

Nu-Cable™

Cable Barrier Systems

INSTALLATION MANUAL

TEST LEVEL - 4
Version 2014.09A



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Nu-Cable™

Cable Barrier Systems

INSTALLATION MANUAL

SECTION A SYSTEM OVERVIEW

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INSTALLATION CONSIDERATIONS

The entire manual should be carefully reviewed prior to construction to ensure proper installation of the Nu-Cable™ Cable Barrier System.

The Nu-Cable™ Cable Barrier System is a straight-forward barrier, which is easy to install and can be safely maintained with the information contained within this installation manual.

The initial installation run for any new crew will need to be trained by a qualified Nucor Distributor or Nucor Steel Marion, Inc. representative. It is also strongly recommended that the first run for any new installation crew be completely installed and tensioned before attempting to start other runs.

If there is ever any doubt about a part of the installation contact Nucor Steel Marion, Inc. at (800) 333-4011 or the appropriate Nucor Distributor immediately.

Distributor contact information is listed on the last page of the manual.

Nucor is not responsible for any certifications, licensing, or permits, such as environmental impact, that may be required in order to complete installation of this or any roadside safety device.

SITE CONSIDERATIONS

The initial layout for the Nu-Cable™ High-Tension System should be free of hazards, obstacles, and debris. The cross-slope should be **4:1, 6:1** or flatter. Grading may be necessary.

It is important to note that the high-tension cable barrier cannot be installed within a range of **1' (305mm) to 8' (2.44m)** from the bottom of a median ditch according to FHWA memorandum. The high-tension cable barrier can be installed in the bottom of the median ditch or within a **1' (305mm)** range either side of the median ditch. However, this is not recommended because of potential water drainage issues and poor soil conditions.



HISTORY AND DEVELOPMENT OF THE NU-CABLE SYSTEM

The Nu-Cable™ system was originally developed by SafeRoads, LLC in 2002. It was designed around the usage of a Marion Steel 4#/ft Rib-Bak® post in a 3-cable configuration. There were three versions of the system: two low-tension and one high tension. The product names were Rib-Bak® Cable System, Modified Rib-Bak® Cable System & the US High-Tension Cable System, respectively. All of the systems were tested using standard cable (non-"pre-stretched"). The US High-Tension Cable system could also be used with factory "pre-stretched" cable. Due to tensioning and temperature cycles, standard cable exhibits the same performance characteristics as "pre-stretched" cables over time. The ability to use standard cable allows for realization of certain economic benefits during installation & maintenance.

Nucor Steel Corporation purchased Marion Steel and Saferoads in July of 2005. Shortly thereafter, Nucor Steel Marion, Inc. renamed the products '*Nu-Cable™*'. The Nu-Cable™ product line utilizes the same Rib-Bak® posts, locking hook bolts and/or hanger, to support the ¾" cable. The cable heights and method of support vary depending the local terrain and desired NCHRP testing level.

The Nu-Cable™ system has amassed an impressive track record of successfully re-directing errant vehicle since its first installations in Ontario, Canada & Winger, Minnesota in 2003. Nucor Steel Marion, Inc. has continued to develop the Nu-Cable™ system to meet the needs of its users. The Nu-Cable™ system can now be used in following applications:

- Low-Tension Applications meeting NCHRP 350 TL-3
 - On 6 to 1 slopes
 - With standard J-Bolts
 - With locking hook-bolts
- High-Tension Applications meeting NCHRP 350 TL-3
 - On 6 to 1 slopes or shallower
 - 4# Rib-Bak® Line posts
 - 3 or 4 cables
 - Direct driven, Driven Steel Sockets, or concrete socketed
 - On 4 to 1 slopes or shallower
 - Utilizing a combination of locking hook bolts, hanger & strap.
- High-Tension Application meeting NCHRP 350 TL-4
 - On 6 to 1 slopes
 - Utilizing a combination of locking hook bolts, hanger & strap.

The Nu-Cable™ system is eligible for reimbursement according to the Federal Highway Administration for use on the National Highway System under the following letters:

BARRIER

B-96, B-96A, B-167
B-183, B-184, B-184A, B-193

TERMINAL

CC-76, CC-105, CC-105A

The NUCOR 4# Rib-Bak® U-Channel posts are an acceptable post alternate in the non-proprietary USDOT 3-Strand Low-Tension Cable Barrier system.

CURRENT CONFIGURATION SUMMARY

There are currently **(2)** main categories of the Nu-Cable™ Cable Barrier. This manual covers the layout, components and installation instructions for both systems.

A. Test Level 3 Cable Barrier & Anchors

- a. High-Tensioned Cable Barrier for roadways up to 65 mph, in median & roadside applications, using:
 - i. NUCOR U-Channel Line Posts – Direct Driven, Concrete Socketed, or Driven Steel-Sockets
 - ii. NUCOR Locking Hook Bolts
 - iii. (3) Strands of 3 x 7 x 3/4" Pre-Stretched or Standard Wire Rope, Field Tensioned for 6:1 or flatter Slope Applications
 - iv. (4) Strands of 3 x 7 x 3/4" Pre-Stretched or Standard Wire Rope, Field Tensioned for 4:1 (Steep) Slope Applications
- b. Various post spacings to fit required design deflection, clear-zone minimums & barrier working width requirements.
- c. Anchorage Options include:
 - i. Cable Release Post (CRP) TL-3 Anchor
 - ii. NU-TEN TL-3 Anchor

B. Test Level 4 Cable Barrier & Anchors

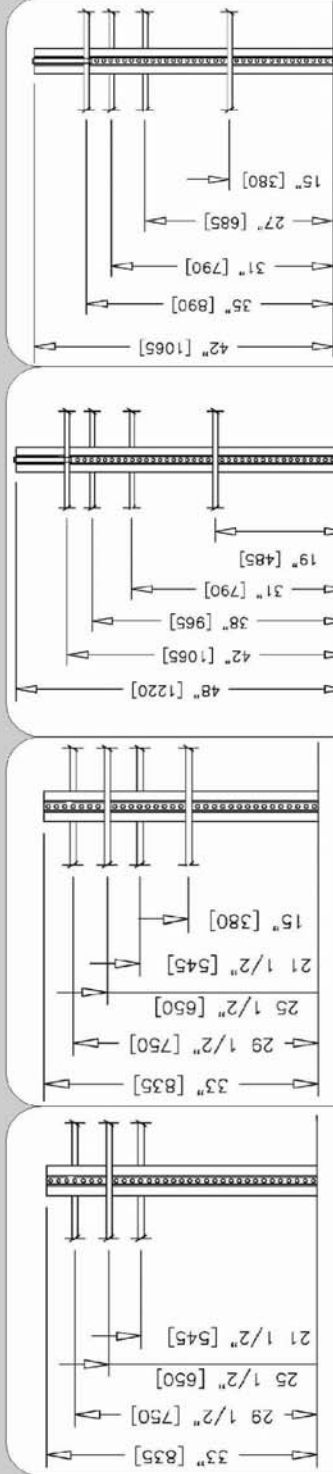
- a. High-Tensioned Cable Barrier for roadways up to 65 mph, with large volumes of heavy vehicle (18,000 lb.) traffic, in median & roadside applications, using:
 - i. NUCOR U-Channel Line Posts – Concrete Socketed or Driven Steel-Sockets
 - ii. NUCOR Locking Hook Bolts, Cable Hanger & Hanger Strap
 - iii. (4) Strands of 3 x 7 x 3/4" Pre-Stretched Wire Rope, Field Tensioned for 6:1 or flatter Slope Applications.
 - b. Various post spacings to fit required design deflection, clear-zone minimums & barrier working width requirements.
 - c. Anchorage Options include:
 - i. Cable Release Post (CRP) TL-3 Anchor
 - ii. NU-TEN TL-3 Anchor
- All High Tension Cable anchors are tested to TL-3. Thus a TL-4 Cable Barrier System would only require a TL-3 Cable Anchor.

Both systems and their anchorages conform to Federal Highway Administration NCHRP-350 crashworthiness standards for use on the National Highway System.



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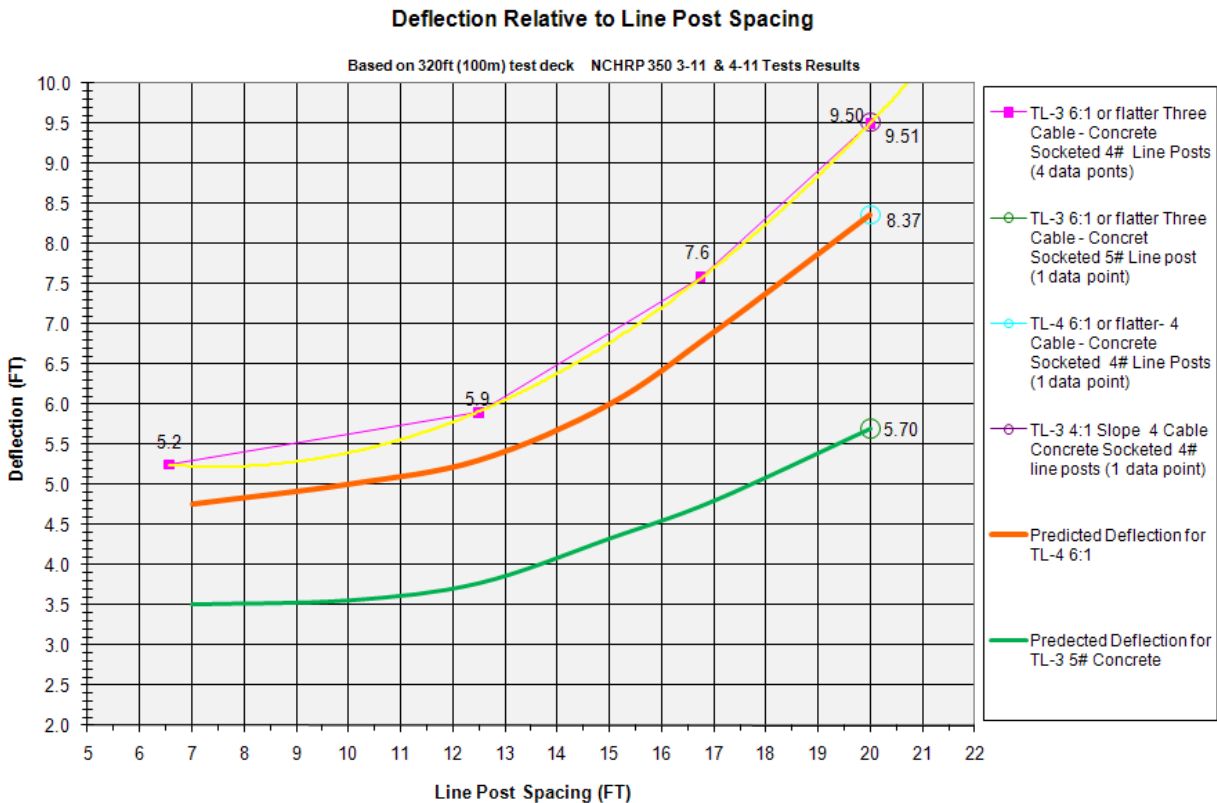
NU-CABLE™ SYSTEM COMPARISON CHART



Test Level (NCHRP-350)	TL-3	TL-3	TL-3	TL-4
Slope Max. (H:V)	6:1	6:1	4:1	6:1
Post Spacing Min.	6' 6" [2 m]	6' 6" [2 m]	6' 6" [2 m]	6' 6" [2 m]
Deflection Min.	6' 6" [2 m]* 5' 2" [1.6 m]† 3' 6" [1.1 m]‡	3' 6" [1.1m]‡	5' 2" [1.6 m]†	4' 7" [1.4 m]†
Post Spacing Max.	16' 5" [5 m]* / 20' 0" [6 m]	20' 0" [6 m]	20' 0" [6 m]	20' 0" [6 m]
Deflection Max.	9' 2" [2.8 m]* 9' 6" [2.9 m]† 5' 8" [1.7 m]‡	5' 8" [1.7m]‡	9' 6" [3 m]†	8' 4" [2.6 m]†
4# NU-CABLE Post	●	●	●	●
5# NU-CABLE Post	●	●	●	●
Concrete Socket Option	●	●	●	●
Driven Socket Option	●	●	●	●
Direct Drive Post Option	●	●	●	●
CRP Anchor Option	●	●	●	●
NU-TEN™ Anchor Option	●	●	●	●
Stretched Cable Option	●	●	●	●
Standard Cable Option	●	●	●	●

Data based on 320ft (100m) test deck. *Driven 4# NU-CABLE Post †Socketed 4# NU-CABLE Post ‡Socketed 5# NU-CABLE Post Copyright Nucor Steel Marion, Inc. 2009

POST SPACING & DEFLECTION CHARTS



TEST LEVEL 3:

The **line post spacing** can be varied from **6'-6" to 20' (2m to 6m)**, depending on desired deflection, ranging from **5' 3" to 8' 9" (1.6m to 2.6m)**.

TEST LEVEL 4:

The **line post spacing** is **20' (6m)**, with a resulting deflection of **8' 4" (2.55m)**. Desired deflection under 8' 4" available by reducing post spacing. See *Deflection Graph* above, for more information

Trend lines shown above for the TL-3 & TL-4 systems using alternate embedment options are based on original TL-3 concrete socket testing results.

*All post spacings were derived from crash testing using a 320' test installation. Actual deflections may vary based upon site variables, installation length and impact conditions.

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SECTION B BARRIER OVERVIEW

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LINE POST OVERVIEW

A string line should be set to aid in properly placing the posts and cables. Mark each run starting with the location of end treatments. Then mark the position for each cable line post to be installed according to project plans to meet required deflections. Please refer to project plans for job specific post spacing.

Please refer to the project plans and specifications to determine which post spacing is required for the installation. FHWA Memorandum dated July 20, 2007 recommends a maximum post spacing of 15' 0" (4.6m) for all manufactures of cable barriers. Varying post spacing can also be used when necessary due to conflicts with utilities or culverts.

It is helpful to mark every **1000' (305m)*** when laying out the system to aid in turnbuckle placement as the cable is unspooled.

**Mark every 750' (229m) if using standard cable.*

LAYING OUT CABLE

The cable used in the Nu-Cable™ system is **3/4" diameter (19mm), 3x7** construction, galvanized cable. It weighs **0.857 lbs/ft**, and is packaged in **2000' or 3000'** (915m) per wooden reel. The empty reel weighs 260 lbs (118kg). Shipping weight per reel is **2831 lbs (1284kg) for 3000'** reel. Illustrated below are different methods contractors have used to transport and pull cable.



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SECTION C

TEST-LEVEL 4: 6:1 SLOPE (OR FLATTER)

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LINE POST INSTALLATION

The TL-4 (6:1 Slope or flatter) system uses a 57" Long 4# Rib-Bak[®] Line Post.

The TL-4 (6:1 Slope or flatter) system is designed for use in concrete-sockets, or driven-sockets per project specifications.

CABLE MOUNTING HEIGHTS

The TL-4 (6:1 Slope) system cable heights measured at the middle of the cable are as follows:

	Top	Upper-Mid	Lower-Mid	Bottom
Median & Roadside	35 in	31 in	27 in	15 in
	±1"	±1"	±1"	±1"
	(890mm)	(790mm)	(685mm)	(380mm)

Please see the *Cable Terminal End Installation* details for terminal end cable heights which vary.

CABLE-TO-POST CONNECTIONS

The TL-4 system uses the NUCOR locking hook bolts to connect the bottom two cables and a cable hanger to connect the upper (2) cables of the system. A hanger strap is to be situated above the top cable.

Insert the special locking hook bolts (pictured below) into the appropriate locations on the line posts to ensure correct cable height and allow them to hang down such that they will accept the cable when it is strung. As the cable is strung, rotate the special hook bolts and attach the nut. Nuts need only be finger-tight, the finished tightened nut will be flush with the threading on the bolt. IT IS NOT NECESSARY TO TIGHTEN THE NUT DOWN TO THE POST. The long hook bolt is used on median applications only.

The cables are located on either the post-face closest to the near-side traffic or the opposite side, depending upon if the installation is for roadside or median applications.

ROADSIDE INSTALLATION

<u>CABLE</u>	<u>POST-FACE</u>	
UPPER		OPPOSITE
UPPER-MIDDLE	NEAR-SIDE	
LOWER-MIDDLE	NEAR-SIDE	
BOTTOM	NEAR-SIDE	

MEDIAN INSTALLATION

<u>CABLE</u>	<u>POST-FACE</u>	
UPPER	NEAR-SIDE	
UPPER-MIDDLE		OPPOSITE
LOWER-MIDDLE		OPPOSITE
BOTTOM	NEAR-SIDE	

TL-4 CABLE HANGER & HANGER STRAP

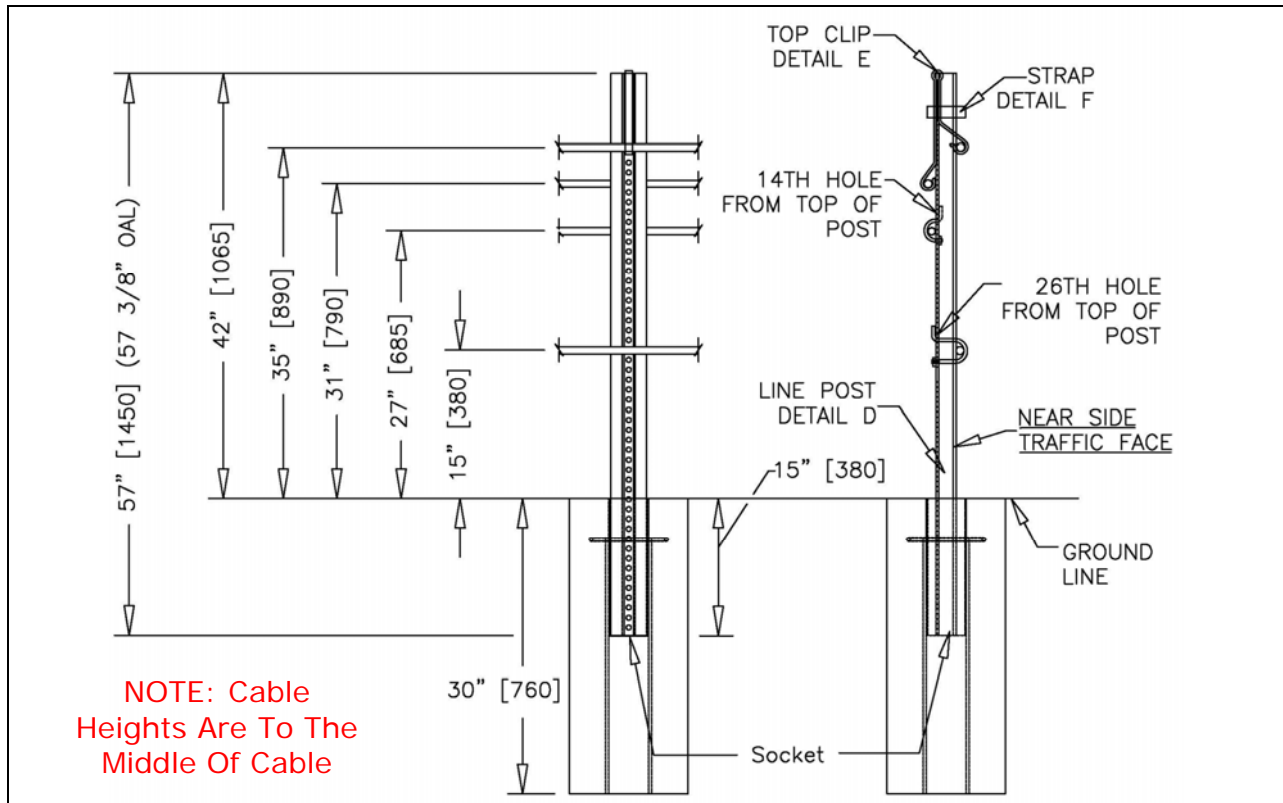
ROADSIDE



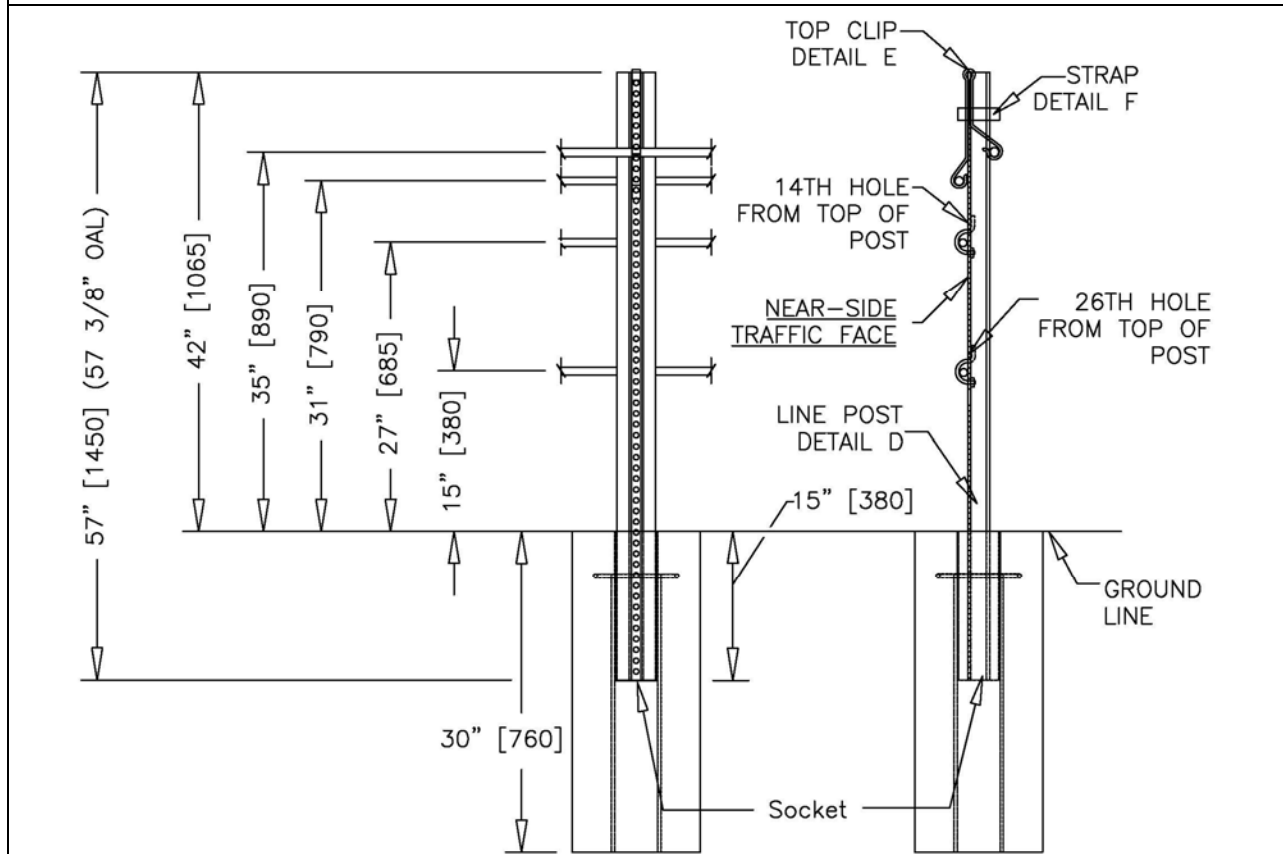
MEDIAN



LINE POST DETAIL - TEST LEVEL 4



MEDIAN CONFIGURATION



ROADSIDE CONFIGURATION

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FOUNDATION OPTIONS

CAUTION: The options shown below are examples of typical foundations for use in strong or weak soil conditions. They should not be assumed to be the only options available. If soil conditions at each installation location are unknown or do not meet the minimum requirements for strong or weak soil as outlined in Section M, a geotechnical review by a professional engineer shall be conducted prior to starting installation. The results of this evaluation shall determine foundation design at each installation location.

Some states may require deeper foundations based on site conditions and performance needs. Check with your project specifications and details to be sure you are utilizing the appropriate foundation design and depth.

Option 1: Direct-Driven Line Post

Only TL-3 systems use the direct embedment method. The post used is a 72" (1829mm) Rib-Bak® Line Post with no soil plate required. Direct driven line posts are driven into natural soil (NCHRP strong soil) using a preset string line to depth of 39" (991mm). The top of the line post should be 33" (838mm) above ground after installation.



When solid rock is encountered consult the state DOT's recommended procedures for resolution. If the state DOT does not have a procedure for installing line posts installed in rock, drill a 4" diameter hole to accommodate at least 15" of the line post.

For example if first encountering rock at a depth of 12", excavate out the enough material to drill an additional 15" into the rock. Total embedment in this case would be 27".

Option 2A: Socketed Foundation, Concrete Footing

The socketed method utilizes a steel or plastic socket set into a 12" diameter x 30" deep [305mm x 762mm] concrete footing. The socket depth is assumed to be in NCHRP 350 strong soil.

If rock is encountered which would prevent minimum embedment, please consult the state DOT's recommended procedures for resolution or contact Nucor for further information.



TEST LEVEL 3 & 4
13 GA 4" OD x 15" (2.41mm x 102mm x 381mm)

All concrete should be 3000 psi (25MPa) minimum and should cure for at least 7 days before tension is added to system.

The concrete foundation is strengthened with one #3 steel reinforcing ring and two #4 x 28" steel dowels (dowel length may vary upon foundation depth). The ring is inserted to a depth of 4"; the dowels are inserted to a depth of 2". The dowels should be installed at approximately 25 degrees off center so that they are in line against oncoming traffic. The steel reinforcement does not need to be tied.

Use a socket insertion tool (see photo) to install socket after steel reinforcement has been placed. The top of the socket should normally be flush with the top of the foundation concrete. To prevent runoff debris from entering the socket, the foundation should be finished with up to 3/4" (19mm) taper to the outer edge. This may not be required when the system is installed in a mow strip.



Option 2B: Precast Socketed Foundation, Concrete Footing

The precast line post socket follows the same detail as the standard socketed concrete footing.

Use a **12" diameter x 30" deep** [305mm x 768mm] form. Some contractors have found that modifying a standard section of **12"** steel culvert pipe works well as a reusable form. Place steel reinforcement as detailed on plan standard. Plumb posts and pour concrete.

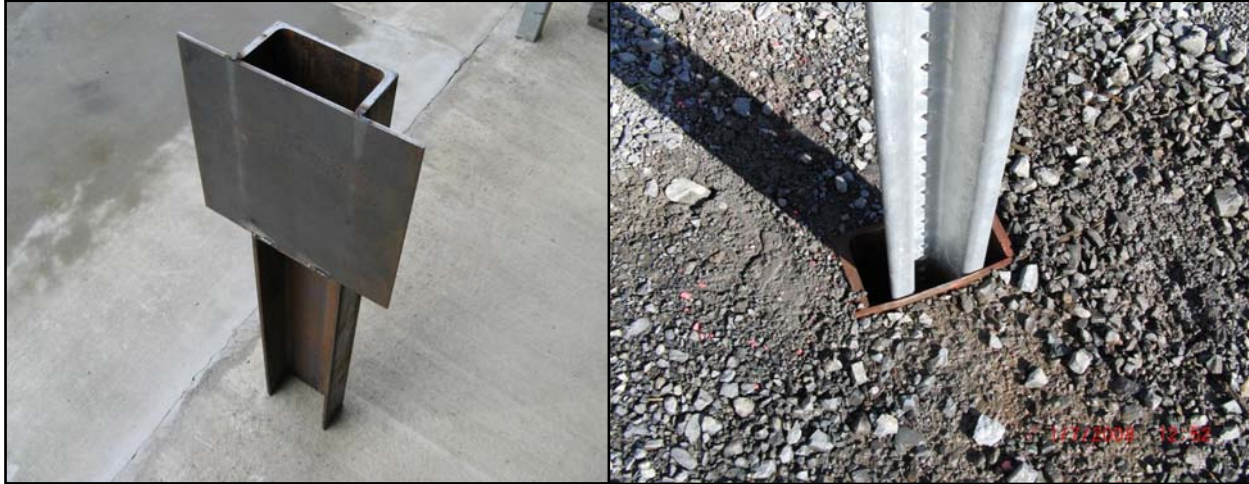
Be sure to **not** leave more than **1"** (25mm) of the line post socket exposed above the ground line. It is easier to plumb the line post socket with a post temporarily inserted in the socket. The back fill material needs to be strong soil compacted in **6"** (153mm) lifts with a hydraulic tamper.



When solid rock is encountered consult the state DOT's recommended procedures for resolution. If the state DOT does not have a procedure for installing concrete piles in rock, drill a 12" [304 mm] diameter hole to accommodate the full depth and width of the precast foundation.

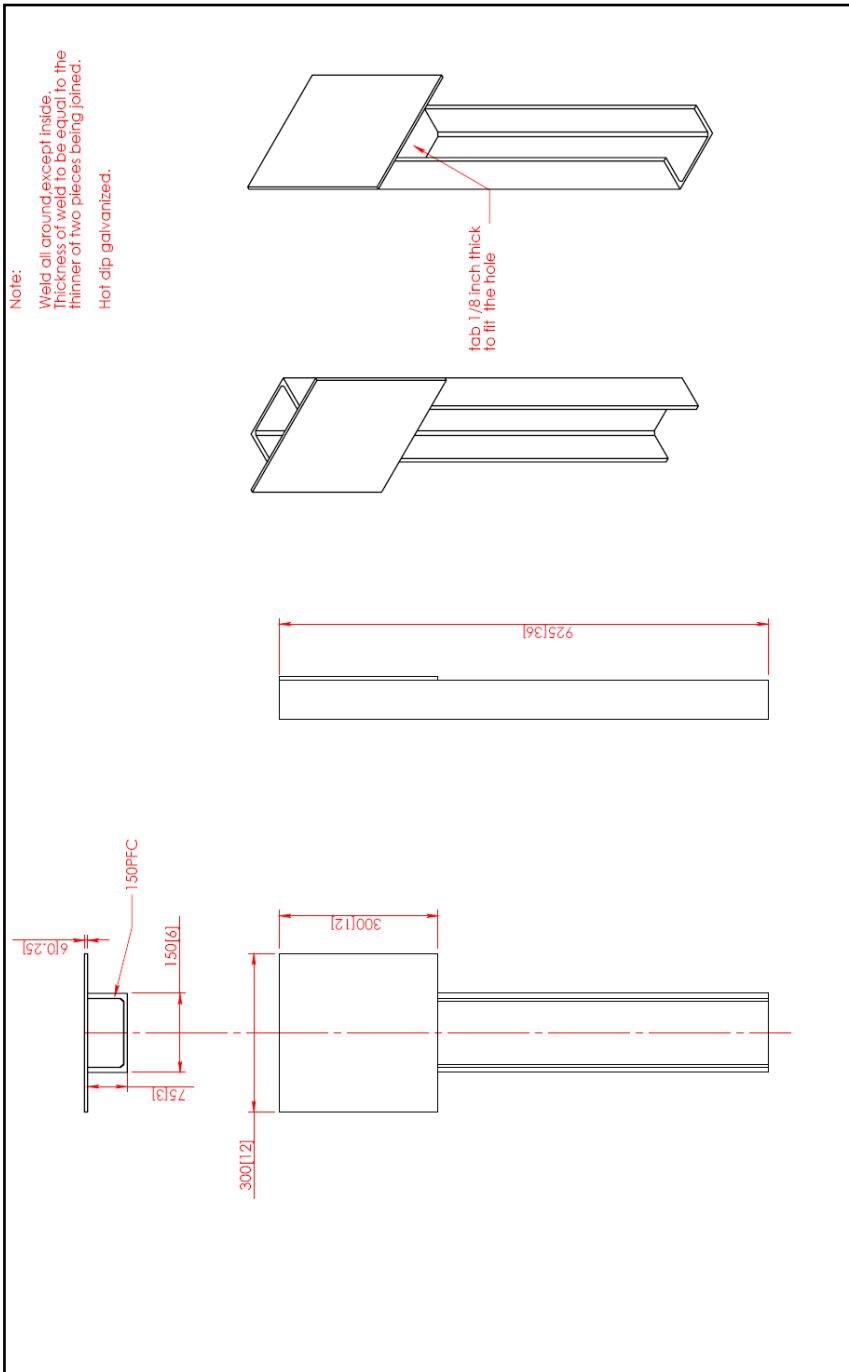
Option 3: Direct-Driven Steel Socket

Much like the direct driven post option, there is a direct driven-steel socket option that can be fitted for post-driving machines and does not require the use of any concrete. This socket allows for the use of a shortened post.



When solid rock is encountered consult the state DOT's recommended procedures for resolution. If the state DOT does not have a procedure for installing line posts installed in rock, drill a 4" [102mm] diameter hole to accommodate at least 15" [381mm] of the line post.

For example if first encountering rock at a depth of 15" [381mm], excavate out the enough material to drill an additional 15" [381mm] into the rock. Total embedment in this case would be 30" [762mm].



For uneven terrain where the potential exists for line posts to be pulled out of their sockets by the tensioning of the cable, remove a shovel full of material around socket, drill a 3/8" (10mm) hole as close to the base of the footing as workable to install a 5/16" x 1 1/4" (8mm) Grade 5 or better bolt to hold the post in place.

UNEVEN TERRAIN

For uneven terrain (see picture below), where the potential exists for line posts to be pulled out of their sockets by the tensioning of the cable, set the socket in the concrete with no more than 1" (25mm) above ground level. After concrete has set, drill a 3/8" (10mm) hole as close to the base of the footing as workable. Install a 5/16" x 1 1/4" (8mm) Grade 5 or better bolt through the post to hold the post in place.



SOFT SOIL FOUNDATIONS

Refer to local guidelines for foundation requirements in soft soil conditions.

In many cases with line post foundations in weak soil, or where the frost line is below **30"** (762mm), the footing should be increased in the depth to accommodate local soil conditions. Some states have successfully utilized 18" diam. (457mm) x 36-48" (914-1219mm) concrete foundations.

Direct-driven steel sockets can be increased in depth to 48" (1219mm) in order to accommodate local soft soil conditions.

Direct drive posts can be increased in depth, in 6" (150) increments, in order to accommodate local soil conditions.

DEBRIS EXCLUDER

Optionally required based on project specifications to help prevent collection of dirt and debris within the foundation socket.



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SECTION E CABLE FITTINGS & TURNBUCKLES

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TURNBUCKLES

Turnbuckles are used to achieve the appropriate tension in the system. By using pre-stretched cable, turnbuckles are required to be installed every 1000' (305m). If pre-stretched cable is used, the hardware must be 1"D (25mm) to approach the breaking strength of the cable. Note: More turnbuckles than the minimum amount may be used if conditions require this option. Some maintenance crews have successfully used turnbuckles in place of cable splices.

In a TL-3 system, if using standard cable, install one turnbuckle per cable every 750' (229m). When using standard cable, the attachment hardware may be ¾" (19mm) or 1" (25mm) diameter. If the length of the run is 750' long (229m), install the turnbuckle near the middle.

There are two options for the turnbuckle style used. The Nu-Cable™ system can either be installed with:

TEST LEVEL 3 or TEST LEVEL 4:

Standard Turnbuckles and "Wedge-Style" Cable Fittings



It is not recommend putting turnbuckles directly above each other in the same section between two line posts (bay). They will be easier to tighten if they are staggered. If a turnbuckle becomes positioned at a post, do not install a special hook bolt at this post. This should be allowed for only one cable per post. If a maintenance crew strongly desires to place all of the turnbuckle in the same bay, the result will have no adverse effect on the crash worthiness of the system.



FIELD APPLIED CABLE ATTACHMENT AND WEDGE ENCASEMENT

Cable attachment hardware requires the wedge to be properly encased in the cable strands and seated into the casting to insure that the cable will not slip out of the hardware.

- The wedge must be seated into the cables such that the flutes in the wedge nest with the three x strands of the cable. If not properly aligned cable slippage is possible.



- The optimum seating for the wedge is such that there is 1" of cable beyond the wedge. At a minimum, the wedge must be seated inside the cable strands such that the top of the wedge is flush with all three 7 x strands. If one strand of the three 7 x strands is not at a minimum flush, then the wedge needs to be reset.



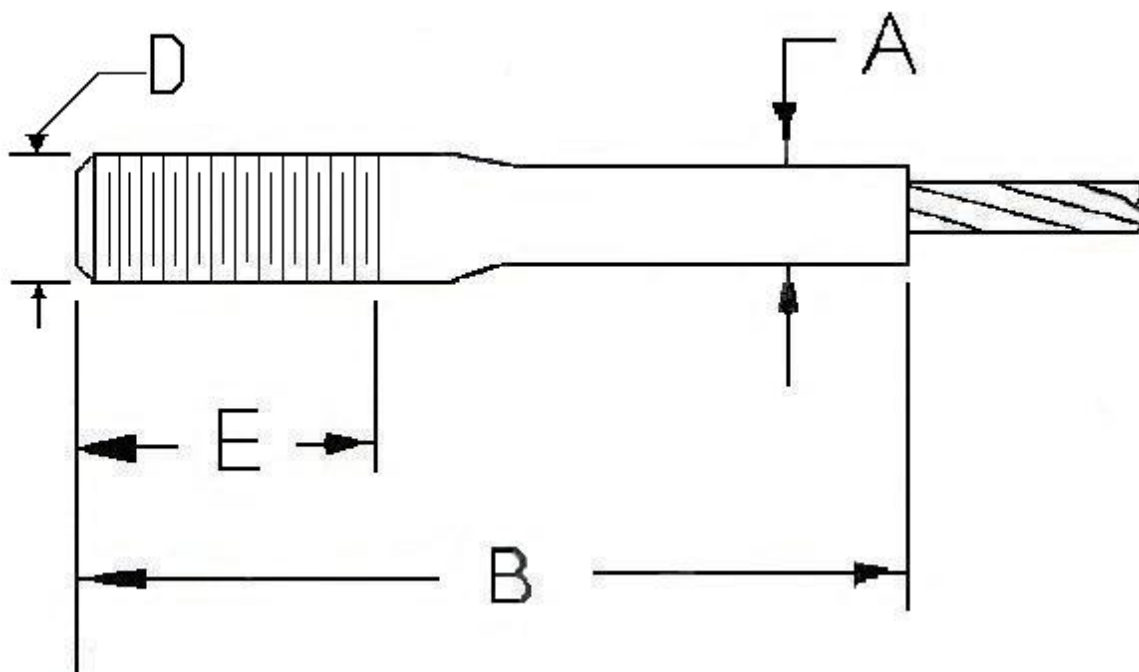
- If slippage between the wedge and strands occurs reset the wedge deeper into the strands.
- It is acceptable for the wedge to protrude up to 1/4" from the bottom of the casting as long as the wedge has been seated properly. If the wedge protrudes more it must be reset.

During the initial installation process the three 7x strands should be set in the body of the casting such that the nut has just enough room to be inserted. This will help ensure that the wedge is seated below the three 7 x strands.

WEDGE INSTALLATION

1. Some contractors choose to use a screw driver to open up the cable and separate the three 7 x strands in preparation for wedge insertion. Once the wedge is inserted into the cable it should be driven approximately 1 inch below the end of the cable.
2. Other contractors have chosen to insert the cable into the casting and twist the casting until the strands "pop open" inside the casting opening up the cable lay. The wedge is inserted into cable strands approximately 1 inch below the end of the cable. The casting is then twisted back so that the cable lay is returned to the initial position.
3. Other installation methods are acceptable as long as the wedge placement & cable engagement is correct.

FACTORY OR FIELD-APPLIED SWADGED FITTING



*NUCOR does not supply the field swadging equipment, which may be available through various rental companies. Use of factory applied swadged fittings will require exact measurements of run lengths prior to fabrication. Be sure to compensate for variations in curvatures, and anchor post spacings, when measuring distances within a run. Cables will be delivered with tagged and numbered spools for installation at a specific location.

SYSTEM SPLICING

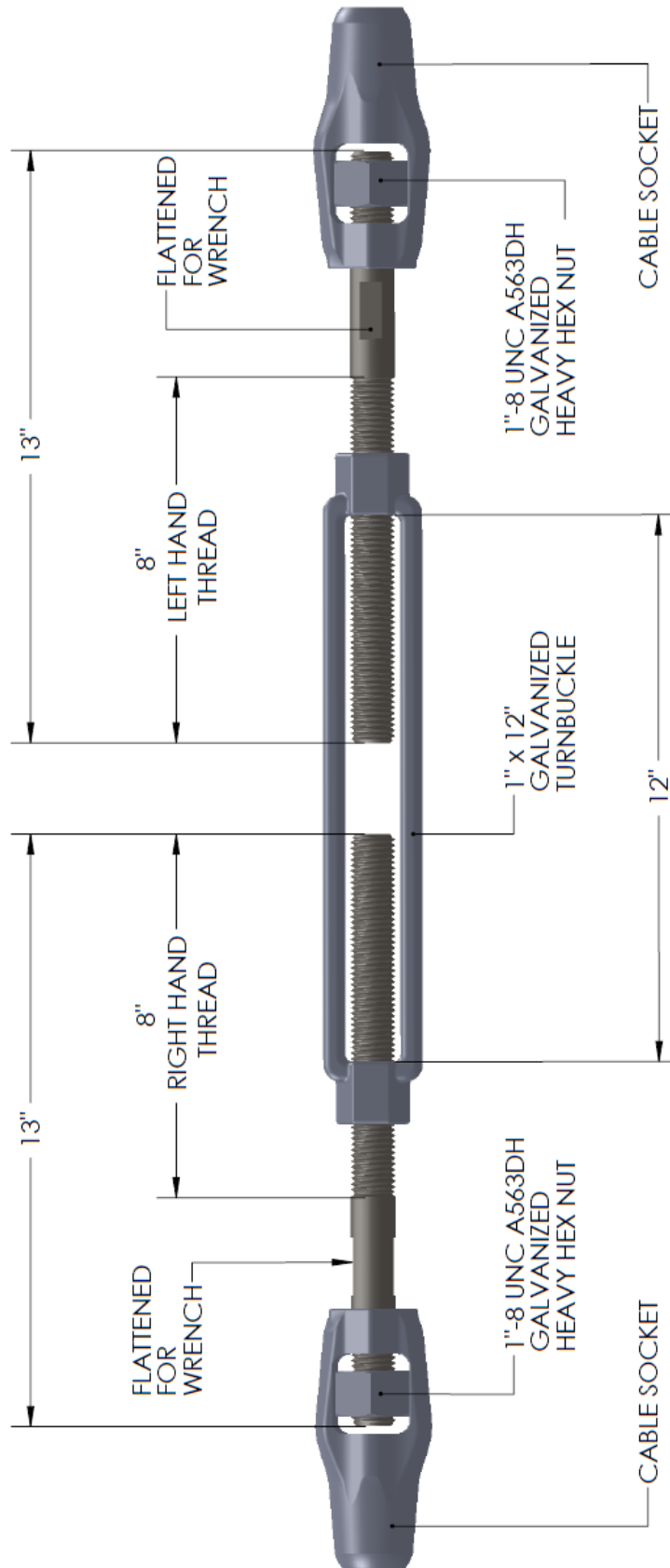


The use of a cable splice is not recommended in the Nu-Cable system. A turnbuckle should be used wherever cable sections are connected. As inspection of a cable coupling is hindered by the closed body design of a standard splice, use of a turnbuckle is strongly encouraged.

However, if needed due to odd cable lengths or for other unforeseen repair or maintenance situations, a standard splice may be used in lieu of a turnbuckle.

STANDARD TURNBUCKLE

SHOWN WITH 1" THREADED ROD



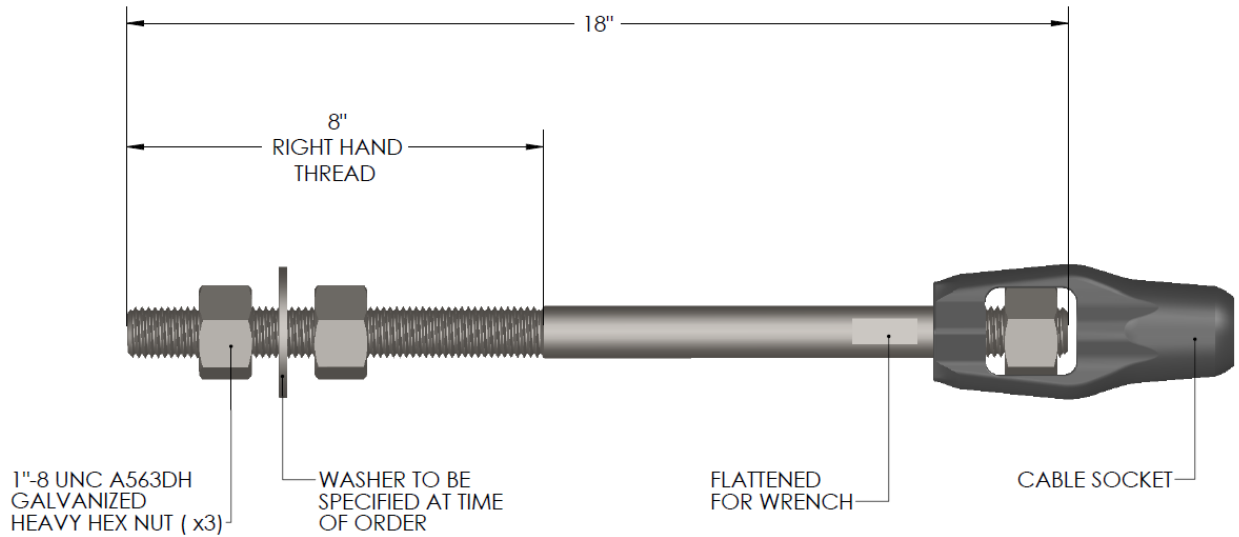
Hardware Strength (Min):

3/4" = 25,000 psi

1" = 36,800 psi

Factory Swaged = 38,000 psi

CABLE END – 18" VERSION



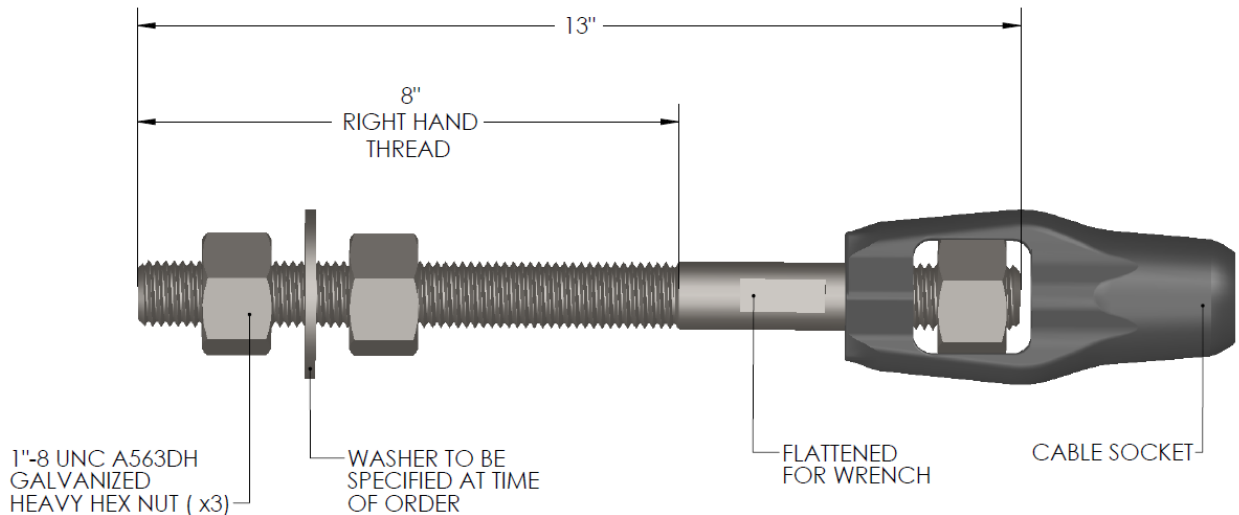
Hardware Strength (Min):

3/4" =
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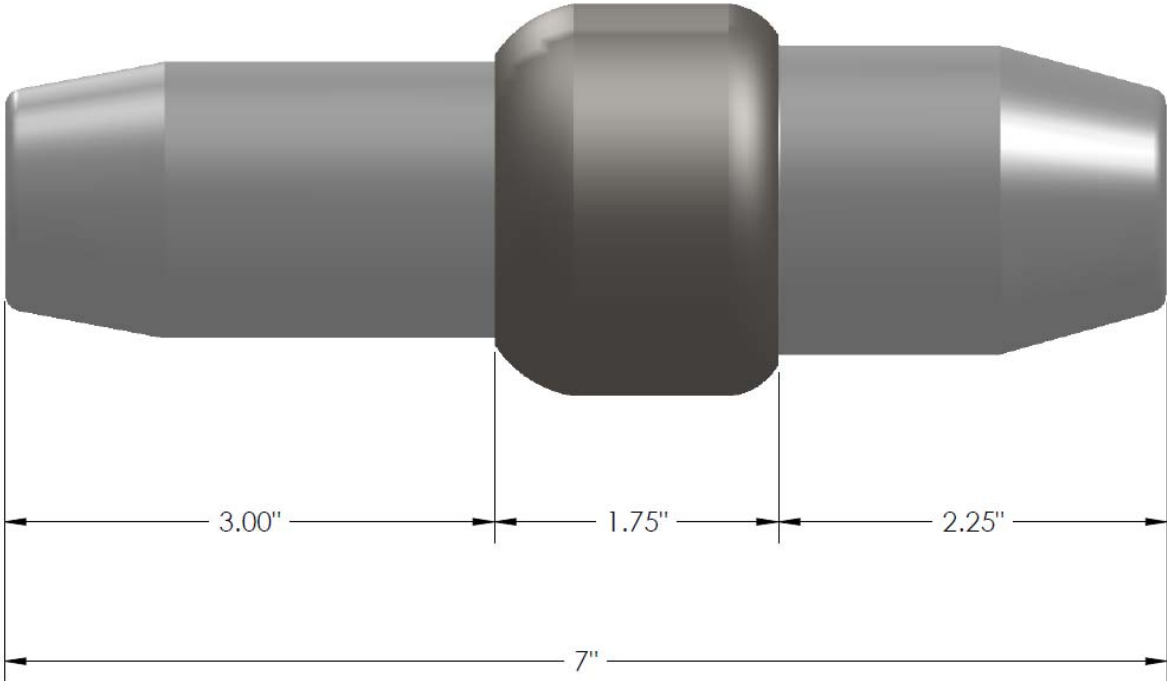
1" =
36,800 psi

Factory Swadged =
38,000 psi

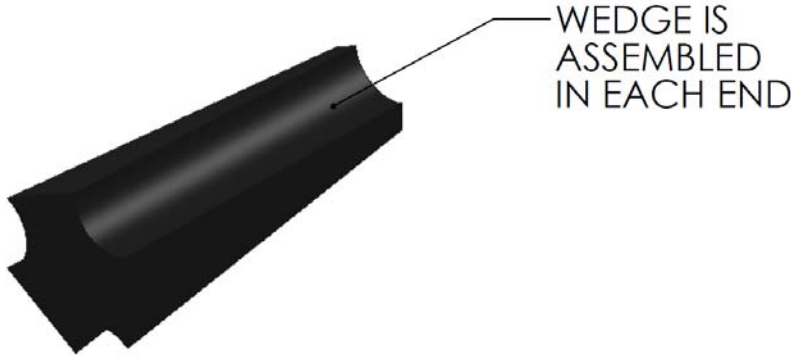
CABLE END – 13" VERSION



CABLE SPLICE



CABLE WEDGE FITTING



Nu-Cable™

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TENSIONING THE SYSTEM

Tensioning Overview

Caution: During tensioning, have safety plan in place to release tension in the event of an emergency.

The last step is setting the proper cable tension by using the turnbuckles. The cable tensioning process is a dynamic process. Regardless of the cable type (pre-stretched or standard) when the cable and cable attachment hardware are brought up to the appropriate tension the following process will occur:

- Cable and wedges will be seated into the cable hardware for the turnbuckles, cable anchor ends, and splices.
- Cable can temporarily “hang up” on hook bolts or posts creating “pinch” points. A pinch point is defined when there is difference in cable tension between cable bays. Over time the cable tension will overcome these “pinch points” and be normalized over the entire run.
- If a pinch point is recognized it can be manually released by adjusting the hook bolt to allow the cable to freely move. Pinch points may become visually evident when a line post is out of plum or a hook bolt is bent.
- Over time the fact that the cable is under tension will in itself remove the construction stretch from the cable.
- Time under tension will also physically change the cable in a fashion similar to yield hardening. This process will occur more with standard cable than pre-stretched.

Each of these processes will cause the cable to physically lengthen. Cable lengthening will cause the initial tension to decrease. Because these processes are dynamic it may take a number of temperature cycles/changes of season before the cables consistently hold tension. Longer runs may take more time for this process to occur than shorter runs. The use of pre-stretched cable will decrease the number of temperature cycles to get cable to hold tension, but its use will not eliminate the processes above from occurring. Vehicle impacts may aid in this stabilization process to some degree too.

The amount of tension in the cable barrier will affect system performance. The cables should be tensioned to the values given in the Tension Table, based upon the temperature of the cable. The tension in the cables will vary with ambient temperature changes.

Tensioning Considerations

If using standard (non-prestretched) cable, the initial tension on a new cable installation should be approximately 15% higher than the desired tension indicated in the temperature/tension table below, to allow for cable "creep." The tension tolerance is + 15-20% or up to 2500 lbs. over desired tension maximum. Most tension meters have an accuracy of about 200-300 lbs. The system should be checked 2 weeks to 3 months after installation, and then periodically over the first year, especially after seasonal changes.

After a significant impact it is recommended to check the tension. Also, check tension if an impact occurs close to an end terminal.

If tension needs to be taken up, make sure that at least 6"-12" of throw is left on the turn buckles. This may require that some length of the cable is removed. Cable should be removed adjacent to any of the attachment hardware (turnbuckles, cable anchors or cable splices.) The attachment hardware can be re-used.

Once a cable has been in service for approximately one to two years, there is no need to use the 15% creep factor after the cable has stabilized.

Best Practices:

- All cables must be checked.
- If a run is between 100ft and 1500ft – Check tension once at the mid-point of each cable.
- If a run is between 1501ft and 2500ft – Check tension twice at one-third of the length from the end treatment of each cable.
- If a run is greater than 2501ft – Check tension at three points in the run: $\frac{1}{4}$ of the length from each end treatment and at the mid point of the run for each cable.

Note: If at any point, the tension varies greater than 5%, additional tension checking needs to be done to determine where the cables are hung-up or "pinched", and a repair may be necessary.

Tensioning Turnbuckles

It is best to use a “cable pull” to get the majority of the tension into the system. Attach the cable pull to a suitable vehicle (truck, skid steer, etc.), pull the cable taut, install the cable end, and attach to the CRP. An alternate method is to attach both cable ends to the CRPs and make the final connection at the turnbuckles.

When using a hydraulic puller, tension the system, install the turnbuckle, and release the hydraulic puller. Plan to pull approximately 1' per 1000' from taut to approximately 6000 pounds tension.



Vehicle Cable Pull



Hydraulic Cable Pull



Pneumatic Cable Pull

Instead of relying on torquing the nut on the threaded rod to compress the turnbuckle, these tools pull the cable and fittings together into the turnbuckle, allowing for easier and faster connections.

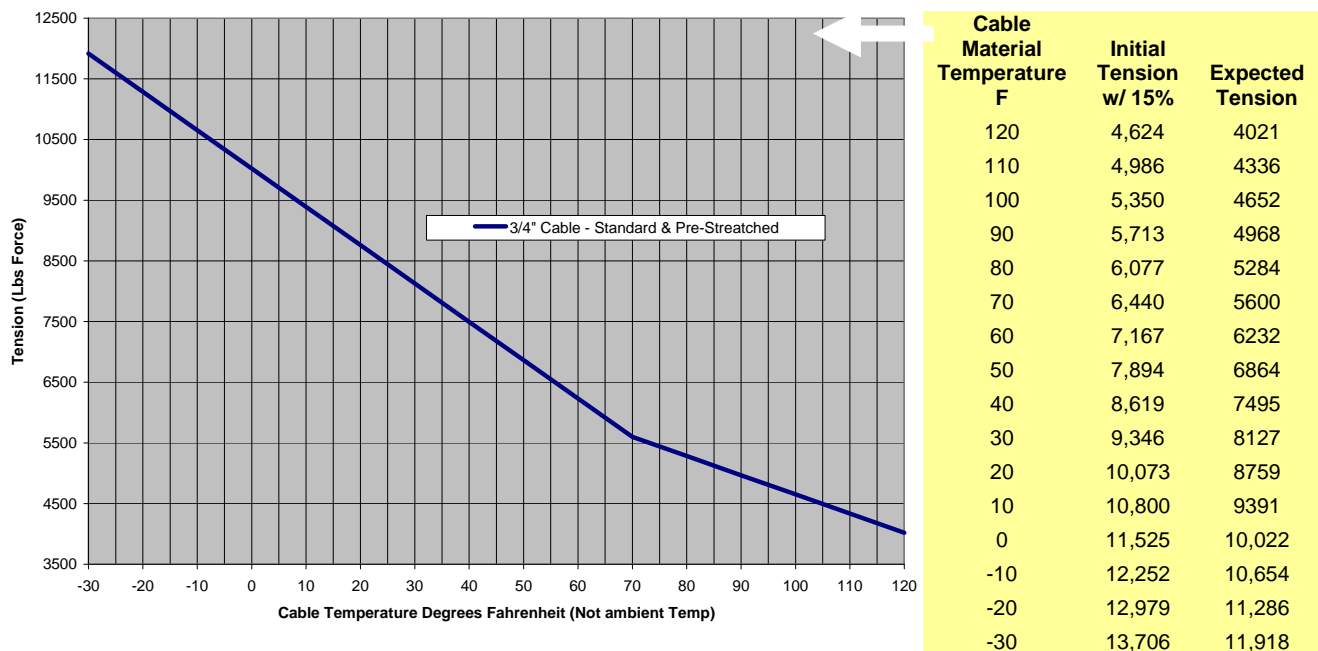
When the appropriate tension is reached, the nuts are then spun down to the bottom of the threaded cable end fittings, thus setting the turnbuckles at the correct position.

The final tension is achieved by tightening the turnbuckles. *The tension should be checked between every turnbuckle to ensure proper tension has been met throughout system.*



Be sure to leave a minimum of 6" of clear throw in each turnbuckle after tensioning. Do not "bottom out" the turnbuckles during initial installation.

Tension Table



The nominal minimum tension for the system, per cable, is 5,600 lbs. (25 kN) at 70°F (21°C).

After one year, the system should be tensioned per the table above. When the cables are properly adjusted, the cables will maintain acceptable tension over expected temperature ranges. Tension should be checked annually as a part of a standard maintenance schedule.

A Tension Log Sheet is provided in the Appendix for accurate record keeping. It is recommended that the contractor and DOT keep accurate, signed records of tension for any future reference.

Tension Log – 3-Cable Systems

NUCOR STEEL MARION INC.

U.S. HIGH TENSION CABLE TENSION LOG SHEET:

If using standard (non-prestretched) cable, the initial tension on a new cable installation should be approximately 15% higher than the desired tension indicated in the temperature/tension table below, to allow for cable "creep."

The tension tolerance is +15 to 20% or up to 2500 lbs. over desired tension maximum.

The system should be checked 2 weeks to a month after installation, and then periodically over the first year, especially after seasonal changes.

Once a cable has been in service for approximately one year, there is no need to use the 15% creep factor.

Date: _____

Location: _____

Project I.D. # _____

Installer: _____

Cable Deg. F	Initial Tension 15% Higher	Tension LBS
120	136	4,021
110	127	4,336
100	115	4,652
90	104	4,968
80	92	5,284
70	81	5,600
60	69	6,232
50	58	6,864
40	46	7,496
30	35	8,127
20	23	8,759
10	12	9,391
0	0	10,022
-10	-12	10,654
-20	-23	11,286
-30	-36	11,918

Recommendations:	Date:	Top Cable Temp	Top Cable Tension	Middle Cable Temp	Middle Cable Tension	Bottom Cable Temp	Bottom Cable Tension	Hardware Replaced	Posts Replaced	Notes:	Initials:
Installation											
30 days after install											
6 to 8 months											
At 1 year											
1.5 years											
After any Accident or repair											
After any Accident or repair											
After any Accident or repair											
After any Accident or repair											
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After any Accident or repair											
After any Accident or repair											

NOTES:
 Please reference temperature chart for correct tension settings.
 Please note any changes & repairs in the notes section (attach accident report & pictures if possible).
 Hardware and post inspections are visual please put check mark in appropriate box.

Tension Log – 4-Cable Systems

NUCOR STEEL MARION INC.

NL-CABLE TL-3; 4-CAB_E & TL-4; 4-CABLE TENSION LOG SHEET

Date: _____
 Location: _____
 Project ID # _____
 Installer/Contractor: _____

Please reference temperature chart for correct tension settings.
 Please note any changes & repairs in the notes section (attach accident report & pictures if possible).
 Hardware and post inspections are visual, and note status in appropriate box.

Cable Deg. F	Initial Tension LBS	Tension 15% Higher	Tension LBS
120	138	159	4,021
110	127	146	4,336
100	116	134	4,652
90	104	122	4,968
80	92	110	5,284
70	81	98	5,600
60	69	86	5,916
50	58	74	6,232
40	46	62	6,548
30	35	50	6,864
20	23	38	7,180
10	12	26	7,496
0	0	14	7,812
-10	-12	2	8,128
-20	-23	-10	8,444
-30	-35	-22	8,760

If using standard cable (non "pre-stretched") in the TL-3 system, the initial tension on a new cable installation should be approximately 15% higher than the desired tension indicated in the table to allow for cable "creep".

The tension tolerance is +/- 5 to 20%, or up to 2500 lbs. over desired tension maximum.

The system should be checked every 2 weeks to a month after installation, and then periodically over the first year, especially after seasonal changes.

Once a cable has been in service for approximately one year, there is no need to use the 15% creep factor.

Inspection Schedule	Date	Top Cable Temp.	Top Cable Tension	Upper-Mid Cable Temp.	Upper-Mid Cable Tension	Lower-Mid Cable Temp.	Lower-Mid Cable Tension	Bottom Cable Temp.	Bottom Cable Tension	Notes	Hardware Replaced?	Posts Replaced & Count	Initials
Installation													
30 Days After													
6-8 Months													
At 1 year													
At 1.5 years													
After Repair													
After Repair													
After Repair													
After Repair													
After Repair													
After Repair													
After Repair													
After Repair													
After Repair													
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After Repair													
After Repair													
After Repair													
After Repair													
After Repair													
After Repair													

Nu-Cable™

Cable Barrier Systems

INSTALLATION MANUAL

SECTION G BARRIER INSTALLATION CHECKLISTS

CONTENTS

INSTALLATION CHECKLIST 2



It's Our Nature.® 

INSTALLATION CHECKLIST

- Are all the cables positioned at the correct height?
- Are the cables properly tensioned?
- Are there irregular curves or joints where an errant vehicle might snag?
Is there evidence of corrosion or damage to the cable? The cable should be scheduled for repair if either of these circumstances exists.
- Check to see that nuts are installed on the special locking hook bolts.
- Check that there is enough thread at the cable connections to allow for future tensioning or repairs.
- Is there sufficient soil behind the posts to prevent them from being pushed out when the barrier is hit? Eroded or disturbed soil should be replaced and compacted.
- Is the post spacing correct?
- Is there evidence of corrosion or damage to the posts? The posts should be replaced if either of these circumstances exists.

TEST LEVEL 3 4:1 SLOPE & TEST LEVEL 4:

- Has the quick-release clip been installed properly at the top of the post?
- Has the clip retainer strap been installed over the quick-release clip?
- Is the grading and slope appropriate for the system to be installed?
- Is the grading consistent and has been completed correctly?
- Are there any storm drains, culverts or other obstructions that could interfere with the barrier?
- Is there anything in front of the cable barrier that might cause a vehicle to vault the barrier or make the barrier ineffective? Items to look for include vegetation, rough ground, debris, or hard packed snow. These items should be removed if present.
- Is there enough clearance between the barrier and the hazard for the expected barrier deflection? Minimum clearance is dependent upon post spacing.

TEST LEVEL 3 - 4:1 Slope:

- Has the system been located 4' 0" (1219mm) from the break of the slope?
- Is the slope 4:1?

Nu-Cable®

Cable Barrier Systems

INSTALLATION MANUAL

SECTION J SYSTEM DELINEATION

CONTENTS

DELINEATION.....	2
POST CAPS.....	3



It's Our Nature. 

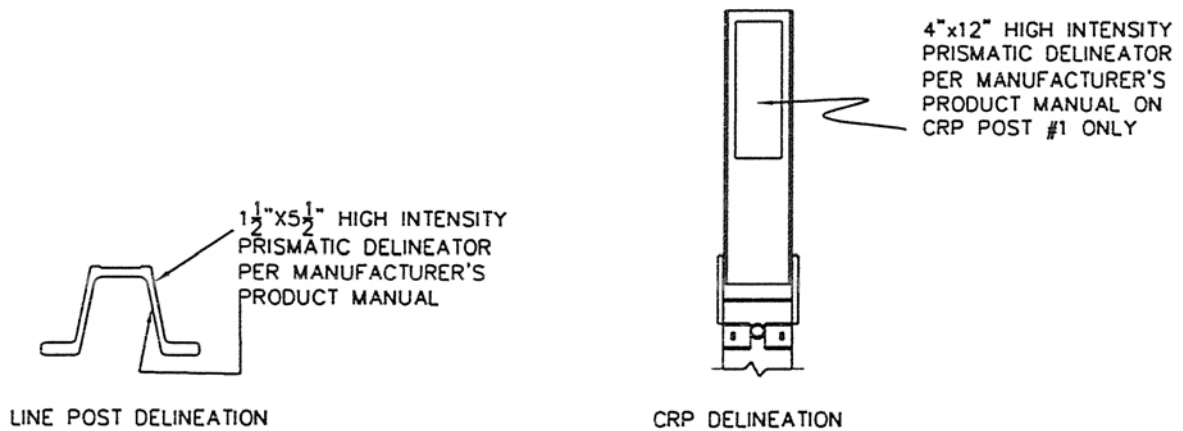
DELINEATION

System delineation is not typically supplied with the Nu-Cable® barrier system due to the wide variety of delineation specifications between states. Delineation should be installed as directed by the engineer.

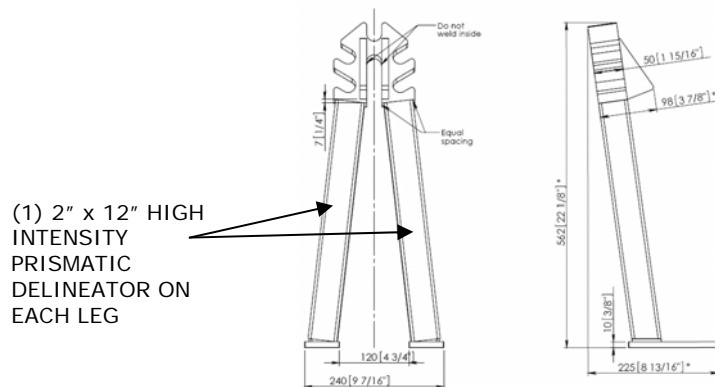
The bonding surface must be relatively clean and dry. Contaminated surfaces should be cleaned with a 50-50 Isopropyl Alcohol and water mixture. Use a lint-free cloth. Substrate temperature must be above 50 degrees F for proper adhesion.

Primer should be shaken well before using. Apply a thin, uniform coating to the bonding surface using the minimum amount that will fully coat the surface. Allow to dry completely before applying tape.

Remove backing from pressure-sensitive reflective sheeting and apply pressure by rolling or rubbing to ensure good contact.



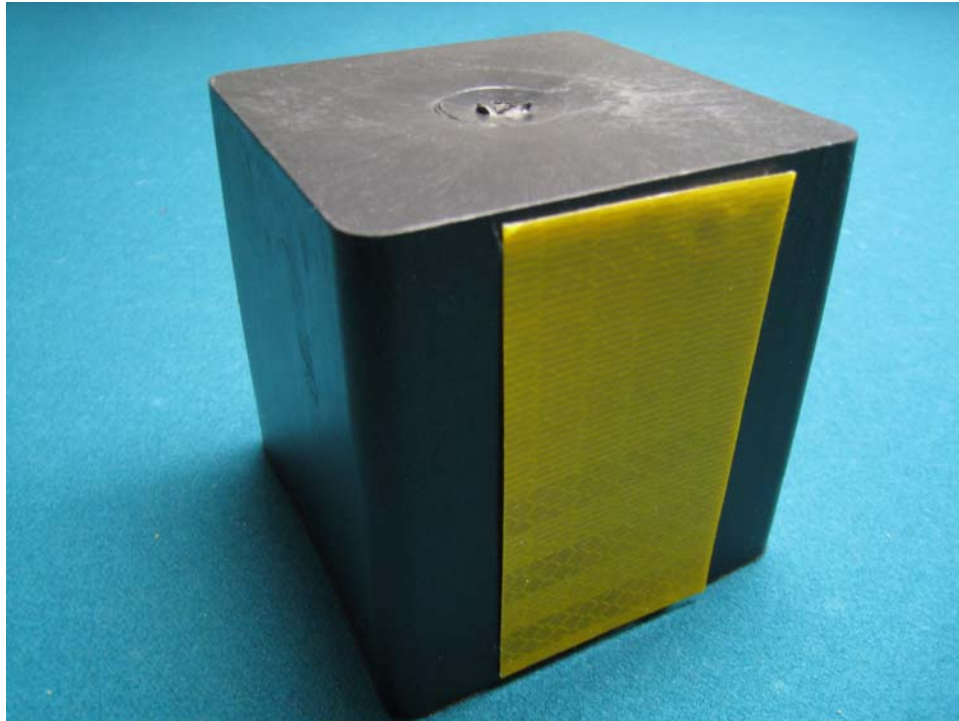
DELINEATION DETAILS



NU-TEN TRIGGER POST

POST CAPS

Optionally required based on project specifications.



The Nu-Cable systems that only use hook bolts (TL3 – 3 or 4 cable for 6:1 slopes) have the line post firmly inside the center grooves of the cap.



The Nu-Cable systems that use hangers and straps (TL3 for 4:1 slopes or TL4 for 6:1 slopes) have the line post inserted all the way to the top of the cover utilizing the top grooves.



Adhesive is optional for securing the caps to the line posts.

Nu-Cable™

Cable Barrier Systems

INSTALLATION MANUAL

SECTION L
APPENDIX: SYSTEM DETAILS

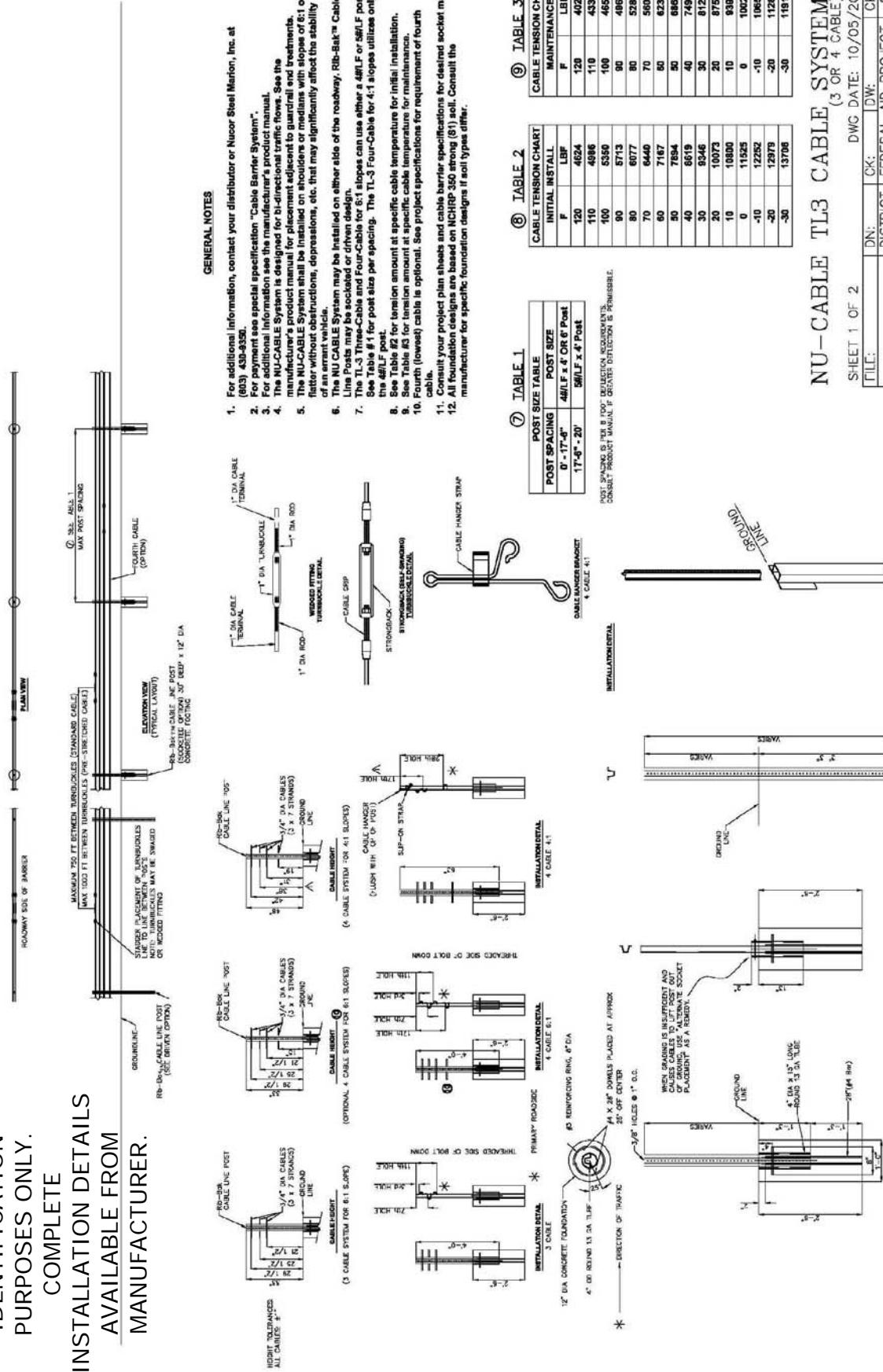
CONTENTS

TL-3 SYSTEMS.....	2
TL-4 SYSTEMS.....	3



It's Our Nature. 

DETAILS FOR IDENTIFICATION PURPOSES ONLY. COMPLETE INSTALLATION DETAILS AVAILABLE FROM MANUFACTURER.



GENERAL NOTES

- For additional information, contact your distributor or Nucor Steel Marion, Inc. at (803) 439-8350.
- For payment see special specification "Cable Barrier System".
- For additional information see the manufacturer's product manual.
- The NU-CABLE System is designed for bi-directional traffic flows. See the manufacturer's product manual for placement adjacent to guardrail end treatments.
- The NU-CABLE System shall be installed on shoulders or medians with slopes of 6:1 or flatter without obstructions, depressions, etc. that may significantly affect the stability of an errant vehicle.
- The NU-CABLE System may be installed on either side of the roadway. Rib-Bak™ Cable Line Posts may be socketed or driven design.
- The TL-3 Four-Cable and Four-Cable for 6:1 Slopes can use either a 48/LF or 56/LF post. See Table #1 for post size per spacing. The TL-3 Four-Cable for 4:1 slopes utilizes only the 48/LF post.
- See Table #2 for tension amount at specific cable temperature for initial installation.
- See Table #3 for tension amount at specific cable temperature for maintenance.
- Fourth (lowest) cable is optional. See project specifications for requirement of fourth cable.
- Consult your project plan sheets and cable barrier specifications for desired socket material.
- All foundation designs are based on NCHRP 350 strong (S1) soil. Consult the manufacturer for specific foundation designs if soil types differ.

TABLE 1

POST SPACING	POST SIZE
17'-5" - 20'	48/LF x 4' OR 6' Post
20' - 24'	56/LF x 4' Post

NOTE: SPACING IS PER 8' TYP. REDUCTION AMOUNTMENT IS CORRECT PROJECT MANUAL IF DRIVER DEFLECTION IS PERMISSIBLE.

TABLE 2

CABLE TENSION CHART INITIAL INSTALL.	
F	LB/F
120	4624
110	4986
100	5350
90	5713
80	6077
70	6440
60	7167
50	7894
40	8619
30	9346
20	10073
10	10800
0	11525
-10	12252
-20	12979
-30	13706

TABLE 3

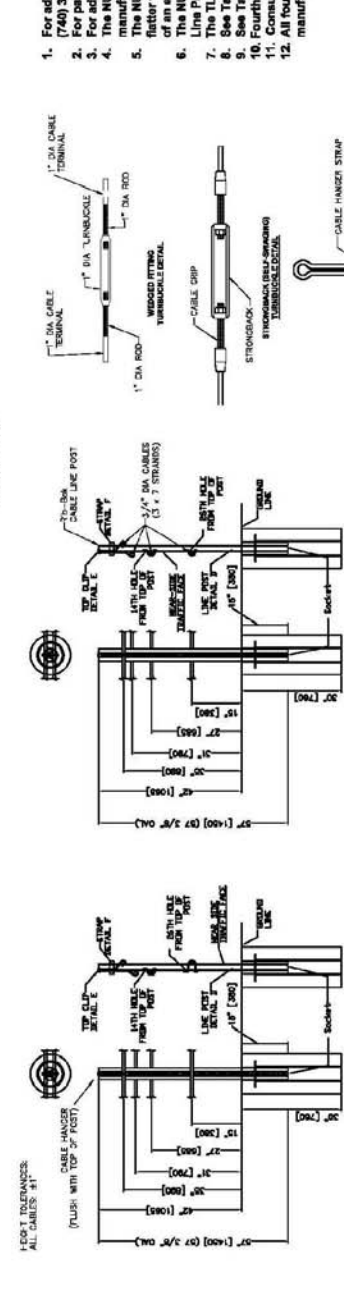
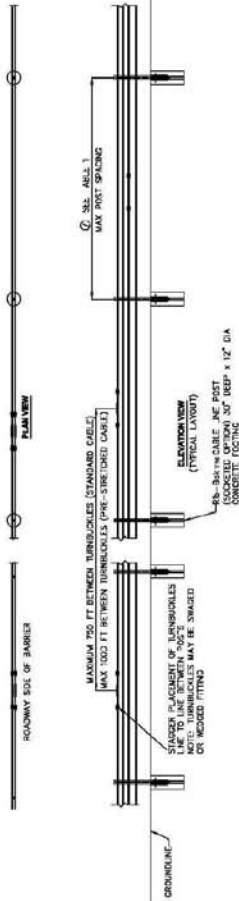
CABLE TENSION CHART MAINTENANCE	
F	LB/F
120	4021
110	4395
100	4652
90	4968
80	5284
70	5600
60	6232
50	6864
40	7495
30	8127
20	8759
10	9391
0	10022
-10	10654
-20	11286
-30	11918

NU-CABLE TL3 CABLE SYSTEM
(3 OR 4 CABLE)

SHEET 1 OF 2
DWG DATE: 10/05/2008

DN:	CK:	DW:	CK:
DISTRICT	FEDERAL AID	PROJECT	SHEET
COUNTY	CONTROL	SECT	JOB
REVISIONS		CONTROL	SECT
DATE: 10/05/08		CONTROL	SECT

DETAILS FOR IDENTIFICATION PURPOSES ONLY. COMPLETE INSTALLATION DETAILS AVAILABLE FROM MANUFACTURER.



LENGTH OF NEED POSTS
MEDIAN CONFIGURATION

LENGTH OF NEED POSTS
ROADSIDE CONFIGURATION

7 TABLE 1

POST SPACING	POST SIZE
0'-17'-6"	48ALF x 57" Post
17'-6" - 20'	48ALF x 57" Post

POST SPACING IS PER 8' FOOT DEFLECTION REQUIREMENTS. CONSULT PRODUCT MANUAL FOR GREATER DEFLECTION & PERMISSIBLE.

8 TABLE 2

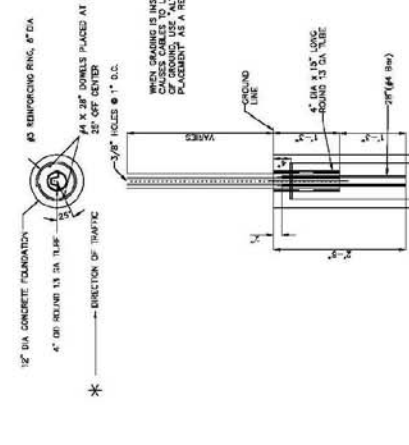
CABLE TENSION CHART	
INITIAL INSTALL	MAINTENANCE
F	LBF
120	4624
110	4396
100	4240
90	4084
80	3928
70	3772
60	3616
50	3460
40	3304
30	3148
20	2992
10	2836
0	2680
-10	2524
-20	2368
-30	2212

9 TABLE 3

CABLE TENSION CHART	
INITIAL INSTALL	MAINTENANCE
F	LBF
120	4021
110	3856
100	3691
90	3526
80	3361
70	3196
60	3031
50	2866
40	2701
30	2536
20	2371
10	2206
0	2041
-10	1876
-20	1711
-30	1546

GENERAL NOTES

- For additional information, contact your distributor or Nucor Steel Merion, Inc. at (740) 383-4011.
- For payment see special specification "Cable Barrier System".
- For additional information see the manufacturer's product manual.
- The NU-CABLE System is designed for bi-directional traffic flows. See the manufacturer's product manual for placement adjacent to guardrail end treatments.
- The NU-CABLE System shall be installed on shoulders or medians with slopes of 6:1 or flatter without obstructions, depressions, etc. that may significantly affect the stability of an errant vehicle.
- The NU CABLE System may be installed on either side of the roadway. Rib-Sak™ Cable Line Posts may be socketed.
- The TL-4 for 6:1 slopes can use a 48LF post. See Table # 1 for post size per spacing.
- See Table #2 for tension amount at specific cable temperature for initial installation.
- See Table #3 for tension amount at specific cable temperature for maintenance.
- Fourth (lower) cable is not optional on the TL-4 system.
- Consult the manufacturer's product manual for additional specifications for designed socket material.
- All foundation designs are based on MCHRP 350 strong (S1) soil. Consult the manufacturer for specific foundation designs if soil types differ.



NU-CABLE TL4 CABLE SYSTEM

SHEET 1 OF 2 DWG DATE: 10/05/2009

FILE:	DN:	CK:	DW:	CK:
	DISTRICT:	FEDERAL AID:	PROJECT:	SHEET:
	COUNTY:	CONTROL:	SECT:	JOB:
	REVISONS			FIGWAY:
	Amen.05.05.cad			

Nu-Cable™

Cable Barrier Systems

INSTALLATION MANUAL

SECTION M
APPENDIX: TESTING SOIL CONDITIONS

CONTENTS

SOIL TESTING..... 2



It's Our Nature. 

SOIL TESTING

This section includes information relevant to determining the soil density & conditions at a specific location. The processes and steps listed here are referenced throughout the manual to determine installation modifications to the system foundations required in order to maintain performance in weak, or soft, soils.

CAUTION: The options shown below are examples of typical foundations for use in strong or weak soil conditions. They should not be assumed to be the only options available. If soil conditions at each location are unknown or do not meet the minimum requirements for strong or weak soil as outlined in Section M, a geotechnical review by a professional engineer shall be conducted prior to starting installation. The results of this evaluation shall determine foundation design at each location.

In order to verify site soil as a particular soil using a DCP (Dynamic Cone Penetrometer) or SV (Shear Vane), please reference the following table and instructions:

Cohesive Soils	
Description Su (kpa)	Foundation Pile Depth NU-CABLE LINE POST
50 - 75	450mm ø x 900-1200mm (18"ø x 36-48") *(As Specified Per Project Engineer)
76 - 125	300mm ø x 750mm (12"ø x 30")
Cohesionless Soils	
Description Phi (0)	Foundation Pile Depth
30 – 41	450mm ø x 900-1200mm (18"ø x 36-48") *(As Specified Per Project Engineer)
>41	300mm ø x 750mm (12"ø x 30")

Table 1

- Purchase the DCP equipment.
- Purchase the ASTM publication ASTM STP 399 (available at the ASTM website) that describes the test procedure
- Submit that to the state or project engineer to make sure the tool is acceptable to them.
- The manual shows a curve that correlates the blow count from the DCP to a Standard Penetration Test (SPT) blow count. For native soil, a blow count of 15 (DCP) is equivalent to a Standard Penetration Testing (SPT) blow counts of 10 blows per foot.
- Once the SPT blow counts are known, we can use them to calculate the undrained shear strength (Su) of the cohesive soil as follows:
 - Su (kPa) = Converted SPT blow count x 5 this is the units included in the NU-TEN manual
 - Or
 - Su (ksf) = Converted SPT blow count /10
- If the blow count in the field is less than 15, then the foundations will have to be increased because the soil will not qualify as stiff.
- Need to make sure whoever runs the test out in the field is familiar with the procedure. It is very easy to make a mistake about procedure of using this particular tool. Whoever performs the test in the field will have to assume responsibility for the results.
- The test should be performed in one-foot intervals down to the design bottom elevation. We are interested in the strength of the soil above (at depths of 0, 6 inches, and 2 feet) the bottom elevation because this is the soil that will provide lateral resistance to the system. You cannot just drill the holes and check the bottom.

Nu-Cable®

Cable Barrier Systems

INSTALLATION MANUAL

SECTION N APPENDIX: REPAIR & MAINTENANCE

CONTENTS

REPAIR & MAINTENANCE	2
Repeat Impacts.....	2
Releasing Tension	3
Cutting Cables	3
Pavement Overlays or Resurfacing.....	4
Emergency Access.....	4
Materials for Maintenance.....	4



It's Our Nature. 

REPAIR & MAINTENANCE

The Nu-Cable® System, regardless of installation method, is very easy to repair after an impact. The longitudinal elements (the cables) of the barrier will rarely need to be replaced. Visually inspect the cables, and if necessary, use cable splices to replace damaged cable.

Damaged posts and hook bolts should be replaced.

In the case of driven posts, the damaged posts must be removed and ground repaired before driving a new post.

After a significant impact it is recommended to check the tension. Also, check tension if an impact occurs close to an end terminal.



The many factors contributing to increased deflections can, in some instances, lead to maintenance and performance issues. The Nu-Cable® High-Tension System is a low-maintenance cable barrier system. Checking the tension of the cables on an annual basis, or after a severe impact, should be adequate. If impacted, a slack cable will result in increased lateral deflections. If the slack allows for a cable to become incorrectly positioned, the propensity for vehicle under-riding may increase. After all impacts, the system requires inspection and replacement or repair of damaged parts.

Repeat Impacts

High-Tension Cable barrier systems have shown capabilities of withstanding additional vehicular impacts on a damaged barrier. Due to the high tension, the cables typically do not fall to the ground as is the case with low-tension cable systems.

Releasing Tension

In certain circumstances, it may be necessary to release the tension in the system. Those may include the need to perform a repair, or a vehicle has become entangled.

There are three common ways to release the tension in the system.

1. On a short run, in a non-emergency situation, the easiest method to release tension is to open several turnbuckles to their maximum length¹. This method allows the de-tensioning and the re-tensioning to be done with hand tools.
2. Using a cable grip and a vehicle of sufficient size, attach the cable grip to the longest end of the run not affected by the accident. Drive the vehicle towards the accident to release tension. A worker can then either take out a turnbuckle or cable splice, unscrew the terminal end connector from the CRP, or cut the cable.
3. Using a ratchet come-along (note capacity²) and two cable grips, pull the cable grips toward each other to release tension. Once tension is safely removed from the section of cable to repair, remove the nearest turnbuckle or cable splice, unscrew the terminal end connector from the CRP, or cut the cable.
4. In emergency situation, the CRPs can be longitudinally run over (slowly) with a truck. The CRPs will simply lay down and release the tension. The CRP posts can be reused. It will then be needed to replace the two 5/16" (8mm) breakaway bolts.



¹ Completely unscrewing the turnbuckle or cable anchor end, or unscrewing the cable splice at all, without first removing the tension can be unsafe. The cables will move rapidly when the threads strip out of the connection. This method is not recommended.

² Most construction come-alongs are only 2000# capacity. Capacity of come-along and cable grip must be equal or greater to the amount of tension in system. Typically 8000# to 12,000# capacity will be needed.

Cutting Cables

Although it can be done, cutting cables under tension should be done with caution. It is best to first release tension in the cables by using the turnbuckles if at all possible. A vehicle becoming entrapped in the system can create a higher-than-normal tension. In an emergency, the cables CAN be cut, by using great care, with an abrasive wheel saw. Make sure no one is near the cutting point upstream or downstream. If cutting near a turnbuckle, remove adjacent posts. Use gloves and safety goggles and cut very carefully. Pay particular attention when there are only a few strands left, at the final stage of cutting. In worst case, use a bolt cutter with long handles.



Pavement Overlays or Resurfacing

Cable heights are critical to performance of the system. If the roadway has experienced an overlay, ensure cable heights are correct, and that the slope to the barrier does not exceed the maximum allowed. For significant overlays, it may be necessary to install extra-height posts.

Where it is anticipated that future roadway construction will require increases in the roadway surface elevation, a pro-active solution is to install extra-height posts in the original installation to allow for vertical adjustment of the cables. This option is only available in Test Level 3 systems.

Emergency Access

A temporary crossover for emergency vehicles or temporary traffic control can be made at any location of the installed cable barrier by removal of the special locking hook bolts and/or cable hanger straps, thus allowing the cables to slacken. The number of posts necessary for removal depends on the tension and temperature, but normally 15-40 posts will be enough. The weight of the cable will provide enough slack for passing over with vehicles.

Materials for Maintenance

Your NUCOR distributor carries an inventory of replacement parts for the Nu-Cable® System to facilitate quick repair of an impacted system. In addition, we recommend that DOTs or maintenance authorities keep a minimum quantity of repair parts on hand.

A general rule of thumb is to stock 2% to 4% of the total project, rounded up to the minimum order quantities (below).

Line Posts	=	50 piece bundles
Small Hook Bolts	=	100 pieces
Large Hook Bolts	=	50 pieces
Cable Hanger & Retainer Strap	=	50 Bundles
CRP/Trigger posts	=	3 or 4 pairs
Turnbuckles	=	3 or 4 pairs
Cable Anchor Ends	=	3 or 4 pieces
Cable Spool	=	2000 ft.

Please contact your distributor for up to date pricing on products.

Nu-Cable®

Cable Barrier Systems

INSTALLATION MANUAL

SECTION P
APPENDIX: CONTACT INFORMATION

CONTENTS

TECHNICAL SUPPORT AND SALES 2



It's Our Nature.® 

TECHNICAL SUPPORT & SALES

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