Defender 100HC™
MASH TL-4
High Containment
Temporary Steel Safety Barrier
Anchored
Product Design and Installation Manual

Safe Barriers Pte. Ltd.
Reference: D100HC-M-1804
April 18
# REVISION HISTORY

<table>
<thead>
<tr>
<th>Rev No.</th>
<th>Author</th>
<th>Reviewed/Approved</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C.Lee</td>
<td>R.Hood</td>
<td>Draft Issue</td>
<td>30 April 2017</td>
</tr>
<tr>
<td>2</td>
<td>D.Moule</td>
<td>R.Hood</td>
<td>Ver 1.0</td>
<td>19 Sept 2017</td>
</tr>
<tr>
<td>3</td>
<td>D.Moule</td>
<td>R.Hood</td>
<td>Ver 1.1</td>
<td>16 Jan 2018</td>
</tr>
<tr>
<td>4</td>
<td>D.Moule</td>
<td>R.Hood</td>
<td>Ver 1.2</td>
<td>22/01/2018</td>
</tr>
<tr>
<td>5</td>
<td>D.Moule</td>
<td>R.Hood</td>
<td>Ver 1.3</td>
<td>15/03/2018</td>
</tr>
<tr>
<td>6</td>
<td>D.Moule</td>
<td>R.Hood</td>
<td>Ver 1.4</td>
<td>17/04/2018</td>
</tr>
</tbody>
</table>

Safe Barriers Pte. Ltd.
PO Box 148, Novena Post Office, Singapore 913017
T: +65 3159 0947
W: [www.safebarriers.com](http://www.safebarriers.com)
E: engineering@safebarriers.com

Local Information

Australia 1800 169 799
New Zealand 09 9507186
USA 1 888 215 4535

Email All Locations info@safebarriers.com
Advice for your Safety

Ensuring all handlers of the product detailed within this installation manual are aware of the potential hazards that could arise while using this product, the guidelines set forth within ASNIZ535 series standards are identified and displayed where appropriate to show the activities potential severity.

Safety Alert Symbol

This symbol is to alert you to potential personal injury hazards. All safety messages that have this image attached shall be followed to ensure injury and death does not occur.

DANGER Symbol

This symbol defines a situation that is hazardous and which, if cannot be avoided, will result in death or serious injury.

WARNING Symbol

This symbol defines a situation that is hazardous and which, if cannot be avoided, could result in death or serious injury.

CAUTION Symbol

This symbol defines a situation that is hazardous and which, if cannot be avoided, may result in minor or moderate injury.

NOTICE Symbol

This symbol defines a situation that could potentially result in non-personal injury. I.e. property damage.
Contents

1. Introduction
   1.1. System Overview 5
   1.2. Delineation 6
   1.3. Important Notes 7

2. Design and Performance
   2.1. Barrier Design 8
      2.1.1. Physical Barrier Design 8
      2.1.2. Alignment Design 8
      2.1.3. Clear Zone, Offset and Deflection Requirements 8
   2.2. Barrier Installation 9
      2.2.1. The Anchored System Installation 9
      2.2.2. Installation Termination and Crash Cushions 10
   2.3. Barrier Performance 11
      2.3.1. Point of Need 11
      2.3.2. Length of Need Deflection 12
   2.4. Pavement Conditions and Anchorage Requirements 13
      2.4.1. Pavement Conditions 13
      2.4.2. Anchorage 13

3. Installation Procedure
   3.1 Planning 14
      3.1.2 Length of Need Anchor Layout Requirements 14
      3.1.3 Terminal Anchor Layout Requirements 15
   3.2 Lifting and Loading 16
   3.3 Loading – Unloading Sequence 17
   3.4 Site Activities 18
      3.4.1 Unloading Sequence 18
      3.4.2 Connection of the Units 18
      3.4.3 Anchor Pin Installation 20
   3.5 Post Construction and Maintenance 21
      3.5.1 Post Installation Inspections 21
      3.5.2 System Maintenance 21
      3.5.3 Post Impact Pin Relocation 22
      3.5.4 End of Useful Life 22

Appendix A Product Drawings 23
Appendix B End Terminal 26
Appendix C Crash Test Summary 27
Appendix D Installation Checklist 28
Appendix E State and Country Approval 29
Table Index

Table 2.1: Design Deflection Table ........................................................................................................12

Figure Index

Figure 1.1: Defender 100 HC Cross Section ..........................................................................................5
Figure 1.2: Barrier Installation Setup for 4-12 HC Crash Test ..............................................................6
Figure 2.1: Standard Barrier Unit ...........................................................................................................9
Figure 2.2: TAU-II End Terminal ...........................................................................................................10
Figure 2.3: Point of Need Diagram .......................................................................................................11
Figure 2.4: Defender 100HC™ Clear Zone Requirements ......................................................................12
Figure 2.5: Ground Anchor Pin Installation Location ............................................................................13
Figure 3.1: Defender 100HC™ Anchor Layout ....................................................................................15
Figure 3.2: Top Rail Slot with Lifting Plate ............................................................................................16
Figure 3.3: Loaded Truck .......................................................................................................................16
Figure 3.4: Sequence of Unit Connection .............................................................................................19
Figure 3.5: Correct Pin Installation ......................................................................................................20
Figure 3.6: Incorrect Pin Installation ....................................................................................................20

Appendices

Appendix A  Product Drawings  ...........................................................................................................23
Appendix B  End Terminal .....................................................................................................................26
Appendix C  Crash Test Summary ........................................................................................................27
Appendix D  Installation Checklist .......................................................................................................28
Appendix E  State and Country Approval ............................................................................................29
1. Introduction

1.1. System Overview

The Defender 100HC™ is a steel safety barrier that is made of hot dip galvanised steel and is intended for use as a temporary barrier system for the protection of workers and motorists within and through a work zone. The barrier is anchored to the road surface every 48.15 metres.

The secure connection of the Defender 100HC™ units is made by interlocking the Male and Female end units together with the insertion of a connection pin to secure each unit in place. The cross section of the unit is detailed within Figure 1.1 below and consists of a 680mm width base with an 800mm height which results in a centre of gravity at 342mm. Each single unit is 3959mm in length, with an effective barrier length of 3900mm and weighs 303kg, or 77.7kg per lineal meter.

![Center of Gravity](image)

Figure 1.1: Defender 100 HC Cross Section

The Defender 100HC™ has undergone the crash tests required by MASH 16 and AS/NZS3845:2015 for safety barriers, as well as the mandatory test for transitions from the safety barrier to the end terminal. A more detailed description and crash test results are detailed within Section 2.3. The system can be installed in one (1) configuration:
Defender 100HC™, anchored every 48.15m with TAU-II End Terminals at each end with a minimum of 25 barriers between terminals.

Figure 1.2 below shows the general arrangement of the Defender Barrier™ System before test 4-12.

Figure 1.2: Barrier Installation Setup for 4-12 HC Crash Test

1.2. Delineation

Barrier installations, whether they are permanent or temporary, may require delineation to be attached for the duration of the installation. The type/shape/colour of this delineation will vary dependant on the local regulatory requirements. Local regulations should be reviewed to ensure correct delineation is attached to the Defender 100HC™.

CAUTION

No modifications are to be made to the skin of the barrier without prior approval form the manufacturer.
1.3. Important Notes

Defender 100HC™ must be installed in accordance with the approvals granted in your local state or country. Proper site design and deployment of the Defender 100HC™ is essential to assure performance. If you have any questions about the deployment of the Defender 100HC™ please contact Safe Barriers before deploying the barrier.

**WARNING** Incorrect installations can lead to outcomes different from the laboratory certification test outcomes.
2. Design and Performance

2.1. Barrier Design

2.1.1. Physical Barrier Design

The standard barrier unit, as detailed within Section 1.1, has an effective barrier length of 3900mm with a base width of 680mm and a height of 800mm. The units are connected using male to female connections with an additional connecting pin through the centre of the joint assembly to ensure a secure connection.

The lifting points are located within the slots in the top rail which allow access to the lifting plates. The lifting plate has a dual purpose, firstly, to ensure structural capacity when lifting and manoeuvring the barrier into place and secondly, to increase structural capacity of the system during an impact. All of these components and the general construction of the barrier unit can be found within Appendix A.

2.1.2. Alignment Design

Horizontal Design

The Defender Barrier™ system can be installed to accommodate a minimum horizontal curvature of 230m. This curvature is accommodated by the end plate assembly connection containing up to 1.0 degree of horizontal movement per joint. This movement allows each section to create a bend in the alignment resulting in the ability to curve the barrier along the roadway to accommodate the road environment.

Vertical Design

The Defender Barrier™ can accommodate a minimum vertical curve radius of 230m within the roadway. This is due to the short individual sections (3.9m each) and their connections which contain 1.0 degree of vertical allowance at each joint.

2.1.3. Clear Zone, Offset and Deflection Requirements

The clear zone is the horizontal distance behind the barrier that is required to support the unobstructed movement of the barrier during an impact. The rear toe of the barrier should be clear of all obstructions, embankments, kerbing and any other object that will impede the sliding movement of the barrier during an impact. In the case of the Defender 100HC™ system, this measurement is also equal to the design deflection that has been obtained during the required crash testing of the product. These crash tests have been conducted with the purpose of obtaining the physical deflections that occur during a design impact.
2.2. Barrier Installation

The configuration (Section 1.1) in which the Defender 100HC™ System can be installed requires the use of a TAU-II crash cushion.

2.2.1. The Anchored System Installation

The Defender 100HC™ has been tested on 150mm asphaltic concrete over / 150mm granular subbase. The system is anchored to the road surface using two steel ground anchor pins, each 30mm x 500mm, every 48.15 metres. The pins are placed directly opposite each other in the same barrier drain location. Each barrier has two (2) sets of symmetrically opposed ground anchor pin locations pre-cut into the barrier drain.

Please refer to drawing D100 within Appendix A for more details.

Figure 2.1: Standard Barrier Unit
2.2.2. Installation Termination and Crash Cushions

The Defender 100HC™ System has been designed to accommodate the following end treatments:

- TAU-II Crash Cushion

**Crash Cushions – End Terminal**

Crash cushions can be used for both uni-directional and bi-directional traffic flows. The TAU-II® crash cushion has been crash tested for use with the Defender 100HC™ system. Figure 2.2 below shows the TAU-II® crash cushion. The connections and transition details can be found within Appendix B. The use of a terminal system may be required on both approach and departure ends of the barrier as per local road authority regulations.

![Figure 2.2: TAU-II End Terminal](image-url)
2.3. Barrier Performance

2.3.1. Point of Need

The tested length of Defender 100HC™ is twenty-five (25) barrier segments or 97.5m. The Universal TAU-II end terminal is a Non-Gating Re-Directive terminal which establishes the length of need location at the nose of the Universal TAU-II end terminal. Do not install a high Containment System at shorter than 97.5 metres without first contacting Safe Barriers.

![Diagram of Point of Need](image)

**Figure 2.3: Point of Need Diagram**
2.3.2. **Length of Need Deflection**

The following table outlines the clear zone requirements for each installation type and each testing requirement. These values can be used during the design process to ensure safe and adequate clearance is catered for.

**Table 2.1: Design Deflection Table**

<table>
<thead>
<tr>
<th>MASH16 Deflection Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defender 100HC™ Test Level 4</td>
</tr>
<tr>
<td>10,000 kg Truck @ 90kph</td>
</tr>
<tr>
<td>15°</td>
</tr>
<tr>
<td>25°</td>
</tr>
</tbody>
</table>

The above deflection value is the tested deflection on the Length of Need of the Defender 100HC™ pinned at 48.15 metres between intermediate anchors.

**Figure 2.4: Defender 100HC™ Clear Zone Requirements**
2.4. Pavement Conditions and Anchorage Requirements

2.4.1. Pavement Conditions

The Defender 100HC™ System has been tested while sitting atop an asphalt surface, 150mm/150mm asphaltic concrete over granular subbase.

2.4.2. Anchorage

The Defender 100HC™ System is anchored every 48.15m using two symmetrically installed 30mm x 500 mm steel ground anchor pins. The pins are placed in the pre-cut slot in the barrier drain at the base of the Defender 100 HC barrier.

Figure 2.5: Ground Anchor Pin Installation Location
3. Installation Procedure

3.1 Planning

When planning the job, it is essential that the following points are established and agreed with the contractor:

- The start, finish and alignment of the Defender 100HC™
- Any curvature of the Defender 100HC™ in both the horizontal and vertical planes
- There is sufficient clearance from overhead cables to allow lifting
- There is adequate working room and safety zone during installation

3.1.2 Length of Need Anchor Layout Requirements

- Two Anchor pins must be placed directly opposite each other in the pre-cut location at a spacing of no greater than 48.15 m. *refer Appendix A: D100HC Installation*
- Each Defender Barrier™ has two pinning locations on each side of the barrier, 1350 mm apart. *Refer Appendix: A D100*
- Pins must be placed in the first available holes after the Approach Terminal and before the Departure Terminal. *Refer Appendix A: BSI-1707033-AP*
- From the pins installed in the first Length of Need Barrier measure a maximum of 48.15 meters to install the next set of pins in the sequence. In other words, after the first barrier is pinned, put pins in every twelfth barrier. *refer Appendix A: D100HC Installation*
- Continue with this process for the entire length of need. Because of the distance between pre-cut pin locations it may be possible that some pins will only be 46.8 meters apart. This is acceptable as it is required to place pins in every twelfth barrier.
- At the Departure Terminal it may occur that pin spacing is narrower than 48.15 meters or 46.8 meters. As you approach the Departure Terminal ensure that pin spacing does not exceed 48.15m.
- If the distance between the second to last pin installed and the final pin in the Length of Need is greater than 48.15 m, place a Pin as close as possible to the mid-point.
3.1.3 Terminal Anchor Layout Requirements

- All Installations of Defender 100HC™ Systems require an Approach Terminal.
  - Appendix A: BSI-1707033 AP and D1-TAU-Approach
- Local Regulations may also require a Departure Terminal.
  - Appendix A: BSI-1707033 AP and D1-TAU-Departure
- The Approach Terminal and the Departure Terminal each are connected to a specific Defender Barrier as part of the tested transition. Each of these barriers is to have 4 anchor pins on each side. Refer Appendix A: BSI-1707033-AP and D7
- After the Approach Terminal, standard Defender Barrier™ is installed for the rest of the run until the departure point is reached.
- Should a departure terminal be required, install as per Drawings referenced in point 2. Otherwise terminate in a locally approved manner.
- The minimum installation length between terminals is 97.5 meters (25 barrier units). Should it be necessary to install a shorter system due to site conditions contact Safe Barriers.
3.2 Lifting and Loading

Each barrier unit contains two (2) lifting plates, 1350mm apart. These lifting plates are equally spaced along the barrier length to ensure adequate weight distribution during the lift and can be found where the open slots are along the top of the barrier, as shown in Figure 3.1 (right). Alternatively, when using a forklift to transport the barrier, the forklift prongs can be used within the drainage slots to lift the barrier and manoeuvre into place.

![Figure 3.2: Top Rail Slot with Lifting Plate](image)

Figure 3.2 below shows a fully loaded truck with the maximum number of layers available for transport. Generally, a standard transportation vehicle (19m flat-bed semi-trailer) will be able to accommodate three (3) layers consisting of three (3) units per layer. This typical stack can be mounted on a standard truck three (3) times resulting in a maximum of 27 units per delivery. These 27 units will enable up to a 105.3m length of run per delivery vehicle.

![Figure 3.3: Loaded Truck](image)
This loading configuration will result in a width of approximately 2.04m with 800mm height per layer. The overall height of the loaded vehicle will vary depending upon the trailer height. In addition to the barrier, and in accordance with Australian transportation requirements, layers of steel cannot be transported without non-metal separation. In this case, the usage of 100mm x 100mm timber dunnage is recommended, however the use of other non-metal separation material is acceptable.

3.3 Loading – Unloading Sequence

The loading of each layer consists of identifying the deployment start point. Deployment from leading terminal (this is the standard). The Defender 100HC™ units are loaded with the MALE end to the rear of the truck and the FEMALE end toward the front of the truck.

1. Base layer of 9 units is loaded
2. Timber dunnage is installed
3. 2nd layer of 9 units is loaded
4. Timber dunnage is installed
5. 3rd layer of 9 units is loaded

The unloading of the truck is done from the rear and done by unloading the full top layer, then moving to the 2nd layer, and finally the bottom layer.

WARNING

When un/loading ensure site safety rules are adhered. Special consideration should be given to the proximity of overhead cables. Ensure that slings/chains used are rated to lift the weight and have been serviced.

The direction of approach to the site will also affect the barrier loading arrangement. If delivering to site for installation in the same direction as traffic flow, load the barriers with the female end to the front of the truck and the male end to the rear of the truck. If delivering to site for installation against the traffic flow, load the barriers with the male end to the front of the truck and the female end to the rear of the truck. This will allow the installation to continue without the need to rotate any of the units during placement.
3.4 Site Activities

3.4.1 Unloading Sequence

Before the unloading can occur, a check to ensure the delivery vehicle is resting on solid, level ground is required. This will ensure the barrier units will remain stable when the harnesses are released.

**WARNING**
Please ensure delivery vehicle is level and secure before releasing the harnesses used for transport. Unstable barriers are a falling risk.

All slings, chains, tag lines and machinery will need to be checked to ensure they are maintained and in acceptable working condition.

The unloading sequence is detailed in section 3.3 above.

3.4.2 Connection of the Units

When connecting the units on site, care must be taken to ensure each section is placed level on the ground with each footing section having contact with the surface. In most cases, the installation process will begin with the upstream (approach) end of the barrier being installed first. Once the first unit is placed, each consecutive unit can be lowered onto the joint of the previously placed unit to create a secure connection at the male/female joints. Once the run has been installed, a second pass can be conducted to engage the connecting pins at the joints, marking the correct connections being done.

**CAUTION**
During the connection of units, ensure spotters are in place and the use of tag lines is incorporated to reduce the chance of workers being pinned/pinched by the lowering barrier.

Figure 3.3 below has been shown in three (3) parts:

Part 1: Shows the difference between the Male (top) and Female (bottom) joints.

Part 2: Shows a typical lifting / connection process using a sling arrangement.
Part 3: Shows the internal connection (before the pin is inserted) of the Male and Female joints.

Figure 3.4: Sequence of Unit Connection
3.4.3 Anchor Pin Installation

D7 Asphalt Anchor Pins have a diameter of 30mm and an overall length of 500mm. They are not galvanised.

Suggested Tools
- Air driven or electric drill
- 28 – maximum 32mm drill bit minimum 500mm
- Sledge hammer or air driven/electric jack hammer with drive head
  Note: the head of the anchor pin is 60mm diameter. Refer Appendix A: D7

Anchor Pin Installation

1. At the desired location drill a hole 28-32 mm diameter using a drill bit to a depth of 480mm
2. Insert the Pin into the hole. It may be necessary to hit it with a small sledge hammer or use a cup ended jack hammer as a driver if the hole is less than 30mm diameter.
3. When installed the pin head must be flush to the barrier. Pins left proud of the barrier foot are not installed correctly and must be driven in until flush.

Figure 3.5: Correct Pin Installation

Figure 3.6: Incorrect Pin Installation
3.5 Post Construction and Maintenance

3.5.1 Post Installation Inspections

Once the installation of the system has been conducted, a post installation inspection shall be done to ensure the product has been installed correctly and is fit for purpose in the required location. The inspection shall consist of checking the following items:

- Horizontal and vertical alignment of the barrier is correct;
- All foot sections have suitable contact with the surface;
- The point of need for the system is in the required location;
- Barrier ends have been terminated with the accepted treatment;
- Each joint has been connected correctly and the connection pin has been fitted in EVERY joint;
- Delineation has been included as/where required;
- The system is anchored in accordance with section 2.4.2;
- Fill in the Installation Checklist in Appendix D

3.5.2 System Maintenance

Due to the product construction, the main reason for barrier maintenance would be due to an impact. If an impact were to occur, a system inspection should be undertaken to ensure the barrier is of sound structural capacity to continue use. The following is a list of observations that would warrant the replacement of a section of barrier:

- Toe / foot sections bent preventing even placement
- Unit skin torn or ripped
- Lifting plate visible through the barrier skin
- Barrier end joints or support plates dislodged or bent

To undertake the replacement of a section of barrier, the downstream unit from the one being replace will need to be removed first and the system pulled to the side. Once the downstream unit is disengaged, the damaged unit, and all other damaged units upstream can be removed and replaced.

Once the barrier has been repaired with the new units, an inspection should be conducted on the full run to ensure the system is adequate for the purpose of the installation. The inspection list detailed in Section 3.5.1 above should be used as a guide.
3.5.3 Post Impact Pin Relocation

After an impact into the Defender 100LDS™ any pin with visible movement in the asphalt surface should be relocated to the anchor location nearest to the previous anchor location.

3.5.4 End of Useful Life

All Defender Barrier™ are made of recyclable mild steel. We recommend sending the barriers to your local steel recycler at the end of useful life.
Appendix A

Product Drawings
NOTES:
1. REMOVE ALL BURRS AND SHARP EDGES.

ITEM DRAWING NO. DESCRIPTION QTY.
1 D7-1 ANCHOR PIN CAP 1
2 D7-2 ANCHOR PIN BODY ... all ±2.0°

ITEM DRAWING NO. DESCRIPTION QTY.
1 D10-1 PIN CAP 1
2 D10-2 PIN BODY ... 2

WEIGHT 3.05 KG

WEIGHT 3.2 KG GALV

Defender 100HC™ – Product Manual Version 1.4.1
Safe Barriers Pte Ltd
Appendix B  End Terminal
## Appendix C  
### Crash Test Summary

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Number</th>
<th>Test Setup</th>
<th>Length (m)</th>
<th>Impact Point</th>
<th>Deflection (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MASH 4-10</td>
<td>131393.3-10</td>
<td>25 Barriers</td>
<td>97.5</td>
<td>Barrier 11</td>
<td>1.80</td>
</tr>
<tr>
<td>MASH 4-11</td>
<td>131393.3-11</td>
<td>25 Barriers</td>
<td>97.5</td>
<td>Barrier 11</td>
<td>2.30</td>
</tr>
<tr>
<td>MASH 3-21</td>
<td>131393.3-21</td>
<td>TAU-II + 14 Barriers</td>
<td>62.6</td>
<td>Transition / Barrier 1</td>
<td>0.310</td>
</tr>
<tr>
<td>MASH 4-12</td>
<td>131393.4-12</td>
<td>25 Barriers</td>
<td>97.5</td>
<td>Barrier 9</td>
<td>2.47</td>
</tr>
</tbody>
</table>
Installation Checklist

Report any installation issues where it was not possible to install to manufacturers instructions or according to the supplied traffic management plan.

Contractor

Job Location

Job ID

Barrier Type

D70 Free standing

D100 Low Deflection

D100 High Containment

Barrier Length

Installed according to Traffic Management Plan

Barrier Pin Spacing

Maximum 9.15 m

Maximum 48.15 m

Other (with approval attached)

Terminals

Absorb 350

TAUII

Not required according to plan

Approach Terminal

Departure Terminal

Both Ends

Terminal Install

Terminal Installed according to manufacturer’s Instructions

TAUII is pinned and transition installed

Absorb 350 is water filled and transition installed

NOTES:

Name

Signature

Date
Appendix E  State and Country Approval

Links to approvals to be added as received