SPP Underground Hardening Application Guide

Revision 1 – 4/16/2020

Revision 2 – 6/14/2021

Contents

REVISION SUMMARY:

The SPP Underground Hardening Application Guide is being revised to remove all discussion around overhead hardening, which will be moved to the Feeder Hardening Design – Scope – and Application Guide. This SPP Underground Hardening Application Guide will provide supplemental guidance for SPP LHUG to the current TUG Detailed Planning Guide. This revision will also include lessons learned and input from various stakeholders after conducting a preliminary Scope and Design of a target on feeders C208 and C210.

1. Title changed to SPP Underground Hardening Application Guide.
2. Added 2nd and 3rd paragraphs for further detail and the TUG and Standards site links.
3. Adjusted "General Duke underground design standards for looping is preferred and shall be followed as discussed in the Looping section."
4. Added "This assessment has been incorporated into the SPP modeling and is reflected in the BCA prioritization methodology. As future weather impacts the system the Target Management Tool (TMT) will have weather data available to assist with target selection based on weather patterns." To further detail how historical outage data was utilized.
5. Added Scoping Targets section.
6. Added Field Assessment section.
7. Added Lighting section and Appendix A.
8. Added Joint Use section.
9. Added Looping section.
10. Added Public Engagement section.
11. Added Multiple Meters section.
12. Added Facilities Found on Project section.
13. Added Open Lots and Open Lots with Existing Facilities section.
14. Added Pedestal Selection section.
15. Added Cable Routing and Equipment Placement section.
16. Added Application Guide and Standards section.
17. Removed all discussion of overhead hardening and will move it to the Feeder Hardening Application Guide.
18. Removed original Appendix A, Pole Foreman Utilization example.

BACKGROUND AND INFO:

Lateral Hardening is a long-term program that will systematically rebuild the laterals. They will be placed underground or hardened overhead to meet the NESC 250C extreme wind load standard. The existing lateral system is approximately 11,800 miles on 1,325 feeders. The Lateral Hardening program will enable the lateral underground and overhead to better withstand extreme weather events. This application guide will focus on the Underground portion of the Lateral Hardening Program.

The intent of the SPP Underground Hardening Application Guide is to supplement the guidance that is already established in the Targeted Undergrounding (TUG) Detail Planning Application Guide for Lateral Hardening Underground (LHUG).

The premise around the TUG program was to maximize the number of outages eliminated by addressing outlier reliability performance. The Lateral Hardening Program as filed in the Storm Protection Plan will target 50/50 spilt between OH and UG hardening efforts to mitigate extreme weather impacts to the system.

Helpful links:

The TUG Detail Planning Guide can be found via this link.

The Distribution Standards can be found via this link.

The Distribution Engineering Manual can be found via this link.

NEW LATERAL STANDARD:

The lateral system includes any infrastructure that is tapped off the feeder via a protective device (recloser, fuse, etc.) and is comprised of approximately 11,800 miles. The lateral system will be underground or overhead hardened. Approximately 5,900 overhead miles will be upgraded structurally to NESC 250C extreme wind standard and bring the associated infrastructure up to the current company standards (For more information on this refer to the SPP OH Hardening Application Guide). The remaining 5,900 miles of infrastructure not OH hardened will be placed underground similar to the current Targeted Undergrounding Program.

PROGRAM VALUE:

The Lateral Hardening program strategically identifies and prioritizes Duke Energy's most vulnerable assets during extreme weather events. In addition to providing increased service reliability and resiliency to customers who have historically experienced significant outages during extreme weather, the program also provides widespread value to all customers following extreme weather events.

LATERAL HARDENING ANALYTICS-BASED APPROACH

The Lateral System has been analyzed within the Storm Protection Plan (SPP) and the following is the analysis and prioritization methodology:

1. Probability of Damage: To prioritize the work in the Florida regions, the Transmission and Distribution system was modeled, and weather simulations were run to provide probabilistic exposure frequency for all asset locations. The weather modeling uses the FEMA HAZUS and SLOSH models, which contain the weather data for storms over the last 200 years. Using the geographical locations of the Florida assets and the historic storm paths embedded in the HAZUS

model, a spatial correlation of future storm exposure can be derived. To determine probability of damage given that exposure, six years of historical outage data was provided and correlated with the closest weather tower to determine the conditions during historic failures recorded in the outage data. Then, the expected quantities of asset failure for simulated future weather exposure conditions was derived by combining simulated weather patterns with historical asset failure through conditional probability methods.

2. Consequence of Damage: Once the output of probabilistic damage is assessed, the probable impact to customers is considered. This step considers number of customers served by a given asset (e.g. each pole, or segment of conductor on a circuit), observed outage durations, the mix of customers, and critical facilities. This step is performed both for the existing configuration of each circuit, and the hardened configuration. The difference between the existing condition and the hardened configuration is the program impact.
3. Distribution subject matter experts then use these outputs to determine the optimum deployment plan considering factors such as current projects in the area, critical customers, operational knowledge, resource availability and location attributes.

LATERAL UNDERGROUNDING

Lateral segments that are most prone to outages during extreme weather events will be placed underground. Doing so will help mitigate both damage costs and outage durations for DEF customers. Lateral Undergrounding focuses on branch lines that historically experience the most outage events, contain significantly aged assets, are susceptible to damage from vegetation, and often have facilities that are inaccessible to trucks. These branch lines will be replaced with a modern, updated, and standard underground design of today. General Duke Energy underground design standards for looping is preferred and shall be followed as discussed in the Looping section.

The Lateral Hardening Underground program will focus on two criteria:

Figure 1: An example of residential customers that would be candidates for Undergrounding due to section of line and service in heavily vegetated areas.

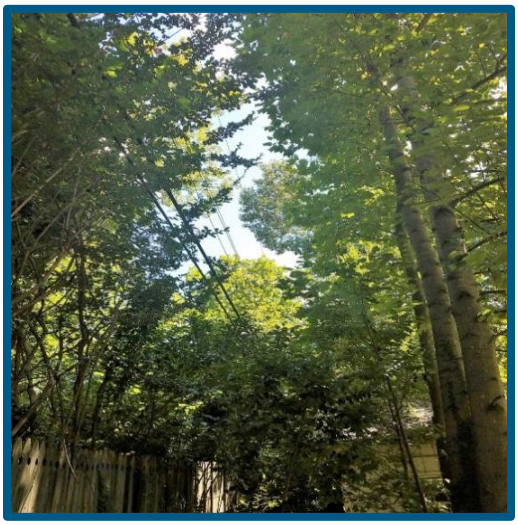


Figure 2: Section of lines that runs through backlot and heavily vegetated areas will be underground.

1. The 10-year outage history of the lateral on the circuit by looking at outages at the fuse and transformer levels. This assessment has been incorporated into the SPP modeling and is reflected in the Benefit Cost Analysis (BCA) prioritization methodology. As future weather impacts the system, the Target Management Tool (TMT) will have annual data refreshes, including MED outages, available to assist with prioritization adjustment.

2. Location attributes such as significant vegetation density or a high percentage of facilities inaccessible to Company vehicles used to maintain and restore lines during outage events.

The field site survey will be a key aspect of criterion 2 to determine if the empirical data of outages align with the mission of placing service underground. This will allow the distribution subject matter experts to use the best engineering judgement with respect to improving the reliability and system performance in extreme weather events.

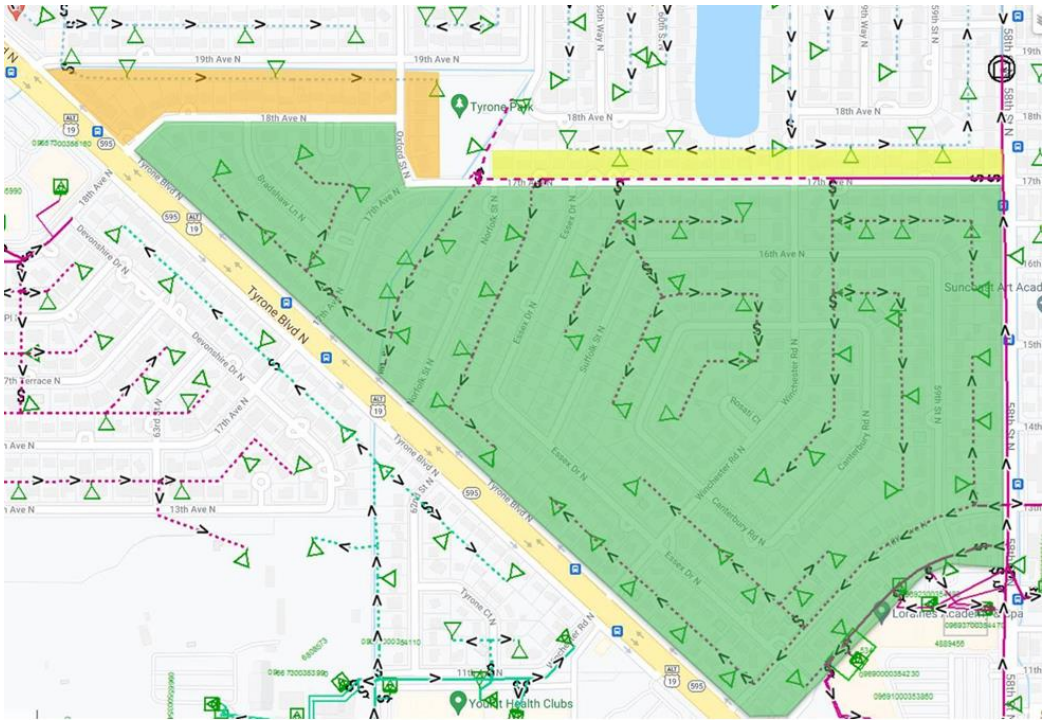
SCOPING TARGETS

To ensure targets are scoped and implemented consistently across the DEF Jurisdiction the follow tasks shall be followed.

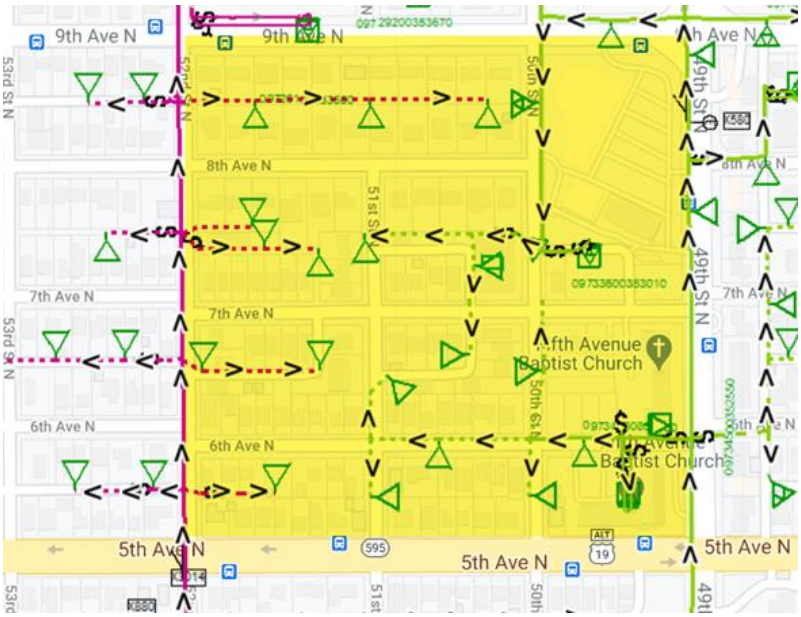
Task 1 will be a virtual evaluation of laterals through MyWorld as the entire feeder is reviewed and scoped for OH or UG hardening. To align with the SPP filing, engineering judgement must be used to scope the target as UG based on vegetation concerns. Another consideration for this task would be to relocate backlot lines to front lot and target them for UG. These two elements align with what was filled in DEF's SPP, to harden the lateral infrastructure susceptible to vegetation damage and relocate segments inaccessible to trucks by replacing with a modern, updated, and standard underground design.

Within the scope of Task 1, scope creep needs to be addressed to ensure the work on the SPP target is completed but neighboring branch lines that are neither part of an SPP target or SO target are also addressed within reason. Below are guidelines to address neighboring branch lines on feeders that are not current SPP or SO targets:

1. If undergrounding a customer front lot that does not eliminate back lot overhead facilities but provides an opportunity to provide service front lot, it is acceptable to include the customers fed from the back lot as a targeted opportunity. (See yellow highlight in example below)
2. If undergrounding a neighborhood or residential area and a street of customers is fed by a different circuit but there will be UG facilities in the front, those customers should be included in the scope of work. (See orange highlight in example below)



3. For operational looping utilize roads to help determine the scope boundary. During this scoping, take the opportunity to create good operational loops by rebalancing customers as needed where roads can be used as a break point. This also can eliminate road crossings and provide an operational benefit by reducing poles. (In the example below 5th Ave and 49th St are used as boundaries due to potential looping scenarios making it logical to include customers from the green circuit and shifting them to the Magenta SPP circuit)

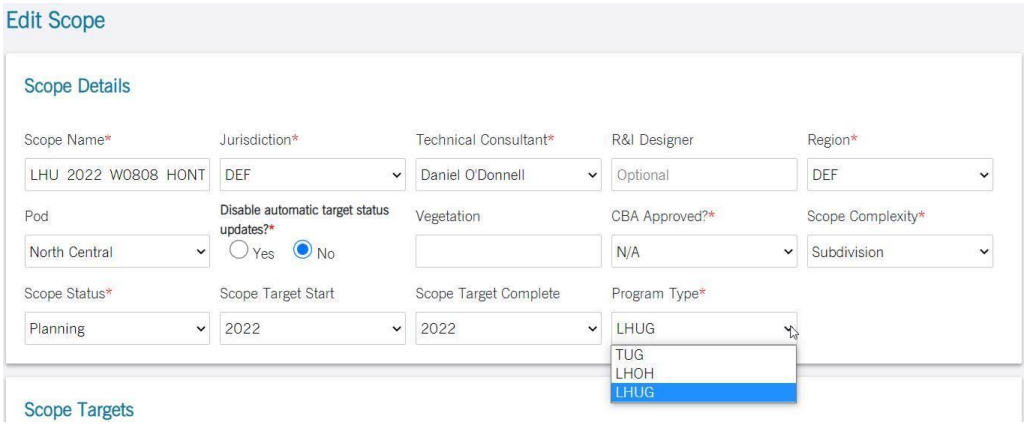


Task 2 will be a site survey that will provide intel of vegetation presence and confirmation of the target selection of OH or UG hardening. This selection will be maintained in the Target Management Tool (TMT) and there will be a drop down on the site survey where the hardening project can be confirmed.

Field Assessment

For Field Assessment guidance refer to Section 5 of the TUG Planning guide. Task 2 is an important step in the planning process and is the feedback loop between the designer and SPP Planning team to ensure the correct selection of targets based on the vegetation coverage.

If the site survey determines the target is a better candidate for LHOH select the appropriate drop down in TMT Program Type (example below) and notify PM and SPP planning.



LIGHTING

The lighting infrastructure within an area targeted for UG shall be reviewed on a case by case basis. During the design process the Lighting Department should be engaged to help determine the best possible solution for the area. Designers and Lighting can provide information to the Public Engagement specialist so they can engage the community, county, or municipality for input on how to proceed with lighting during the project. This is needed due to the rate difference in lighting that is fed overhead versus underground. Appendix A list the current rates and differences from switching service type and this appendix should be used to communicate the current delta in costs to customers so they can make informed decisions. The rates listed in Appendix A are locked until new rates agreements are made with the PSC so most cost questions can be handled by referencing this pricing information. If there are detailed billing questions that occur due to a LHUG project the designer or PM can reach out to the Lighting team to work with the customer directly.

If design and public engagement specialists are working with a customer who is adamantly opposed to providing service to their lighting underground due to the rate impact, public engagement should suggest the possibility of upgrading the lighting to LED. The LED UG rate will be cheaper than UG HPS rate potentially keeping the customer close to their current rates. If a scenario like this arises during a project, design should inform the PM and the lighting group for further rate explanation if needed.

The need for input on how to proceed shall be communicated from Public Engagement Specialist to the designer based on customer feedback due to rate differences.

JOINT USE

For LHUG designs involving Joint Users, section 8 of the TUG Application Guide shall be followed.

LOOPING

General Duke Energy underground design standards for looping is preferred and should generally be followed for TUG designs. Those standards can be found on the Distribution Standards page linked in the Background and Info section.

20.02-121A – Basic Design Requirements (Looping)

20.02-121B – Basic Design Requirements (Looping)

LHUG may differ from TUG with regards to scoping and customer mixes within the scope. In LHUG scopes may include commercial and residential. Things to consider for looping:

1. All 3 phase commercial loads will be on a standalone dedicated loop.
2. Duke Energy shall hire a licensed electrician under contract (this can be the same contractor that converts all meter cans to UG) to install customer owned cable.
3. If you have a scope that includes 3 phase and 1 phase customers, multiple loops will be required. At least one loop for 3 phase customers and another for 1 phase customers.

When developing the design for the loop, the maximum customers will be limited by the upstream protective device. Refer to DSS-APN-DEF-0001, Simplified Lateral Terminal Pole Fusing for the LHU Program and the table within to help determine appropriate fusing for the target. If the target is more complex and additional insight is needed for the terminal pole fusing coordinate with area planners on appropriate fuse size for the loop.

PUBLIC ENGAGEMENT

For LHUG, Public Engagement, section 10 of the TUG Application Guide shall be followed.

MULTIPLE METERS

When designing the layout for a lot that has multiple meter points, all services on the property will be underground. For example, if a property has second meters for boat houses/docks, guest house, workshop, etc. they will be placed underground. This could mean multiple residential meters could be on the property, to help determine meter classification refer to the RS-1 Rate Schedule. Another resource would be to check CSS and the current rate associated with that meter.

Refer to the Index of Rates Schedules Sharepoint, RS-1 Residential Service.

FACILITIES FOUND ON PROJECT

There may be times where equipment is found on a target that will need to be addressed (i.e. a live pedestal with no services yet).

If live equipment is found on a target but currently there is no service being provided, follow up will need to be completed to determine if it needs to be included in the design or eliminated. Review CIAC records to see if a customer has paid or been invoiced. If so, the equipment will need to be included in the design. Secondly, review permitting for active permits for service that will need to be accounted for in the design. If there are no records of payment and permits are expired, notify the PM to determine whether to include the live equipment.

If old equipment is found on a project with no active service account work with Public Engagement to reach out and contact the customer or property owner for more information about the equipment. Working with Public Engagement and the customer will provide input to the design on plans customers may have with the facilities found on properties, or if Duke Energy can potentially remove old facilities that are not being utilized anymore.

OPEN LOTS AND OPEN LOTS WITH EXISTING FACILITIES

When developing the preliminary facility layout design, open lots and open lots with facilities should be noted. All open lots will need to be included in the design to provide future service for potential customers. Necessary steps such as upsizing the transformer or provisioning for a pedestal to the open lot need to be accounted for in the design.

Facilities that are designed and installed in open lots will also need to be tagged in MyWorld or CSS that they were placed in service based on SPP LHUG to account and assist with future services to the customer. It is important to have these facilities tagged for the future undergrounding of services cost decisions as undergrounding it will be the most economical way of providing future services to customers.

PEDESTAL SELECTION

When determining what pedestal to utilize on a project refer to Section 25 of the Standards Manual. Other considerations from local operations, customer input, ease of easement acquisition, etc. will come into play with selecting the appropriate pedestal for the job. It is recommended to start the preliminary design process with the upright pedestal as it is the most cost effective and they provide operational benefits when service is required.

CABLE ROUTING AND EQUIPMENT PLACEMENT

It is recommended in the design process to route cables along the property lines and in the ROW. This would also include routing cable around the block versus down a property line between two customer's properties for service, which will keep cables near the roads.

Equipment shall be placed on properties lines if easement agreements can be reached. The second option would be to place equipment in the right of way as close to property lines as possible. It is recommended that surveys are obtained for both easement and equipment location for verification of equipment placement.

APPLICATION GUIDE AND STANDARDS

Duke Energy Standards shall be followed for all designs. The intent of this guide and the TUG Detailed Planning guide is to provide a common approach for all zones in DEF. Discussions within these guides do not supersede anything in the Standards Manual. If there are questions or concerns that come up during

the design process, communicate those through the proper management channels so that lessons learned can be included in these guides.

APPENDIX A: Lighting OH to UG Billing Changes

Only Roadway and Flood lights have both OH and UG rates that would change as a result of how they are fed in the field. Below is a synopsis of the pricing differences. For any questions or clarifications, please reach out to your local Lighting Design Manager.

HPS:	**OH Rate:**	**UG Rate:**	**Increase:**
100W HPS Roadway	$7.90	$10.48	$2.58
150W HPS Roadway	$9.46	$13.26	$3.80
250W HPS Roadway	$12.17	$16.35	$4.18
400W HPS Roadway	$17.01	$20.61	$3.60
250W HPS Flood	$13.16	$17.61	$4.45
400W HPS Flood	$17.24	$21.41	$4.17

In most cases, it will be cheaper for the account owner to have an LED conversion performed as the LED UG rate would be cheaper than the HPS UG rate. Please contact your local Lighting Design Manager if the customer would be interested in pursuing a cost comparison.

LED:

All LED roadways and floods have both OH and UG rates, except for Black roadways. The price increase for the UG rate for all is $1.50.

Poles:

If all Duke Energy facilities are removed from a pole and any Joint Use on the pole is removed, with just the lighting service wire/cable being attached as an OH or UG feed, the pole would become a billable lighting pole on the account owners monthly bill. Our wood and static concrete poles rates are below:

30ft/35ft Wood pole - $2.17

40ft/45ft Wood pole - $5.25

30ft/35ft Concrete pole - $5.05

40ft/45ft Concrete pole - $10.19