



Sentryline II Cable Barrier System

TL-3 & TL-4 System

Product and Installation Manual

Please call Australian Construction Products on 02 8708 4400 or visit www.acprod.com.au for more information

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SMARTER SAFETY SOLUTIONS

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Product and Installation Manual: Sentryline II Cable Barrier System

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TL-3 and TL-4 – 4 Cable Barrier System

Introduction

Sentryline II TL-3 and TL-4 is a high tension cable barrier system consisting of unique ‘oval’ shaped steel posts. Slots within the posts house the 4 barrier system cables at the required height and each post has a concrete footing.

The system has been designed and tested to meet the evaluation criteria of NCHRP 350 Test Level 3 (TL-3) and 4 (TL-4) for a longitudinal barrier system.

It is recommended that the 4 cable **Sentryline II** barrier system is anchored using the **Sentryline Terminal End III** which has been accepted to NCHRP 350 TL-3.

System Overview

Sentryline II TL-3 and TL-4 Cable Barrier System is designed and constructed to provide acceptable structural adequacy, minimal occupant risk and safe trajectory as set forth in NCHRP 350 for longitudinal barrier systems.

When impacted with an 820kg, 2000kg and 8000kg vehicle at speeds of up to 100kph and side on entry angles up to 25 degrees, the impacting vehicle is re-directed in a safe manner.

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Limitations & Warnings

Sentryline II TL-3 and TL-4 cable barrier systems have been rigorously tested and evaluated per the evaluation criteria in the NCHRP 350 guidelines for a longitudinal barrier system. The impact conditions recommended in NCHRP 350 are intended to address typical in-service collisions.

Sentryline II barrier systems allow an impacting vehicle to be re-directed in a safe and predictable manner under the NCHRP 350 impact conditions. It is imperative that the system is installed as per manufacturers' specification.

Vehicle impacts that vary from the NCHRP 350 impact conditions described for longitudinal barrier systems 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 (weight, speed and angle) may result in system performance that may not meet the NCHRP 350 evaluation criteria.

Before Installation

Design, selection and placement of the **Sentryline II** shall be in accordance with the Road Controlling Authority's guidelines and the details shown in the construction drawings. Installation shall be in accordance with the installation instructions supplied for this product.

Note: Concrete foundations will have to be designed by a local geotechnical engineer if soil conditions on site do not meet the required level described in the manual.

Depending on the application, post spacing and conditions on site, installation and assembly of the system should take a 3 person crew less than 4 hours to cast the piles, install the posts and place the cables for a 100m section.

Sentryline II 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 up of the system.



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Safety Statements

General Safety

- > All required traffic safety precautions should be complied with. All workers should wear required safety clothing. (Examples, and not limited to, include: high visibility vests, steel capped footwear, gloves etc.)
- > Only authorised trained personnel should operate any machinery. Where overhead machinery is used, care must be taken to avoid any overhead hazards.
- > Before drilling or excavation always ensure that the area is clear of underground services. (The appropriate service providers may need to be contacted).

Geotechnical Warning

The **Sentryline II** line post concrete foundations require sufficient strength from the supporting soil and guidelines contained within this manual on foundation sizes relate specifically to the corresponding soil strength. If it is determined that soil conditions on site do not meet or exceed these requirements, alternative size foundations must be designed by a local geotechnical engineer for use at that location.

Sentryline II Safety Statements

- > All installers must be well clear of drilling or excavating machinery operating.
 - > The cable and reel are extremely heavy so it is recommended that the cable is run out from a single axis spindle. Do not place hands or fingers in or around moving parts.
 - > Only trained personnel can use the tensioning machine. All installers must be extremely careful they are clear of moving parts when the machine is being operated.
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Limited Warranty

Australian Construction Products Ltd (ACP) has tested the impact performance of its barrier systems and crash cushion systems, and other highway safety hardware under controlled conditions, however, ACP does not represent nor warrant that the results of those controlled conditions would necessarily avoid injury to persons or property.

ACP EXPRESSLY DISCLAIMS ANY WARRANTY OR LIABILITY FOR CLAIMS ARISING BY REASONS OF DEATH OR PERSONAL INJURY OR DAMAGE TO PROPERTY RESULTING FROM ANY IMPACT, COLLISION OR HARMFUL CONTACT WITH THE PRODUCTS OR NEARBY HAZARDS OR OBJECTS BY ANY VEHICLE, OBJECTS OR PERSONS.

ACP warrants that any product or component part manufactured by ACP will be free from defects in material or workmanship. ACP will replace free of cost any Product or component part manufactured by ACP that contains such a defect.

THE FOREGOING WARRANTY IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES NOT EXPRESSLY SET FORTH HEREIN, WHETHER EXPRESS OR IMPLIED BY OPERATION OF LAW OR OTHERWISE, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ACP'S LIABILITY UNDER THIS WARRANTY IS EXPRESSLY LIMITED TO REPLACEMENT FREE OF COST OF PARTS SUPPLIED BY ACP ONLY (IN THE FORM AND UNDER THE TERMS ORIGINALLY SHIPPED), OR TO REPAIR OR TO MANUFACTURE BY ACP, PRODUCTS OR PARTS NOT COMPLYING

WITH ACP SPECIFICATIONS, OR, AT ACP'S ELECTION, TO THE REPAYMENT OF AN AMOUNT EQUAL TO THE PURCHASE PRICE OF SUCH PRODUCTS OR PARTS, WHETHER SUCH CLAIMS ARE FOR BREACH OF WARRANTY OR NEGLIGENCE. ACP SHALL NOT BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL LOSSES, DAMAGES OR EXPENSES OF ANY KIND, INCLUDING, WITHOUT LIMITATION, ANY SUCH LOSSES, DAMAGES OR EXPENSES ARISING DIRECTLY OR INDIRECTLY FROM THE SALE, HANDLING OR USE OF THE PRODUCTS FROM ANY OTHER CAUSE RELATING THERETO, OR FROM PERSONAL INJURY OR LOSS OF PROFIT.

Any claim by the Buyer with reference to Products sold hereunder for any cause shall be deemed waived by the Buyer unless ACP is notified in writing, in the case of defects apparent on visual inspection, within ninety (90) days from the delivery date, or, in the case of defects not apparent on visual inspection, within twelve (12) months from the said delivery date. Products claimed to be defective may be returned prepaid to ACP's plant for inspection in accordance with return shipping instructions that ACP shall furnish to the Buyer forthwith upon receipt of the Buyer's notice of claim. If the claim is established, ACP will reimburse that Buyer for all carriage costs incurred hereunder.

The forgoing warranty benefits shall not apply to (i) any Products that have been subject to improper storage, accident, misuse or unauthorized alterations, or that have not been installed, operated and maintained in accordance with approved procedures and (ii) any components manufactured by the Buyer.

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Design Considerations

Curves

Horizontal – If temperatures can reach as low as zero degrees Celsius, the minimum allowable curve is 150m radius.

Note: Post spacing and concrete footings sizes will need to be determined to accommodate a radius this tight. For all further assistance contact ACP.

Vertical – Maximum allowable vertical sag of 2400m radius. This maximum does not apply to crests of hills.

Curve Multiplying Factor Table – Multiply the relevant deflection by the appropriate factor from the table below to calculate the likely deflection of the barrier system on a curve.

Note: The multiplying factor applies to convex curves only.

Length (m)	Convex Curve Radius (m)					
	200-400	400-600	600-800	800-1000	1000-1500	1500+
0-100	1.5	1.4	1.3	1.2	1.1	1.0
101-200	1.8	1.6	1.4	1.3	1.2	1.1
201-300	2.0	1.8	1.6	1.4	1.3	1.1
301-400	2.2	2.0	1.8	1.6	1.4	1.2
401-500	2.5	2.2	1.9	1.7	1.5	1.2
500+	2.5	2.2	2.0	1.8	1.5	1.2

Undulating ground conditions

Site specific grading may be necessary to ensure that there are no ‘humps’ or ‘hollows’ that may significantly alter the impacting vehicles stability or substantially alter the cable heights in relation to the ground.

Slopes

A maximum slope of 10:1 is preferable. On slopes greater than this, advice should be followed from the Road Controlling Authority’s guidelines.

Curbs

As with all road side safety hardware, **Sentryline II** has been designed and tested so the centre of gravity of the impacting vehicle is a constant height in relation to the system. For this reason, it is preferred that curbs or channels are not in front or behind the barrier system as they will result in altering the height of the vehicle at impact. If there is no option but to install near a curb advice should be followed from the Road Controlling Authority’s guidelines.

Ditches

If the slope of the ditch is greater than 10:1 then follow the Road Controlling Authority’s guidelines.

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System Design

Median and Roadside Applications

The **Sentryline II** Cable Barrier System can be impacted from either side of the post with no difference in performance. Therefore the barrier system can be used in both median and roadside situations in either orientation as long as the slot arrangement is consistent.

Barrier System Length

Minimum – Is 25m and represents the distance between the upstream and downstream Length of Need (LoN) of the terminal ends. i.e. excludes the 8m of **Sentryline Terminal End III** at either end.

Note: A shorter barrier system may not have sufficient length to fully re-direct an errant vehicle.

Maximum – No theoretical limit if the barrier system is essentially straight in both horizontal and vertical alignment and tensioned as required. However, when a barrier system is impacted, the ability of the barrier system to resist subsequent impacts before repair is not guaranteed. For this reason, **Sentryline Terminal End III** is recommended to be limited to a maximum of 1000m between terminal ends.

For all further assistance on how to tension long installations correctly, contact ACP.

Flare Rate

The maximum flare rate allowed is 30:1 measured from the tangent.

Terminal End Treatments

The **Sentryline II** Cable Barrier System is terminated using the **Sentryline Terminal End III**. For further details consult the **Terminal End III** Product Manual.

Transitions

Transitions from **Sentryline II** to other types of barrier systems are possible and details are available on request. Please contact ACP.

Intermediate Anchors

It is recommended that a **Sentryline II** barrier system is limited to 1000m in length and that intermediate anchors are utilised when a barrier system greater than 1000m is required.

To create an intermediate anchor, simply overlap one **Sentryline II** barrier system run with the next. A minimum 300mm gap between the barrier systems is required. The Length of Need (LoN) of each barrier system must be as per the **Sentryline Terminal End III Overlap** drawing. **(See Appendix section of this manual)**

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Batter Hinge Point

NCHRP 350 recommends that the lateral extent of the soil, outside an envelope of the embedded portion of the test article, be approximately 1.3 times the embedment length. This is so that the foundations have sufficient support during impact to resist movement.

ie: If the **Sentryline II** footing is 300mm ϕ by 750mm deep, it will require a minimum of 1 metre supporting soil outside the line of posts. **(shown in Figure A)**

If the batter hinge point is reduced to only 600mm, the 300mm ϕ pile will need to increase to a depth of 1000mm. **(shown in Figure B: MGL 15 Sept 2006 – Post Foundation Under Later Load)**

Note: These are examples only and based on a particular soil type. It may be required that a specific foundation will need to be designed by a local geotechnical engineer.

Length of Need (LoN)

The Length of Need (LoN) for a **Sentryline II** Cable Barrier System connected to a **Sentryline Terminal End III** is at post #5, where post #1 is positioned 2m from the ground anchor. Posts #1 – #5 are always at 1.5m spacing; therefore the LoN is 8m from the 'trigger' post. **(shown in Figure C)**

Note: As per the LoN design section of the Road Controlling Authority's guidelines, care must be taken when calculating the actual length of the barrier system required versus the theoretical length of the LoN. The physical placement of the **Sentryline Terminal End III** must be with post #5 positioned at the LoN.

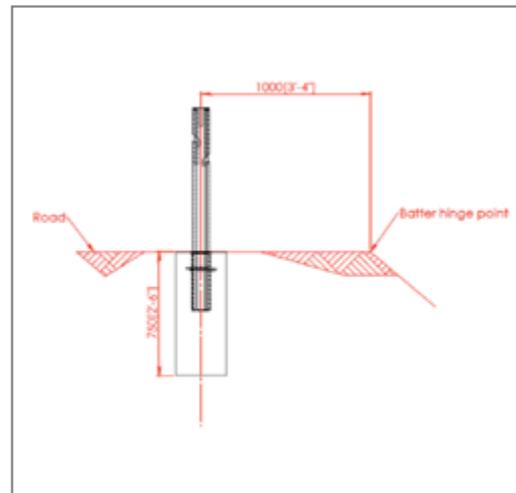


Figure A

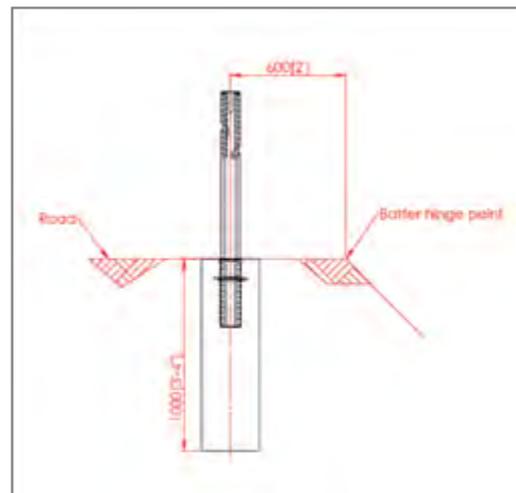


Figure B



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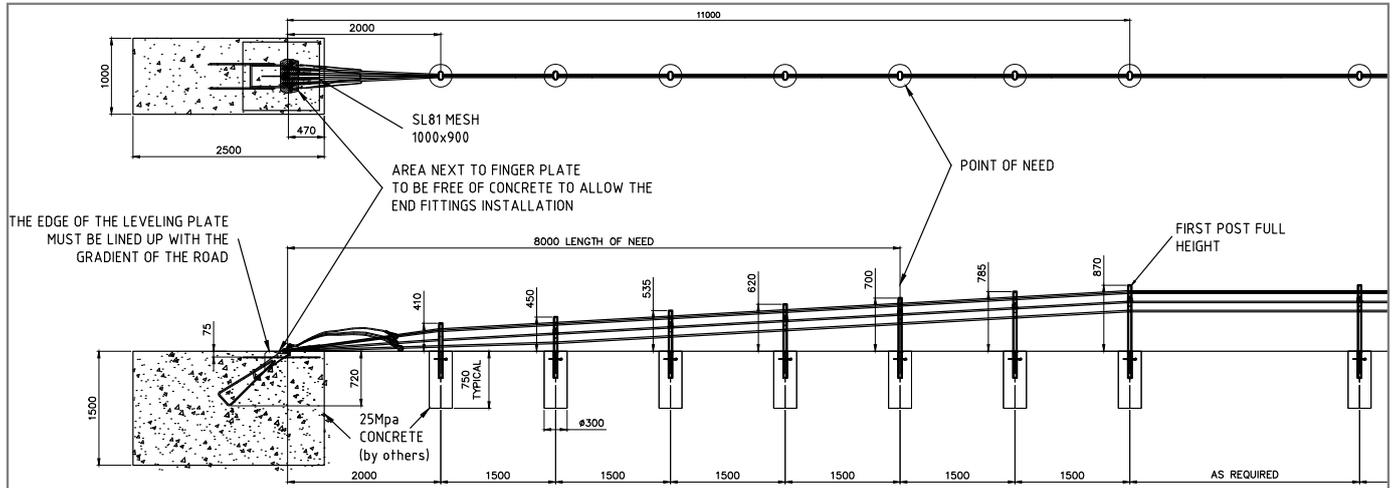


Figure C

Deflections

Deflection measurements from actual crash testing can be useful when assessing a products suitability to perform as required at a given location. The below distance measurements are from NCHRP 350 compliance testing on the 4 cable systems.

Note: The greatest impact severity of all tests at TL-3 & TL-4 is the test involving the 2000P vehicle. This is test 3-11 or 4-11, which are the exact same test.

Results from **Test 3-11 (NCHRP 350)** are the **published TL-3 Deflection**.

TL-3 Deflection Results

Test 3-11:	2000kg pickup truck, 100kph at 25 degrees		(NCHRP 350 TL-3)
	Post Spacing	Dynamic Deflection	Working Width
	3.0m	1.54m	1.54m
	Post Spacing	Dynamic Deflection	Working Width
	9.0m	3.27m	3.27m

TL-4 Deflection Results

Test 4-12:	8000kg truck, 80kph at 15 degree angle		(NCHRP 350 TL-4)
	Post Spacing	Dynamic Deflection	Working Width
	3.0m	1.10m	2.15m

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Interpolation of Results:

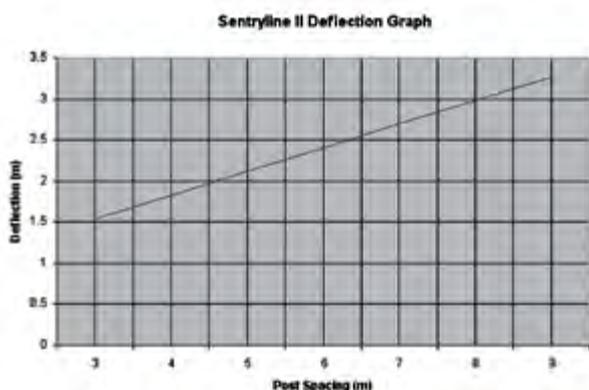
When two identical tests are run on a cable barrier system with different post spacing it is acceptable (FHWA) to interpolate the results so deflection measurements at other post spacing's can be known. (The results and interpolation of the two actual 2000P tests are shown below)

Note: Deflection is influenced by cable temperature, post spacing, soil stability, barrier system length and barrier system curvature. Consequentially, allowance should be made for barrier systems to deflect more than that shown during one particular test. The deflection listed below should only be used as an indication of what deflection measurement to expect.

Line Post Foundation Piles

For the line post foundation pile to provide the required support to the post during vehicle impact, and have sufficient strength to resist movement, it relies on the design of the concrete foundation and the surrounding soil conditions on site. Soil conditions have different characteristics that will affect the strength of the concrete foundation and accordingly **Sentryline II** has a range of foundations options which allow for economical construction, while still maintaining the performance levels required.

IF SOIL CONDITIONS ON SITE DO NOT MEET OR EXCEED THE REQUIRED STRENGTH DETAILED IN THIS MANUAL, SITE SPECIFIC FOUNDATIONS MUST BE DESIGNED BY A LOCAL GEOTECHNICAL ENGINEER



Post Spacing (m)	Deflection (m)
3	1.54*
4	1.83
5	2.12
6	2.41
7	2.69
8	2.98
9	3.27*

***Actual deflections from NCHRP 350 testing**

Note: All technical information required to assist in designing a site specific foundation is available from ACP as a **Foundation Assistance Package**.

Two foundation options are available in this manual; the soil conditions that exist on site will determine which ones can be used.

Note: Foundation piles can be pre-cast but special attention must be made that adequate soil compaction is achieved after placement. For further information contact your ACP sales representative.

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Option 1:

TO USE OPTION 1 THE TESTED SOIL CONDITION MUST MEET OR EXCEED THE STRENGTH DETAILED IN TABLE 1 BELOW

The post socket and rebar ring must be cast into concrete foundation piles with the following dimensions. The augured holes for this option are 300mm diameter by 900mm deep and filled with 25mpa concrete. (Theoretical volume 0.064m³)

Cohesive Soils		
Soil Type	Description Su (kpa)	Foundation Pile Depth
Firm – Stiff	50 – 75	300mm ø x 900mm

Cohesionless Soils		
Soil Type	Description Phi (0)	Foundation Pile Depth
Dense – Medium Dense	30 – 41	300mm ø x 900mm

Option 2:

TO USE OPTION 2 THE TESTED SOIL CONDITION MUST MEET OR EXCEED THE STRENGTH DETAILED IN TABLE 2 BELOW

The post socket and rebar ring must be cast into concrete foundation piles with the following dimensions. The augured holes for this option are 300mm diameter by 750mm deep and filled with 25mpa concrete. (Theoretical volume 0.053m³)

Cohesive Soils		
Soil Type	Description Su (kpa)	Foundation Pile Depth
Stiff – Very Stiff	75 – 125	300mm ø x 750mm

Cohesionless Soils		
Soil Type	Description Phi (0)	Foundation Pile Depth
Very Dense	> 41	300mm ø x 750mm

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Tension

It is important that when tensioning the **Sentryline II** that the tension machine is set to make allowance for the temperature at the time of installation.

The Tensioning Machine is usually pre-set so advice should be sought on all installations ACP.

Note: Temperature refers to air temperature.

NOTE: DO NOT TENSION A BARRIER SYSTEM FOR AT LEAST 7 DAYS AFTER THE FOUNDATION PILES HAVE BEEN CAST.

Note: As with all cable barrier systems it is recommended that 2 weeks after the barrier system is tensioned for the first time, it should be re-tensioned to remove 'construction creep'. It is also recommended that the tension on the cables is checked after impacts.

Temp °C (air)	0 – 3	4 – 9	10 – 14	15 – 20	21 – 26	27 – 32	33 – 37	38 – 43
Tension kN's	32	30.5	28.5	26.5	25	23.2	21.5	19.5

Tension Bays

For installations less than 300m long, 1 tension bay located near the middle of the Sentryline II installation is sufficient. For installations greater than 300m, multiple tension bays will be required. The first tension bay is to be located 150m in from each terminal end and any other tension bays are at a maximum spacing of

350m from each other. When positioning the strong back brackets, care must be taken to cut the cables mid-span between the posts so that they are offset to each other.

Note: Do not place two strong backs within 30m of each other when on the same cable.



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Special Circumstances

Trapped Vehicles

If a vehicle is entrapped in the cables it may be causing greater tension than would otherwise be present. To remove, follow the instructions below before cutting cables.

DO NOT CUT CABLES THAT ARE UNDER ANY TENSION

De-tensioning Cables (with a Tension Machine)

Best practice is to release the tension **fully** from each cable using the tension machine at a tension bay. (Process outlined on page 24 of this manual)

De-tensioning Cables (without a Tension Machine)

If a tension machine is not available it is possible to release the tension at a tension bay using a ring spanner to unwind the nuts from the swage fittings within the strong back bracket.

Note: When using either method it is usually required that a tension bay **on either side** of the trapped vehicle is de-tensioned. If there is not a tension bay on either side of the trapped vehicle, de-tension all the cables at the tension bay available first. Then move the trapped vehicle in the direction of the terminal end until the remaining tension in the cables is removed sufficiently.

Only then, once the cable barrier system is **fully de-tensioned on each side** of the vehicle, can the cables be cut using appropriate cutting equipment and the vehicle removed.

Re-instate the barrier system as per the installation instructions contained in this manual.

Emergency Access

Sentryline II Cable Barrier System can be lowered to the ground by removing an adequate length of cable housed in the posts. After the posts are removed from the sockets in this area, a 'gate' is formed and vehicles can pass to the other side of the barrier system. There is no need to de-tension the system and no machinery or lifting devices are required to perform this task.

To decommission:

- > Remove the plastic caps from 20-40 posts. (amount will vary due to conditions on site)
- > By hand lift the cables out of the slots at each post in the intended 'gate' area. When removed from a sufficient number of posts the cables will lower to the ground and create a 'gate' in the system where vehicles can ride safely over the barrier system cables.
- > Remove and store the posts from the sockets in the 'gate' area so the vehicles have unrestricted access to the other side.

To reinstate:

- > Place the posts back into the sockets making sure that the slot orientation matches.
- > Lift each cable and place back to their respective slots making sure that the two bottom cables are under the notches on the side slots.
- > Push the caps firmly back into place taking care that the cap sleeves are on the outside of the cables in the side slots.

Note: If the cables are to be removed from the location, the system will need to be de-tensioned.



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Sentryline II – Parts identification



> Line Post & 'O' Ring



> Machine Swage Fitting



> Post Cap



> Strong Back Bracket



> Post Socket



> 4 Cable Barrier System



> Rebar Ring

All steel components used in the Sentryline II are hot dipped galvanised, EXCEPT the rebar ring which are cast into the concrete piles.



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Sentryline II – Bill of Materials

Components required for each post:

- > 1x Galvanised Line Post (powder coating is optional)
- > 1x Plastic Cap
- > 1x Plastic Socket
- > 1x Rebar Ring
- > 1x Rubber 'o' Ring

Cable required for the TL-3 and TL-4 System:

TL-3 and TL-4 – 4 Cable Barrier System

- > 4x the total length of the barrier system of 19mm cable

Note: It pays to be conservative with these lengths.

Strong Backs required for the TL-3 and TL-4 System:

TL-4 – 4 Cable Barrier System

- > 4x Strong Backs for each tension bay

Note: There may be more than 1 tension bay per barrier system run depending on the length or design of the barrier system.

Swage Fittings and associated components:

TL-3 and TL-4 – 4 Cable Barrier System

- > 8x Swage Fittings c/w M20 Nuts for each tension bay
- > 4x Swage Fittings c/w M20 Nuts for each **Sentryline Terminal End III**

Note: There may be more than 1 tension bay per barrier system run depending on the length or design of the barrier system.

Concrete required for each post:

- > As per foundation pile option used.

Note: From the foundation details shown in this manual or calculated by 'other' are theoretical. Allowance must be made that the holes may be larger than this due to the act of drilling and removing spoil on site.

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Sentryline II – Installation Preparation

Getting Started

For all installations of **Sentryline II** Cable Barrier System, whether median or edge of road locations, start from the last post of the terminal end. The 7 staggered height posts between the terminal end ground anchor and the **Sentryline II** Cable Barrier System must always be at 1.5m spacing.

Preparation

Before installing a **Sentryline II** Cable Barrier System, ensure that all components required for the system are on site and have been identified. The **Sentryline II** is a highly engineered safety device made up of relatively small number of parts. Before starting installation ensure that one is familiar with the make up of the system. Refer to the **Parts Identification** and **Bill of Materials** section in this manual for more information.

Ensure that the area where the **Sentryline II** is to be installed is flat enough so that the ground conditions will not significantly alter the height of the vehicle in relation to the height of the barriers systems cables.

Minor site grading may be required.

Soil Conditions

The **Sentryline II** line post foundation pile has been designed to have sufficient strength to remain intact after multiple vehicle impacts. Also it must be able to support the posts which house the 4 cables under tension on horizontal curves up to 150m radius. Therefore it is extremely important that the soil conditions on site have the adequate bearing capacity **Sentryline II** foundation pile.

Refer to the **Foundation Options** in the **System Design** section in this manual for more information.

It is recommended that soil tests are carried out at the location the **Sentryline II** Cable Barrier System is to be installed.

IF SOIL CONDITIONS ON SITE DO NOT MEET OR EXCEED THE REQUIRED STRENGTH DETAILED IN THIS MANUAL, SITE SPECIFIC FOUNDATIONS MUST BE DESIGNED BY A LOCAL GEOTECHNICAL ENGINEER

Tools Required

The tools required to install the **Sentryline II** Cable Barrier System are:

- > Drilling or excavating machinery suitable for foundation design
- > Concrete trowel or float
- > String line, measuring tape and marker pen
- > Machinery capable of lifting the cable reel and a single axle spindle
- > Cut off saw (generator)
- > Tensioning Machine



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Sentryline II – Installation instructions

Step 1 – Site Preparation

It is preferred that the **Sentryline II** is installed on flat, level ground with sufficient distance behind the foundation piles as described in the **Batter Hinge Point** section. The **Sentryline II** barrier system starts at post #5 of the **Sentryline Terminal End III** with post spacing as described in the construction drawings.

Note: The **Sentryline II** Cable Barrier System is a continuation of the **Sentryline Terminal End III** and should be installed in a tangent position. The maximum flare rate allowed is 30:1 measured from the tangent.

BEFORE DRILLING ALWAYS ENSURE THAT THE AREA IS CLEAR OF UNDERGROUND SERVICES

Step 2 – Foundation Construction

Excavate or drill the area that the Sentryline II posts are to be located as per the foundation option required. (shown in Figure 1 & 2)

All technical information on the 3 foundation options available, or for guidance on site specific foundations design, is located in the **System Design** section in this manual under **Foundation Options**.

DO NOT PROCEED PAST THIS POINT IF THE TYPE OF FOUNDATION REQUIRED HAS NOT BEEN ESTABLISHED

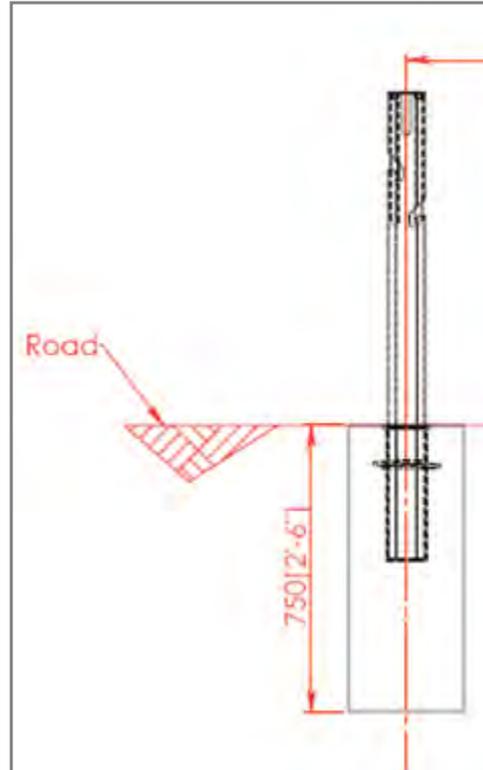


Figure 1



Figure 2

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Step 3 – Construction of a Foundation Pile

COMPLETE ALL OF STEP 3 BEFORE MOVING TO NEXT FOOTING

Fill the hole to no closer than 100mm from the top with concrete (25mpa), place the rebar ring in the centre. (shown in Figure 3)

Fill the remainder of the hole with concrete immediately. (shown in Figure 4)

Immediately push the socket ('flat' side perpendicular to direction of barrier system) into the centre of the footing until the top edge is flush with the concrete. (shown in Figure 5)

Using string lines and levels will aid in correct positioning of the rebar ring and socket.

Note: To prevent the possibility of a socket 'floating' use a stiff mix of concrete or place a post in the socket to ensure the final position will remain as intended. (shown in Figure 6)

At this stage extreme care must be taken to ensure that the sockets will be at the correct height. This guarantees that when the barrier system cables are installed, the cable heights will be within the construction tolerance as required in the manufacturer's specification.

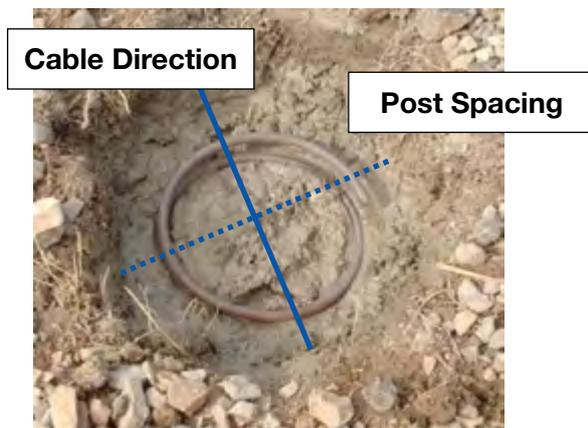


Figure 3

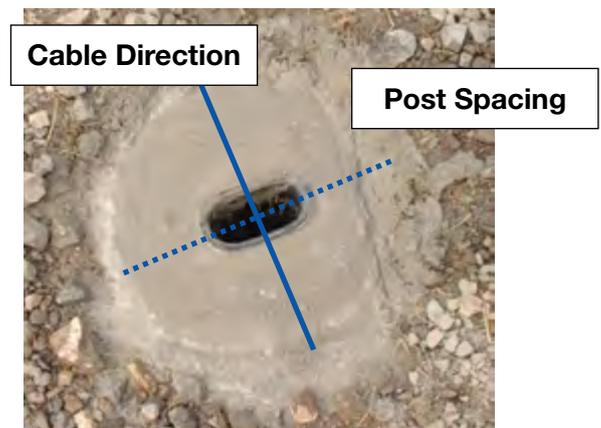


Figure 5



Figure 4



Figure 6

Note: Diagrams showing cable heights can be found in the **Appendix** of this manual.



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Step 4 – Installing the Posts

Push the rubber 'o' ring onto the bottom of the post by approximately 350mm. (shown in Figure 7)

This will prevent debris from building up in the socket which can make removal difficult.

Slide a post into the socket once the concrete has set and adjust the 'o' ring so that it fills the gap between the post and post socket. (shown in Figure 8)

Ensure that the posts are aligned so that the orientation of the two slots located on the side of the post are consistent. (shown in Figure 9)



Figure 7



Figure 8

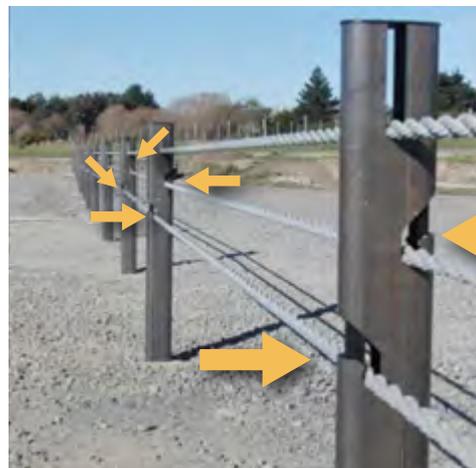


Figure 9



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Step 5 – Installing the Cables

Using a truck or trailer fitted with a cable reel frame, run the cables out to the desired length with cables on either side of the posts. (shown in Figures 10 & 11)

One or more of the cables may be run out at the same time depending on the installer's equipment. (shown in Figures 10 & 11)

For a 3 cable system place the bottom 2 cables into the bottom slots on either side of the post and the top cable into the top slot. (shown in Figure 12)

For a 4 cable system place the bottom 2 cables into the bottom slots on either side of the post and the top 2 cables into the top slot. (shown in Figure 13)

Ensure that the cables are pushed fully down to the bottom of their respective slots.



Figure 10



Figure 12



Figure 11



Figure 13



Product and Installation Manual: Sentryline II Cable Barrier System

Removing the slack from the cables

It is necessary to pull out the slack progressively out of the cable before tensioning the system. This should be done gradually starting at one Sentryline Terminal End III and working towards the other Sentryline Terminal End III. The slack will be easier to remove by using 3 Tonne rated rope grips with a strop rated 1.5 Tonne.



Method

Run the cable completely the full length of the installation from one Sentryline Terminal End III to the other Sentryline Terminal End III. At the end of each cable the strop is hooked to the anchor and as much slack is taken out before fitting the end cable swage fitting at this Sentryline Terminal End III.

The tension bays are then marked at the correct spacing. The rope grips are placed either side of the tension bay and strop is used to take out any slack. At the same time at the tension bay location cut out a 800mm section of rope and fit the tension bay. Repeat this process on each rope and at each tension bay along the installation finishing at the other Sentryline Terminal End III.

Note: Place a piece of folded steel over the strop webbing to protect it from being accidentally cut while cutting the cable to fit the tension bays.

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Step 6 – Placing the Post Caps

Slide the cap down the inside of the post and push down until cap is ‘hard home’ onto the top of the post. (shown in Figure 14)

If using a mallet or similar, make sure that the cap is not damaged in any way.

Ensure that the cap sleeves are on the outside of the 2 cables in the bottom slots. (shown in Figure 15)

Step 7 – Connecting to the Cable Barrier System Terminal End

Connect the cables to the terminal end as per the manufacturer’s instructions.

The **Sentryline Terminal End III** is the recommended terminal end for **Sentryline II** Cable Barrier System. (shown in Figure 16)



Figure 14



Figure 16



Figure 15

Product and Installation Manual: Sentryline II Cable Barrier System

Step 8 – Connecting the Machine Swage Fittings

1.1 Personal Protection

Before operating the swaging and tensioning equipment read all instructions and follow the safe operating procedures. While operating this equipment it is recommended that the following personal protective equipment be worn:

- > Long sleeve shirt and trousers or overalls
- > High visibility vest or high visibility component included in clothing
- > Gloves
- > Safety glasses/ face shield or other appropriate eye protection
- > Steel capped protective footwear

To avoid personal injury keep hands and feet away from moving components during operation.

Always keep your body to the side of the swaging operation, and ensure guards are in place during operation. Be sure there is adequate ventilation when the generator is in use.

Running the generator will cause the engine and exhaust to become hot. Keep body parts clear until components have cooled.

Ensure that the equipment is in proper working order and the guards are all in place; cycle the equipment at least once without a swage fitting in the dies before commencing the job.

Read all instructions, warnings and cautions carefully. Follow all safety precautions to avoid personal injury or property damage during system operation.

ACP cannot be held responsible for damage or injury resulting from unsafe product use or incorrect product and/or system operation. Contact ACP when in doubt regarding safety precautions and operations.

1.2 Equipment Operation

The ACP swaging unit is designed for the swaging of ACP supplied swage fittings, keep free of kinks and keep away from fire. All other use is prohibited.

Avoid kinking or twisting the hoses and avoid contact with fire.

1.3 Site Safety

Identify the area where work is to be completed and clear area of debris so there are no trip hazards or other obstructions which may prevent the work being conducted in a safe manner and ensure suitable traffic control is in place.

Select a safe area where the swaging and tensioning unit will sit during the duration of the process. Make sure the area complies with the site safe working conditions.

Observe weather conditions and operate the equipment out of the rain, or cover if using in the rain to protect the equipment.

Keep the swaging area clean and clear of debris

Product and Installation Manual: Sentryline II Cable Barrier System

2. Inspections

2.1 Hose Inspections

Before operating the swaging unit, check that all hose connections are tight with the proper tools. If loose, tighten using proper tools. Do not over tighten. Connections need only be tightened securely and leak free.

The hydraulic hoses are fitted with protective sheathing to prevent escaping hydraulic fluid from causing injury. Do not operate the swaging tool if the sheathing is damaged or missing.

2.2 Hydraulic Fluid Level

Check the fluid level in the hydraulic reservoir through the oil level gauge. The power supply is to be disconnected when adding fluid to the reservoir. Only use approved Enerpac hydraulic fluid to fill the reservoir.

2.3 Bleeding Air from the System

Air can accumulate in the hydraulic system during the initial set-up or after prolonged use, causing the cylinder to respond slowly or in an unstable manner. To remove the air;

1. Loosen a fitting that is situated higher than the rest of the fittings in the system.
2. Run the pump until the oil is flowing freely.
3. Tighten the fitting

2.4 Generator Fuel Level

The Honda engine is designed to run on unleaded fuel. Check the fuel level before starting the generator.

If refuelling is required, refuel when the engine is not running. Do not over fill, and wipe away any spilled fuel. Avoid getting water or dirt in the fuel tank. Ensure fuel is stored in an approved container.

2.5 Generator Oil Level

Oil is a major factor affecting performance and service life. Check the engine oil level with the engine stopped and in a level position. Use Honda 10W-30 or equivalent.

1. Remove the oil filler cap/dipstick and wipe it clean.
2. Insert the oil filler cap/dipstick into the oil filler neck, but do not screw it in, then remove it to check the oil level.
3. If the oil level is near or below the lower limit mark on the dipstick, fill to the upper limit mark. Do not overfill.
4. Reinstall the oil filler cap/dipstick.

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3. Generator Operation

A generator is used as the power source to the hydraulic pump.

To operate the generator

1. Turn the fuel valve ON and turn the key to the on position.

2. Move the throttle lever to the MAX position

3. Using the pull cord, pull the cord and start the engine

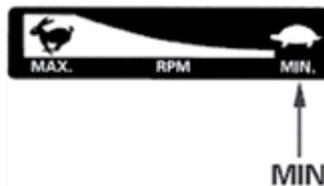
4. Move the throttle lever away from the MAX position, about 2/3 of the way toward the MIN position

5. Turn pendant switch to the swaging position, far right as indicated.

6. Position the throttle lever for the desired engine speed.

To stop the generator in an emergency, simply push the emergency stop button (red button).

When transporting the generator, ensure the fuel lever valve is switched OFF. If left ON, fuel may gather in the engine crankcase and dilute the engine oil. This will reduce the lubrication properties of the oil and can cause severe engine damage.



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4. Swaging Unit Operation

4.1 Attachment of the End Fitting

Only end fittings supplied by ACP are to be used.

1. Identify the location where the end fitting is to be attached to the wire rope

2. Cut the wire rope at the required location.

This can be achieved by using a wire cutter or a disk grinder. If using a disk grinder the following is to be observed;

- i. The operator is to be fitted with a full face shield and PPE as noted in Section 1.1
 - ii. The wire rope is to be appropriately clamped or secured. The wire rope should NOT be held by hand when cutting
 - iii. Care is to be taken not to contact the wire rope downstream of the cutting location
-

3. When the wire rope is cut to its correct length, remove any burrs with a file and ensure the rope is correctly twisted

4. Insert the wire rope into the end fitting.
Making sure the wire rope is driven hard into the back of the terminal.





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4.2 Swaging the End Fitting

1. Turn the generator on in accordance with Section 4.0.

2. Remove the nut from the end fitting.

3. Feed the end fitting through the roller die area so that the threaded section of the end fitting passes through the cross bar.

4. Reattach the end-fitting nut so that the thread of the end fitting is flush with the back of the nut. Refer above.

5. Gripping the end fitting, pull back to ensure a tight connection with the cross.





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6. Close the roller heads against the end fitting so they rest on this and insert the safety key to begin the swaging operation.

7. Operate the hydraulic ram by pressing the button on the pendant control.

8. Pressure around the end fitting will increase as the hydraulic ram moves and the roller dies rotate. The end fitting will pull through the roller dies.

9. Once the swage is complete, rotate the roller dies to the front of the swaging unit.

10. Remove the end fitting from the cross bar by releasing the nut.

11. Return the nut to the end fitting.

To stop the hydraulic pump in an emergency press the emergency stop buttons located on the unit. Under normal conditions turn the main switch on the control box to the OFF position.

Completed process – Swaged wire





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5. Troubleshooting

Repairs must be performed in a dirt-free environment by qualified personnel familiar with this equipment.

Problem	Cause	Solution
Generator will not start	<ol style="list-style-type: none"> 1. Fuel valve OFF 2. Choke OPEN 3. Engine switch OFF 4. Out of fuel 5. Spark plug faulty 6. Flooded engine 7. Fuel filter restricted 8. Carburettor malfunction 9. Ignition malfunction 	<ol style="list-style-type: none"> 1. Move lever to ON position 2. Move lever to CLOSED position unless warm 3. Turn switch to ON position 4. Refuel 5. Replace spark plug 6. Dry and reinstall spark plug. Start engine with throttle lever in MAX position 7. Repair by authorised service dealer 8. Repair by authorised service dealer 9. Repair by authorised service dealer
Generator lacks power	<ol style="list-style-type: none"> 1. Filter element(s) restricted 2. Wrong fuel 3. Fuel filter restricted 4. Carburettor malfunction 5. Ignition malfunction 	<ol style="list-style-type: none"> 1. Clean or replace filter element(s) 2. Drain fuel tank and carburettor and refuel 3. Repair by authorised service dealer 4. Repair by authorised service dealer 5. Repair by authorised service dealer
Pump does not operate	<ol style="list-style-type: none"> 1. Main isolator switch OFF 2. Unit is not plugged in 3. Emergency stop button has not been reset 4. Swaging guard open 	<ol style="list-style-type: none"> 1. Switch main isolator ON 2. Plug unit in 3. Reset emergency stop buttons and press reset button on the control box 4. Close the swaging guard
Pump is not delivering oil or delivers only enough oil to advance hydraulic ram partially or erratically	<ol style="list-style-type: none"> 1. Low fluid level in reservoir 2. Air trapped in system 3. Loose coupler 4. Contaminated oil 5. Relief valve or low pressure valve out of adjustment 	<ol style="list-style-type: none"> 1. Check fluid level in accordance with Section 3.2 2. Remove air from system in accordance with Section 3.3 3. Check all couplers 4. Repair by authorised service dealer 5. Repair by authorised service dealer valve



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5. Troubleshooting

Repairs must be performed in a dirt-free environment by qualified personnel familiar with this equipment.

Problem	Cause	Solution
Swaging Dies do not Turn	<ol style="list-style-type: none"> 1. Low fluid level 2. Directional Valve Spool is sticking 3. Oil leakage through hose of fitting Selector Switch is in wrong position 4. Valve spool is sticking 	<ol style="list-style-type: none"> 1. Check fluid level and refill if necessary 2. Repair by authorised service provider 3. Move selector switch on pendant to swage position 4. Repair by authorised service provider
Tensioning Unit does not extend or contract	<ol style="list-style-type: none"> 1. Selector switch on pendant in wrong position 2. Low hydraulic fluid level 3. Oil leakage coming from hose or fitting 4. Blocked hose, fitting or valve 5. Valve spool is sticking 	<ol style="list-style-type: none"> 1. Move selector switch on pendant to the tensioning position. 2. Check fluid level and refill if necessary 3. Tighten fittings or replace hoses and refill tank with hydraulic oil 4. Repair by authorised service provider 5. Repair by authorised service provider



Product and Installation Manual: Sentryline II Cable Barrier System

Step 9 – Tensioning the Barrier System

Tensioning the barrier system is achieved by pulling the swage fittings attached to the ends of the cable together using a hydraulic machine. The swage fittings can then be secured to the strong back bracket which will hold the tensioned cables together when the machine is released.

ENSURE FULL TENSION MACHINE TRAINING, INCLUDING SAFE USE, HAS BEEN COMPLETED BEFORE OPERATING A TENSION MACHINE

Tension Machine and associated training is available from your local ACP sales office.

Place swage fittings and strong back bracket into the tension machine ensuring that the cable is held by the safety catches. Once all personnel's hands are clear activate the machine so that it extends and pulls the swage fitting together. (shown in Figure 21.)

Note: The tension machine is pre-set to stop at tension; therefore it may be necessary to adjust the settings on the machine. Refer to **Tension** in the **System Design** section in this manual or contact ACP for more information.



Figure 21

Run nuts along the threaded section of the swage fittings inside the strong back bracket using a ring spanner until secure. (shown in Figure 22)

Activate the tension machine so it contracts and the machine can be lifted from the cable. Repeat Step 9 until all the cables are tensioned.

KEEP HANDS AND FINGERS CLEAR OF MOVING COMPONENTS

De-Tensioning the Barrier System

The barrier system can be de-tensioned simply reversing the above procedures as outlined below.

Place tension machine on the cable ensuring that safety catches are in place. Extend the machine slightly which will release the tension on the nuts against the strong back bracket. Using a ring spanner remove the nuts from the swage fitting thread. Contract the machine so the tension is released from the cable and remove the tension machine.



Figure 22



Product and Installation Manual: Sentryline II Cable Barrier System

Step 10 – Delineation

Delineation may be required as per the Road Controlling Authority guidelines.

For further details including type, location and placement contact ACP.

Sentryline II – Installation Example



Sentryline II Test Level 4 – 4 Cable Barrier System

Product and Installation Manual: Sentryline II Cable Barrier System

Sentryline II – Maintenance and Repair

Maintenance

Sentryline II is a maintenance-free high tension cable barrier system. However it is recommended that all cable barrier systems are checked after impacts to ensure that the tension is maintained. Refer to **Installation Instructions** section in this manual for more information.

Repair

After a typical impact

Recommended tool

> Crow bar

Replacement parts required for an average impact

> Posts

> Caps

Appropriate safety gear must be used at all times.

Remove all damaged caps.

Remove and replace all damaged posts with new ones.

Note: Ensure that the 'slots' on the side of the posts match the configuration of the rest of the intact barrier system posts.

Place the cables back into the appropriate slots.

Put new caps onto the posts.

Note: The caps need to be pushed hard home and ensure that the sleeves are on the outside of the 2 cables in the bottom slots.

Non-Standard Impacts

If for whatever reason a cable is damaged (any one strand or more are severed) then that cable must be replaced. Refer to **Installation Instructions** section in this manual for more information.

Note: Do not place two strong backs within 30m of each other when on the same cable.

If the impact was at or near an end anchor, tension may need to be checked and / or the cables re-attached to the **Sentryline Terminal End III**. Refer to **Installation Instructions** section in this manual and the **Sentryline Terminal End III Manual** for more information.

Foundations which are constructed correctly should not move or be damaged in anyway.

Product and Installation Manual: Sentryline II Cable Barrier System

TL-3 and TL-4 – 4 Cable Barrier System – Installation	Y	N
> Ground is level and the top of the pile is flush.		
> The plastic socket is cast in correctly and a rebar ring is positioned 100mm down from the top.		
> If installed near a steep slope, there is sufficient supporting soil outside the line of the posts in relation to the foundation size.		
> Posts are spaced as per the Construction Drawings. (1m-3m)		
> Posts are installed with slot orientation consistent for the entire length of the barrier system.		
> Top 2 cables are positioned in the top slot while the bottom 2 cables sit at the bottom of the slots on either side of the post.		
> An 'o' ring seal is positioned on all posts at the top of the socket.		
> All posts have a plastic cap inserted in the top. (make sure each cap sleeve is on the outside of the bottom cables)		
> Cable heights , 530mm, 650mm, 770mm and 790mm. (± 25mm)		
> Each of the 4 cables has been tensioned correctly.		

Location:			
Installed by:		Date:	
Inspected by:		Date:	

Contact ACP for more information on this or other road safety products

Product and Installation Manual: Sentryline II Cable Barrier System

Sentryline II – Frequently Asked Questions

1) What type of equipment is required to install the Sentryline II?

Standard tools required include a wrench, measuring tape, string line and trowel. Machinery suitable for drilling or excavating the line post foundation holes. A cable reel device to dispense the cable and lifting equipment to lift the cable reels. A cut off saw (cutting wheel) is required to cut the cables and a tension machine to tension the system.

2) How much concrete is required to install the footings on a Sentryline II and what strength does it need to be?

The volume will vary depending on the type of foundation being used. There are three foundation options contained in this manual and the corresponding theoretical volumes are: Option 1 = 0.064m³, Option 2 = 0.053m³, Option 3 = 0.095m³. The concrete used must be 25mpa. (Due to the drilling and removing spoil the actual amount may be larger than this)

Note: Other foundation sizes and types might be required due to on site soil conditions. Concrete volume requirements will vary accordingly.

3) Is there a curing period for the concrete before the cable barrier system can be tensioned?

Yes, it is recommended that the system is not tensioned until at least 7 days after all concrete piles have been poured.

4) Does your company provide spare parts? What is the lead-time for supply?

It is important to fix a damaged cable barrier system as soon as possible because it most probably won't perform as required when damaged. For this reason it is recommended that spares are held by maintenance contractors. (The concrete piles are very unlikely to be damaged)

5) On average, how long does it take to install a Sentryline II Barrier System?

Depending on the application and circumstances at the site, installation and assembly of the system should take a three person crew less than 4 hours to cast the piles, install the posts and place the cables for a 100m section. (Assuming posts are at 3m spacing and have a 300mm by 750mm pile foundation)

6) What about vandalism, can the Sentryline II be easily damaged?

No, once the system has been tensioned it is an extremely rigid system and tampering without the use of heavy duty tools or machinery is very unlikely to damage or affect the performance of the system.

Product and Installation Manual: Sentryline II Cable Barrier System

Sentryline II – Frequently Asked Questions continued

7) How easily can the Sentryline II be restored after impact?

Sentryline II is the simplest cable barrier system to fix on the market and including the **Sentryline Terminal End III** the system is easily repaired after impact. Damaged line posts can be removed using a crow bar and new ones positioned in the sockets before the cables and caps are repositioned. It is recommended that the cable tension is checked after impact.

If the system has been de-tensioned due to major damage on the terminal, a hydraulic tension machine and trained personnel will be required to re-tension the system after damaged parts are replaced. The foundation and ground anchor should not be damaged in anyway.

8) What maintenance does the Sentryline II require?

Sentryline II is a maintenance free barrier system as the cables used are pre-stretched. It is however recommended that the cable barrier system is checked 2 weeks after initial tension and after impacts. Refer to the **Maintenance** section in this **Sentryline II** Product Manual for recommendations on maintenance.

9) Will the plastic caps require frequent replacement due to weather deterioration of the product?

The plastic caps and legs are made from UV stabilised plastic and are extremely resistant to deterioration from the weather.

See separate Assessment of Materials report for further details.

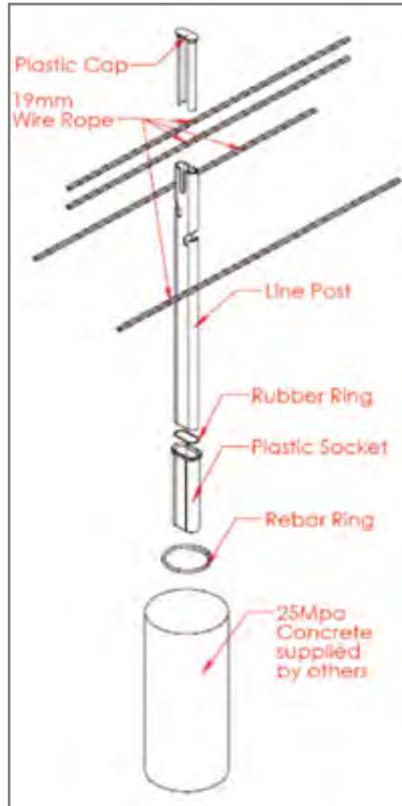
10) What is the Deflection rating of the Sentryline II?

Deflection is from actual crash testing and the figure published is from the test involving a 2000kg pickup truck at a 25 degree angle and at 100kph. The **Sentryline II** at 3.0m post spacing has a Dynamic Deflection of 1.54m.

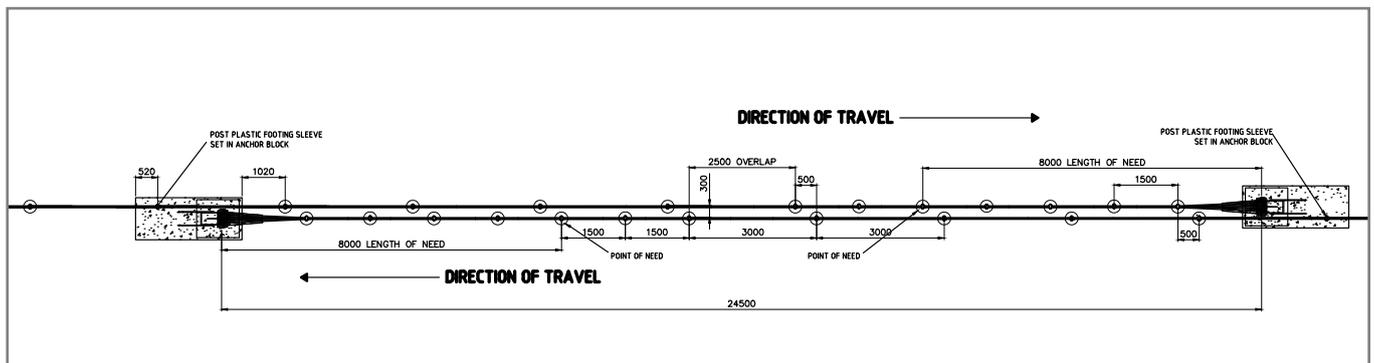


Product and Installation Manual: Sentryline II Cable Barrier System

Appendix – Technical Drawings



4 Cables Line Post Set Up

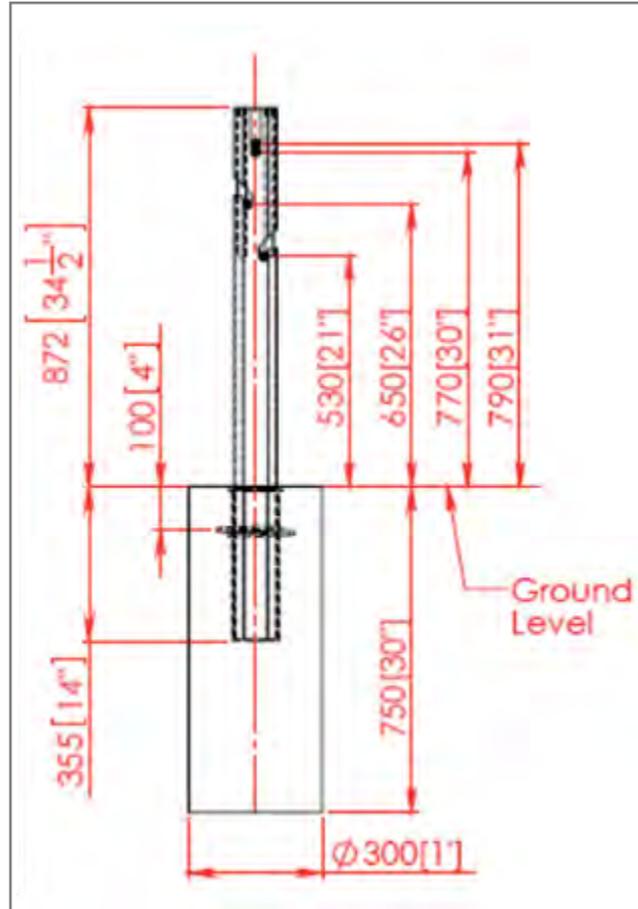


Sentryline Terminal End III – Overlap



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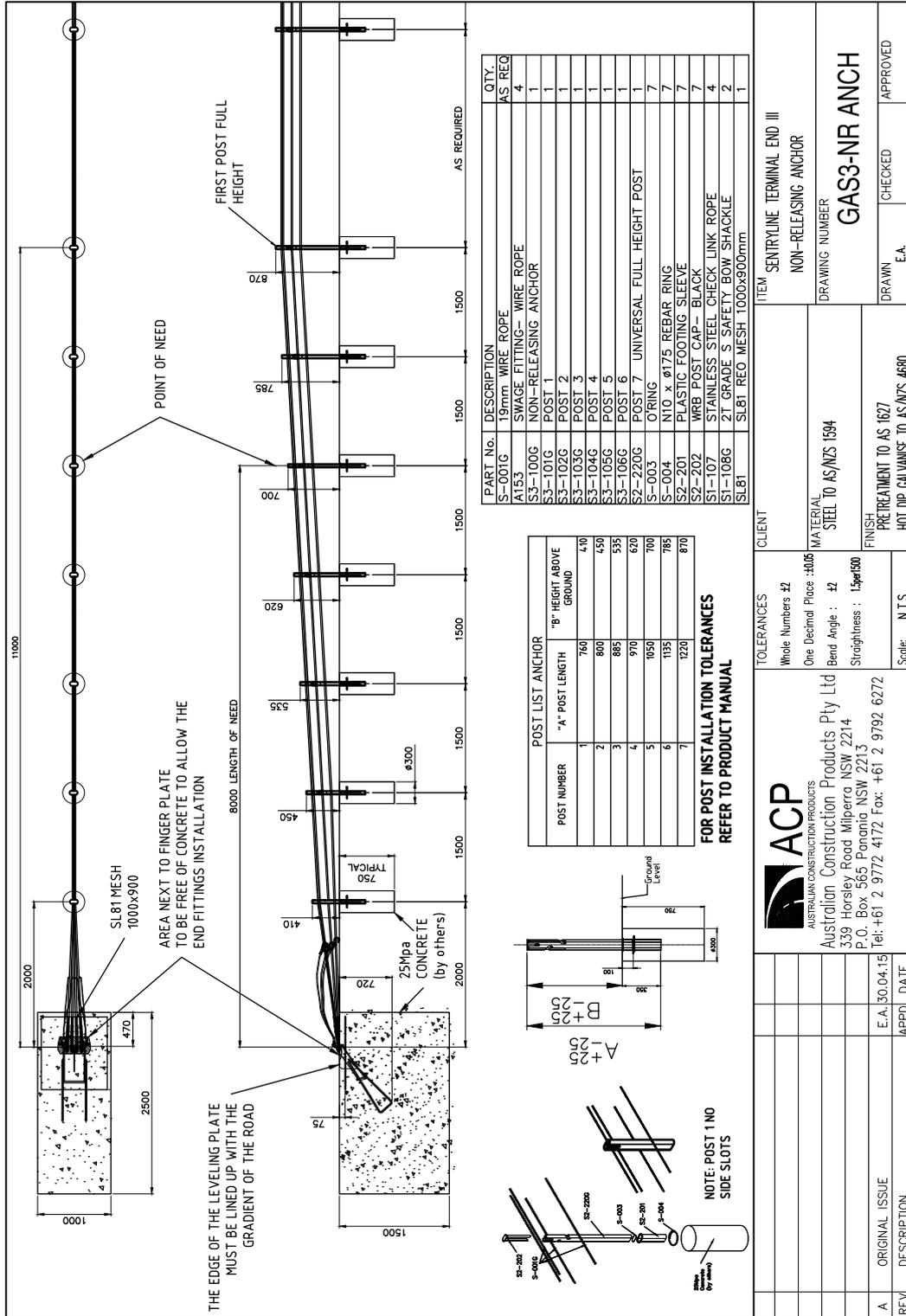
Appendix – Technical Drawings



Sentryline II TL-4 – Cable Heights
 (measured in mm to the centre of the cable,
 tolerance $\pm 25\text{mm}$)



Product and Installation Manual: Sentryline II Cable Barrier System



Sentryline Terminal End III