X-TENSION 350 Guardrail End Terminal Tangent and Flared

Installation Manual for Tangent and Flared Applications

Please call Australian Construction Products on 1800 724 172 or visit www.acprod.com.au for more information

July 2019

SMARTER SAFETY SOLUTIONS

ACP

AUSTRALIAN CONSTRUCTION PRODUCTS

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ACP may make changes to this Product Manual from time to time. Please check the ACP website prior to using this Product Manual to ensure that you have the latest version**.**

X-TENSION 350

Introduction

The X-TENSION 350 Guardrail End Terminal has been designed and tested to meet the evaluation criteria of NCHRP 350 Test Level 3 (TL-3). The system has been tested to the guidelines in NCHRP 350 for a non-gating, re-directive guardrail end treatment. When correctly installed and maintained, the system is capable of stopping, containing, or re-directing an errant vehicle in a safe manner under NCHRP 350 impact conditions.

The X-TENSION 350 Guardrail End Terminal is a fully re-directive, non-gating guardrail terminal end. The unique X-TENSION 350 technology is a tension based solution rather than compression based. It offers exceptional vehicle control and energy absorbing capabilities in head on impacts, where the energy is absorbed with resistance at the impact head rather than being transferred down the rail as occurs with other systems. Even head on, high angle (15° during testing) impacts on the nose resulted in the vehicle being redirected and controlled.

System Overview

The X-TENSION 350 Guardrail End Terminal is designed and constructed to provide acceptable structural adequacy, minimal occupant risk and safe trajectory as set forth in NCHRP 350 for guardrail terminal ends.

When impacted head on with an 820 – 2000kg vehicle at speeds of up to 100kph the impacting vehicle is brought to a controlled stop or allowed to penetrate to the back side, depending on the impact conditions.

Before Installation

Placement and use of the X-TENSION 350 Guardrail End Terminal should be done in accordance with the guidelines and recommendations set forth in the “AASHTO Roadside Design Guide”, FHWA memoranda and local road controlling authority standards.

Depending on the application and circumstances at the site, installation and assembly of a Test Level 3 system should take a two-person crew less than two hours.

The X-TENSION 350 Guardrail End Terminal is a highly engineered safety device made up of a relatively small number of parts. Before starting installation ensure that one is familiar with the make of the system.

Limitations and Warnings

The X-TENSION 350 Guardrail End Terminal has been rigorously tested and evaluated per the recommendations in the NCHRP 350 guidelines for terminals. The impact conditions recommended in NCHRP 350 are intended to address typical in–service collisions.

When properly installed and maintained, the system is capable of containing and re-directing impacting vehicles in a predictable and safe manner under the NCHRP 350 impact conditions.

Vehicle impacts that vary from the NCHRP 350 impact conditions described for guardrail end terminals may result in significantly different results than those experienced in testing. Vehicle impact characteristics different than or in excess of those encountered in NCHRP 350 testing may result in system performance that may not meet the NCHRP 350 evaluation criteria.

Safety Statements

General Safety

All required traffic safety precautions should be complied with. All workers should wear required safety clothing (high visibility vests, steel capped footwear, gloves, hard hats, safety glasses etc.)

All underground services must be located before installation of any posts.

Only authorised trained personnel should operate any machinery. Where overhead machinery is used, care must be taken to avoid any overhead hazards.

Gloves should be worn at all times. Particular care should be taken to avoid galvanising spikes.

X-TENSION 350 Safety Statements

All installers must be well clear of post driving machinery when in use.

Avoid placing hands or fingers in and around moving parts when components are being lifted and maneuvered into place. (i.e. around splice holes, etc.)

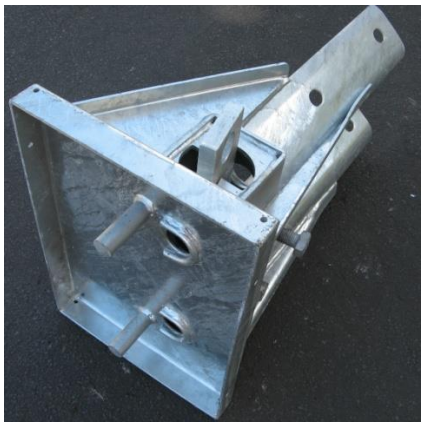
One person only should fit the cables. Other workers should stand clear to avoid being caught in moving cables.

Securely fasten the impact head and rail before turning the friction plate.

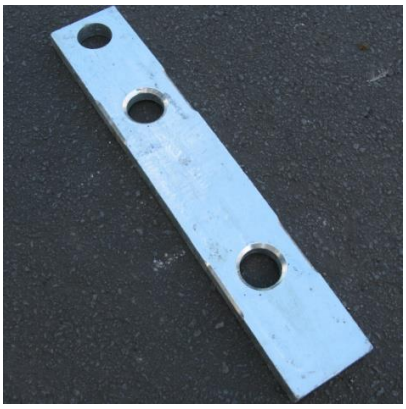
The friction plate should be turned manually with a crow bar and extension handle. Do not attempt to turn it with the assistance of machinery. Ensure crow bar is securely held while the 4 locking bolts are tightened.

Safe lifting methods must be employed when handling components of the system that weigh more than 20kg. These components are the Impact Head, Soil Anchor, Ground Strut, Post 1 Bottom and the Highway Rail.

X-TENSION 350 Parts Identification



Impact Head
(1 required)



Friction Plate
(1 required)

Soil Anchor
(1 required)

Slider Bracket + Angle Bar
(1 required roadside)

Cable Bracket
(1 required)

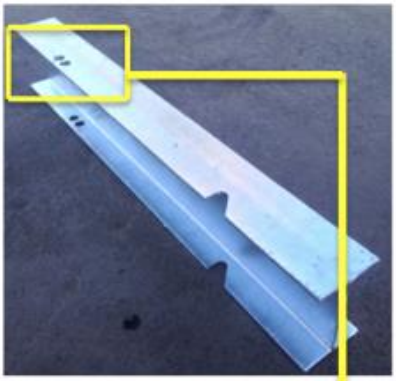
Cable Assembly
(2 required)

Slider Panel
(1 required roadside)

Standard Highway Rail

Ground Strut
(1 required)

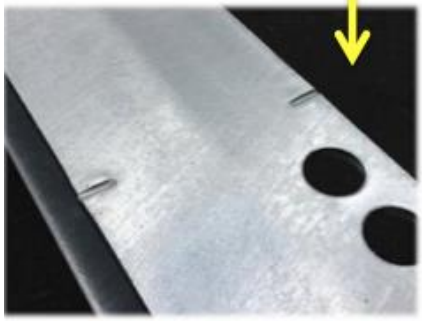
X-TENSION 350 Parts Identification continued

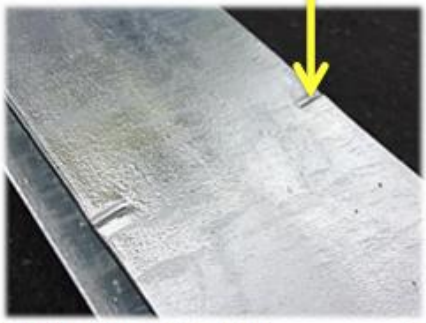


Post # 1- Top
(1 required) – *Frangible*

Post # 2
(1 required) – *Frangible*

Post # 1 Bottom
(1 required)





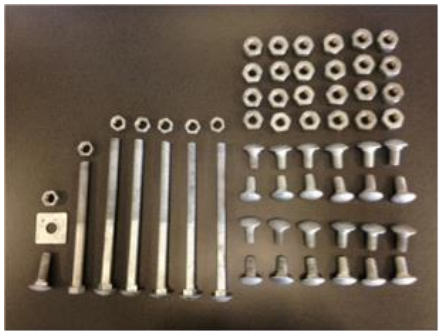
(Close up of crimps on all flanges of Post # 1- Top & Post 2)

Standard Steel Line Post (3 - 6)
(4 required)

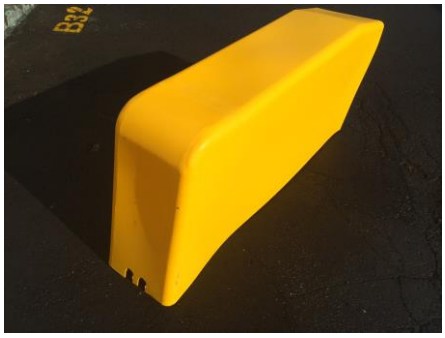
Shear Bolts
(8 required)

Nut Protectors
(12 required)

Blockout (plastic)
(5 required)



Hardware set



Nose Cone
(1 required)

X-TENSION 350 - Preparation for all applications

Before installing an X-TENSION 350, ensure that all materials required for an 11.43m system are on site and have been identified. See and parts identification sheet.

Ensure that the area where the X-TENSION 350 is to be installed is flat enough so that the soil anchor will not protrude more than 100mm from ground level, when measured with a straight line over a 1.5m cord. The maximum slope should not exceed 7%. Slopes above this may cause the terminal to behave differently in a vehicle impact to what was tested. Minor site grading may be required.

Soil Conditions

The X-TENSION 350 has been designed for installation in edge of road locations and in soil that meets or exceeds the AASHTO “standard soil” specification. If rock is encountered during post installation, refer to local road controlling authority specifications.

Tools Required

The same tools required to install standard guardrail will also install an X-TENSION 350.
Specifically: Sockets (commonly used in Guardrail), Drill, Wrenches, Large Crow Bar, String line, Level, Augers, Tampers and Post Pounders commonly used in driving posts.

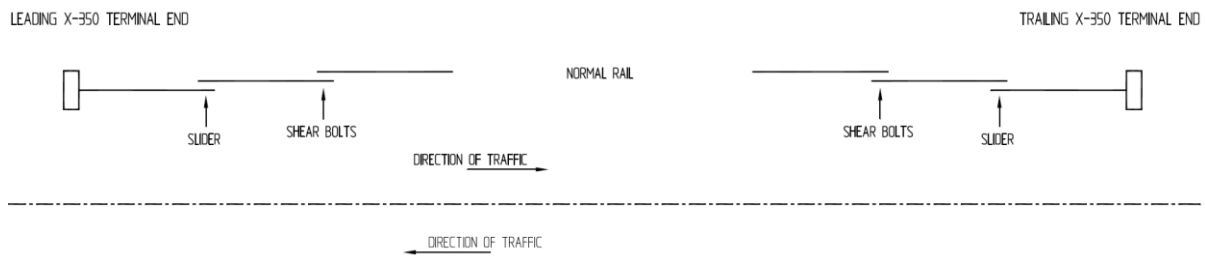
Before Starting

For all applications, begin the installation from the downstream end of the terminal at the point where it joins the standard guardrail (post 7).

For the tangent and flared applications, the X-TENSION 350 connects directly to standard steel post, W – beam highway guardrail.

When a X-Tension 350 End Terminal is installed in a ***trailing/exit location***, where the terminal head is facing away from the direction the vehicle is travelling, the splice join at rails 1, 2 and 3 of the terminal will be against the direction of traffic.

Please note this situation is different from the X-Tension 350 Terminal End being installed in a leading/entry location, where the terminal head is facing towards the vehicle, the rail then laps in the conventional way, in the direction of traffic.



Note: For any existing installations that have not been installed correctly the splice join to change is from rail 2 to 3 only.

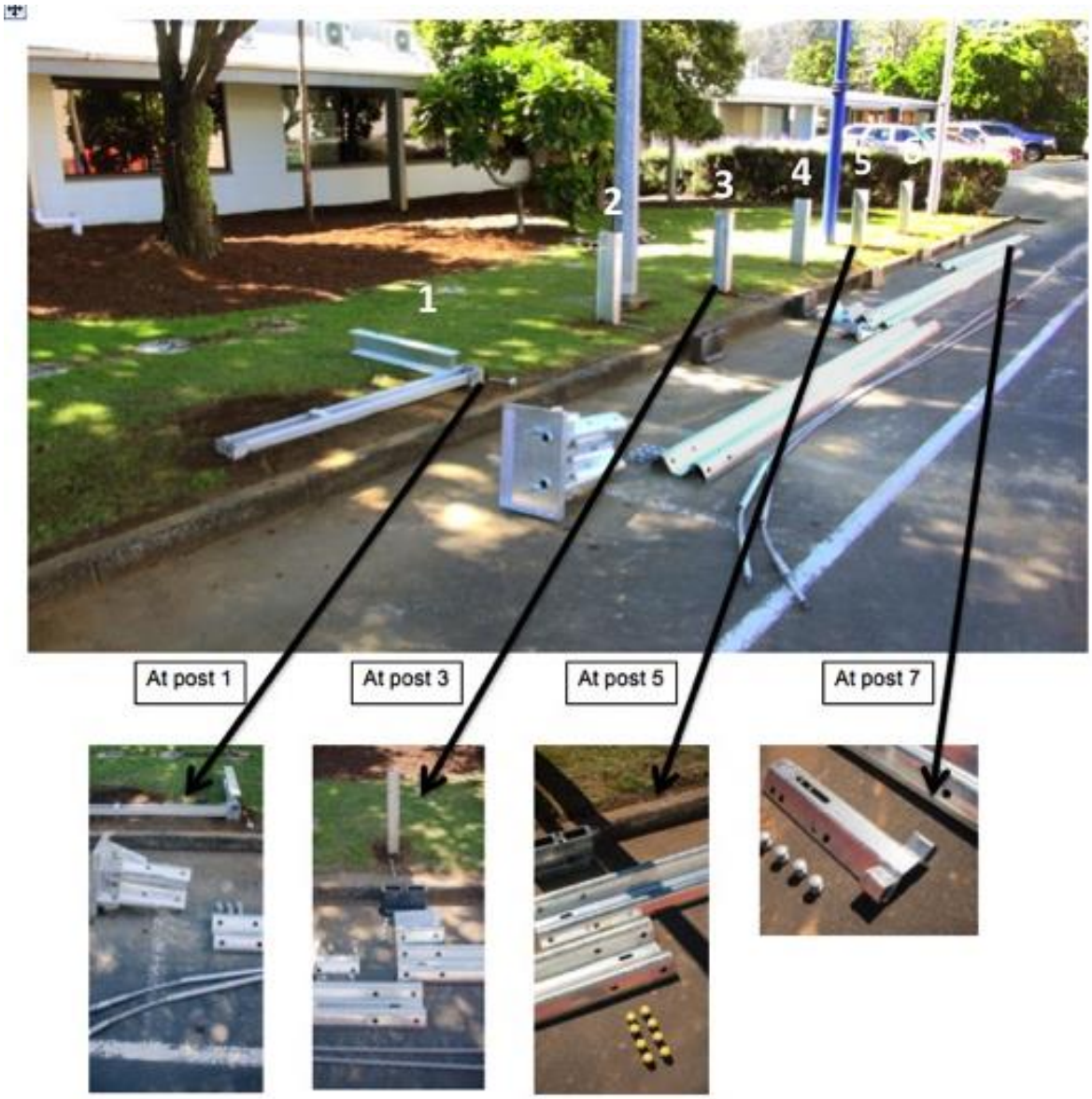
X-TENSION 350 - Tangent Installation Instructions

Step 1 - Set Out

The tangent terminal is essentially an 11.43m continuation of the standard guardrail run.

Pull a string line out with the desired offset 0 - 450mm over the length of the system, in a straight flare (Figure 1). No parabolic curve is required. The string line should be set to follow the roadside edge of the posts.

All the posts except post #1 have a blockout so take care to place the roadside face of post #1 200mm towards the roadway to compensate for the lack of blockout.



Step 2 - Installing Posts 6 - 2

Note: Posts #3 to #6 are standard "I" beam posts. Post #2 is a 'Frangible' "I" beam post with 4 crimps on its flanges (as shown on second page of the '*Parts Identification' page*) and can be differentiated from the standard "I" beams as it has 3 holes drilled near the top compared to only 2 on the standard "I" beams.

Post #2
With extra
Identification hole

Post #3 to #6

Install posts 2 to 6 at standard highway rail Spacing 1905mm, to the correct height.

Ensure posts are laid out in the correct positions as instructed in the previous step. Refer to the detailed arrangement drawing at the end of this manual for further clarification if needed.

Steel posts may be directly driven, or in stiff soils a 150mm diameter hole drilled, and the post then driven into the hole.

Hint: Offset Post 3 back from the string line 40-50mm to make it easier to push rail 1 and Slider Panel over rail 2.

When driving steel posts, ensure that a driving cap with timber or plastic insert is used to prevent damage to the galvanizing on the top of the posts.

Bolt the blockout to the post at post 3, prior to attaching to the rail (Figure 2).

Figure 1. Pull a string line with the desired offset

Figure 2. Bolt the blockout prior to attaching the rail

Step 3 - Post 1, Ground Strut and Soil Anchor

Place the roadside face of post 1 bottom anchor, 200mm towards the roadway to compensate for the lack of blockout (Figure 3). Post 1 bottom the Ground Strut and the Soil Anchor are then placed parallel to the string line at this roadside offset position. Drive or place the bottom of post 1 in the augured hole so that no more than 75mm (100mm max) protrudes above ground level.

Use the Ground Strut as a template to place the Soil Anchor in the correct place. The Soil Anchor can then be driven into place or placed in an augured hole and backfilled. The Ground Strut should be level or lower at the anchor end than at the post 1 bottom end (Figure 4).

Place post 1 top in the post 1 bottom anchor ensuring that the post bolt notches are at the top and facing the Soil Anchor (Figure 5). Use M16 x 200mm hex head bolt with nut and washers. **Do not over tighten bolt.**


Figure 3. Measure 200mm towards roadway


Figure 4. Drive Soil Anchor into augured hole


Figure 5. Post 1 top in post bottom

Step 4 - Hang Rail 3 and Cable Anchor Bracket

Rail 3 is installed like standard guardrail with post 6 at the centre of the rail and blockouts between the rail and post.

Place the Cable Anchor Bracket on the back of the rail at the joint between rail 3 and rail 4 (post 7) refer to Figure 6. Figure 6A shows the bracket once X350 is fully installed.

The two “boxes” on the cable bracket should be on the impact head side of the splice joint.
Attach rails to post with post bolt and splice rail 3 to rail 4 with 8 standard splice bolts.

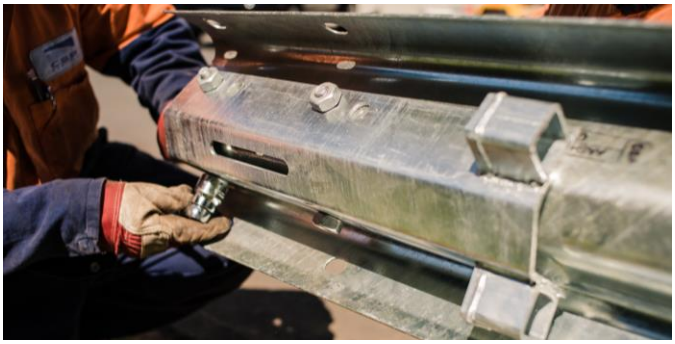


Figure 6. Cable Anchor Bracket on back of rail 3


Figure 6A. Cable Anchor Bracket post X-350 installation

Step 5 - Hang Rail 2 and Shear Bolts

Before installing rail 2 double check that the blockout is already bolted to post 3.

Bolt rail 2 to the post and blockouts at posts 4 and 5 with the appropriate post bolt (Figure 7). **DO NOT BOLT THE RAIL TO POST 3.**

Splice rail 2 to rail 3 with **the 8 special shear bolts (yellow) supplied (Figure 8)**. **Put the washer and nut on inside of rail.**

IMPORTANT NOTE: DO NOT USE STANDARD SPLICE BOLTS AT POST 5 SPLICE


Figure 7. Bolt rail 2 to post and blockouts


Figure 8. Splice rail 2 to rail 3 with 8 special shear bolts

Step 6 - Attach Slider Bracket to Rail 2

Bolt the Slider Bracket to the end of rail 2 at post 3 (Figure 9). Use 4 standard splice bolts. The angle bar end should be closest to the Impact Head end. **Remove the angle bar and 2 x M20 x 40mm bolts (Figure 10).**


Figure 9. Bolt Slider Bracket to end of rail 2 at post 3


Figure 10. Remove angle bar bolts

Step 7 - Assemble Slider Panel onto Rail 1

Start by sitting rail 1 on a blockout or post so that it is raised off the ground as shown (Figure 11). Slide the Slider Panel onto the downstream end of rail at post 3 location (Figure 12) and bolt into place using 4 standard splice bolts, pushing the bolt through from the inside of the slider to the outside so that the **nut is on the traffic face.**

The curved and reinforced (post breaker) end of Slider Panel sits at the rail end.
Use guardrail pin bar or crow bar to assist with lining up splice holes.


Figure 11. Sit rail 1 so it is raised off the ground


Figure 12. Slide the Slider Panel onto downstream end

Step 8 - Hang Rail 1

Lift rail 1 with Slider Panel attached and push the slider end over rail 2 (Figure 13). Overlap the rails as per a standard splice joint overlap.

Bolt rail 1 and blockout to post 2 using a standard post bolt that is supplied (Figure 14).

Re-attach the angle bar to the slider bracket on the backside of the rail (Figure 15).


Figure 13. Push Slider Panel over rail 2


Figure 14. Bolt rail 1 and blockout to post 2


Figure 15. Reattach the angle bar

Step 9 - Attach Impact Head

Place Impact Head on upstream end of rail 1 and attach using 8 standard splice bolts with nuts on traffic face (Figure 16). **Hint**: Place bottom two bolts first then use guardrail pin bar to lever head up snug onto rail.

Bolt head and rail 1 to post 1 using the supplied M16 x 50mm guardrail post bolt. Use a 50mm x 50mm washer under the M16 small nut on the inside of post 1 (Figure 17).

Figure 16. Attach Impact Head to rail 1


Figure 17. Bolt head and rail 1 to post 1 with washer

Step 10 - Place the Cables

Push the cables under the steel strap on the Ground Strut (Figure 18) and forward through the holes at the top of the Ground Anchor. Lay the cables out parallel to the guardrail, downstream from the Ground Anchor. Ensure that the bottom cable (closest to road) has half the thread protruding through the Ground Anchor, as shown. Ensure the top cable has the nut wound on with 10-15mm of thread protruding above the nut. (Figure 19)

Note: 6.00mm minimum thread protrusion above the nut is required at all four swaged ends of the cables.
Note: Top and bottom cable refers to the position of the ropes as installed behind the W-beam.

Figure 18. Push cables under steel strap on Ground Strut

Figure 19. Thread the nuts as shown

Step 11 - Installing the Cables

Install the Friction Plate in the top of the Impact Head, adjustment hole up. Take the cable closest to the road, pick up the downstream cable fitting and walk to the head, passing the cable through the bottom hole, through the Friction Plate (Figure 20) and out the backside of the Impact Head.

Now thread the cable down the backside of the rail following the bottom trough of the W-beam and attach to the bottom “box” on the Cable Bracket at post 7. Repeat this process with the other cable but push it through the top hole and thread it along the top trough of the W-beam.

Place the nuts and washer on the cables at the Cable Bracket end but only run them a few turns (Figure 21).
Do not tighten cables at this stage (or the Friction Plate will not turn)


Figure 20. Pass the cable through the bottom hole

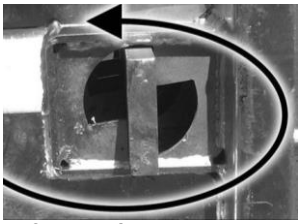

Figure 21. Do not tighten nuts at this time

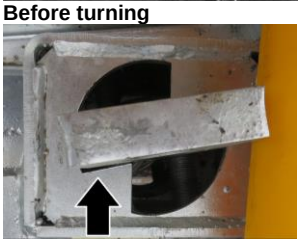
Step 12 - Turning the Friction Plate

Put a crow bar through the hole at the top of the friction plate (Figure 22) and turn it in slot as far as it will go. Using a socket spanner tighten the 4 - M20 x 75mm bolts on the side of the impact head to lock the bar in the turned position (Figure 23).


Figure 22. Use crow bar to turn Friction Plate


Figure 23. Use socket to lock bar in the turned position


Before turning


Locked position

Step 13 - Tightening the Cables

Only tighten the cables using the nuts at the Cable Bracket end (post 7) (Figure 24). **Do not tighten the cable nuts at front of the Ground Anchor.**

Tighten the cables until they are taut, i.e. they rest in the backside of the W-beam and do not visibly sag between posts (Figure 25). There is no torque requirement for the cables.

Note: 6.00mm minimum thread protrusion above the nut is required on all four swaged ends of the cables.

Figure 24. Tighten cables at Cable Bracket end (post 7)

Figure 25. Tighten cables until they are taut

Step 14 - Attach Nose Cone and Nut Protectors

Fit Nose Cone over the top of the impact head with slot centred above the cables. Attach the nose cone by loosening the cable nuts. The nose cone is to fit firmly over the cables. Retighten the nuts and make sure they are against the nose cone. The nuts need to be finger tight so they can hold the nose cone in place. (Figure 26). Delineation to be attached to nosing as per Local Authority requirements.

The X-TENSION 350 Plastic Nut Protectors are available for all X-TENSION 350 Terminal Ends. They protect pedestrians and cyclists from exposed splice bolt nuts and threads. Fit 8 Nut Protectors on the Impact Head (Figure 27) and 4 on Slider Panel.

Figure 26. Attach nose cone using cable nuts

Figure 27. Nut Protectors fitted on Impact Head

X-TENSION 350 - Flared Installation Instructions

This section deals with installation of a Flared X-TENSION 350 system in a roadside guardrail terminal end application.

Apart from the initial set out, the flared X-TENSION 350 and installation procedure is identical to the Tangent system, the only difference being the amount of offset used.

Site preparation

The Flared terminal may be installed either parallel to the edge of the roadway (tangent) or with the impact head end of the rail offset by up to 1.2m away from the road (Figure 29) in a straight flare, over the length of the system. No parabolic curve is required.

Ensure that the area where the X-TENSION 350 is to be installed is flat enough so that the anchor will not protrude more than 75 mm (100 mm max) above ground level, when measured with a straight line over a 1.5m cord. Minor site grading may be required.

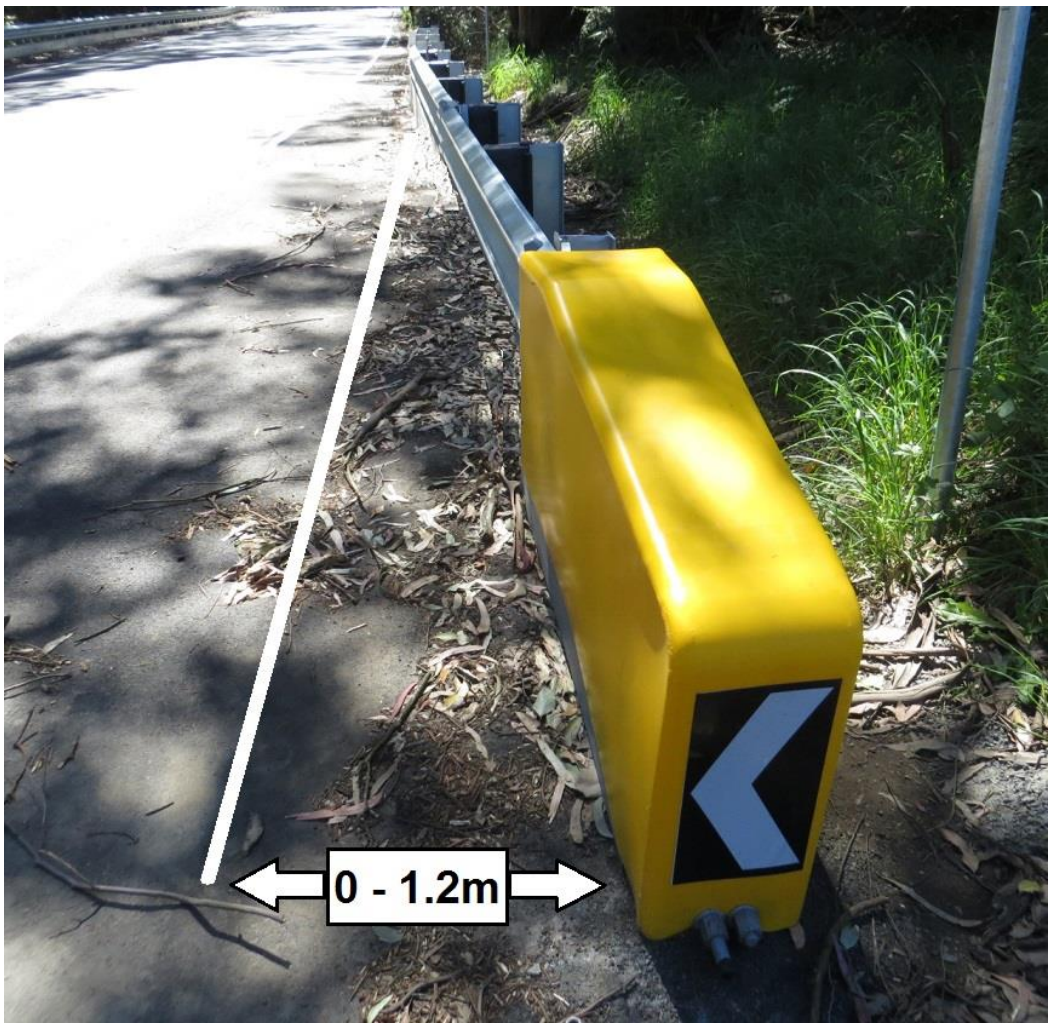


Figure 29. Maximum offset is 1.2 m

Step 1 - Set Out

Pull a string line out with the desired offset 0 -1.2m. Note that the flare is a straight flare, over the length of the system (11.4m).

The string line should be set to follow the roadside edge of the posts (Figure 30).

All the posts except post 1 have a blockout so take care to place the roadside face of post 1 200mm towards the roadway (Figure 31).

Post 1 bottom; the Ground Strut and the Soil Anchor are then placed parallel to the string line on the roadside of it (Figure 32).

Figure 30. Pull string line to follow roadside edge of post

Figure 31. Place roadside face of post 1 towards roadway

Figure 32. Place ground strut parallel to string line

Now follow steps 2 – 14 in the Tangent installation instructions.

Note: The "kink" in the line of rail between rail 3 and rail 4 (at post #7) is formed by simply pushing the rails around to follow the flared line of posts.
This is not factory bent.

X-TENSION 350 Maintenance (Traffic Face Impacts)

Types of repair are divided into two categories: Traffic Face Impacts and Head on Impacts (Next Page)

Traffic Face Impacts

Key Repair Steps:

1. Remove cables
2. Remove damaged rail
3. Remove components from rails
4. Remove damaged posts
5. Assess damage
6. Reassemble

Step 1: Remove Cables
Undo nuts at downstream cable bracket (post 7). Take out the bolts on the side of the impact head that hold the friction plate in place and rotate the locking bar backwards.
Pull one cable at a time from the front side of the impact head and completely remove them.
Rotating the cables as you pull them will help. Undo nuts at ground anchor end and remove cables.

Step 2: Remove Rails
Unbolt the splice bolts first. Then unbolt the post bolts and lower rails to ground.

Step 3: Remove X-TENSION 350 Components
All the X-TENSION 350 components are attached to the rails with standard splice bolts. Unbolt and remove the components.

Step 4: Remove Posts
Undo the bolt at the bottom of Post 1 and pull out post. For all other damaged line posts, attach a chain to the top half of the post and pull out of the ground with either a crane truck or digger. Note it is sometimes possible to remove steel posts by hand.

Step 5: Assess the Damage
Any part that cannot be reused must be replaced with a new part. **Always replace the yellow shear bolts**. Cables can be reused.
Generally, all the specialized components of the system such as the head and brackets should be undamaged.

Step 6: Reassemble
Reassemble as per system installation instructions.

X-TENSION 350 Maintenance (Head on Impacts)

Key Repair Steps:

1. Remove the cables
2. Pull the rails back
3. Remove components from rails
4. Remove damaged posts
5. Assess damage
6. Reassemble

Step 1: Remove Cables

After a head on impact the cables may appear to be slack but may in fact still retain some tension from the impact. Care must be taken when removing the cables.
DO NOT UNDO THE CABLES FROM THE GROUND ANCHOR END FIRST, ALWAYS UNDO THE CABLES FROM THE CABLE BRACKET (post 7) FIRST.

Undo nuts at downstream cable bracket (post 7). Take out the bolts on the side of the impact head that hold the friction plate in place and turn the friction plate back.
Pull one cable at a time from the front side of the impact head and completely remove them. Rotating the cables as you pull them will help. Undo nuts at ground anchor end last and remove cables.

Step 2: Pull Rails Back Out

Attach a chain or two ton strap to the front of the impact head and pull upstream to its' original position with a light truck or utility vehicle. The components are easier to unbolt when the rails are separated.

Step 3: Remove X-TENSION 350 Components

All components are attached to the rails with standard splice bolts. Unbolt and remove parts.

Step 4: Remove Posts

Undo the bolt at the bottom of Post 1 and pull out post. For all other damaged line posts, attach a chain to the top half of the post and pull out of the ground with either a crane truck or digger. Note it is sometimes possible to remove steel posts by hand.

Step 5: Assess The Damage

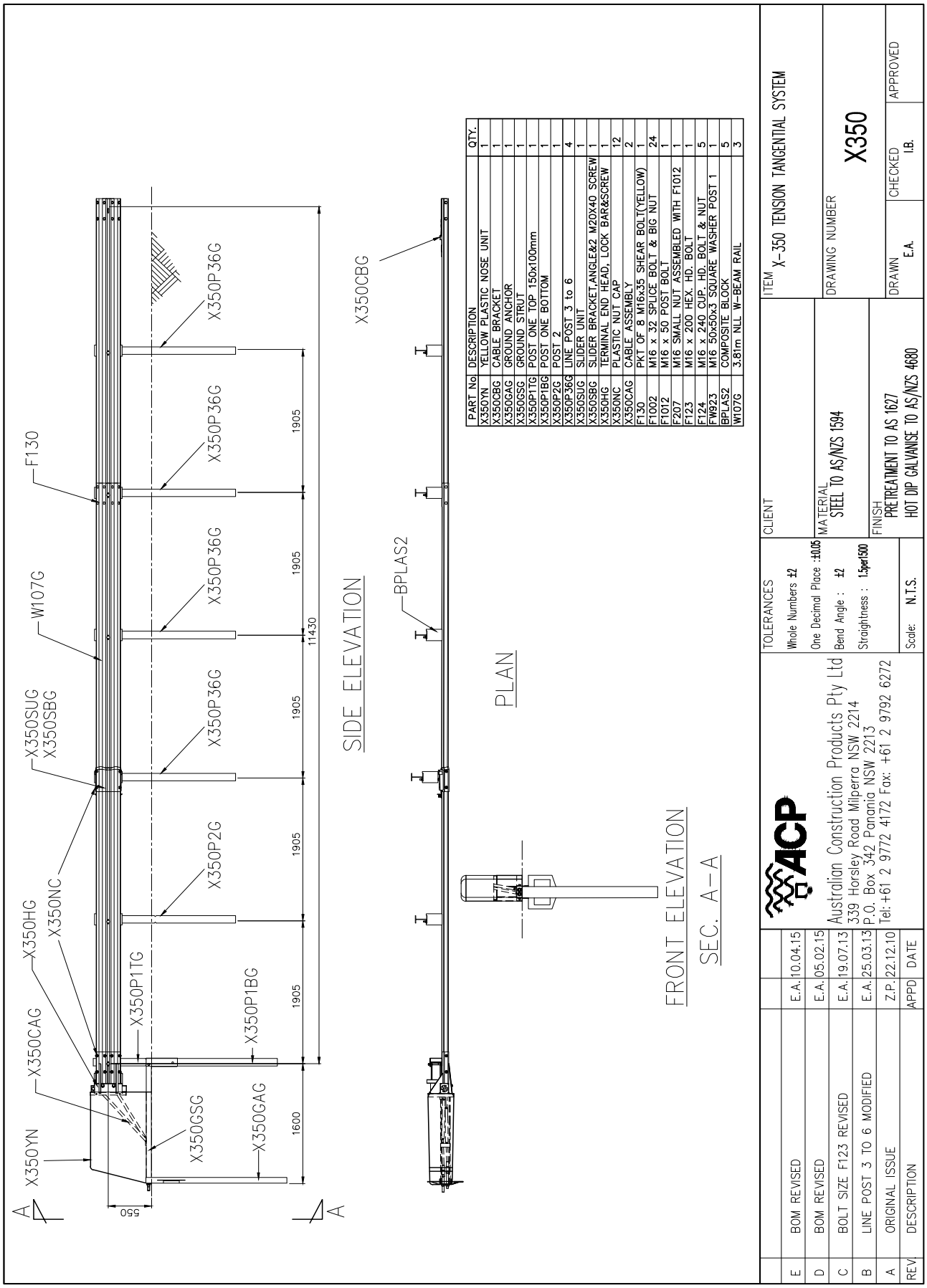
Any part that cannot be reused must be replaced with a new part. In minor impacts the cables can be reused by turning them end for end, but only if the cable sleeves are not damaged. If additional damage has occurred, replace the cables. Generally, all the specialised components of the system such as the head and brackets should be undamaged.

Step 6: Reassemble

Reassemble as per system installation instructions.

X-TENSION 350 Maintenance (Fire Event)

If a X-TENSION 350 has been involved in a fire event an inspection needs to be undertaken. This will ascertain component damage and what parts of the terminal will require replacing. For assistance please contact Australian Construction Products.


SIDE ELEVATION
PLAN
FRONT ELEVATION
SEC. A–A
F130
W107G
X350SUG
X350SBG
X350NC
X350HG
X350CAG
X350YN
X350P1TG
X350P1BG
X350GSG
X350GAG
X350P2G
X350P36G
X350P36G
X350P36G
X350P36G
X350CBG
BPLAS2
550
1600
1905
1905
1905
1905
1905
11430
A
A
PART No DESCRIPTION QTY.
X350YN YELLOW PLASTIC NOSE UNIT 1
X350CBG CABLE BRACKET 1
X350GAG GROUND ANCHOR 1
X350GSG GROUND STRUT 1
X350P1TG POST ONE TOP 150x100mm 1
X350P1BG POST ONE BOTTOM 1
X350P2G POST 2 1
X350P36G LINE POST 3 to 6 4
X350SUG SLIDER UNIT 1
X350SBG SLIDER BRACKET,ANGLE&2 M20X40 SCREW 1
X350HG TERMINAL END HEAD, LOCK BAR&SCREW 1
X350NC PLASTIC NUT CAP 12
X350CAG CABLE ASSEMBLY 2
F130 PKT OF 8 M16x35 SHEAR BOLT(YELLOW) 1
F1002 M16 x 32 SPLICE BOLT & BIG NUT 24
F1012 M16 x 50 POST BOLT 1
F207 M16 SMALL NUT ASSEMBLED WITH F1012 1
F123 M16 x 200 HEX. HD. BOLT 1
F124 M16 x 240 CUP. HD. BOLT & NUT 5
FW923 M16 50x50x3 SQUARE WASHER POST 1 1
BPLAS2 COMPOSITE BLOCK 5
W107G 3.81m NLL W-BEAM RAIL 3
CLIENT
ITEM X-350 TENSION TANGENTIAL SYSTEM
MATERIAL STEEL TO AS/NZS 1594
FINISH PRETREATMENT TO AS 1627
HOT DIP GALVANISE TO AS/NZS 4680
DRAWING NUMBER X350
DRAWN E.A.
CHECKED I.B.
APPROVED
TOLERANCES
Whole Numbers ±2
One Decimal Place ±0.05
Bend Angle ± 2
Straightness : 1.5per1500
Scale: N.T.S.
ACP
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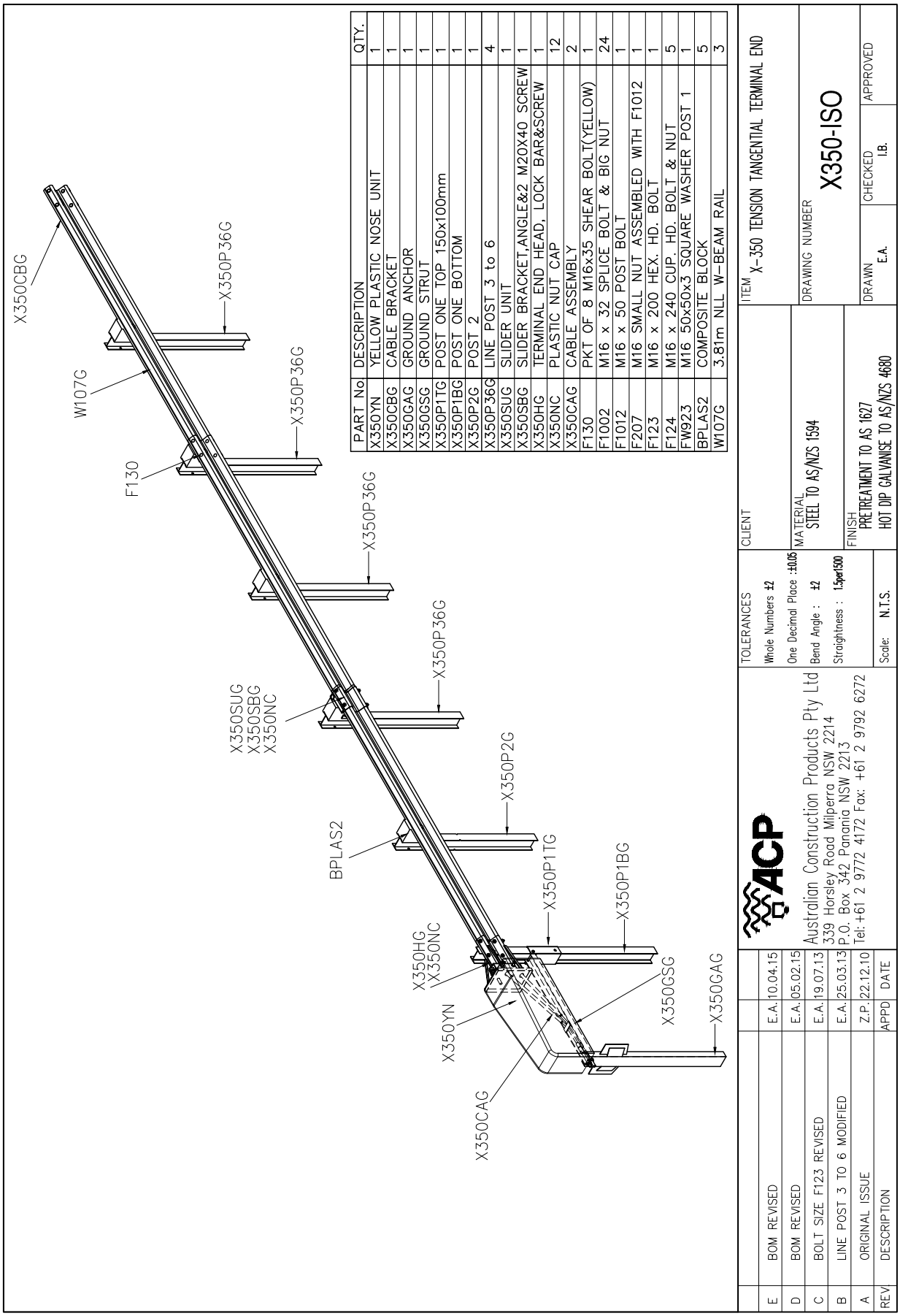
REV DESCRIPTION APPD DATE
E BOM REVISED E.A. 10.04.15
D BOM REVISED E.A. 05.02.15
C BOLT SIZE F123 REVISED E.A. 19.07.13
B LINE POST 3 TO 6 MODIFIED E.A. 25.03.13
A ORIGINAL ISSUE Z.P. 22.12.10



PART No	DESCRIPTION	QTY.
X350YN	YELLOW PLASTIC NOSE UNIT	1
X350CBG	CABLE BRACKET	1
X350GAG	GROUND ANCHOR	1
X350GSG	GROUND STRUT	1
X350P1TG	POST ONE TOP 150x100mm	1
X350P1BG	POST ONE BOTTOM	1
X350P2G	POST 2	1
X350P36G	LINE POST 3 to 6	4
X350SUG	SLIDER UNIT	1
X350SBG	SLIDER BRACKET,ANGLE&2 M20X40 SCREW	1
X350HG	TERMINAL END HEAD, LOCK BAR&SCREW	1
X350NC	PLASTIC NUT CAP	12
X350CAG	CABLE ASSEMBLY	2
F130	PKT OF 8 M16x35 SHEAR BOLT(YELLOW)	1
F1002	M16 x 32 SPLICE BOLT & BIG NUT	24
F1012	M16 x 50 POST BOLT	1
F207	M16 SMALL NUT ASSEMBLED WITH F1012	1
F123	M16 x 200 HEX. HD. BOLT	1
F124	M16 x 240 CUP. HD. BOLT & NUT	5
FW923	M16 50x50x3 SQUARE WASHER POST 1	1
BPLAS2	COMPOSITE BLOCK	5
W107G	3.81m NLL W-BEAM RAIL	3