

NUCOR U.S. High Tension Cable Barrier System

INSTALLATION MANUAL



It's Our Nature. 

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INSTALLATION CONSIDERATIONS

The US High Tension Cable system is strait forward and easy to install and can be safely installed by the use the installation manual alone. **This manual should be carefully reviewed prior to construction to ensure proper installation of the US High Tension Cable System.** The initial insulation run for any new crew will need to be supervised by a qualified Nucor Distributor or Nucor Steel Marion Inc representative, or properly trained crew that has successfully installed the system. We also strongly recommend that the first run for any new installation crew be completely installed and tensioned before attempting to start other runs. It there is ever a doubt about any part of the installation contact Nucor Steel Marion Inc (800) 333-4011 or your Nucor Distributor immediately. **Distributor contact information is listed on the last page of this manual.**

SYSTEM LAYOUT

Site Preparation

The initial layout for the US High-Tension System should be free of hazards, obstacles, and debris. The cross-slope should be **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 standards. 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.



Line Posts

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.

The **line post spacing** can be varied from **6'-6" to 20' (2m to 6m)**, depending on desired deflection. Please refer to the project plans and specifications to determine which post spacing is required for your installation. Varying post spacing can also be used when necessary due to conflicts with utilities or culverts.

It is helpful to mark every **750' (229m)** when laying out the system to aid in turnbuckle placement as you pull cable. *Mark every **1000' (305m)** if using prestretched cable.*

Anchor Posts

Each Cable Barrier Terminal Section consists of **3 (2-part) Cable Release Posts (CRP)** at **6'3"** post spacing and **6** line posts at **6'6"** post spacing.

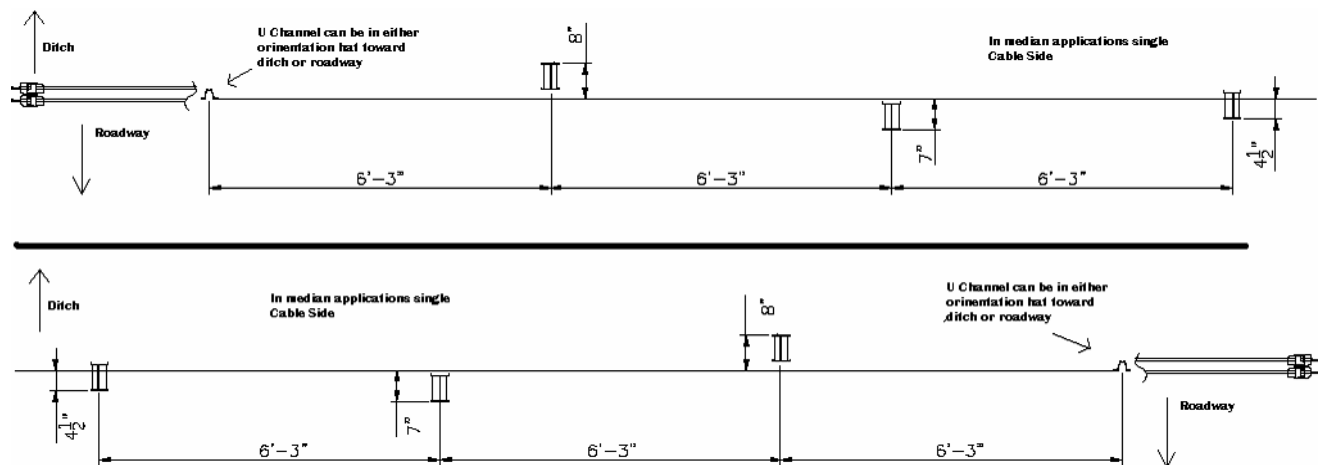
The CRP terminal posts (#1, #2 & #3) are offset from the centerline of the string line. The remaining terminal posts (#4 through #7) and all cable line posts should be centered on the string line.

Installation tolerances of the CRP locations are as follows:

- +/- 12 inches parallel to the system**
- +/- 6 inches perpendicular to the system***

*CRP posts may be in contact with cables leading to other posts, but may not cause more than ½ inch deflection.

Note that the opposing end treatments on a particular run are mirrored in their layout (see figure below).



INSTALLING POSTS

Anchor Posts

There are **two** options for installing CRPs. They can be either cast-in-place in a concrete footing or directly embedded (driven), depending upon project specifications.

Option 1: Driven CRP posts with soil plate

For permanent or temporary usage or where soil is known to be very strong, there is an option of installing CRP post without a concrete footing. The CRP post base is **72" (1829mm)** long and has a **1/4" x 18" x 48" (6mm x 457mm x 1219mm)** welded soil plate. Attach the CRP top to the base with the **two 5/16" (8mm)** breakaway bolts provided. Where soils are weaker than NCHRP 350 strong soil consult the manufacturer for special CRP post anchors that can be designed to appropriately meet the demands of your soil conditions.

Option 2: CRP posts cast-in-place

In strong soil conditions drill **18" (457mm)** diameter x **5'-0" (1524mm)** deep hole. Place steel reinforcement as detailed on plan standard. Plumb posts and pour concrete. Be sure to not leave more than **4" (102mm)** of the CRP post base exposed above the ground line. It is easier to plumb the CRP bases with the CRP top posts attached. Attach the CRP top to the base with the **two 5/16" (8mm)** breakaway bolts provided.



Option 3: Precast CRP posts

Use an **18" (457mm)** diameter x **5'-0" (1524mm)** form. Some contractors have found that modifying a standard section of 18" 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 **4" (102mm)** of the CRP post base exposed above the ground line. It is easier to plumb the CRP bases with the CRP top posts attached. The back fill material needs to be strong soil, compacted in **6" (162mm)** lifts with a hydraulic tamper.



Soft Soil foundations options for the CRP posts

CRP foundations in soft soil should be a minimum of **8'** in depth with an **18"** diameter shaft; use **12"** rebar cage reinforced with **#5's at 6"** O.C. with straps. Pouring a monolithic concrete pad for all three CRP post is also a viable option.

- ***For embedment less than 5'***: Use a **4'** wide x **3'** deep monolithic concrete pad that spans the length of all **3** of the CRP posts. It will need to extend **2'** past each end CRP Post; total length being approximately **16.5'**. Use **#5** steel reinforcement bars equally spaced at **6"** O.C.
- ***For embedment depth of 5' to 5.9'***: Drill a **48"** diameter shaft. Use a **40** rebar cage reinforced with **#5's** equally spaced at **6"** O.C. with straps.
- ***For embedment depth is 6' -6.9'***: Drill a **36"** diameter shaft. Use a **30** rebar cage reinforced with **#5's** equally spaced at **6"** O.C. with straps.
- ***Embedment depth is 7' -7.9'***: Drill a **24"** diameter shaft. Use an **18** rebar cage reinforced with **#5's** equally spaced at **6"** O.C. with straps.

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

- Direct Driven CRP foundations are **8'** in length with attached soil plate.

Line Posts

There are **two** options for installing the line posts. They can be either directly embedded (driven) or installed in sockets, depending upon project specifications.

The system can be installed using either a 4# or 5# Rib-Bak[®] Line Post.

- ❑ 20' TL3 system use 5# Rib-Bak[®] Line Post
- ❑ All other current TL3 system options use 4# Rib-Bak[®] Line Post

Option 1: Direct-Driven Line Post

The direct embedment method uses **72"** (1829mm) Rib-Bak[®] Line Post with no soil plate required. Direct driven line posts are driven into natural 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.



Option 2: Socketed Foundation, Concrete Footing

The socketed method utilizes a **12 GA 4" OD x 15"** (102mm x 381mm) steel socket set into a **12" diameter x 30" deep** [305mm x 768mm] concrete footing. The socket depth is assumed to be in NCHRP 350 strong soil. In weak soil or where the frost line is below **30"** (305mm) the depth of the socket should be increased to accommodate.

The concrete foundation is strengthened with **one #3** steel reinforcing ring and **two #4 x 28"** steel dowels. 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.



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 **2"** (51mm) above ground level with no less than 13" (330mm) embedment. After concrete has set, drill a **3/8"** (10mm) hole as close to the base of the footing as workable to install a **5/16"** (8mm) bolt to hold the post in place. The socketed method requires a **48"** (1219mm) Rib-Bak[®] Cable Line Post. The top of the line post should be **33"** (838mm) above ground after installation.



Option 3: 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 **not** leave more than **2"** (51mm) 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.



INSTALLING CABLE

The cable used in the U.S. High-Tension 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 two different methods contractors have used to transport and pull cable.



Cable-to-Post Connections

Each cable is attached to each post using a **5/16"** [8mm] diameter locking hook bolt. **Right-side-of-the-road** applications have all **3** cables on the travel side of the line posts. When installing the cable barrier in a **median**, the **lower and upper** cables should be located on the post side closest to the **roadway**, and the **middle** cable should be located on the **opposite** side.



MEDIAN

RIGHT-SIDE

MEDIAN

US High-Tension System cable heights measured at the middle of the cable are as follows:

	Top	Middle	Bottom
Median & Roadside	29.5 in	25.5 in	21.5 in
	±1"	±1"	+0"/-2"
	(750mm)	(650mm)	(545mm)

Please **see *Cable Terminal End Installation detail*** in the Addendum for terminal end cable heights which vary on posts #4 -#9. **Tolerances** for all posts are **±1"** for the top and middle cable, and **+0"/-2"** for the bottom cable.

Connecting Cable Ends

To connect the cables to the terminal, affix a cable end anchor to the end of each cable. **Grease** is recommended on all threaded rods to ease tensioning.



Insert the cable end anchor into the CRP post and through the L-Bracket, and install double nuts. The bottom cable shall be attached to CRP #3, the middle cable to CRP #2, and the top cable to CRP #1. **Before putting final tension in system, ensure the L-Bracket is properly situated as show below.**



Leave nuts as far down on the threads as possible to leave yourself ample room for tensioning the cables. Run the cable along the ground to the respective turnbuckle location. Cut the cables and affix to one end of the turnbuckle. Attach the other end of the turnbuckle to the adjacent segment of cable and then connect the turnbuckle leaving the maximum amount of threads for tensioning. Repeat for all three cables to end of run.



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 wedge needs to be at minimum 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 minimum flush then the wedge need to be reset. The optimum seating for the wedge is such that there is 1" of cable is beyond the wedge.



- 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 insure 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.

Connection Hardware



Insert the special locking hook bolts (pictured at left) 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 long hook bolt is used on median applications only.

Turnbuckles

Turnbuckles are used to achieve the appropriate tension in the system. In a system using **standard** cable, install one turnbuckle per cable every **750'** (229m). If your run is **750'** long (229m), install the turnbuckle near the middle. If using **prestretched** cable, you can install turnbuckles every **1000'** (305m). Note: You can install more turnbuckles than the minimum amount above if conditions require this option. Some maintenance crews have successfully used turnbuckles in place of cable splices.

We recommend not putting all the turnbuckles between the same two posts. 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 your 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.



System Splicing



A splice may be used where needed. If an open faced splice is needed, use a turnbuckle instead of the standard splice.

Prestretched Cable Option

Factory prestretched cable can be used in the U.S. High-Tension Cable System; however, it is not required for the system to function as designed.

If you are using factory pre-stretched cable, it is allowable to increase the distance between turnbuckles to 1000 feet.

Tensioning the System

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.



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. Using a hydraulic puller, tension the system, install the turnbuckle, and release the hydraulic puller. Plan to pull approx **1' per 1000'** from taut to **6000** pounds tension.



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.*

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**.

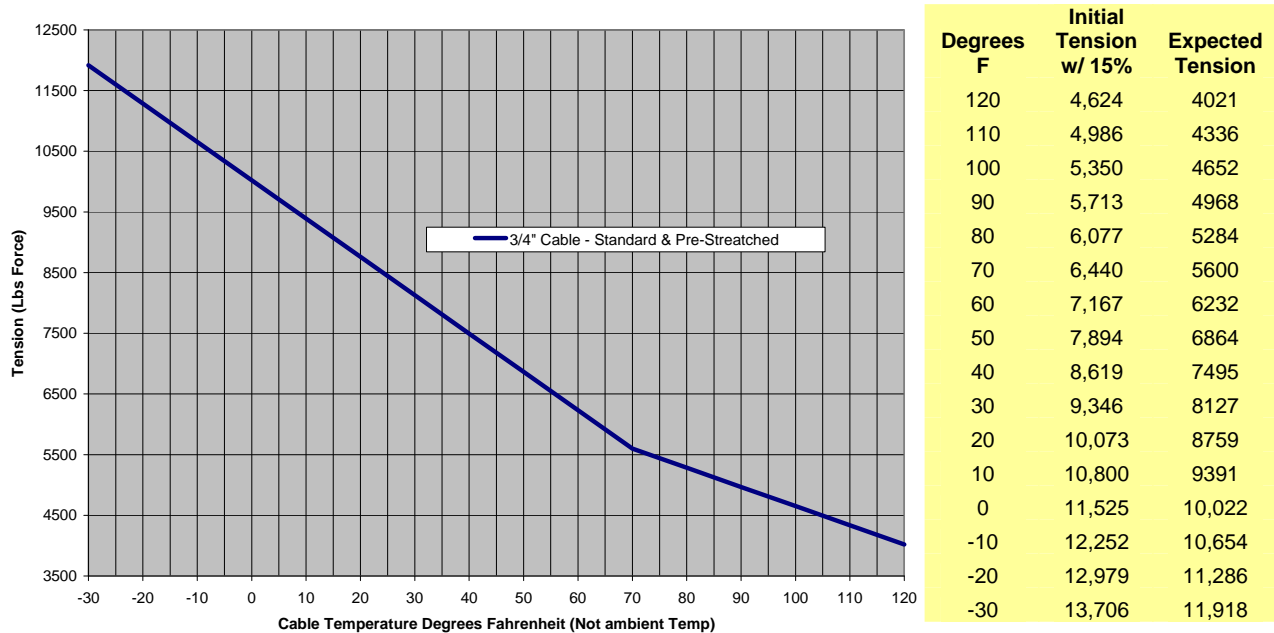
After a significant impact it is recommended to check the tension. Also, check tension if an impact occurs close to an end terminal.

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.

Tension Table



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. **We recommend the contractor and DOT keep accurate, signed records of tension for any future reference.**

DELINEATION

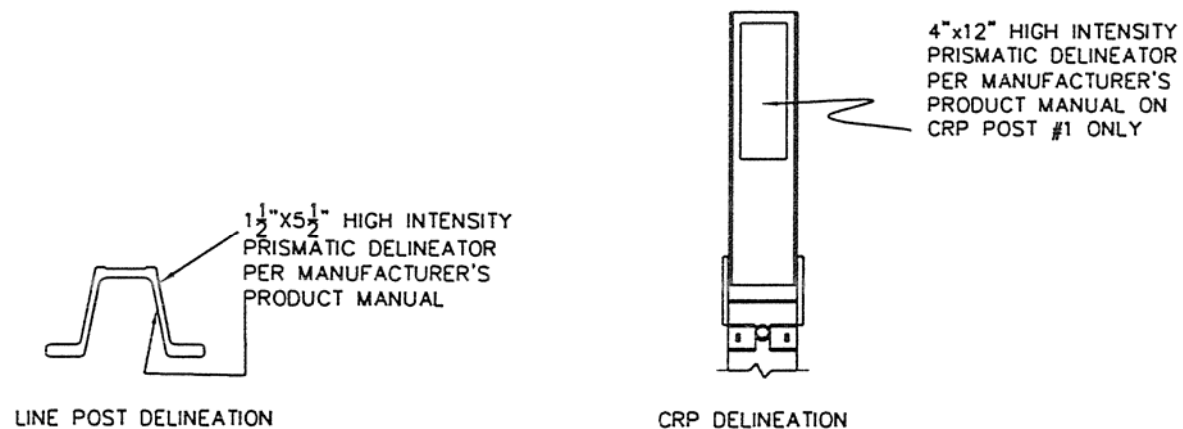
System delineation should be as shown on the US High Tension Cable standard drawing or as directed by the engineer.

Adhesive delineators shall be 3M High Intensity Prismatic #3931 Reflective Sheeting. Primer shall be **3M #94 Primer**.

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.

#94 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

REPAIR & MAINTENANCE

The Nucor US High-Tension 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 also lead to maintenance and performance issues. The US 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 that you can 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 detensioning and the retensioning 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. You can then 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 that you intend to repair, you can then take out a 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. You will simply need 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. 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.



Overlays

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.

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 allowing the cables to slacken. The number of posts necessary for removal depends on the tension and temperature, but normally 25-40 posts will be enough. The weight of the cable will provide enough slack for passing over with vehicles.

Materials for Maintenance

Your distributor may carry an inventory of replacement parts for the Nucor U.S. High Tension Barrier System. However, we recommend that DOT's keep repair parts on hand for quick repair of an impacted system.

A general rule of thumb is for DOTs 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
CRP posts	=	3 pairs
Turnbuckles	=	3 pairs
Cable Anchor Ends	=	3 pieces
Cable Spool	=	2000 ft.

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

INSTALLATION CHECKLISTS

Cable Checklist

- 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.
- Has the roadside grading been completed correctly?
- Is there enough clearance between the barrier and the hazard for the expected barrier deflection? Minimum clearance is dependent upon post spacing.
- Is the cable barrier the correct height?

Cable heights measured to the middle of the cable are as follows:

	Top	Middle	Bottom
Median & Roadside	29.5 in [750 mm]	25.5 in [650 mm]	21.5 in [545 mm]

- 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 exist.
- Check to see that nuts are installed on the special locking hook bolts.

Post Checklist

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 recompact.

- 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 exist.

Terminal/Anchor Checklist

- Is there soil erosion around the end anchor? Eroded or disturbed soil should be replaced and recompact.
- Was the L-bracket installed with the CRP Posts?
- Did the CRP foundation move after tensioning the cable?
- Is the embankment depth such that no more than 4" of the base of the CRP post is exposed above ground level?

APPENDIX

Tension Log

Standard

Cable Terminal End Installation Details

Technical Support and Sales

Contact Information

Manufacturer NUCOR Steel Marion, Inc.

www.nsmarion.com

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GSI High Tension Cable LP

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TECHNICAL SUPPORT AND SALES (cont.)

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Highway Supply

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