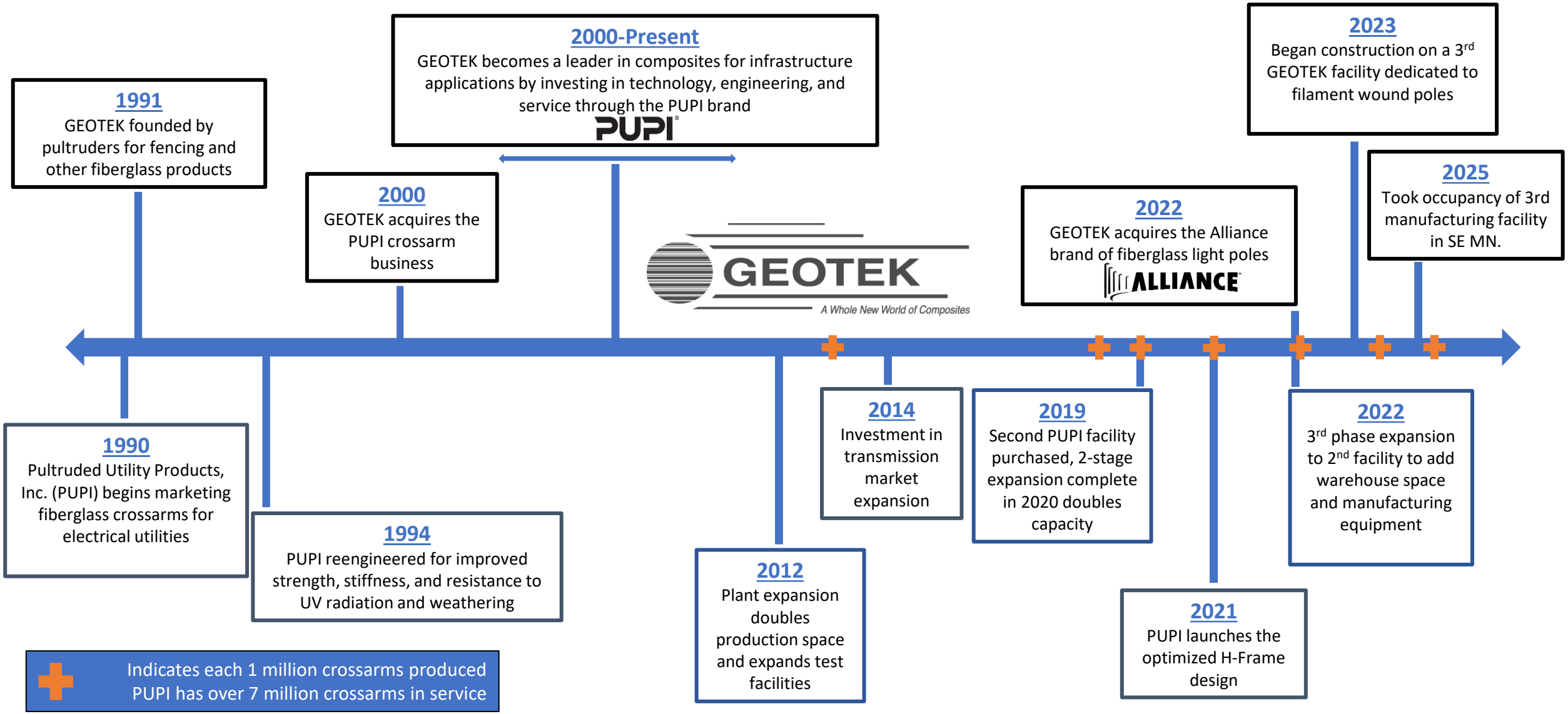
Transmission 69kV +



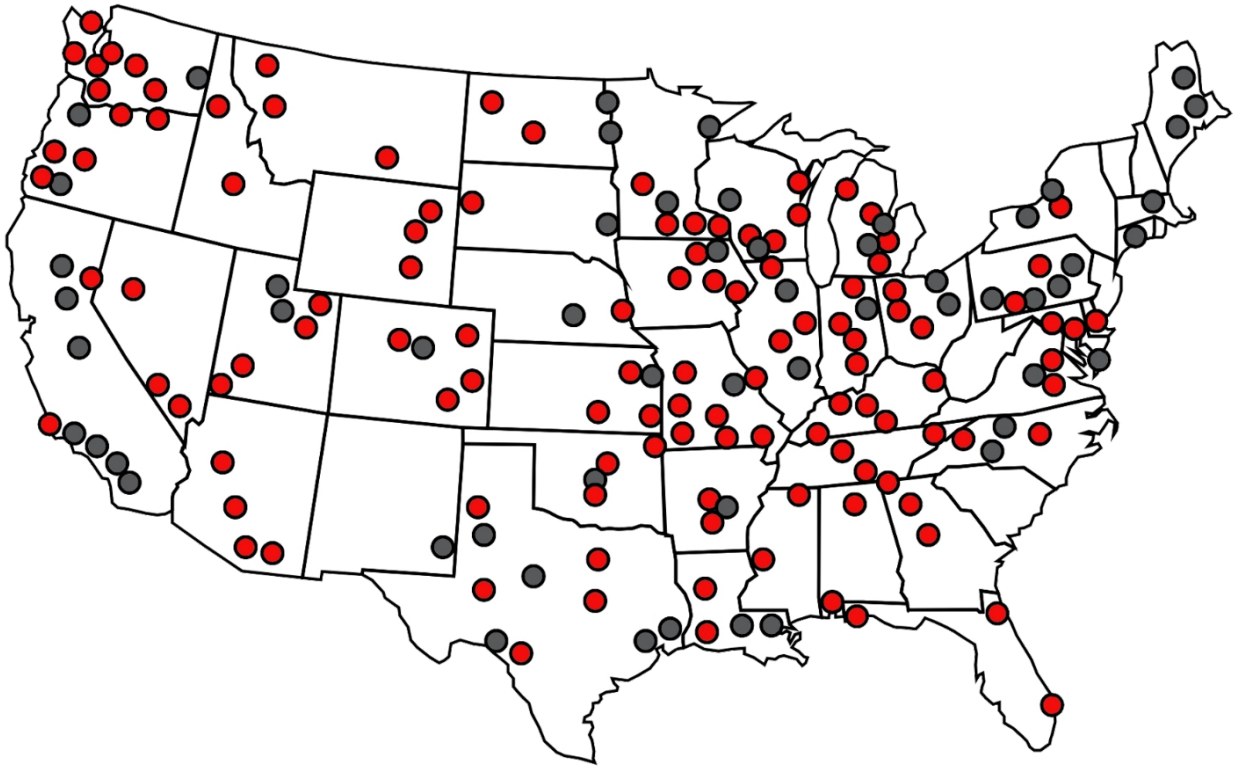




GEOTEK and PUPI® History



Utility Market Presence



PUPI® technology has driven the market adoption of FRP crossarms in The United States.

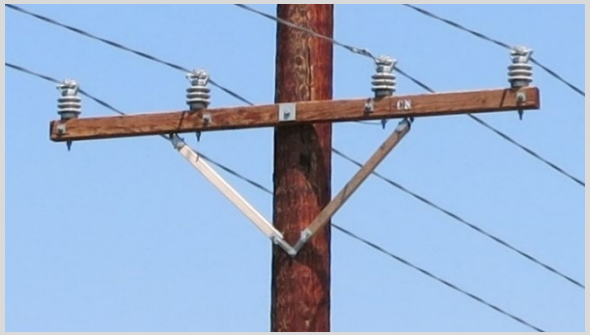
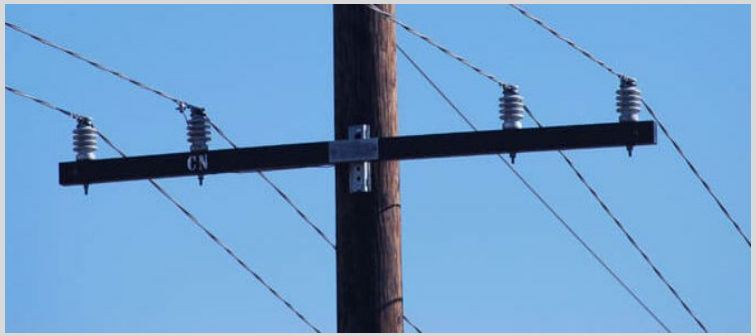
Domestic	International
• 70+ IOUs in the USA and Canada • 650+ Co-ops and RUS customers	• Southeast Asia • Caribbean • Central America • Australia

Over 7 million crossarms in service

Fiberglass vs. Wood in Application

Fiberglass **Application Advantages vs. Wood**

Fiberglass crossarms are engineered for consistent strength and reliability.
Wood crossarms show considerable natural variances and deteriorate over time.

	Wood Installation	Fiberglass Installation
Deadends		
Tangents		

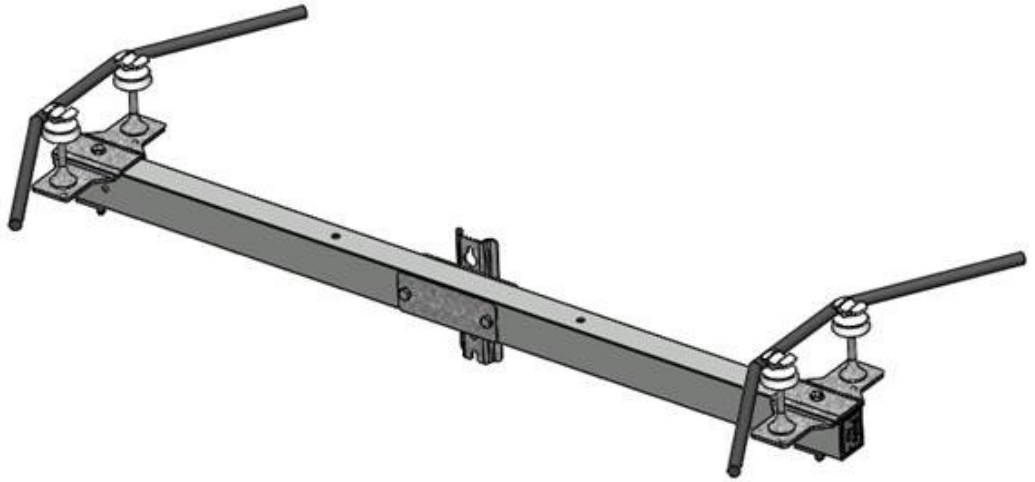
Fiberglass Advantages

- Consistent Performance
- Maintenance free
- Up to 6x stronger
- Storm resilience
- Flammability benefits
- Impervious to insects and woodpeckers
- Fast and easy installation
- Attractive total cost of ownership

Fiberglass **Application Advantages vs. Wood**

Streamline for Value

- Part consolidation and reduced total cost of ownership
- Reduced installation (framing) and maintenance cost
- Reduced faults from avian nesting
- Increased clearances at the pole top
- Seated design will not rotate on the crossarm
- Strength, reliability, and longevity of a FRP product

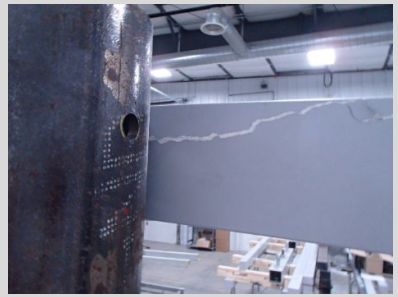


Examples of standard double arm constructions from RUS bulletin 1728F-804: C2.21, C2.5.1

Fiberglass **Crossarms Outperform Wood**

Test data has been obtained from 2 sets of 5 beams.

- REA Type-03 Wood Crossarms (Purchased new in 2016)
- Wood Equivalent Fiberglass Crossarm

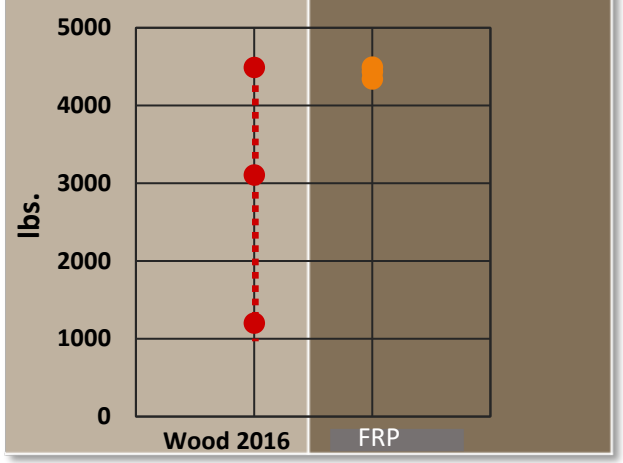
Test Specimen	Test Set-Up	Loaded Beams		
Wood Equivalent FRP				
Wood (New 2016)				

Crossarms were tested in accordance with ASTM D8019-15 with standard mounts used for each type of material.

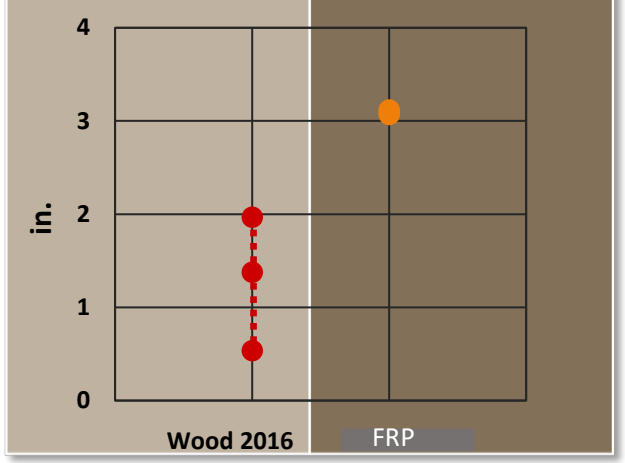
Performance Comparison

Results show fiberglass crossarms outperform wood crossarms on the basis of consistency in performance. Extreme variation in results was experienced with wood crossarms.

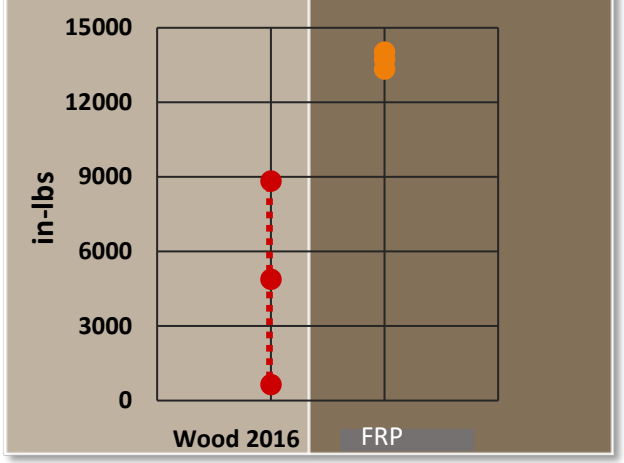
	Ultimate Load (lbs)	
	Wood (New 2016)	Wood equivalent FRP
Average:	3109	4436
StDev:	1264	62
COV:	41%	1%



	Ultimate Deflection (in)	
	Wood (New 2016)	Wood equivalent FRP
Average:	1.378	3.096
StDev:	0.595	0.023
COV:	43%	1%



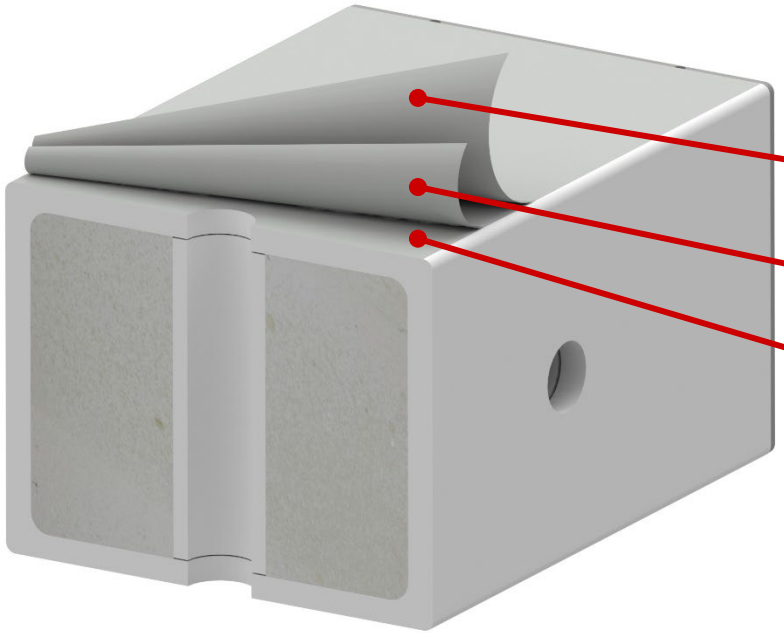
	Material Toughness (in-lbs)	
	Wood (New 2016)	Wood equivalent FRP
Average:	4877	13,736
StDev:	3323	281
COV:	68%	2%



Technology

Comprehensive UV protection

Properly coated beams with a UV resistant coating will resist UV damage for **60+** years.



Layer 1 –Thermally bonded SUNGUARD® UV coating

Layer 2 – Ultraviolet-resistant polyester veil

Layer 3 - Broad spectrum UV inhibiter

UV Protection Technology

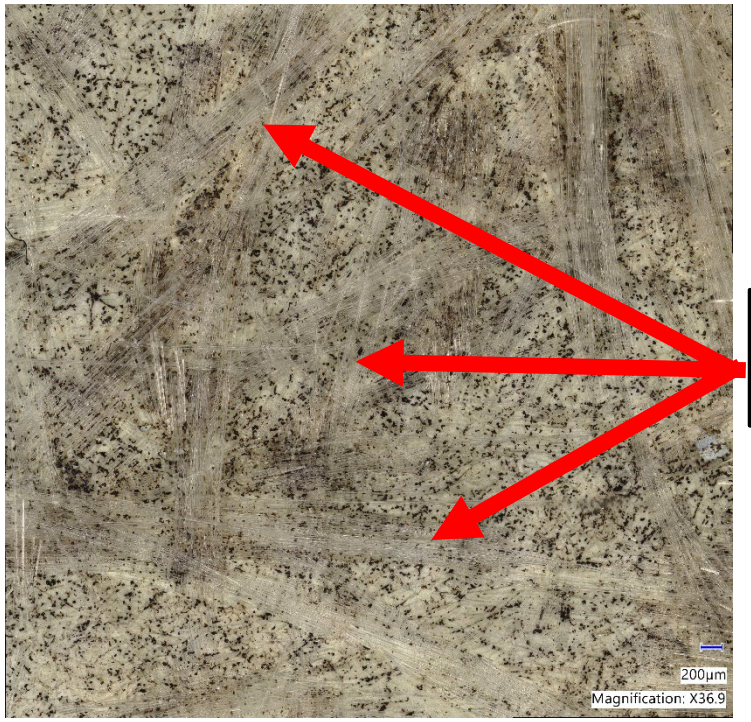
Surface Coated

Uncoated

Aged Crossarms – Surface Condition

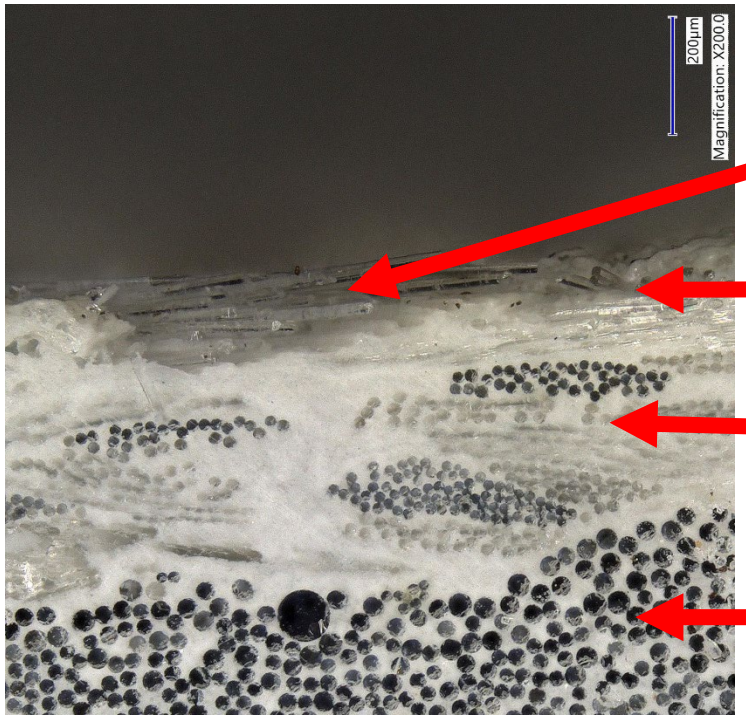
Uncoated FRP Crossarm

Top View



Fiber Blooming

Cross-Section



Fiber Blooming

Surface Veil

Reinforcing Mat

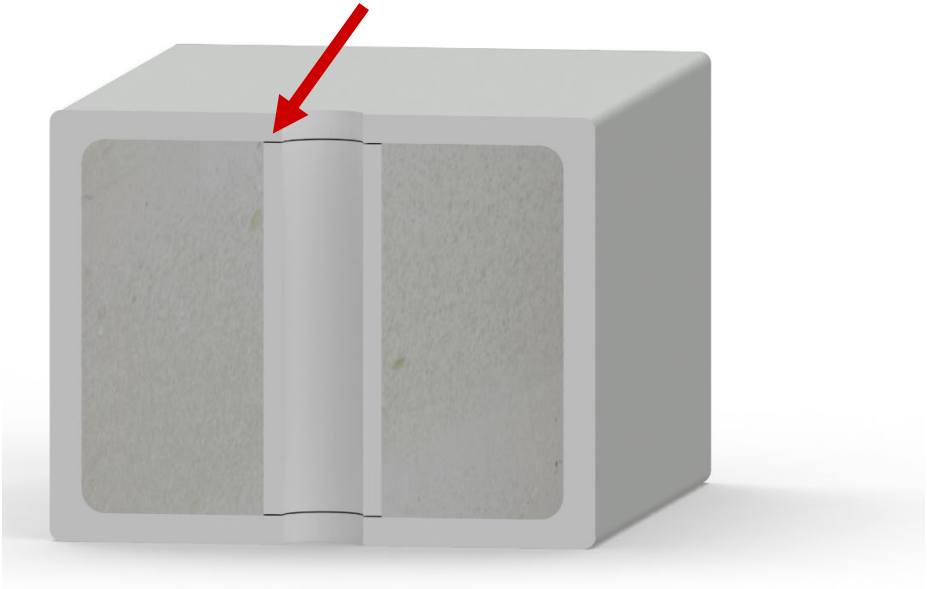
Bulk FRP

Fiber blooming on uncoated crossarms, and resultant contaminant trapping and potential pathway for arc tracking, is well documented.

Internal bushing and crush resistance

TorqueGUARD™ bushings prevent crush damage from overtightening.

Internal bushings engage the wall of the crossarm for increased crush resistance.

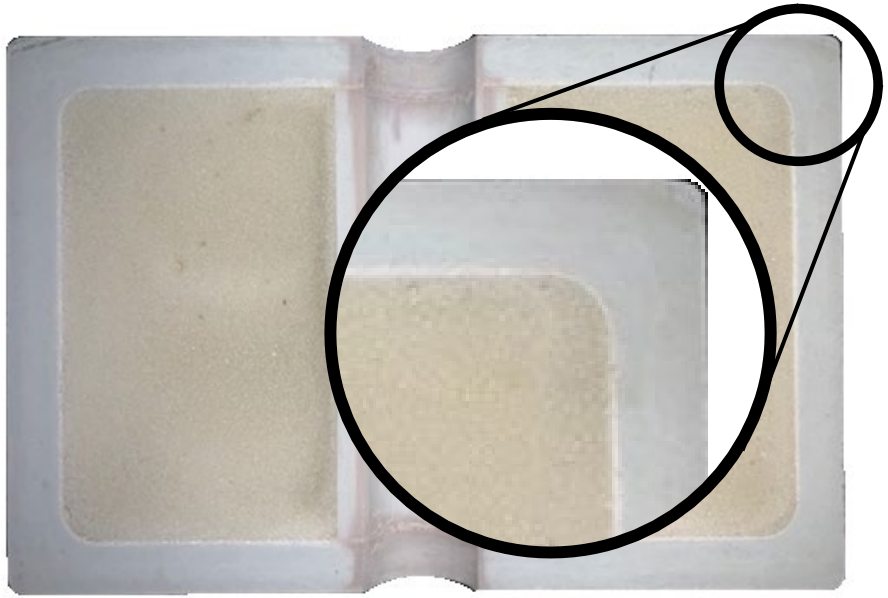


"Having a torque wrench in the bucket for a 2AM install when it's sleeting is not my first priority"

Lineman, Grundy County Rural Electric Cooperative

Can withstand over **450 ft-lbs** of bolt-tightening torque.

Quality in Construction = Reliability



Consistency in beam forming, manufacture, and fabrication can have a dramatic effect on strength, which can directly influence longevity and reliability

Manufacturer	Literature Value (lbs/wire)	Tested Average Ultimate Load (lbs/wire)	Tested Versus Literature (lbs/wire)	% Difference
10 ft PUPI® S4000 4x6 (4-Wire)	11,750	12,199	449	3.8%
Other 10 ft Heavy Duty 4x6 (2-Wire)	11,000	8,565	(-2,435)	(-22.1%)

Fire Performance and Damage Mitigation

PUPI Fire Performance and Damage Mitigation

PUPI® crossarms improve the safety and reliability of your grid - before, during, and directly after a fire event.

1. Don't Drop the Phase

- Extensive testing shows better strength and consistency than alternatives
- **Reduce likelihood of causing a fire**

2. Stop Fire Propagation

- Reduce arc tracking
- Reduce pole top fires
- **Reduce possibility of fire spread at the crossarm**

3. Retain Strength after a wildfire

- Performance is not diminished after exposure to very high temperatures
- **Maintain power in critical situations**

Reduce likelihood of causing a fire

1. Don't Drop th Phase
2. Stop Fire Propagation
3. Retain Strength after a wildfire

PUPI is stronger and more consistent than wood, and the failure mode is much less likely to drop an energized conductor.

Poor design, forming, and QC of fiberglass crossarms can lead to variations in ultimate strength. Possible results are field failures and decreased factor of safety and service life.

Performance vs. Wood

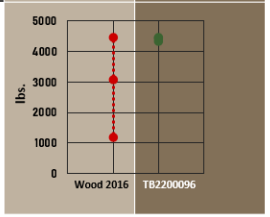
PUPI

Engineered Properties = Confidence in Performance

ASTM D8019-15 test Data was obtained for 2 sets of beams.

Test Specimen	Test Set-Up	Loaded Beams
PUPI 2200 (TB220009603X)		
REA Type-03 Wood (New 2016)		

Ultimate Load (lbs)	Wood (New 2016)	PUPI 2200 (TB2200096)
Average:	3109	4436
StDev:	1264	62
COV:	41%	1%

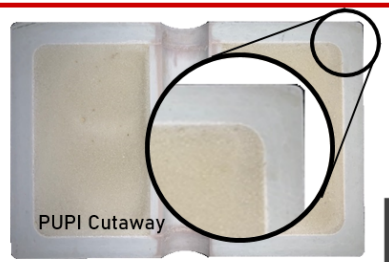


The consistency and subsequent reliability of designing with PUPI crossarms relative to wood was observed empirically.

Technology

Quality in Construction = Reliability

PUPI



Consistency in beam forming, manufacture, and fabrication can have a dramatic effect on strength, which can directly influence longevity and reliability

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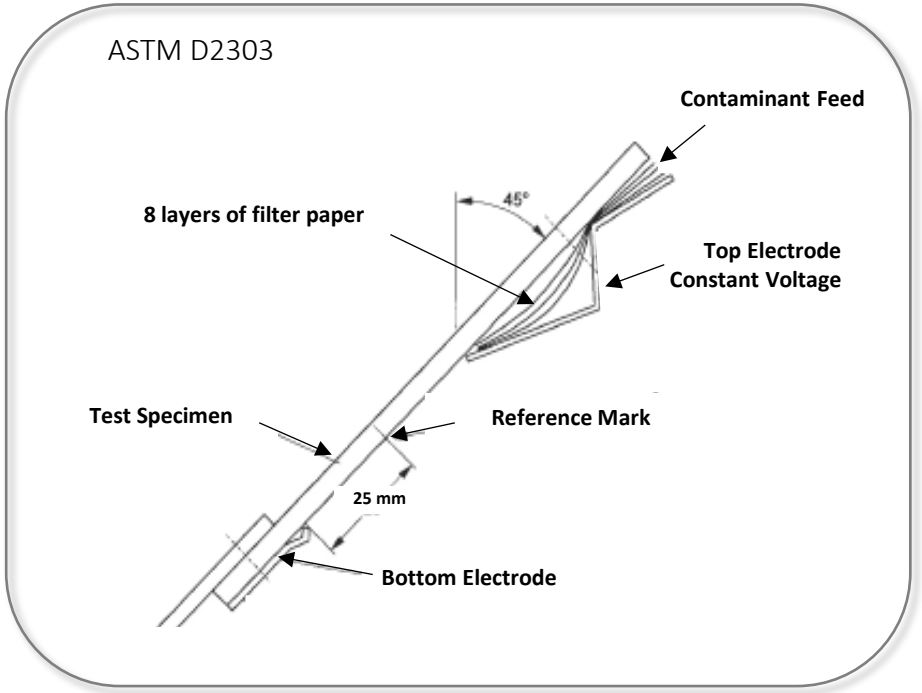
10 ft PUPI® S4000 4x6 (4-Wire)	11,750	12,199	449	3.8%
Other 10 ft Heavy Duty 4x6 (2-Wire)	11,000	8,565	(-2,435)	(-22.1%)

Reduce arc tracking and pole top fires

1. Don't Drop th Phase
2. Stop Fire Propagation
3. Retain Strength after a wildfire



Arc track testing under ASTM D2303 shows PUPI outperforms wood (ignited) and other fiberglass competitors (time to track).

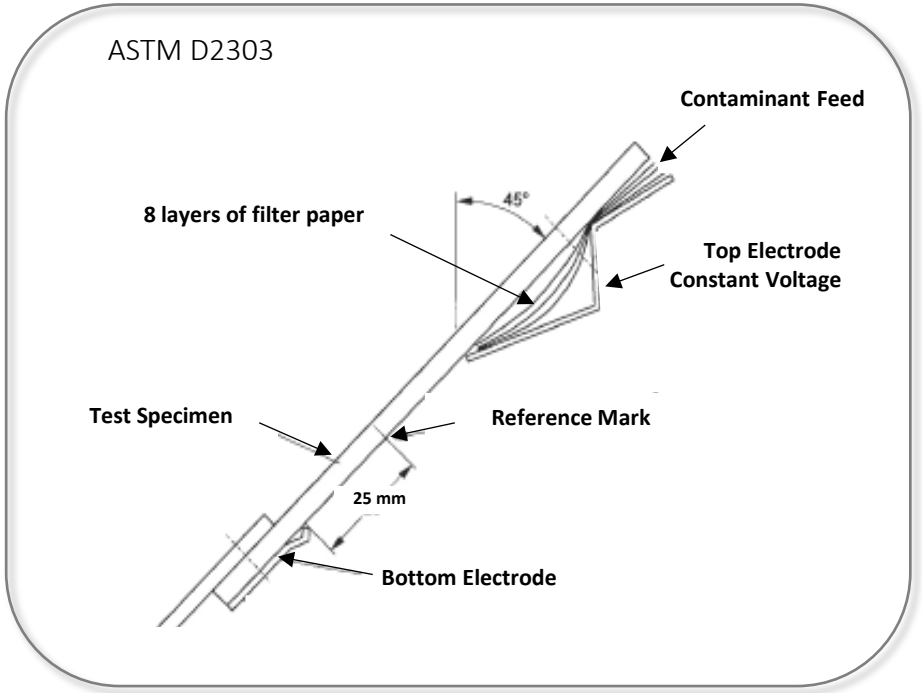
Wood

Tracked before test voltage reached

Testing performed at Powertech Labs

Reduce arc tracking and pole top fires

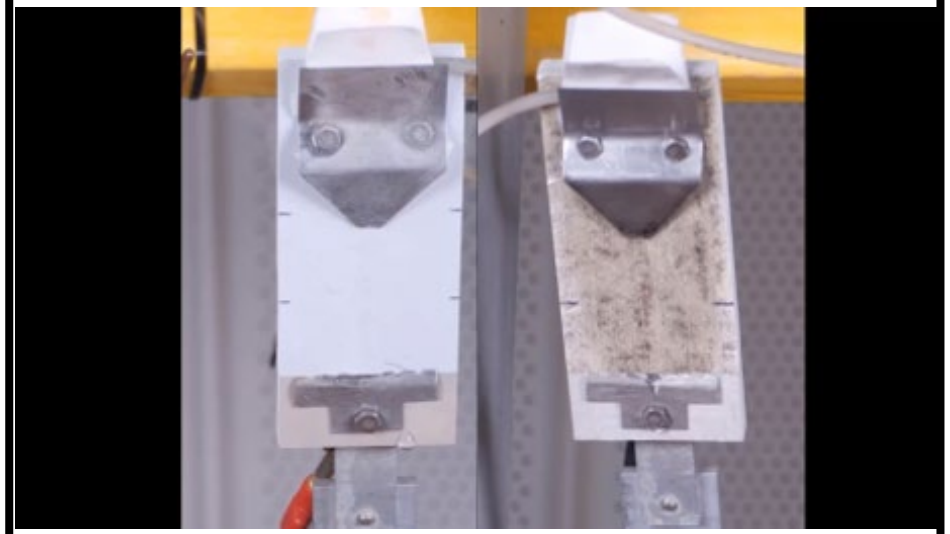
1. Don't Drop th Phase
2. Stop Fire Propagation
3. Retain Strength after a wildfire



Arc track testing under ASTM D2303 shows PUPI outperforms wood (ignited) and other fiberglass competitors (time to track).

AGED Crossarm Coupon Samples

Coated PUPI	Uncoated Sample

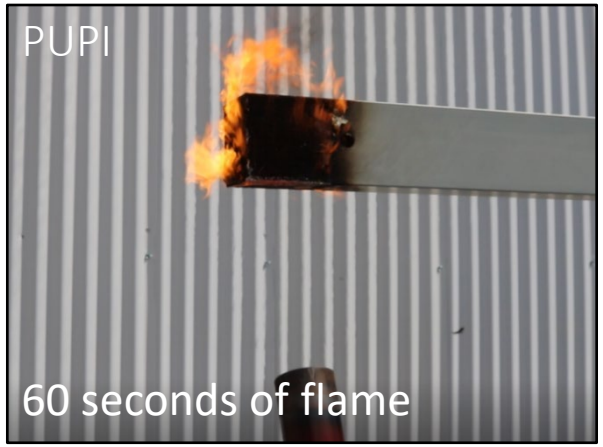


Time to Track: 3:50	Time to Track: 0:14

Testing performed at Powertech Labs

Fire resistant composition

1. Don't Drop th Phase
2. Stop Fire Propagation
3. Retain Strength after a wildfire



When subjected to <u>500,000 BTU</u> torch:

- **PUPI crossarm** self extinguishes after torch flame removal
- **Wood crossarm** continues to exhibit an open flame 2 minutes after torch flame removal

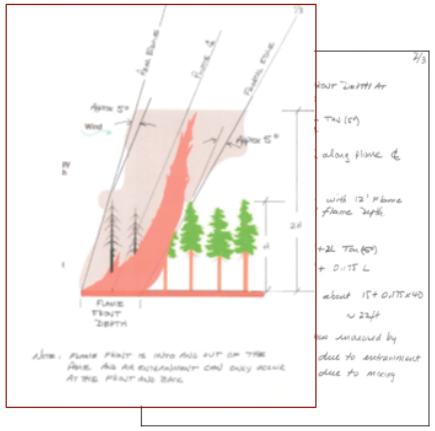
Maintain power in critical situations

1. Don't Drop th Phase
2. Stop Fire Propagation
3. Retain Strength after a wildfire

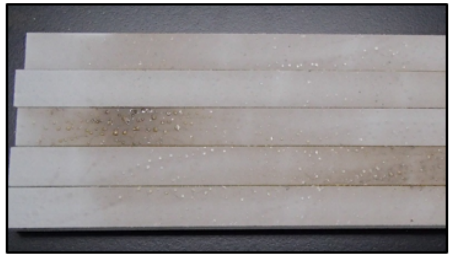
Wild Fire Resistance

CONFIDENTIAL

PUPI®



Dr. Mark Ackerman from the University of Alberta, a wildfire expert and consultant to SCE, estimated crossarms will experience air temperatures of 670°C (1238°F) for less than 1 minute.



Average Flexural Strength, psi				
Series	Control	Time @ 670°C, sec		
		15	30	60
2000	74,552	75,262	71,422	77,250
2500	103,893	99,639	94,954	104,683
4000	92,135	90,368	95,599	98,436

Testing conducted by PUPI based on Dr. Ackerman's analysis

Test of endcap material

PUPI Crossarms show resistance to the effects of heat/duration estimated to be found in wildfires

Testing has been completed on PUPI crossarms, in conjunction with a leading wildfire expert, which shows the product retains its strength after being exposed to conditions typical of a wildfire.

Distribution Applications

Fiberglass Crossarm Market Development Progression

Deadends

- Began with beam reduction (2:1)
- Obvious Strength Advantage
- Drove Technology Investment
- Install Advantages Observed

Tangents

- Use Accelerated last 3-5 Years
- Huge Service Life Advantage ($$)
- Installation Efficiencies offset FC
- Grid Hardening Benefits Exist

Transmission

- Engineering & Innovation Driven
- FRP Benefits Translate Very Well
- Applicable to Many Structures
- Extremely High Repurchase Rates

Reliability benefits and engineered material attributes are magnified.

Accelerating market: The accepted value of fiberglass composites in Distribution Applications directly correlate to significant advantages in Transmission Structures.

Distribution Products

Deadend Crossarms

PUPI

DEADEND

Longitudi
Asse
Longitudi
Asse
Longitudi
Asse

Tangent Crossarms

PUPI

Alley Arms

PUPI

Equipment Arms

PUPI

Pole top extensions

PUPI

Cost-effective Alternative to Pole Replacement.

- Lightweight, strong 5" x 5" fiberglass beams
- Adjustable, galvanized steel mounting bracket installs on pole diameters from 6" to 10"
- Outstanding UV protection with thermally-bonded SunGUARD® UV resistant coating
- Holes reinforced with TorqueGUARD™ bushings
- Sealed, UV resistant endcap
- Filled with closed cell rigid foam to exclude moisture and contaminants
- Brown or gray color available
- Can be field drilled

Switch Arms

PUPI CUSTOM DRILL PATTERN

PUPI®
www.pupicrossarms.com

REVISIONS			
REV.	DESCRIPTION	DATE	INITIALS

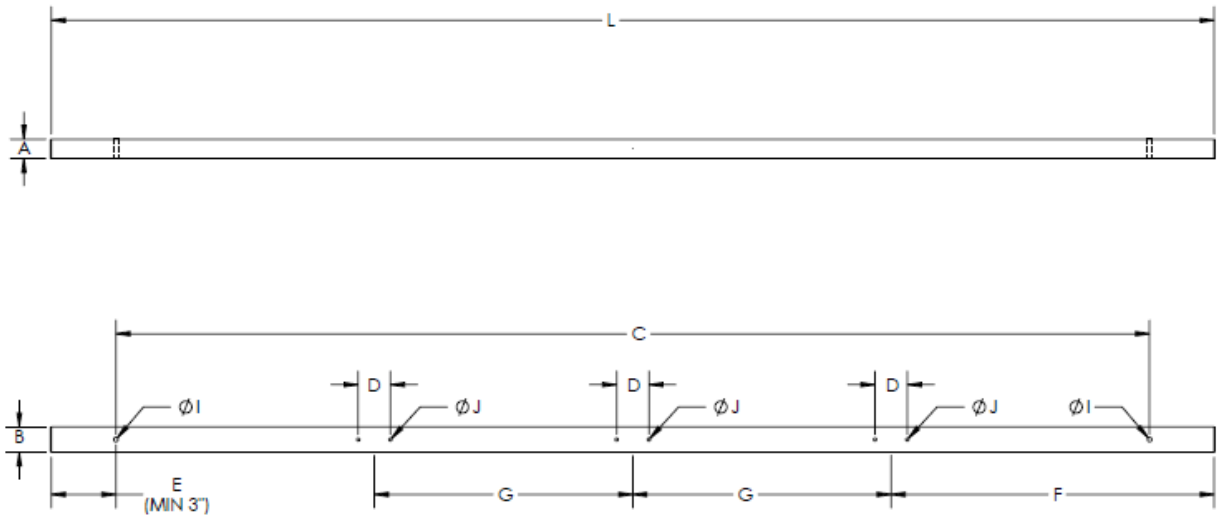
STANDARD PUPI CROSSARM DRILL PATTERNS ARE AVAILABLE AT PUPICROSSARMS.COM. FOR CUSTOM CROSSARM INQUIRIES, COMPLETE THE TEMPLATE BELOW IN AS MUCH DETAIL AS POSSIBLE. PLEASE PROVIDE CONTACT INFORMATION FOR PUPI ENGINEERING TO RESPOND WITH ANY APPLICATION QUESTIONS. FORWARD A COMPLETED COPY OF THIS CROSSARM TEMPLATE TO pupisales@geotek.com FOR A CROSSARM RECOMMENDATION.

PROFILE DIMENSIONS		
DIMENSION LABEL	S3000	S4000
"A"	3-5/8"	4"
"B"	4-5/8"	6"
Please Circle Desired Profile (S3000 or S4000)		

POLE MOUNTING DIMENSIONS	
DIMENSION LABEL	VALUE (in.)
OVERALL LENGTH "L"	
POLE SPACING "C"	
HOLE TO END OF ARM "E" (MIN 3")	
HOLE DIAMETER "I"	

SWITCH MOUNTING DIMENSIONS	
DIMENSION LABEL	VALUE (in.)
END OF ARM TO SWITCH "F" (ON CENTER)	
PHASE SPACING "G" (ON CENTER)	
SWITCH MOUNTING HOLE SPACING "D"	
HOLE DIAMETER "J"	

CROSSARM LOADING	
DIMENSION LABEL	VALUE (LBS)
SWITCH WEIGHT	



CUSTOMER CONTACT INFORMATION

COMPANY:

CONTACT NAME:

PHONE NUMBER:

EMAIL ADDRESS:

-----UNLESS OTHERWISE SPECIFIED-----
DIMENSIONS ARE IN INCHES
INTERPRET DIM AND TOL PER ASME Y14.5-2009
ANGULAR: MACH±2°
BEND±2°
TWO PLACE DECIMAL±0.02
THREE PLACE DECIMAL±0.005

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MATERIAL:		
FINISH:		
REPLACES:	-	

THIRD ANGLE PROJECTION

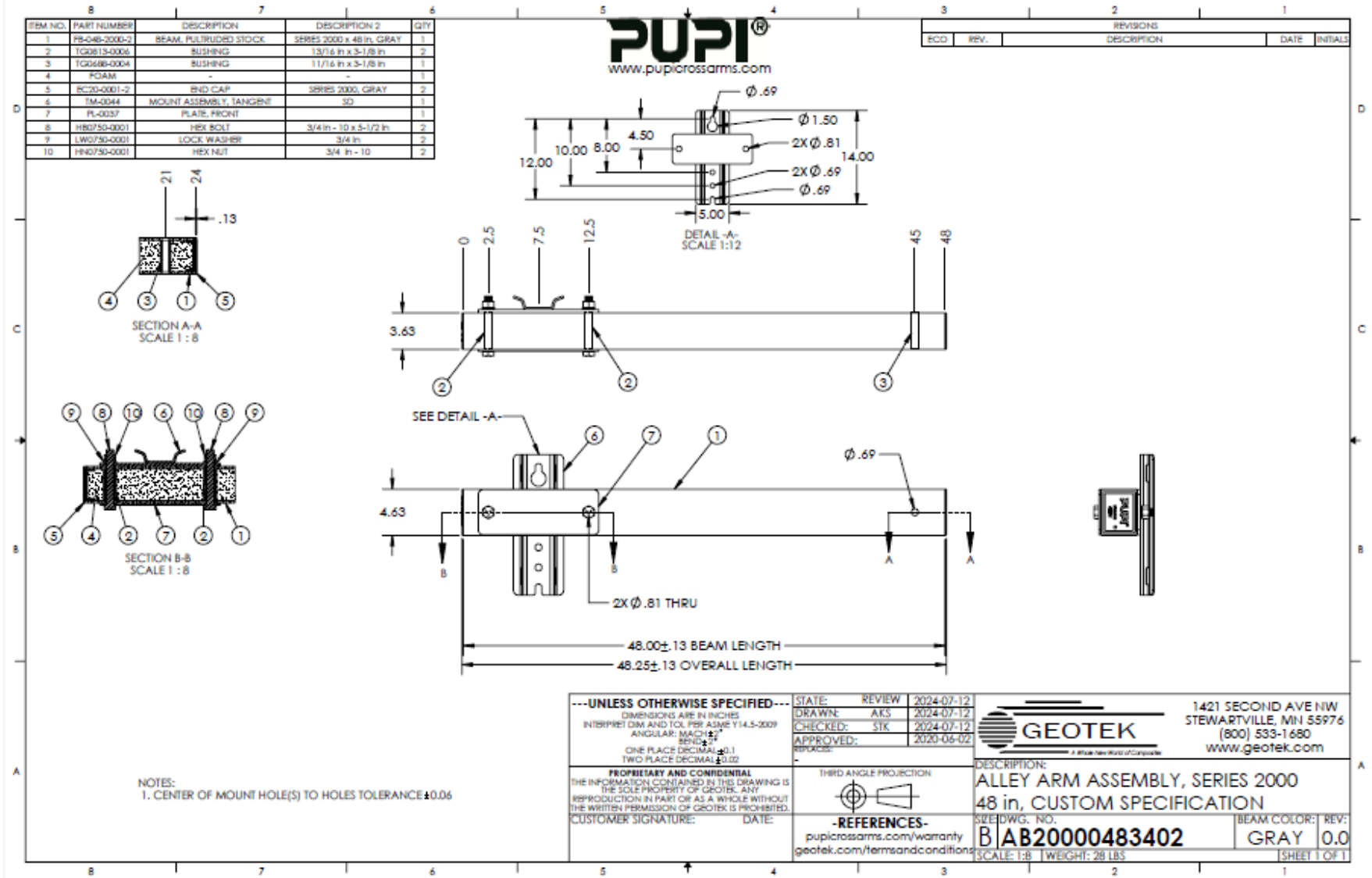
GEOTEK
A Whole New World of Composites

1421 SECOND AVE NW
STEWARTVILLE, MN 55976
(800) 533-1680
www.geotekinc.com

DESCRIPTION:
SWITCH MOUNT ASSEMBLY
CUSTOM CROSSARM TEMPLATE

SIZE:	DWG. NO.	REV:
B	CUSTOM SWITCH ARM TEMPLATE	-
SCALE: 1:16	WEIGHT:	SHEET 1 OF 1

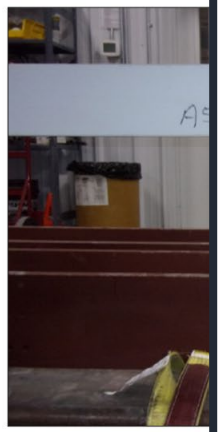
Apparatus specific arms



Pin Torque – Double Pin Application

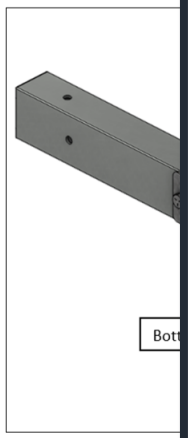
Application Spotlight – Transverse Pin Torque

Testing



Application Spotlight – Transverse Pin Torque

Configura



Product Application

Doubl

Single ar

RUS Qualification Pending

Product Application

Strea

- Part cons ownershi
- Reduced maintena
- Reduced
- Increased
- Seated de
- Strength, FRP prod

RUS Qualification Pending

Product Application

Maximum pin torque capacity with a single crossarm

Pin insulator bracket is available in Standard Duty (3/8") and Heavy Duty (1/2") plate designs to support your application needs.

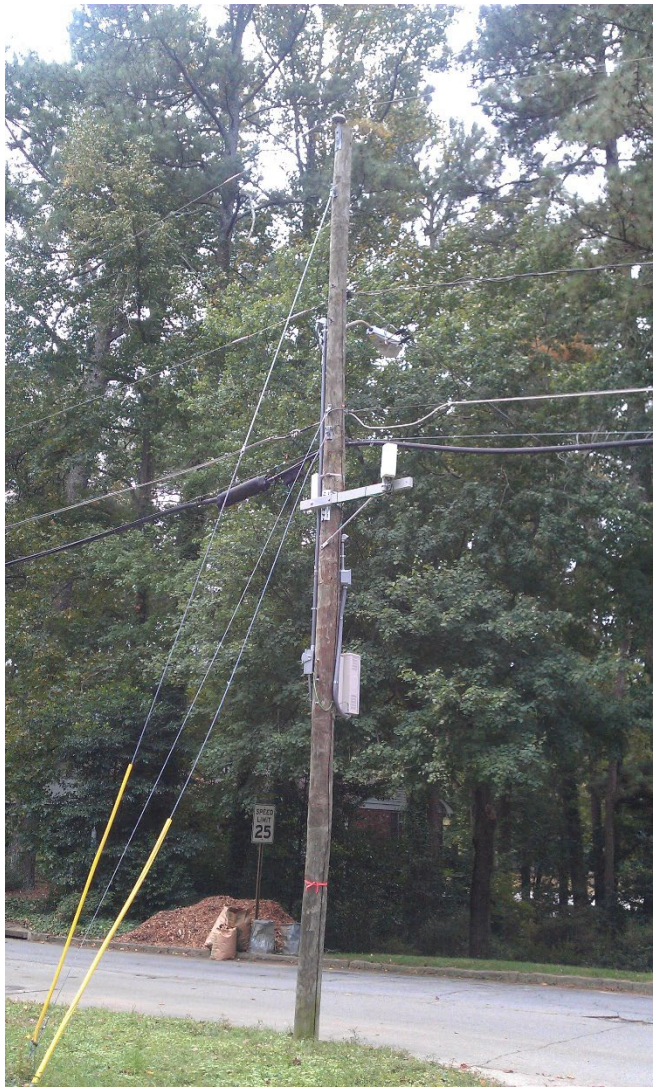
PUPI Crossarm Tangent Series	Configuration	Bracket Thickness (IN)	Max Moment Capacity* (IN-LBS)	Limiting Component
2200	Standard Duty	3/8	28,800	Pin Insulator
2000	Standard Duty	3/8	28,800	Pin Insulator
	Heavy Duty	1/2	34,320	Crossarm
2500	Standard Duty	3/8	28,800	Pin Insulator
	Heavy Duty	1/2	34,320	Crossarm
3000	Heavy Duty	1/2	52,116	Crossarm

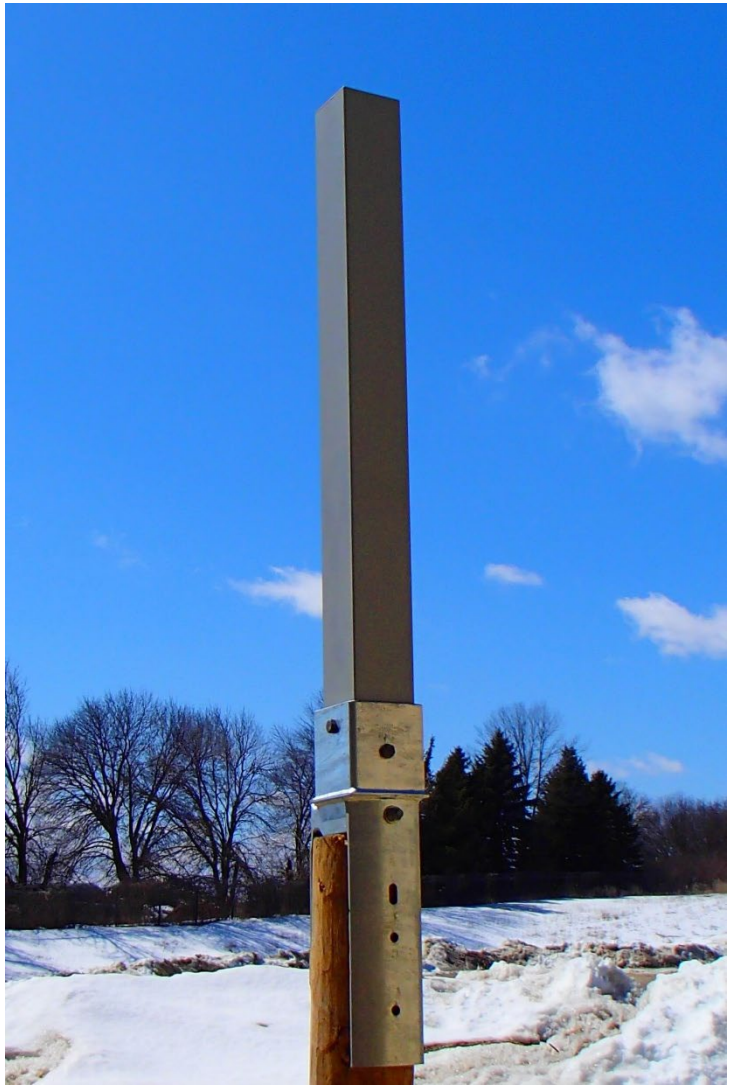
* Testing was done on full assemblies comprised of a PUPI crossarm and two pin insulators per plate.

RUS Qualification Pending: C2 Structure

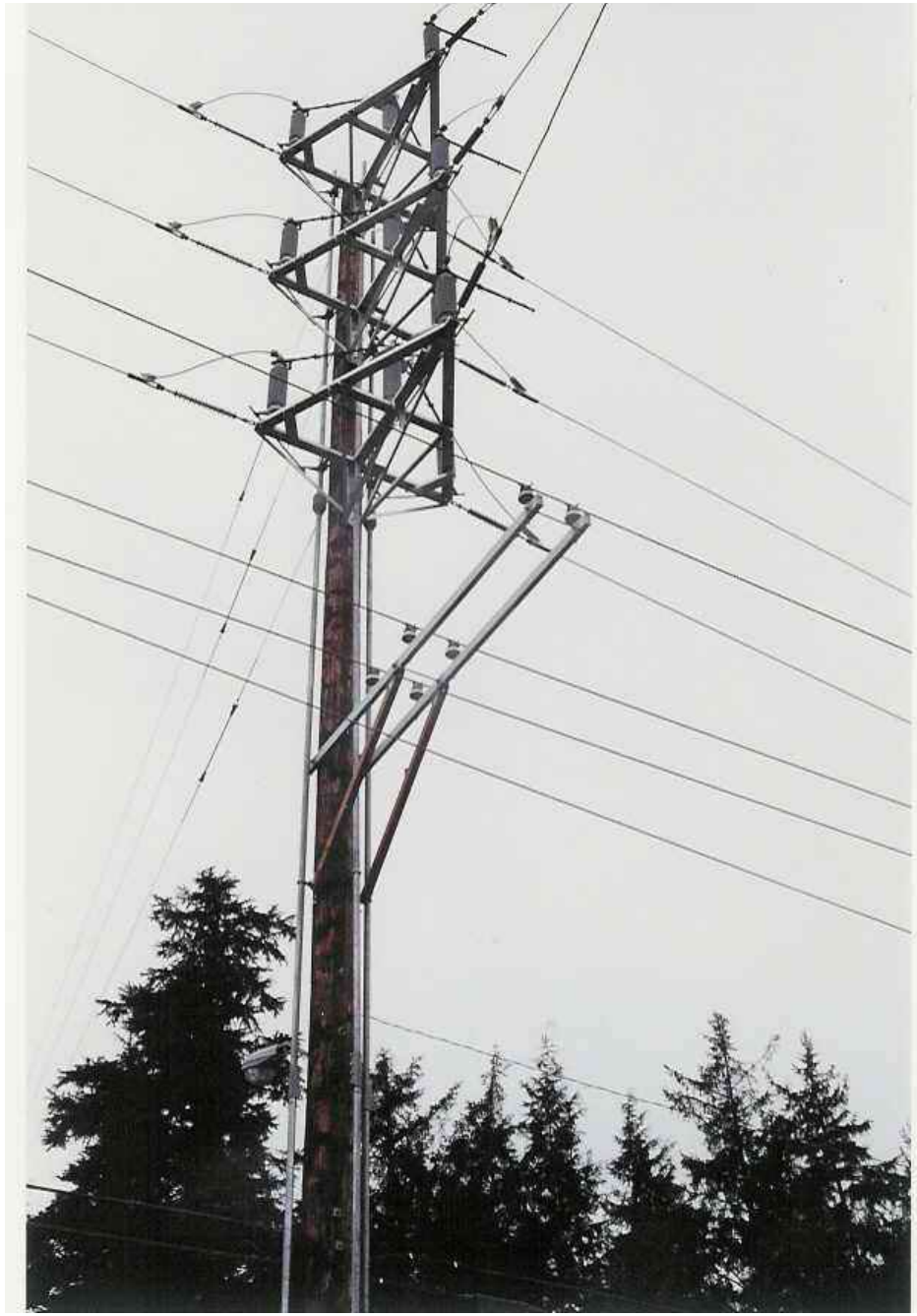
Applications

Applications





Applications



Questions

DISCLAIMER

1. GEOTEK performed mechanical strength testing in connection with the tests underlying this publication, but the strength tests were inconclusive and are not referenced herein.

2. Other environmental factors aside from UV radiation that may affect crossarm degradation and coating reliability, such as pollution, freeze-thaw cycling, wind-blown particulates, salt fog, and/or bird feces, were not considered as part of the testing underlying this publication. As Q-Lab document LL-9031 states, while the accelerated UV testing will result in the "same amount of UV deposited over five years of Florida (subtropical) testing" ... "[t]his is not meant to imply that the degradation that occurs over one year of Q-TRAC natural sunlight concentrator testing will necessarily be the same as five years of Florida testing." Q-Lab document LL-9031 further states: "As with all accelerated testing, the amount of acceleration depends on many variables such as material composition, mode of degradation, temperature response and moisture.“

3. ASTM G90 states that the "relative durability of materials in natural or field exposure can be very different depending on the location of the exposure because of differences in UV radiation, time of wetness, temperature, pollutants, and other factors. Therefore, even if results from a specific accelerated test condition are found to be useful for comparing the relative durability of materials exposed in a particular exterior location, it cannot be assumed that they will be useful for determining relative durability for a different location." The accelerated testing underlying this publication was performed in Arizona.

4. Q-Lab document LU-8030 states that "Joules do not reflect variations in degradation caused by differences in exposure to moisture, temperature, or wavelength spectrum of the light source. Characterization and control of these other parameters is often more important than Joules of radiant dosage." While the accelerated testing described herein was not timed in Joules, one may note that Q-Lab document LU-8030 states: "Exposures of equal Joules do not necessarily produce equivalent degradation.“