Nu-Cable™

Cable Barrier Systems

INSTALLATION MANUAL

TRANSITIONS

Version 2014.09A

NUCOR STEEL MARION, INC.

It's Our Nature.

CONTENTS

Nu-Cable™

Cable Barrier Systems

INSTALLATION MANUAL

SECTION K
CABLE TO GUARDRAIL

CONTENTS

NUCOR STEEL MARION, INC.

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F H W A M E M O B - 1 4 7

The following letter was provided by the Federal Highway Administration, outlining available design configurations for transitioning High-Tension Cable Barriers to Corrugated Metal Beam Guardrail.

These designs are not developed nor fabricated by Nucor Steel Marion, Inc. They are included for reference only. Nucor makes no representations regarding performance of these transitions when used in conjunction with the Nu-Cable™ Cable Barrier System.

U.S. Department of Transportation
Federal Highway Administration

Memorandum

Subject: INFORMATION: Cable Barrier Transitions to W-Beam Guardrail

Date: May 8, 2006

/original signed by/

From: John R. Baxter
Director, Office of Safety Design

Reply to
Attn. of: HSA-10/B147

To: Director of Field Services
Resource Center Managers
Division Administrators
Safety Field

In the late 1980's, the Southwest Research Institute conducted successful crash tests on a cable barrier transition to a strong-post W-beam guardrail using a passenger sedan. In 1998, the Midwest Roadside Safety Facility (MwRSF) tested this transition design using NCHRP Report 350 test vehicles and concluded that it met all appropriate evaluation criteria at test level 3 (TL-3). The non-proprietary design tested in both cases was one developed by the South Dakota Department of Transportation. This design transitioned the generic 3-strand cable barrier over and under the W-beam using special steel straps and connected each cable to a standard concrete anchor block located behind the W-beam. A reduced post spacing was used as the cable barrier approached the W-beam installation, which was itself anchored with a Breakaway Cable Terminal (BCT) offset 4 feet from the cable barrier. In 2002, the MwRSF again tested this design successfully with the 2000-kg pickup truck, but with a FLEAT guardrail terminal anchoring the W-beam installation in lieu of a BCT. Although the South Dakota design remains an acceptable TL-3 transition, the 6-foot or more dynamic deflection of the cable barrier in each of the Report 350 crash tests allowed direct vehicular contact with the W-beam terminals, resulting in considerable pitch, yaw, and roll to the pickup trucks. This design also requires installation of a downstream anchor for the cable barrier.

Recently, the manufacturers of several of the high-tensioned proprietary cable barrier systems have requested acceptance of unique transition designs for connecting their barriers to strong-post W-beam and/or Thrie-beam guardrail. Each of these eliminates the need for a separate downstream cable anchor by attaching each cable directly to the metal beam rail element. Like the South Dakota design, the cable rail post spacing is also reduced to further limit deflection of the cable in the transition area. Reduced dynamic deflection can also be expected with the greater cable tension specified for all of the proprietary designs.

Each of these designs has been previously accepted as a TL-3 transition based on our review of the designs themselves and the crash testing done on the South Dakota design. Copies of the letters sent to each manufacturer are attached for ready reference. Note that for each specific design, the W-beam terminal itself should be offset at least 4 feet. Because the cable will prevent virtually all head-on impacts into the W-beam terminal, a light-weight, non-energy absorbing terminal would be the preferred method of anchoring the W-beam barrier. The MELT, which has been accepted as a TL-2 design, could be used to anchor the W-beam if a generic terminal is desired.

Attachments

U.S. Department of Transportation
Federal Highway Administration

June 8, 2004

400 Seventh St., S.W.
Washington, D.C. 20590

In Reply Refer To: HSA-10

Mr. Rodney A. Boyd
Trinity Highway Safety Products Division
P.O. Box 568887
Dallas, Texas 75356-8887

Dear Mr. Boyd:

In his May 12 letter to Mr. Richard Powers of my staff, Mr. Brian Smith requested formal Federal Highway Administration acceptance of a design by which your CASS cable barrier is transitioned to a strong-post W-beam or Thrie-beam guardrail.

The CASS to W-Beam Transition and CASS to Thrie Beam Transition were submitted for acceptance for use in front of standard W-beam terminals having a 4'0" minimum offset behind the 3-cable prestretched and tensioned CASS system. The transition includes 10-gauge W-beam (either two 12'6"-long or one 25'-long element) or 10-gauge Thrie beam rail elements (one 12'6"-long element and one 6'3"-long transition element) with one-inch wide by 12-inch long slots in the valley of the rail elements. The cables are threaded through the front of the rail and connected to standard cable anchor brackets bolted to the backside of the rail elements. The first CASS post is placed 12'0" from the point where the cables first meet the W-beam or Thrie beam. The transition then consists of 14 CASS posts spaced at 5'0" on center, and then 5 posts spaced on 10'0" centers. The 3 cables, starting at the second post or 17'0" from the tangent W-beam or Thrie beam, taper together to nest into the valley(s) of the W-beam or Thrie beam. Design and layout details are shown in the enclosed drawings.

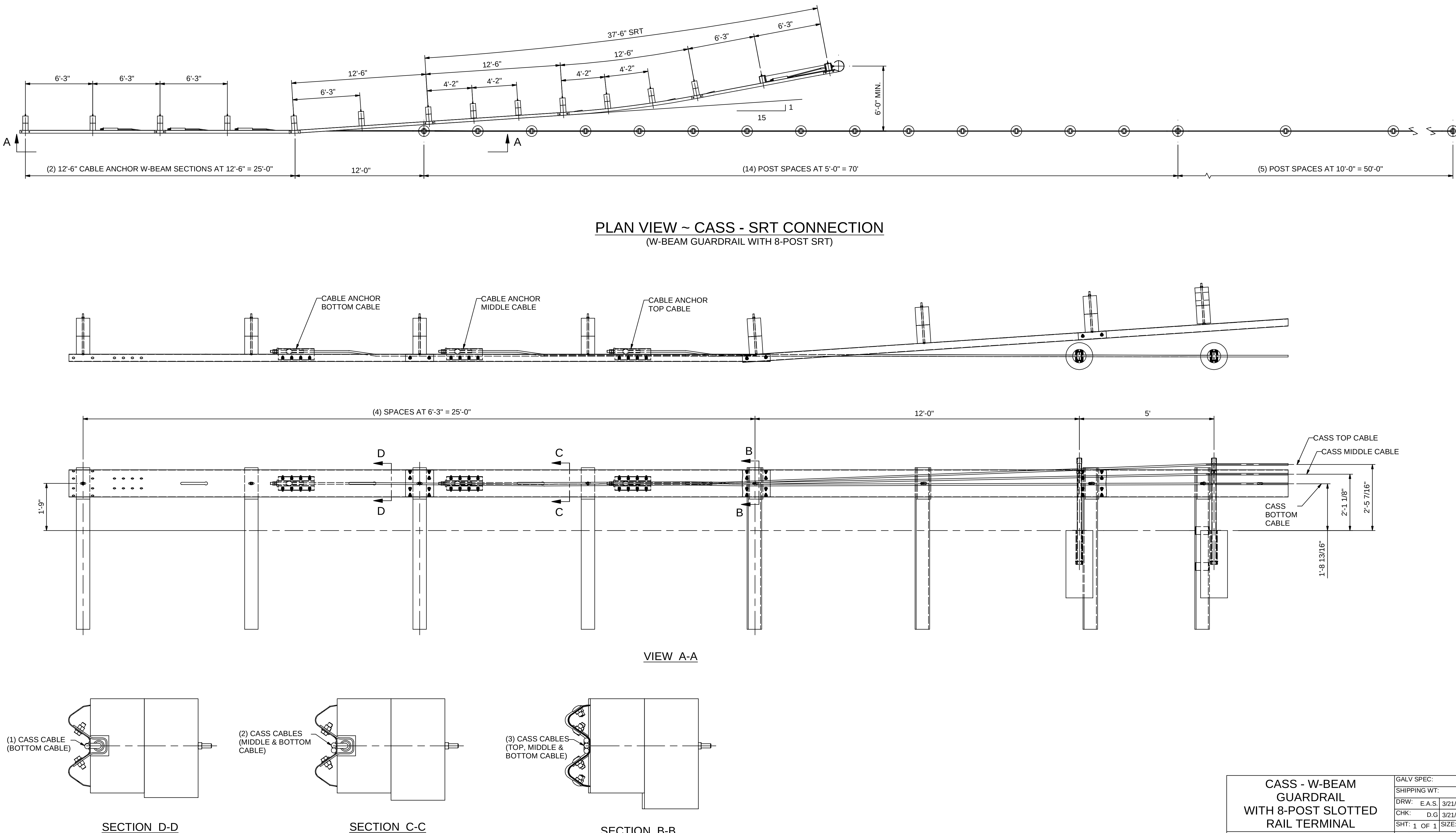
Previous full-scale crash testing has shown that the high tension and pre-stretched cables of the CASS system result in lower deflections than those seen in the non-tensioned cable barrier. In earlier cable-to-W-beam transition testing with the lower-tensioned generic cable rail, the cable deflection allowed the W-beam terminals to be impacted, resulting in some vehicle instability. With the CASS Transition, it is less likely that the nose of the terminal will be impacted in a typical design impact.

Based on the specific design details noted above, the CASS to W-Beam or Thrie Beam Transitions may be considered acceptable for use on the National Highway System at National Cooperative Highway Research Program Report 350 test level 3 when used in conjunction with any crashworthy terminal having a minimum 4-foot offset from the cables. Since this design has not been physically tested, field installations should be monitored to verify both its ease of construction and its presumed crashworthiness.

Sincerely yours,

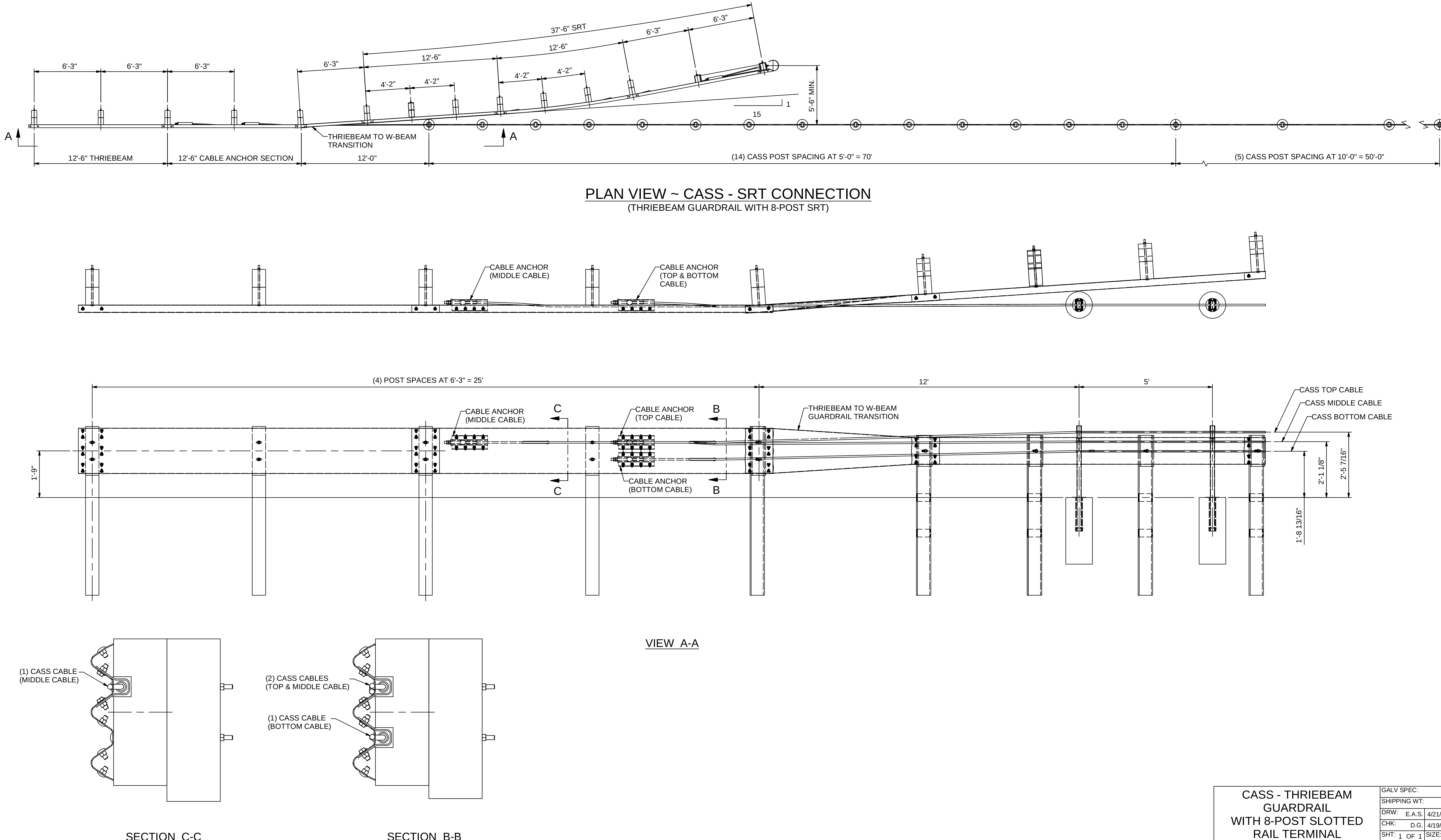
/***Original Signed by Richard D. Powers***/
~for~
John R. Baxter, P.E.
Director, Office of Safety Design
Office of Safety

Enclosures

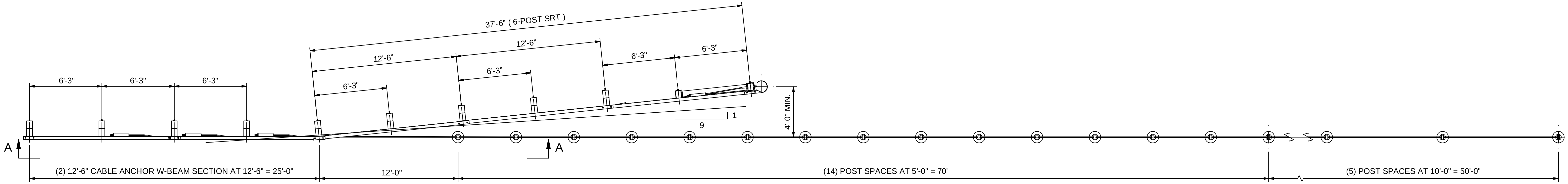


CASS - W-BEAM GUARDRAIL WITH 8-POST SLOTTED RAIL TERMINAL	GALV SPEC:
	SHIPPING WT:
	DRW: E.A.S. 3/21/2004
	CHK: D.G 3/21/2004
	SHT: 1 OF 1 SIZE: D
TRINITY INDUSTRIES, INC. HIGHWAY SAFETY DIVISION	DWG NO: CASS-WB REV 0

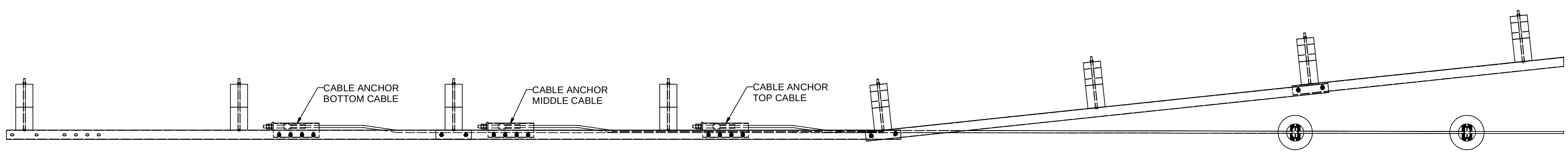
PROJ. CASS - WB - SRT (8)

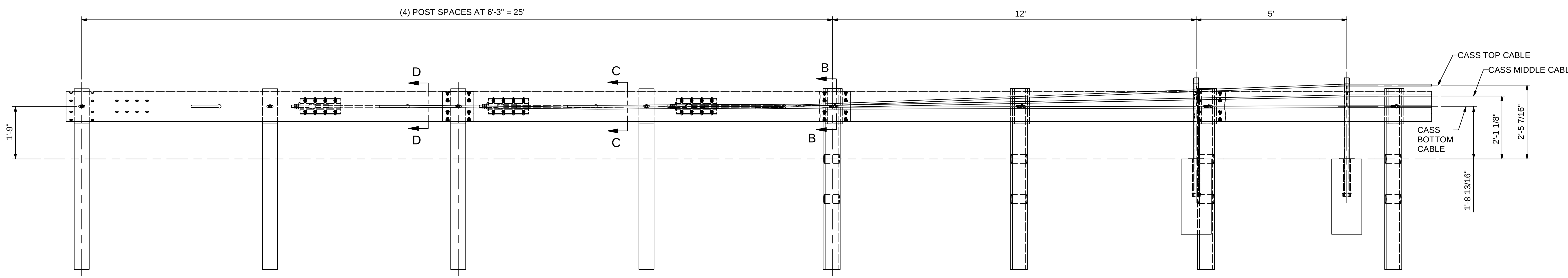


CASS - THRIEBEAM GUARDRAIL WITH 8-POST SLOTTED RAIL TERMINAL	GALV SPEC:
	SHIPPING WT:
	DRW: E.A.S. 4/21/2004
	CHK: D.G. 4/19/2004
	SHT: 1 OF 1 SIZE: D
TRINITY INDUSTRIES, INC. HIGHWAY SAFETY DIVISION	DWG NO: CASS-TB REV 0
PROJ. CASS - TB - SRT (8)	

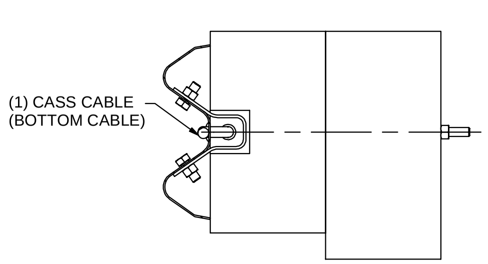


PLAN VIEW ~ CASS - SRT CONNECTION
(W-BEAM GUARDRAIL WITH 6-POST SRT)

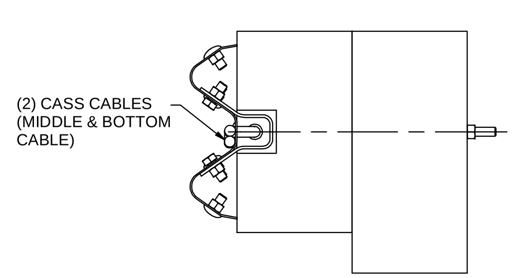




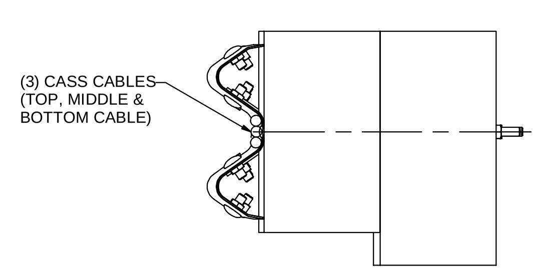
VIEW A-A



SECTION D-D



SECTION C-C



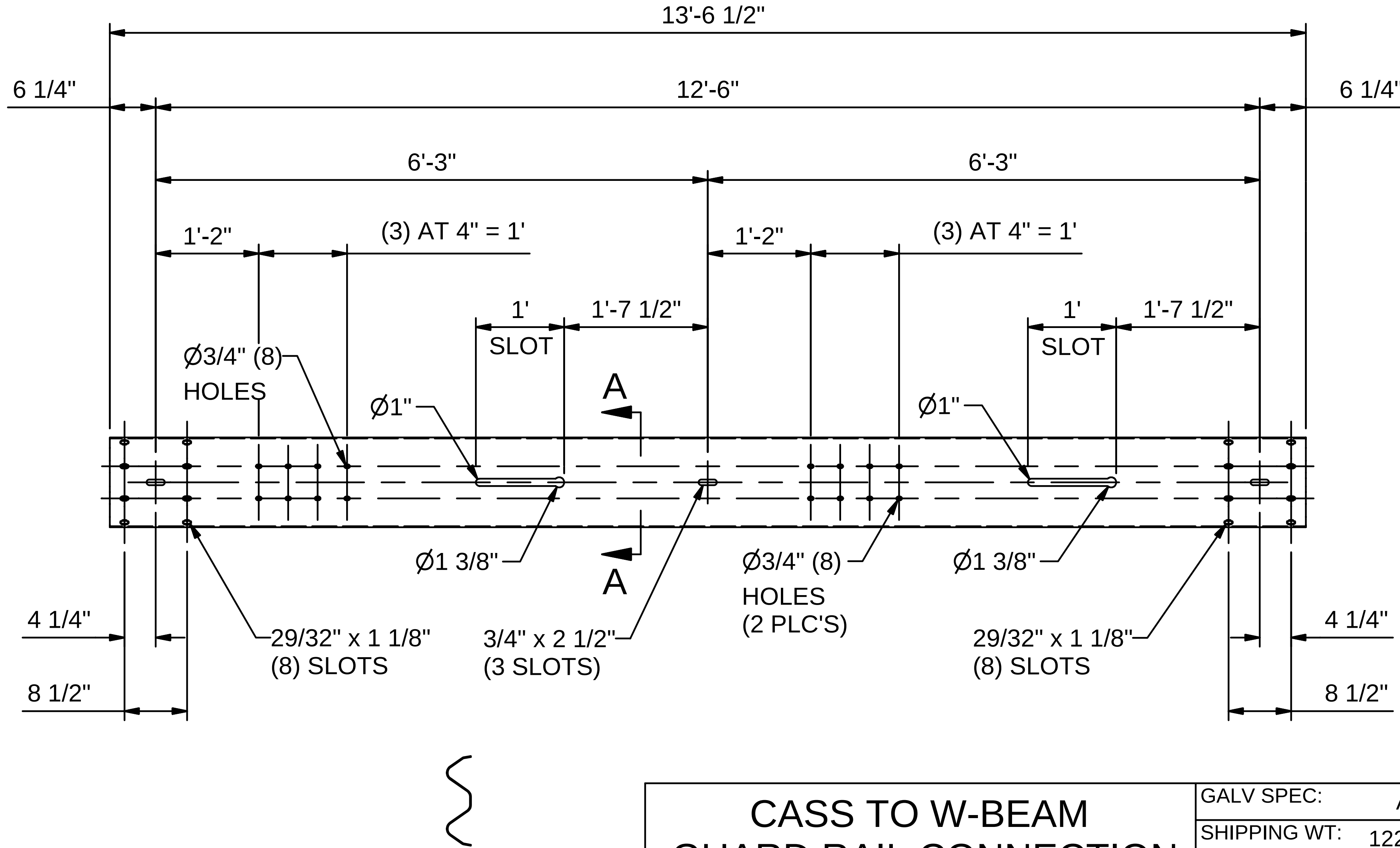
SECTION B-B

CASS - W-BEAM GUARDRAIL WITH 6-POST SLOTTED RAIL TERMINAL	GALV SPEC:	
	SHIPPING WT:	
	DRW: E.A.S.	5/7/2004
	CHK: D.G	5/7/2004
	SHT: 1 OF 1	SIZE: D
TRINITY INDUSTRIES, INC. HIGHWAY SAFETY DIVISION	DWG NO: CASS-6P	REV 0

PROJ. CASS - WB - SRT (6)

BILL OF MATERIAL

QTY	ITEM	DESCRIPTION	LENGTH	Lbs / Each	MATERIAL
1	1	10 GA W-BEAM	12'-6"	115.18	M180



SECTION A-A

PROJ.	CASS - WBEAM

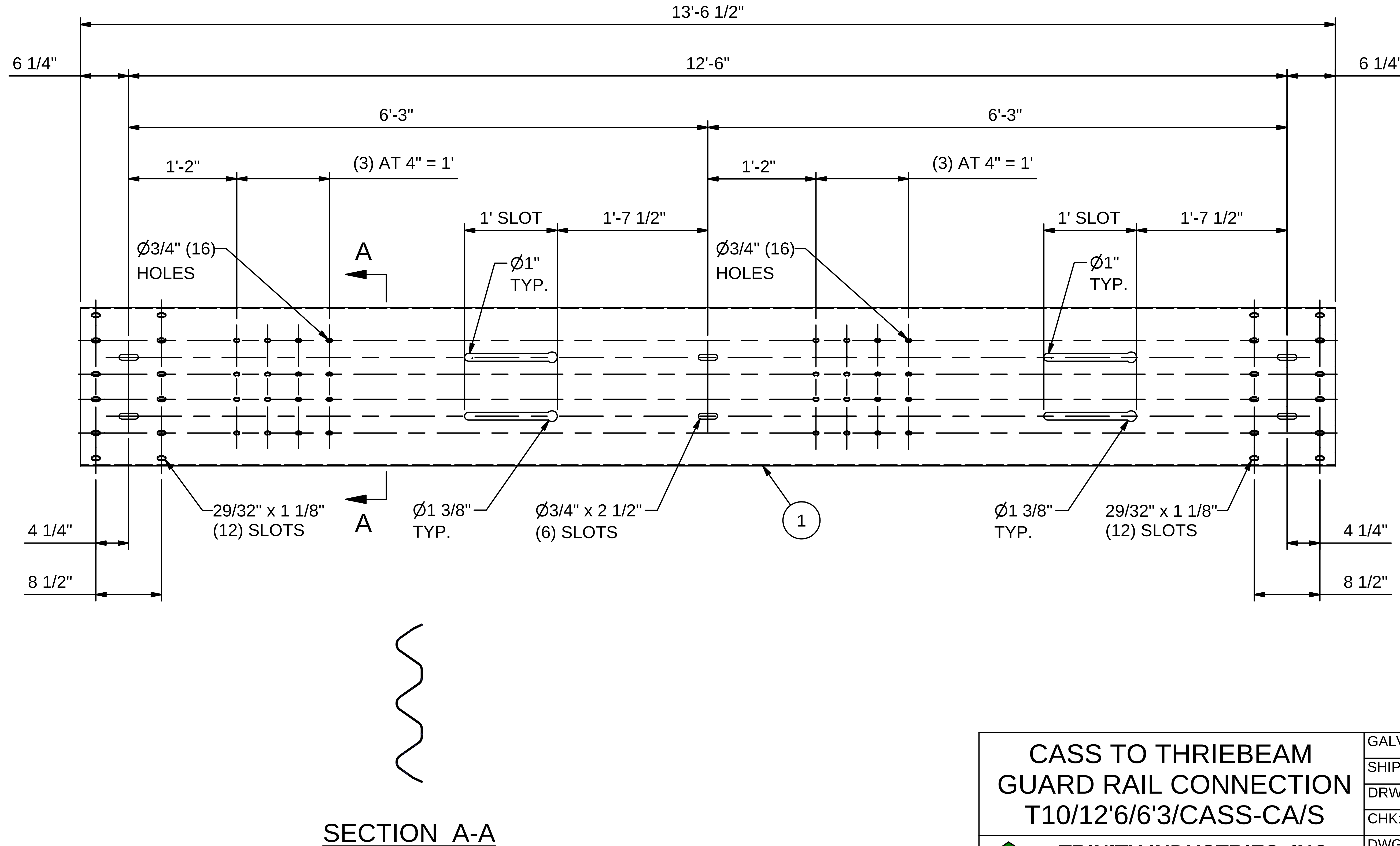
CASS TO W-BEAM
GUARD RAIL CONNECTION
10/12'6/6'3/CASS-CA/S

TRINITY INDUSTRIES, INC.
HIGHWAY SAFETY DIVISION

GALV SPEC:	A123	
SHIPPING WT:	122.1 lb	
DRW:	E.A.S.	5/24/2004
CHK:	R.M.H.	5/25/2004
DWG NO: 033920		REV 0

BILL OF MATERIAL

QTY	ITEM	PC NO.	DESCRIPTION	LENGTH	Lbs / Each	MATERIAL
1	1	033922	10 GA THRIEBEAM	12'-6"	182.92	M180



SECTION A-A

CASS TO THRIEBEAM GUARD RAIL CONNECTION T10/12'6/6'3/CASS-CA/S	GALV SPEC:		A123
	SHIPPING WT:		193.9 lb
	DRW:	E.A.S.	5/24/2004
	CHK:	R.M.H.	5/25/2004
TRINITY INDUSTRIES, INC. HIGHWAY SAFETY DIVISION	DWG NO: 033922		REV 0

PROJ. CASS - THRIEBEAM

U.S. Department
of Transportation
Federal Highway Administration

400 Seventh St., S.W.
Washington, D.C. 20590

October 19, 2005

In Reply Refer To: HSA-10

Mr. Rick Mauer
Outside Sales National Representative
Nucor Steel Marion, Inc.
912 Chaney Avenue
Marion, Ohio 43302

Dear Mr. Mauer:

In your September 2 letter to Mr. Richard Powers of my staff, you requested formal Federal Highway Administration acceptance of a design concept by which your high-tension cable rail could be transitioned and connected to a strong-post W-beam guardrail.

Your transition design is intended for use in conjunction with a W-beam installation that has a standard, crashworthy terminal with a minimum 4'-0" offset from the cable. A unique gusset plate is nested behind and bolted to the back of a special 6 foot-3 inch W-beam panel at the splice located at the first line post. Each cable is threaded through 1-in by 2-in slots in the W-beam panel and connected to the bracket. The first U-channel cable post is placed in line with the barrier proper and 6.5 feet upstream from the first W-beam line post. The transition then consists of 11 additional line posts also set on 6.5 foot centers, at which point your standard post spacing begins. Details for the transition design are shown in the enclosed drawings.

Previous full-scale crash testing has shown that high-tension cable barriers result in lower deflections than those seen in the lesser-tensioned generic cable barrier. In earlier cable-to-W-beam transition testing with the lower-tensioned generic cable rail, the cable deflection allowed the W-beam terminals to be impacted, resulting in significant vehicle instability. With your high-tension design, it is less likely that the nose of the terminal will be impacted in a typical impact. Even so, the use of a lightweight, non-energy absorbing W-beam terminal is suggested to minimize vehicle instability if the terminal is hit.

Based on the specific design details noted above, your proposed transition design is acceptable for use on the National Highway System at National Cooperative Highway Research Program Report 350 test level 3 when used in conjunction with a crashworthy terminal having a minimum 4-foot offset from the cables. Since this transition design has not been physically tested, field installations should be monitored to verify their presumed crashworthiness.

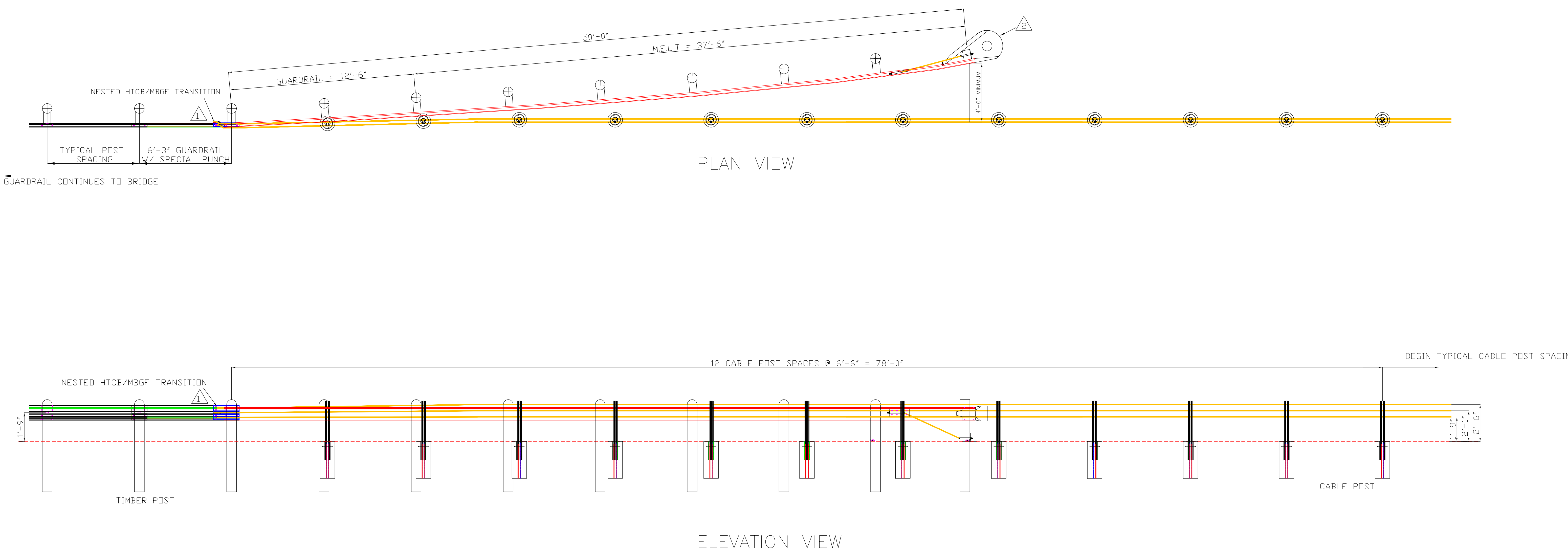
Sincerely yours,

/original signed by George Ed Rice, Jr./

~for~

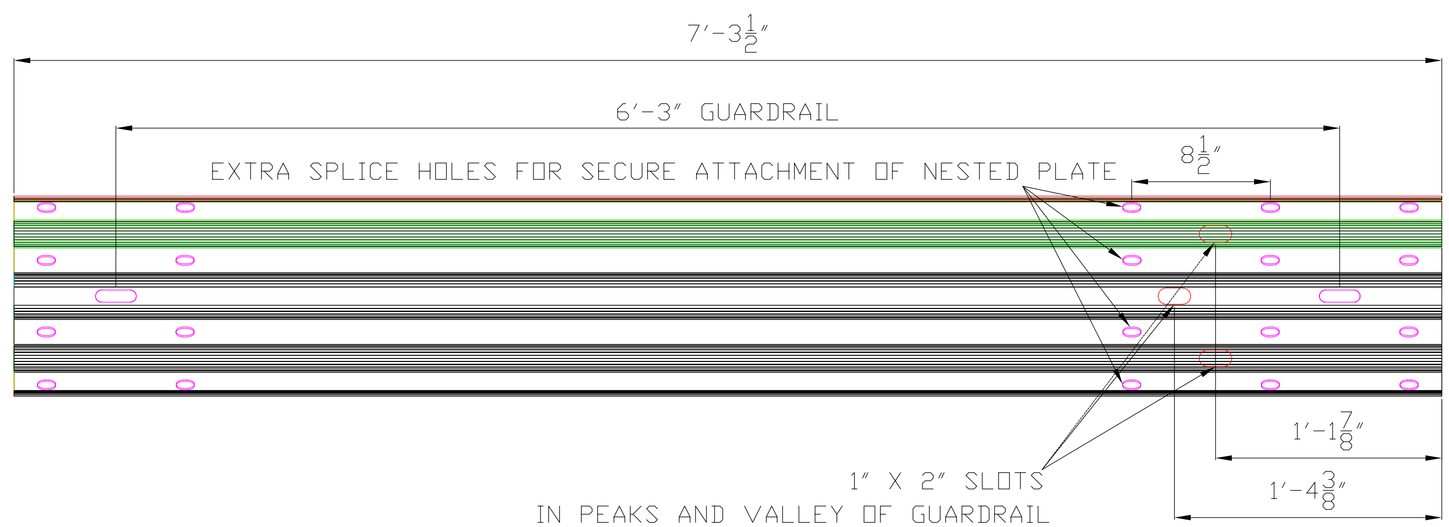
John R. Baxter, P.E.
Director, Office of Safety Design
Office of Safety

Enclosure

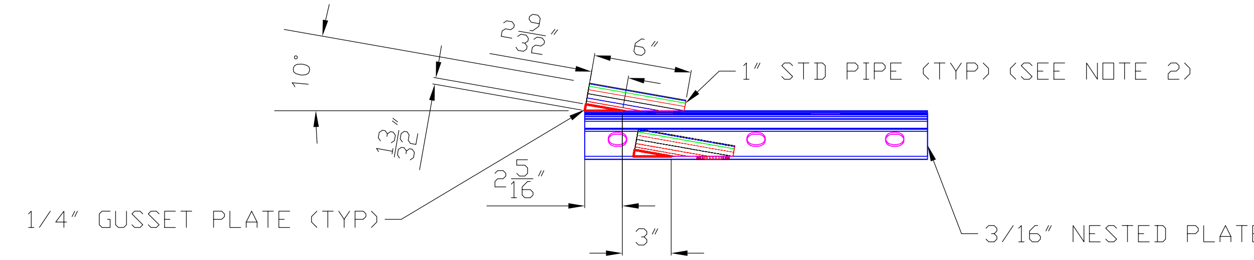


NOTES:
1. CABLE TERMINATES INTO ADJUSTABLE CABLE END FITTINGS BEHIND GUARDRAIL.
2. M.E.L.T. OR OTHER END-SECTION AS NEEDED PARTICULAR TO TRAFFIC REQUIREMENTS.

G.S.I. HIGH TENSION CABLE, LP		
720 W. WINTERGREEN RD., HUTCHINS, TEXAS 75141 (972) 225-1660		
CONTRACTOR:		
SCALE: VARIES	GSI#:	DATE: 10/05/05
REVISED:	CHECKED:	DRAWN: DPD
NESTED PLATE DETAIL FOR HTCB TO MBGF TRANSITION		
TYPE MBGF/HTCB TRANSITION	LAYOUT	1/3



SPECIAL 6'-3" GUARDRAIL FOR NESTED PLATE



PLAN VIEW

SHOWING GUSSET PLATE, 1" PIPE DETAIL

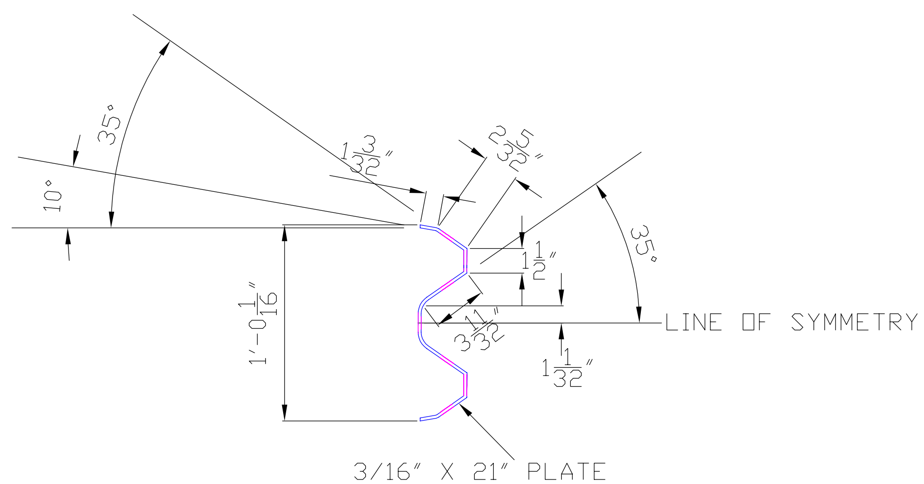
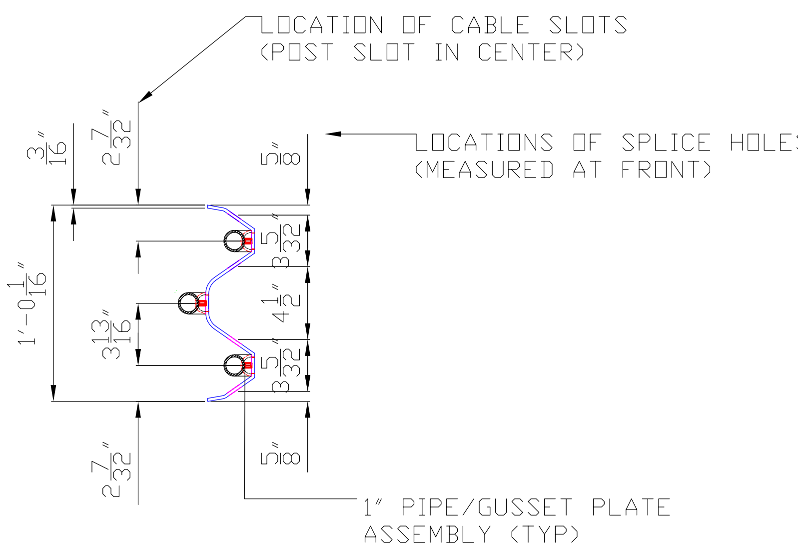
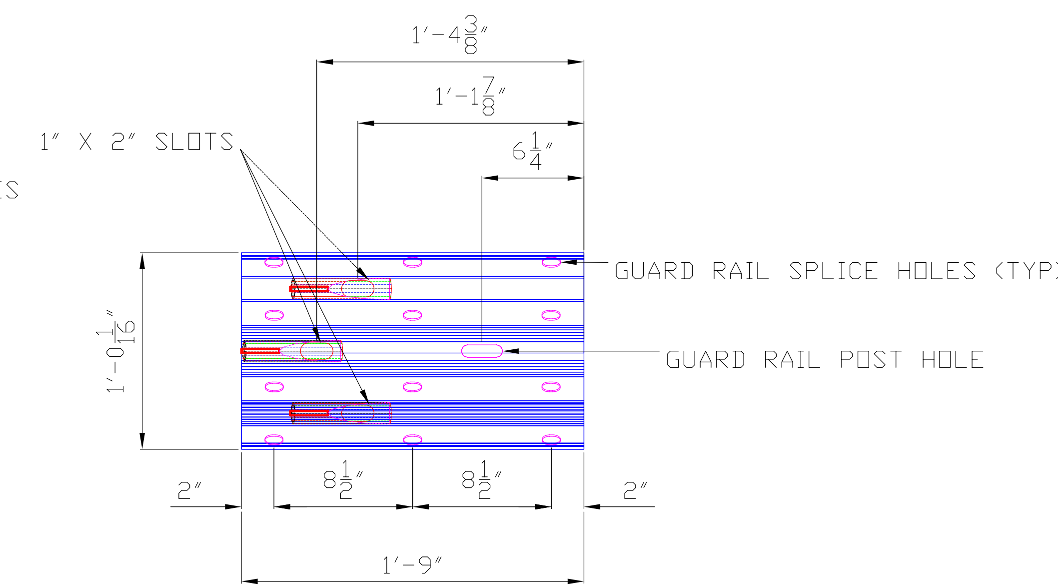


PLATE DIMENSIONS



HOLE LOCATIONS

SECTION VIEW

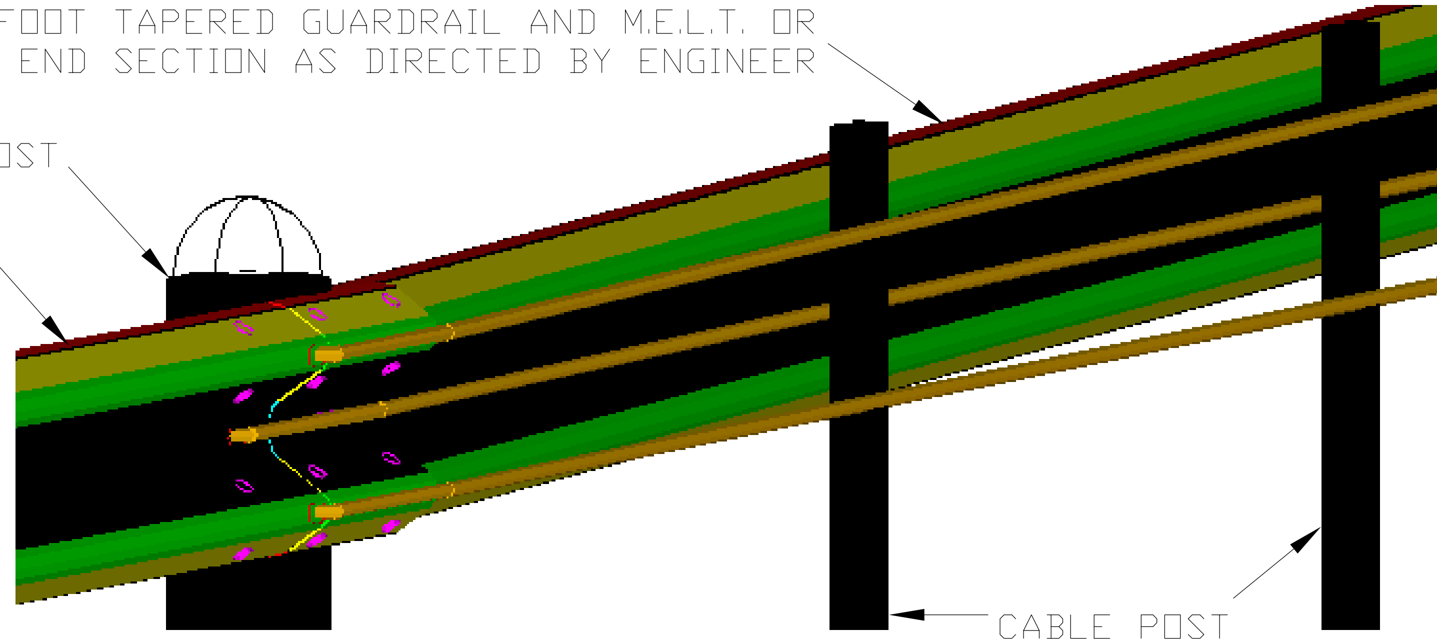


ELEVATION VIEW

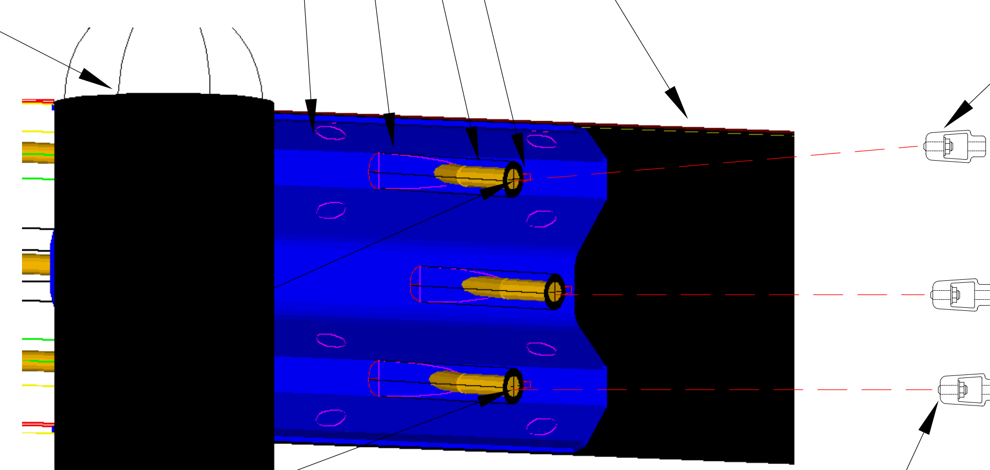
SHOWING FRONT HOLE PATTERN

NOTES: 1. FILLET WELD ALL CONNECTIONS
2. CUT 1" PIPE FROM ℄ TO EDGE AT 10°ANGLE.

G.S.I. HIGH TENSION CABLE, LP		
720 W. WINTERGREEN RD., HUTCHINS, TEXAS 75141 (972) 225-1660		
CONTRACTOR:		
SCALE: NONE	GSI#:	DATE: 10/05/05
REVISED:	CHECKED:	DRAWN: DPD
NESTED PLATE DETAIL FOR HTCB TO MBGF TRANSITION		
MBGF/HTCB TRANSITION	FABRICATION	2/3



ISOMETRIC OF HTCB/MBGF TRANSITION



BACK OF HTCB/MBGF TRANSITION SHOWING CABLE END DETAILS

G.S.I. HIGH TENSION CABLE, LP		
720 W. WINTERGREEN RD., HUTCHINS, TEXAS 75141 (972) 225-1660		
CONTRACTOR:		
SCALE: NONE	GSI#:	DATE: 10/05/05
REVISED:	CHECKED:	DRAWN: DUGAN
NESTED PLATE DETAIL FOR HTCB TO MBGF TRANSITION		
MBGF/HTCB TRANSITION	CABLE END DETAILS	3 / 3

Nu-Cable®

Cable Barrier Systems

INSTALLATION MANUAL

SECTION J
SYSTEM DELINEATION

CONTENTS

NUCOR

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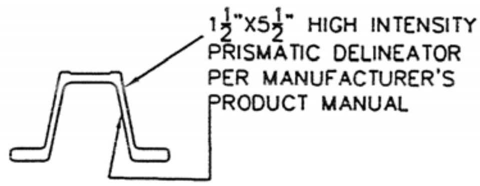
DELINEATION

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.

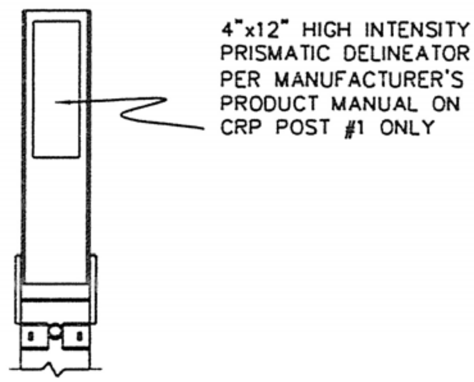
The bonding surface must be relatively clean and dry. Contaminated surfaces should be cleaned with a 50-50 Isopropyl Alcohol and water mixture. Use a lint-free cloth. Substrate temperature must be above 50 degrees F for proper adhesion.

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.

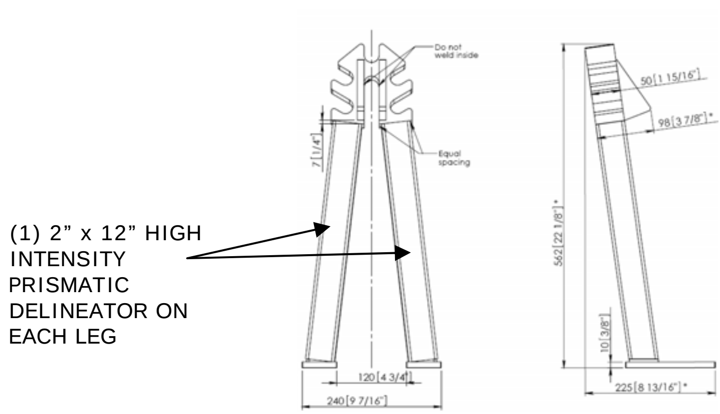


LINE POST DELINEATION



CRP DELINEATION

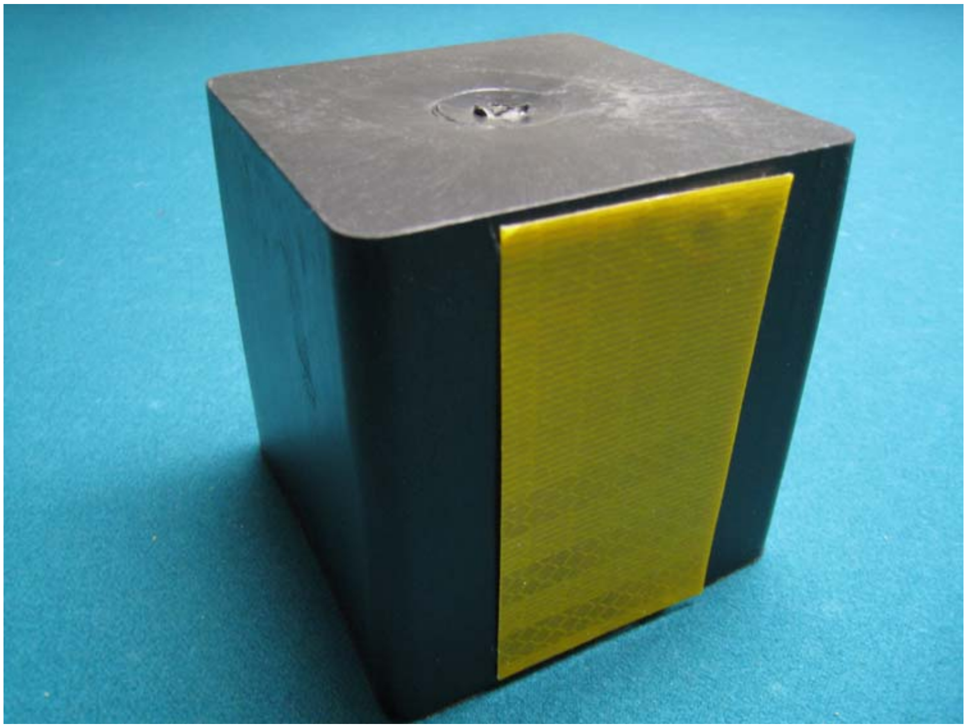
DELINEATION DETAILS



NU-TEN TRIGGER POST

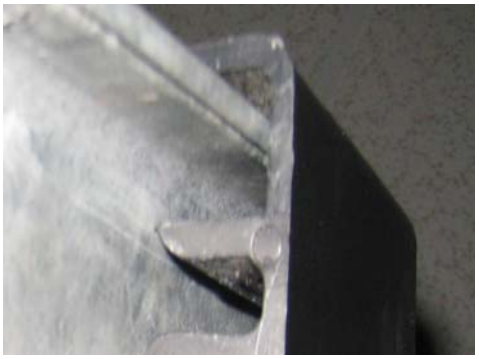
POST CAPS

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 M
APPENDIX: TESTING SOIL CONDITIONS

CONTENTS

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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

NUCOR

NUCOR STEEL MARION, INC.

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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 length[1]. 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 capacity[2]) 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

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It's Our Nature®

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