
FHWA-TS-90-034

**BREAKAWAY TIMBER UTILITY POLE
INSTALLATIONS IN KENTUCKY**

OCTOBER 1989



**U.S. Department of Transportation
Federal Highway Administration**

Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, Virginia 22101-2296

**Research Report
KTC-89-53**

**BREAKAWAY TIMBER UTILITY POLE
INSTALLATIONS IN KENTUCKY**

by

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in cooperation with

**Kentucky Transportation Cabinet
Commonwealth of Kentucky**

**Federal Highway Administration
US Department of Transportation**

and

Kentucky Utilities Company

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October 1989

1. Report No. FHWA-TS-90-034		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Breakaway Timber Utility Pole Installations in Kentucky				5. Report Date October 1989	
				6. Performing Organization Code	
7. Author(s) Ronald D. Hughes				8. Performing Organization Report No.6 KTC-89-53	
9. Performing Organization Name and Address Kentucky Transportation Center College of Engineering University of Kentucky Lexington, Ky 40506-0043				10. Work Unit No. (TRAIS) 3A9e0083	
				11. Contract or Grant No. DTFH61-86-C-0032	
				13. Type of Report and Period Covered Interim	
12. Sponsoring Agency Name and Address Kentucky Transportation Cabinet State Office Building Frankfort, KY 40622				14. Sponsoring Agency Code	
15. Supplementary Notes Prepared in cooperation with the U.S. Department of Transportation, Federal Highway Administration					
16. Abstract This report describes the installation of ten breakaway timber utility poles in Lexington, Kentucky. Installations were made by Kentucky Utilities Company personnel and monitoring has been performed by Kentucky Transportation Center investigators. Retrofit hardware is described and locations of modified poles are detailed. Modified poles have not been struck by vehicles to date. Monitoring will continue until September 1991 at which time a final report will be issued.					
17. Key Words Breakaway Utility Pole Safety			18. Distribution Statement Unlimited with the approval of the Kentucky Transportation Cabinet		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 20	22. Price

CONTENTS

List of Figures	iv
Executive Summary	1
Introduction	2
Breakaway Design and Hardware	3
Kentucky Installations	6
Summary	17

List of Figures

Figure 1	- Slip Base Connections.....	4
Figure 2	- Pole Band Assembly.....	5
Figure 3	- Steel Strap Detail.....	5
Figure 4	- Breakaway Sequence.....	6
Figure 5	- Traffic Control.....	8
Figure 6	- Insulate Lines.....	8
Figure 7	- Install Support Cables.....	9
Figure 8	- Affix Collar.....	9
Figure 9	- Remove Soil, Base Cut, Groove, Use Preservative on Both Cut Surfaces Figure.....	10
Figure 10	- Install Lower Tube with Base.....	10
Figure 11	- Place Filler.....	11
Figure 12	- Install Upper Tube with Base.....	11
Figure 13	- Add Slip Plate, Bolts, Washers, Nuts, and Torque to 200 Ft-Lb.....	12
Figure 14	- Place Filler.....	12
Figure 15	- Drill through Pole.....	13
Figure 16	- Cut Top.....	13
Figure 17	- Apply Preservative and Pole Bands.....	14
Figure 18	- Install Straps and Torque Bolts to 100 Ft-Lb.....	14

Executive Summary

This report describes the installation of ten breakaway timber utility poles in Lexington, Kentucky. Installations were made by Kentucky Utilities Company personnel and monitoring has been performed by Kentucky Transportation Center investigators. Retrofit hardware is described and locations of modified poles are detailed.

Modified poles have not been struck by vehicles to date. Monitoring will continue until September 1991 at which time a final report will be issued.

Introduction

There are approximately 3.9 million miles of public roads and streets within the United States. It has been estimated there are as many as 88 million utility poles located within the rights-of-way of those roads and streets. Vehicles colliding with fixed objects adjacent to the roadways account for 4.3 percent of all accidents and 9.3 percent of all accidents involving a fatality. Vehicles colliding with fixed objects adjacent to roadways are 2.2 times more likely to lead to a fatality than other first harmful events. Approximately 1,500 persons are fatally injured each year as a result of vehicles impacting utility poles. Vehicle-utility pole accidents account for approximately 65,000 other types of injuries yearly. Approximately 85 percent of pole accidents occur within urban areas. Utility poles are second only to trees as the most frequently struck obstacles in fatal accidents.

Countermeasures to minimize vehicle-utility pole collision problems include: a.) place utility lines underground, b.) place poles further from the roadway, c.) reduce pole density, d.) shield poles, and e.) use breakaway poles. All of the options would be relatively expensive for use in correcting existing hazardous situations. The options should be considered for new or relocated installations.

Breakaway installations were first considered for use in the late 1950's by personnel in the Ministry of Transport in England. A slip base concept was conceived by D. L. Hawkins, Texas Department of Highways, and tests on sign supports were conducted in 1963. Breakaway designs were developed and employed for most man-made obstacles, except utility poles, encountered in the roadside environment. Those developments took place during the 1960's and 70's.

Breakaway timber utility poles were first considered for use in the late 1960's. Much of the work on application of the breakaway technology, as applicable to timber utility poles, was conducted by Southwest Research Institute personnel between 1974 and 1982. Conceptual designs evolved during a study sponsored by the Federal Highway Administration (FHWA). Additional work was performed by investigators at the Texas Transportation Institute (TTI), by contract with FHWA. The primary objective of that work was to produce an effective breakaway shear connection at ground level and to overcome problems of pole detachment, conductor failure, and entanglement.

TTI investigators made efforts to meet the requirements of NCHRP Report 230 and overcome factors that had caused reservations on the part of FHWA and industry officials toward selective implementation. Those efforts proved fruitful and successful tests were performed.

FHWA officials forwarded a prospectus to personnel in each state in October 1983 and requested responses relative to expressions of interest in participating in field trial installations. Kentucky Transportation Cabinet (KyTC) officials notified FHWA personnel of a willingness to install and evaluate several breakaway utility poles. FHWA personnel granted permission for KyTC to participate in the field trials to be evaluated by Kentucky Transportation Center (KTC) investigators.

KyTC officials were notified of further developments in the breakaway design and testing program. Field installations in Kentucky were delayed to allow for crash tests on modified designs. A contract for Federal Task Order DTFH61-86-C-00032 was executed by FHWA and KyTC officials in August 1986. That task order provided \$75,000 for installations and evaluation of the breakaway utility poles. An agreement for KTC investigators to perform the evaluation was finalized in September 1986. Negotiations for installations by Kentucky Utilities Company (KU) (Lexington, Kentucky) crews were formalized in

December 1986. The agreements provided for funding limits of \$32,500 for KTC evaluation and reporting and \$42,500 Kentucky Utilities Company retrofit hardware purchases and installations.

KU officials placed an order for sufficient hardware to retrofit ten poles in August 1987 and hardware was received in December. Retrofits were made beginning in January 1988. Ten poles had been retrofitted by October 23, 1989. This report documents those installations and performances to date.

Breakaway Design and Hardware

The breakaway concept reported herein was developed for and tested on 40-ft, class 4 timber utility poles. The modifications for new or in-place poles consist of a slip base lower connection, hinged upper connection, and two overhead guys or upper support cables. The slip base is designed to withstand moments imposed by wind loads.

The lower shear plane is created by sawing through the pole perpendicular to the long axis at an elevation that is or will be 3 in. above the ground line. The shear plane consists of two 5/8-in. or two 3/4-in. thick base plates separated by a 0.0179-in. keeper plate and serves to maintain a fixed diameter circle for six 1 1/8-in. diameter bolts which are used to connect the 5/8-in. or 3/4-in. plates.

Each base plate is welded to 30-in. long steel pipe or mechanical tubing and is braced by six stiffeners welded to the base plate and pipe or tubing. A 1/4-in. thick washer is used under each bolt head and under each nut. Bolts are 3 1/2-in. in length and are torqued to 200 ft-lb. Pipe or tubing diameter and wall thickness for use is governed by the pole diameter near the ground line. Lower connection details are shown in Figure 1.

A moment-sensitive upper connection is created by sawing through the pole perpendicular to the long axis at an elevation that is or will be approximately 20 ft above the ground line. The connection consists of two four-part pole bands for installation above and below the cut and four steel straps. The pole bands and steel straps are depicted in Figures 2 and 3, respectively.

One pole-band assembly is placed above the upper cut and one assembly is placed below the upper cut. The assemblies are to be positioned equal distances above and below the cut so that the center to center distance between assemblies is 16 in. A minimum torque of 100 ft-lb is to be applied to each bolt. A hole is drilled through the pole 8 in. above the cut to accommodate a 1-in. diameter, all-thread bolt to affix the upper pole-band assembly and two opposite straps to the pole. The upper pole-band assembly and other two opposite straps are then affixed to the pole by use of a second 1-in. diameter, all-thread bolt placed 90 degrees and below the first bolt. The pole-band assembly and portions of straps below the cut are affixed to the pole in the same manner used for the upper assembly.

Steel support cables are placed immediately above the upper connection and near the cross arm. The cables are attached to adjacent poles on each side of the breakaway pole. The lower cable serves as a pivot point for the lower pole segment when the pole is impacted by a vehicle. The upper cable is intended to stabilize the upper pole segment and to minimize damage to the power lines.

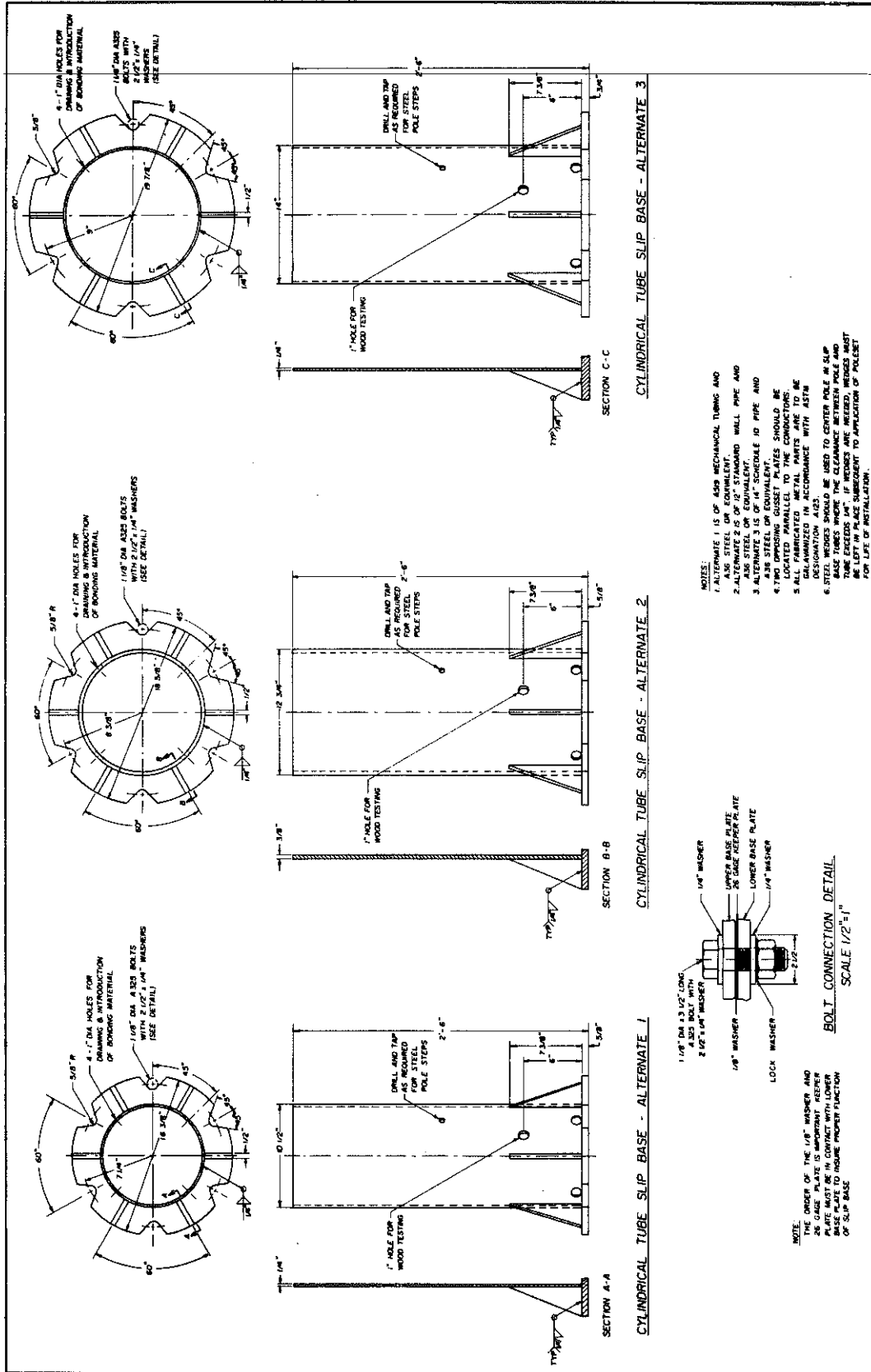


Figure 1 - Slip Base Connections

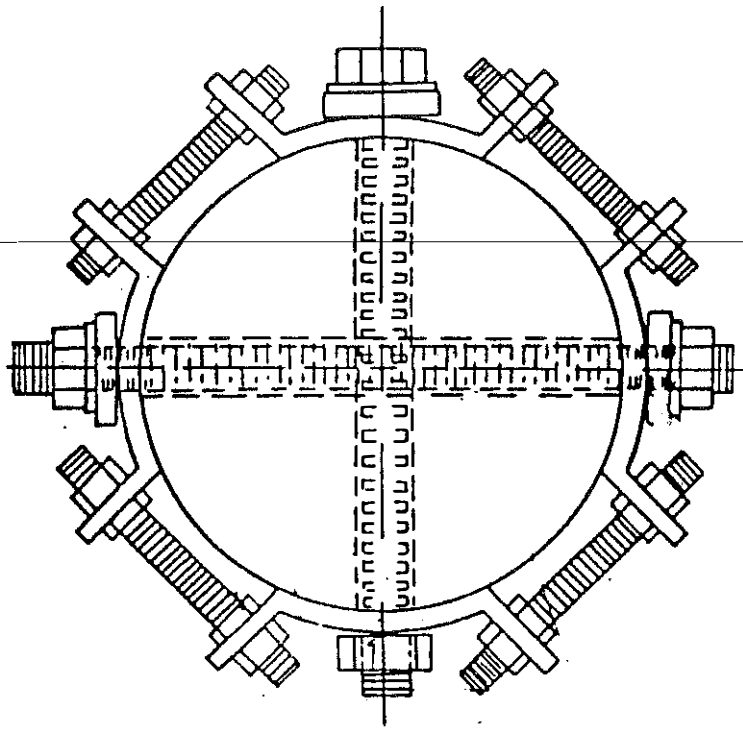


Figure 2 - Pole Band Assembly

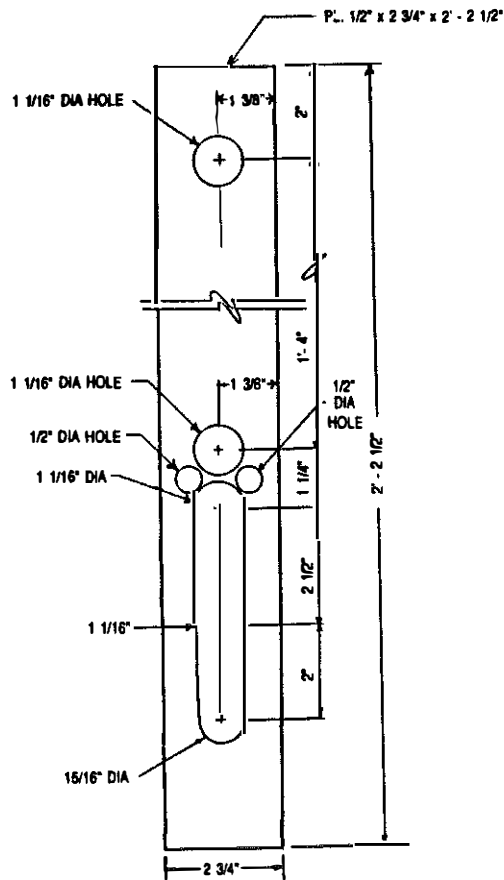


Figure 3 - Steel Strap Detail

The breakaway timber utility pole is designed to activate when struck by a vehicle travelling at speeds ranging from 20 to 60 mph. It is expected that most of the hardware used for the retrofit would be reusable after an accident. The keeper plate would not be a reusable item. It is possible that all four straps would need to be replaced after an accident.

Upon impact, slip base bolts shear the keeper plate and the pole slips along lower cut plane. The pole rotates and one or more strap holes shear to allow for bolt and strap slot relative movement within the area of the pole band assembly below the upper cut. It is intended that the pole will rotate sufficiently so that the pole clears the vehicle's hood, windshield, and roof and allow the vehicle to pass under the pole without injury to vehicle occupants. It is expected that the pole would be partially supported by the steel cables and conducting lines should remain in service. The sequence of events for the concept is depicted in Figure 4.

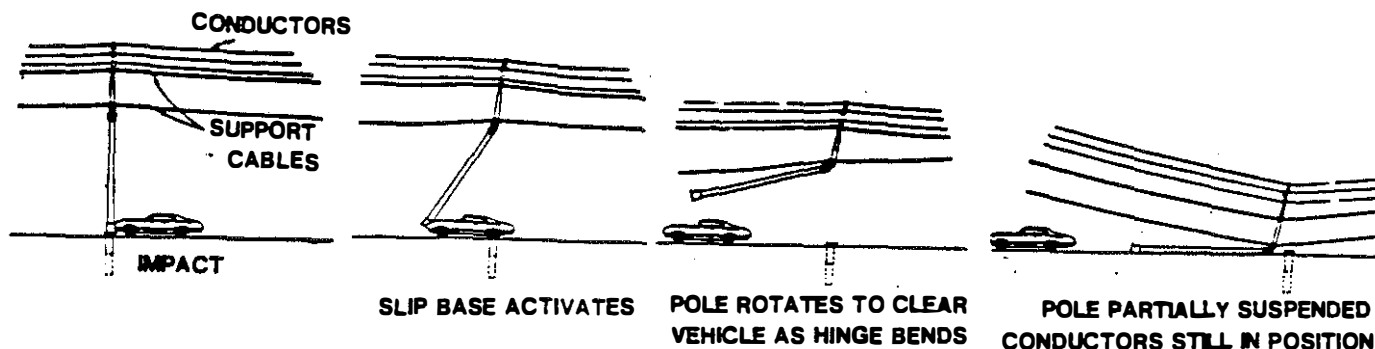


Figure 4 - Breakaway Sequence

The current design does not provide for retrofits on poles having tap lines that would create side tension. Poles should not be located in a sharp curve and the breakaway pole should not contain transformers, reclosers, or other units that could cause eccentric loading on the pole. There should be a clear zone to allow the pole to swing free of fixed objects.

Kentucky Installations

The breakaway timber utility pole hardware may be used to retrofit existing conventional poles, or it may be used on a new pole which could be used for a new installation, or it could be used to replace an existing pole. KU officials choose to retrofit existing poles for all installations.

Sufficient hardware to retrofit ten poles was ordered from Robert F. Shepherd, Timber Products Consultant, Box 162-A, Rindge, NH 03461. Retrofit hardware cost \$1,263 per pole in January 1988, labor and equipment costs were approximately \$1,447 per pole, for a total per pole cost of about \$2,710.

KU Construction Department personnel considered several items when selecting poles for retrofit installations. An attempt was made to identify poles which had been replaced due to vehicular accidents. Those poles were considered as first candidates for retrofits and then additional poles were chosen to fulfill the ten-pole requirement. Items considered during the selection process included:

- a) Lexington area
- b) close to roadway
- c) speed limit greater than 35 mph
- d) high traffic volume
- e) possibly near a hill or in a curve
- f) at an intersection
- g) straight line pole
- h) no tap lines from pole
- i) clear zone near pole to allow for pole swing
- j) no heavy equipment on pole

The same construction crew supervisor coordinated each installation. The crew was composed of a Supervisor A, two Line Technician A, a Line Technician B, and a General Laborer. Vehicles used during installations included a digger derrick, a double bucket truck, and a flat-bed truck. An arrow-board trailer was pulled by the flat-bed truck and that vehicle was used for traffic control primarily. The general construction sequence for installation of the retrofit hardware follows.

Traffic control elements, in accordance with the Manual on Uniform Traffic Control Devices, were placed and electrical lines were covered with insulating pads. Two support cables were affixed to the pole to be retrofitted and were then attached to each adjacent pole. The pole ground wire at the base was removed. A collar to support the upper portion of the pole was placed around the pole within six to eight feet of the top of the pole and the collar was attached near the end of the boom of the digger derrick. Soil was removed at the pole base. The pole was sawed horizontally 3 in. above ground line and two grooves were sawed in the stub near the ground pole surface to provide channels for distribution of Poleset, a two-component thermo setting material. Wood preservative was applied to the upper cut surface. The lower base-plate assembly was placed on the in-ground pole section. Poleset or a similar compound was poured through a hole in the center of the base plate to fill all voids between the pole and base-plate assembly.

The upper base-plate assembly was placed at the base of the out-of-ground pole section. The assembly was positioned concentrically around the pole with three set screws. The pole and upper assembly were positioned above the in-ground section and the keeper plate and six washers were positioned between the base plates. The set screws were loosened and the upper base-plate assembly was rotated to align bolt slots and then the set screws were tightened to provide equal space between the pole and pipe or tube circumferentially. Poleset or its equivalent was placed to fill the void between the upper base-plate assembly and pole. The six sets of bolts, washers, and nuts connecting the lower and upper base plate assemblies were placed and bolts were torqued to 200 ft-lb.

Holes to attach pole bands and straps were drilled through the pole. The pole was cut horizontally approximately 20 ft above the ground line. The pole section above that cut was raised and wood preservative was applied to the cut surfaces. The pre-assembled pole bands were placed above



Figure 5 - Traffic Control

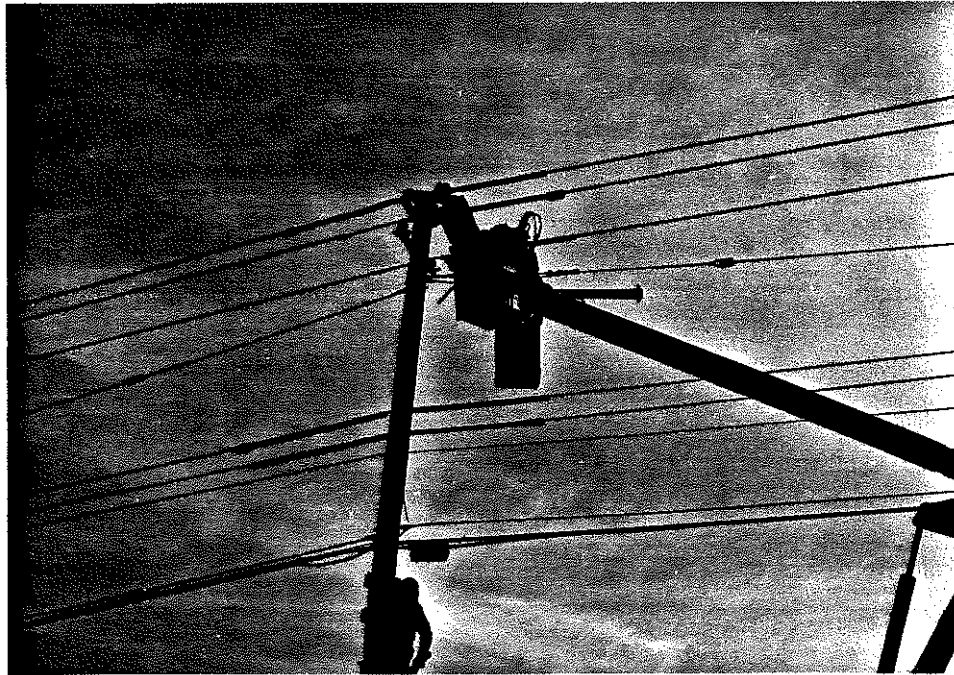


Figure 6 - Insulate Lines

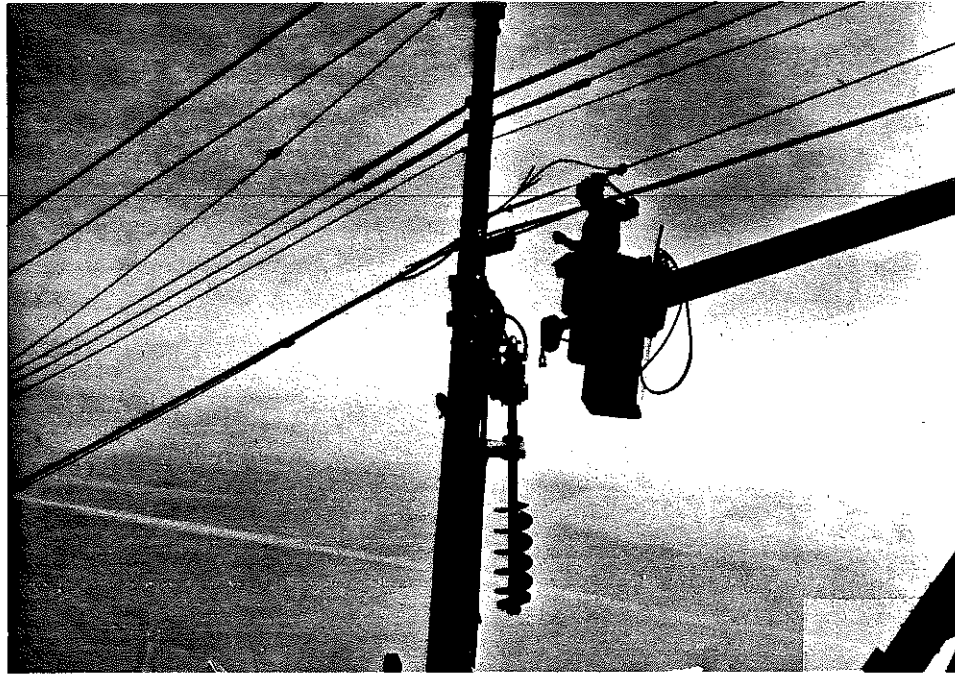


Figure 7 - Install Support Cables

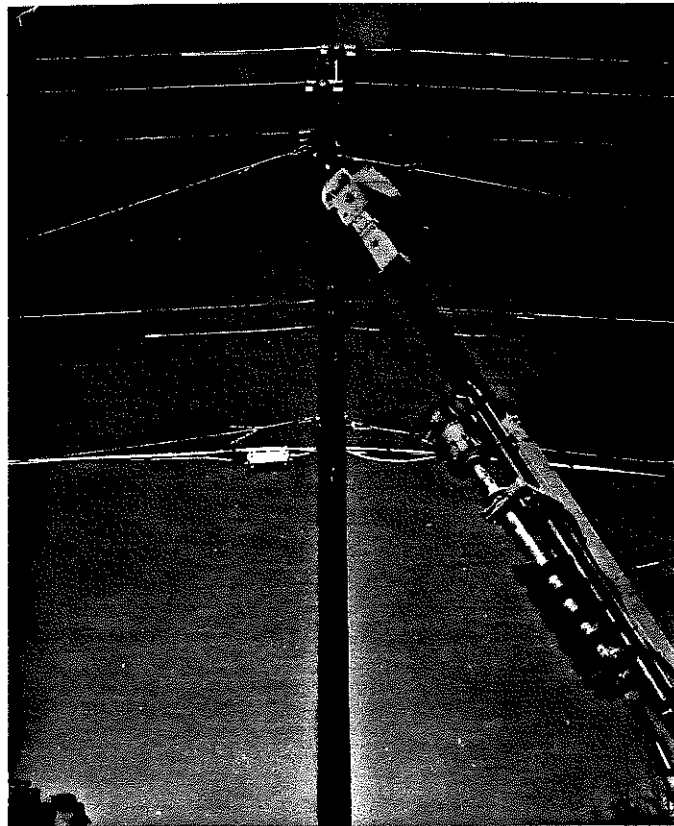


Figure 8 - Affix Collar



Figure 9 - Remove Soil, Base Cut, Groove, Use Preservative on Both Cut Surfaces



Figure 10 - Install Lower Tube with Base

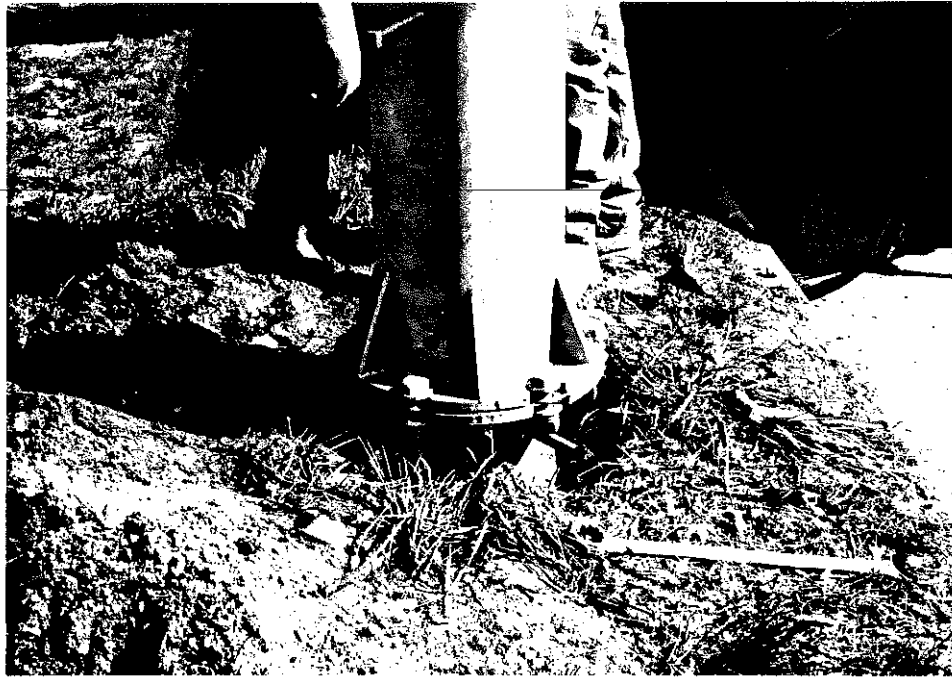


Figure 13 - Add Slip Plate, Bolts, Washers, Nuts, and Torque to 200 Ft-Lb



Figure 14 - Place Filler



Figure 11 - Place Filler



Figure 12 - Install Upper Tube with Base



Figure 15 - Drill through Pole



Figure 16 - Cut Top

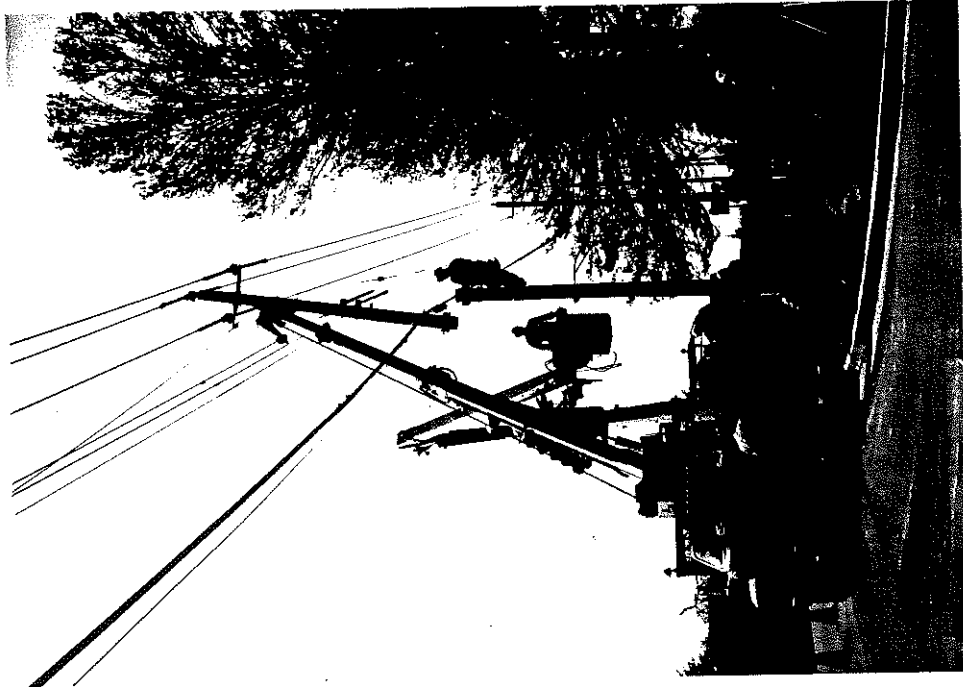


Figure 17 - Apply Preservative and Pole Bands

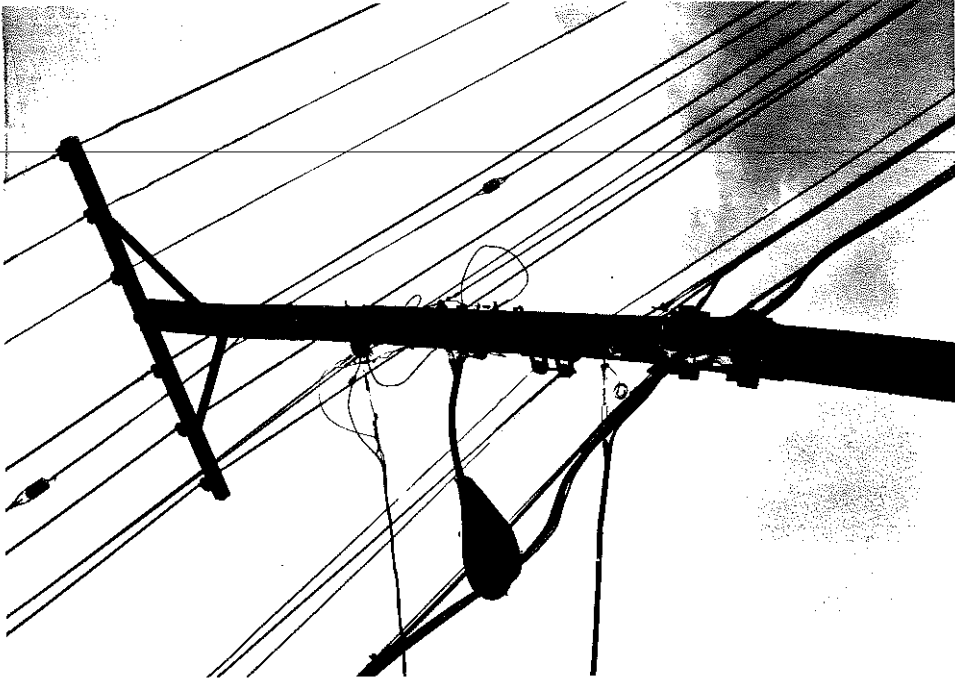


Figure 18 - Install Straps and Torque Bolts to 100 Ft-Lb

and below the cut. The upper band was positioned and bolts were partially tightened. The lower band was positioned and bolts were partially tightened. The all-thread bolt was inserted and a washer and nut were placed at each end to affix the upper band and two opposing straps to the pole. The other all-thread bolt and remaining two straps were placed on the pole.

Bolt holes in opposing straps were used to position the lower band and to affix the lower band and straps to the pole. Bolts were torqued to 100 ft-lb to complete the installation. The pole grounding wire at the base was replaced. The installation steps are shown in the following figures. An installation could be completed within six to eight hours.

Locations of Breakaway Installations

Ten poles have been retrofitted to date at the following locations within Lexington. Pole and location details are listed in Table 1.

1. Press Avenue and Virginia Avenue
2. Richmond Road and East Fairway
3. Richmond Road and West Fairway
4. Richmond Road and Lincoln Avenue
5. Tates Creek Pike and McMeekin Place
6. Tates Creek Pike and Albany Road
7. Viley Road and Parterre' Place
8. South Pin Oak Drive (GTE Switching Complex)
9. 811 West High Street
10. 1081 South Broadway

Table 1 - Pole and Location Details

Pole No.	Pole Height- (Above Ground) ft	Upper Cut to Ground-ft	Curb to Pole-ft	Curb Height- ft	Distance to		ADT	Posted Speed (MPH)	Number of Lanes
					Support Poles-ft N or W	S or E			
1	39	19.5	0	0	100	106	10,195	35	2
2	35	21.1	0.5	0.1	102	138	29,800	35	4 (divided)
3	35	20.2	0.5	0.1	150	113	29,800	35	4 (divided)
4	38	18.8	1.0	0.5	146	112	24,800	35	4 (divided)
5	39	22.2	2.3	0.5	233	124	24,000	45	4 (divided)
6	35	19.5	2.2	0.5	251	173	26,100	45	4 (divided)
7	35	20.5	5.0	0	149	144	3,260	35	2
8	28	17.5	0.5	0.3	84	52	4,240	35	2
9	28	17.5	0.5	0.3	74	47	11,800	35	2 (one way)
10	30	20.5	0.5	0.2	63	60	31,500	35	4

Summary

Ten poles had been retrofitted by October 20, 1989. Company officials will soon decide whether other installations will be placed. Sufficient funds remain to cover costs for five or six additional retrofits.

Retrofitted poles have been inspected quarterly and no indications of problems have been observed. No severe weather conditions have occurred since the first installation and none of the retrofitted poles have been hit by a vehicle.

The pole at 811 West High Street was retrofitted during January, 1989. At approximately 11:18 pm on March 28, a car hit a steel guard post adjacent to a timber utility pole at 833 West High Street. The retrofitted pole was two poles east of the accident location. Two persons died as a result of the accident. Reports indicated excessive speed and alcohol were contributing factors. The retrofitted pole was not a factor in the accident.

During the week of October 23-27, 1989, KU personnel made a detailed inspection of retrofitted installations. Slight adjustments in some pole alignments were made and bolt torque was checked at all locations. All bolts were of the specified torque.

Quarterly inspections will be continued until September 1991 at which time a final report will be issued.