



# **Removable Rollcage Specification v4.1**

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## 1.0 Introduction: About This Specification

All changes to requirements of the ANDRA Removable Rollcage Specification v4.0 are highlighted by blue text in this new ANDRA Removable Rollcage Specification v4.1.

All ANDRA specification removable rollcages that begin fabrication after 1<sup>st</sup> May 2022 should comply with the applicable requirements in this document.

Prior to fabricating a removable rollcage, you are encouraged to contact ANDRA Technical at [technical@andra.com.au](mailto:technical@andra.com.au) with any questions you may have regarding the specifications.

**ANDRA understand that there is a vast array of vehicles competing under its sanctioning and that due to this a rollcage design may require tailoring to a certain vehicle. If there is a requirement to diverge from these specifications, please contact ANDRA Technical prior to the construction/fabrication stage of the build. Any divergence from these specifications requires written permission from ANDRA Technical prior to rollcage fabrication. No retrospective permission will be granted to non-compliant rollcage components without the prior written permission which is granted by ANDRA Technical. This is the case even if a vehicle and/or rollcage has passed an ANDRA Technical Inspection.**

This design specification is intended for a full-bodied car with a stock or modified/ OEM floor-pan with a firewall and with an OEM frame or Uni-Body construction, used in ANDRA drag racing competition to a performance limitation of 8.00 seconds 1/4 mile (or equivalent).

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This document is the official Removable Rollcage Specification of the Australian National Drag Racing Association Ltd (ANDRA), recognised by Motorsport Australia and the Federation Internationale de l'Automobile (FIA). The validity of this specification as an official ANDRA publication will be noted by ANDRA Stewards Hearings, Tribunals, and the Australian Motor Sports Appeal Court (AMSAC).

The requirements published in this specification remain in effect until suspended or revised by the ANDRA Board. Announcement of such changes will be notified in writing to all ANDRA Divisional



Councils and posted on the ANDRA website giving at least 28 days' notice on implementation of a change, or immediately in the case of urgent safety amendments.

A representation of compliance with this specification is not an indication, nor an assurance that the rollcage will provide adequate driver protection in all situations of a vehicle crash. However, it is suggested that rollcages which do not comply with the design information given, may not perform their intended function nor might they provide adequate protection to a driver in a crash situation.

This specification is concerned only with the protective characteristics of the driver area and its adjoining structure in the event of a crash, and not with racing performance properties.

This specification is advisory only. There is no agreement between ANDRA, or any other party to be guided by it and its use by any association, organisation, manufacturer, or individual is entirely voluntary. ANDRA will not accept any responsibility for consequences resulting from its application. This specification is in addition to the ANDRA Rulebook. All applicable requirements and specifications in the ANDRA Rulebook must also be followed.

## **2.0 Removable Rollcage Definition**

- 2.1 Any rollcage that has removable components is deemed to be a removable rollcage and should comply with this specification.

### 3.0 Removable Rollcage Registration

3.1 All removable rollcages must be assessed for compliance whilst unpainted (uncoated).

3.2 ANDRA replaced the requirement for a rollcage Pre-Technical Inspection with this Removable Rollcage Registration Process.

3.3 Either during the design process or once the removable rollcage is complete (and prior to the vehicle's Technical Inspection) pictures of the removable rollcage must be sent with the [removable rollcage registration form](#) to ANDRA Technical.

Emailing digital pictures to [technical@andra.com.au](mailto:technical@andra.com.au) is the preferred method.

3.4 Together the pictures must cover all components of the removable rollcage and be detailed enough to allow viewing of the full structure, including all joints and mounting points.

3.5 Removable rollcage registration must take place in the following circumstances.

- a) The fabrication and fitment of a new removable rollcage.
- b) Fitment of a removable rollcage to a vehicle that has an existing Logbook.
- c) Modification of an existing removable rollcage.
  - i. This may also include after a vehicle incident where the Technical Inspection sticker has been removed.

3.6 The removable rollcage design is reviewed by ANDRA Technical.

- a) If approved, ANDRA Technical will advise the person who sent the information (member/ customer/ fabricator) they can proceed with arranging the Technical Inspection and a Removable Rollcage Registration ID Number (sticker) is issued. Approvals can also be emailed to the relevant Division Director.
- b) If not approved, ANDRA Technical advises of the area/s whereby the removable rollcage does not meet the necessary minimum requirements.

3.7 Once the removable rollcage is approved and the ID sticker is issued the Technical Inspection is arranged by the member/ customer.

- a) The Removable Rollcage Registration ID Number must be noted on the Technical Inspection form.
- b) The Technical Inspection can then approved/ signed off by the Technical Inspector.

3.8 It is the vehicle owner's responsibility to ensure that the removable rollcage is unmodified from its registration document specification.

- a) Any modification to an existing registered removable rollcage (post-Technical Inspection) must be approved by ANDRA Technical in writing prior to the modification taking place.
- b) Modifications to the removable rollcage after registration are treated as a new removable rollcage and further pictures and an updated removable rollcage registration form are also required.

## 4.0 Materials

4.1 A removable rollcage may be fabricated from either 4130N Chromoly to 4130N-MIL-T-6736B specification or 350 MPa minimum yield stress Mild Steel.

4.2 Compliance to the relevant material specification lies with the fabricator.

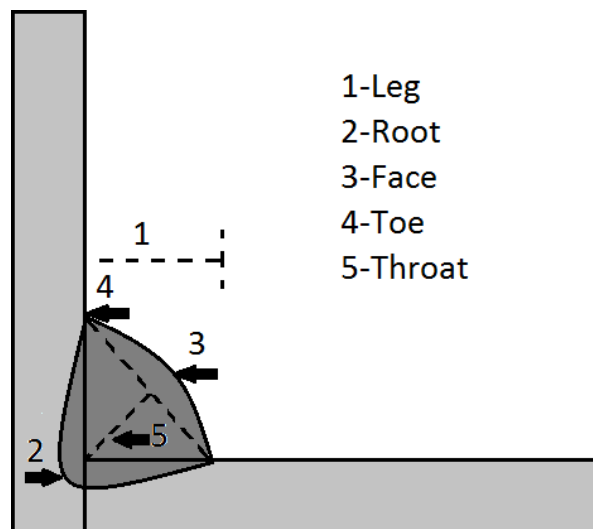
**Table 1.**

<b>Minimum Specification of Materials Used in ANDRA Removable Rollcages</b>	
<b>Rollcage Component</b>	<b>All Chromoly 4130N-MIL-T-6736B Specification</b>
All Rollcage Tubing	1 5/8" x 0.083"
Forward Support Reinforcement	1 5/8" or 1 1/2" x 0.083"
Mounting Pads/Plates	3mm thickness 4130N Chromoly or 3mm thickness 350N/mm <sup>2</sup> minimum tensile strength Mild Steel plate
Bolts	M8, ISO (SAE) Class 8.8 or greater The class must be clearly stated on the bolt head
Nuts	Size appropriate for bolt, ISO (SAE) Class 8
Sleeved Joints	Must be a near interference fit with the tube being held within. Minimum gauge 0.083" 4130N Chromoly.
Double Tab Clevis Joint Tabs	5mm thickness 4130N Chromoly or 5mm thickness 350N/mm <sup>2</sup> minimum tensile strength Mild Steel
<b>Rollcage Component</b>	
<b>Mild Steel of a 350MPa Minimum Yield Stress</b>	
Main Hoop	1 5/8" x 0.120" or 1 3/4" x 0.102"
Main Hoop Diagonal Braces	1 1/4" x 0.102"
Rear Stays (without Stiffening Tubes)	1 5/8" x 0.120" or 1 3/4" x 0.102"
Rear Stays (with Stiffening Tubes)	1 1/2" x 0.102"
Rear Stay Stiffening Tubes	As per Rear Stays
Taxi Bar	1 1/2" x 0.102"
Back-set Taxi Bar Supports	1 1/2" x 0.102"
Side Intrusion Bars	1 1/2" x 0.102"
Forward Supports	1 5/8" x 0.120" or 1 3/4" x 0.102"
Forward Support Reinforcement	1 5/8" x 0.120" or 1 3/4" x 0.102"
Front/Rear Roof Support (Windscreen Brace)	1 5/8" x 0.120" or 1 3/4" x 0.102"
Roof Braces	1 1/2" x 0.102"
Mounting Pads/Plates	3mm thickness 4130N Chromoly or 3mm thickness 350N/mm <sup>2</sup> minimum tensile strength Mild Steel plate
Bolts	M8, ISO (SAE) Class 8.8 or greater The class must be clearly stated on the bolt head
Nuts	Size appropriate for bolt, ISO (SAE) Class 8
Sleeved Joints	Must be a near interference fit with the tube being held within. Minimum gauge 0.102" Mild Steel (350N/mm <sup>2</sup> )
Double Tab Clevis Joint tabs	5mm thickness 4130N Chromoly or 5mm thickness 350N/mm <sup>2</sup> minimum tensile strength Mild Steel

## 5.0 Design and Fabrication of a Removable Rollcage

- 5.1 Removable rollcages must be designed and fabricated so that, when correctly installed, they substantially reduce body shell deformation and so reduce the risk of injury to occupants, in the event of a crash.
- 5.2 The fabricator should label each rollcage with the manufacturer's name and serial number, as well as the date of manufacture. If applied the identification tag must be clearly legible at all times and not covered by any component that may inhibit the visual inspection of the identification information.
- 5.3 Longitudinally, the rollcage should be entirely contained between the dimensions of the wheelbase, however, it can extend beyond the rear axle into the boot floor and the Rear Stay mounts should be mounted/ welded to a substantial chassis component, or by any of the methods described in section 17.0 and/or 18.0 of this specification.
- 5.4 No rollcage tube may carry fluid.
- 5.5 No section of a rollcage may be electroplated.
- 5.6 All rollcage tube components must be fabricated from one single piece of tube.
- 5.7 No rollcage tube may unduly impede the egress of the occupant(s) from the vehicle or the use of any controls including foot pedals.
- 5.8 It is recommended that all tubing should be bent by a cold working process.
- 5.9 The bend radius centreline must be at least three times the outside diameter (OD) of the tube being bent.  
  
e.g., If 1 5/8" (41.3mm) OD tube is being bent the minimum bend centreline radius is 124mm.
- 5.10 If tubing is ovalised during bending, the ratio of thinnest OD to original OD must be 0.9 or greater.  
  
e.g., if using 1 5/8" (41.3mm) tube the minimum tube diameter within the bend, must be no less than 37.1mm.
- 5.11 The surface of the tube must be smooth and even, without ripples or cracks.
- 5.12 When measuring from the end of a bend on a rollcage tube, the end of the bend is defined as where the tube becomes straight again.
- 5.13 It is recommended that the minimum distance between the end of one bend and the start of another bend in the same plane is two times the tube OD.
- 5.14 It is recommended that the minimum distance between the end of one bend and the start of another bend in differing planes is three times the tube OD.

- 5.15 It is recommended that the minimum distance to the start of a bend from the end of a tube is two times tube OD.
- 5.16 All welds on 4130N Chromoly material must be by the Gas Tungsten Arc (TIG) welding process. MIG welding may be used on Mild Steel material.
- 5.17 Compatible filler rods should be used in the welding of 4130N Chromoly. Examples of compatible filler metal that could be used, dependent upon desired strength and ductility, are ER80SD-2, ER70S-2 & ER70SD-6.
- 5.18 To prevent embrittlement, 4130N Chromoly must not be allowed to cool quickly. If welding of 4130N Chromoly is undertaken in an ambient temperature of 15°C or below, it is recommended that the weld is cooled in a controlled manner.
- 5.19 If welding of 4130N Chromoly is undertaken in an ambient temperature of 15°C or below it is recommended to preheat the area to be welded.
- 5.20 It is recommended that pre-weld heating and post-weld stress relief be undertaken on 4130N Chromoly which has a thickness of greater than 3mm (1/8”).
- 5.21 Fillet size must be a minimum of the sum of the gauges of the two components being welded. e.g., 2.1mm gauge tube to 3.0mm pad, weld fillet (face) must be a minimum of 5.1mm.



- 5.22 All welds must be continuous (not stitched) around the whole perimeter of a tube.
- 5.23 Where the welding of a joint will produce a fully sealed tube section, a pressure relief hole should be drilled. The hole should be as small as possible. If welding tube to plate, the hole should be in the plate. If fittings are welded into a tube at both ends the fitting should have a through hole.
- 5.24 Grinding of welds is not permitted.





## 6.0 No Rollcage Required

6.1 The following vehicles do not require a rollcage.

- a) Unmodified Modern Cars with an ET 10.000 seconds or slower (1/4 mile or equivalent).
- b) Unmodified Cars with an ET of 10.500 seconds or slower (1/4 mile or equivalent).
- c) Modified Cars with an ET of 12.000 seconds or slower (1/4 mile or equivalent).
- d) Street Registered Open Cars with an ET of 13.000 seconds or slower 1/4mile (or equivalent).
- e) Open Competition Cars, certified by and complying with relevant Motorsport Australia (CAMS) regulations, 11.000 seconds or slower 1/4 mile (or equivalent).

6.2 Definitions.

**Unmodified Modern Cars:** A car with factory fitted OEM four-wheel disc brakes, with OEM driver's airbags and with no modifications to the floor, rear wheelwells\* or boot floor, with a fixed standard OEM fixed roof.

NOTE: Replacing floor panels with like-for-like material (specification and thickens), for example rust repair etc. is not considered as a floor modification.

**Unmodified Car:** A car without factory fitted OEM four-wheel disc brakes and/or without OEM driver's airbags and with no modifications to the rear floor, rear wheelwells\* or boot floor, with a fixed roof.

NOTE: Replacing floor panels with like-for-like material (specification and thickens), for example rust repair etc. is not considered as a floor modification.

**Modified Car:** Any car with modifications to the floor, rear wheelwells\* and/or boot floor with a fixed roof.

NOTE: Replacing floor panels with like-for-like material (specification and thickens), for example rust repair etc. is not considered as a floor modification.

**\*Modified Rear Wheelwells:** Where material has been added to the wheelwells and has changed the profile of the wheelwell, (e.g., mini-tubbing or tubbing to accommodate larger rear tyres). Any changes to the chassis at the wheelwell location is recognised as a modification and is therefore classed as "modified wheelwells". The reshaping of existing OEM wheelwell material is not considered as a "modified wheelwell".

**Street Registered Open Cars:** Vehicles that do not have a permanent fixed roof and that are currently registered to drive on Australian roads legally.

**Open Competition Car:** A purpose-built competition car certified and complying with relevant Motorsport Australia regulations.

## 7.0 Rollcage Classification – Single Rollover Hoop

- 7.1 A Single Roll Over Hoop (Figure 1) is the minimum rollcage specification that is required in the following vehicles.
- a) Unmodified Cars with an ET of between 10.000 and 10.499 seconds (1/4 mile or equivalent).  
 \* recommended between 10.500 and 11.999 seconds (1/4 mile or equivalent).
  - b) Modified Cars with an ET of between 11.000 and 11.999 seconds (1/4 mile or equivalent).
  - c) Street Registered Open Cars, 11.000-12.999 seconds 1/4 mile (or equivalent).
- 7.2 A Single Rollover Hoop must have the following components, in the positions illustrated in Figure 1, as a minimum.
- A. One Main Hoop
  - B. Two Rear Stays
  - C. One Taxi Bar (can be one-piece, two-piece or more where Diagonal Support/s are used)
  - D. One Intrusion Bar
  - E. **A one-piece Diagonal Support within the Main Hoop is highly recommended, see Fig 7, component B.**
- 7.3 A single Side Intrusion Bar (D) on the driver's side is the minimum acceptable only if no passenger is present. If a passenger is present, then a Side Intrusion Bar is also required on the passenger's side of the vehicle.
- 7.4 A back-set Taxi Bar may be fitted to a Single Rollover Hoop, as per Figure 8, component C.

A back-set Taxi Bar must be fitted with Taxi Bar Upper Supports (Figure 8, components H2). It is recommended to also fit Taxi Bar Lower Supports (Figure 8, components H1) to a back-set Taxi Bar.

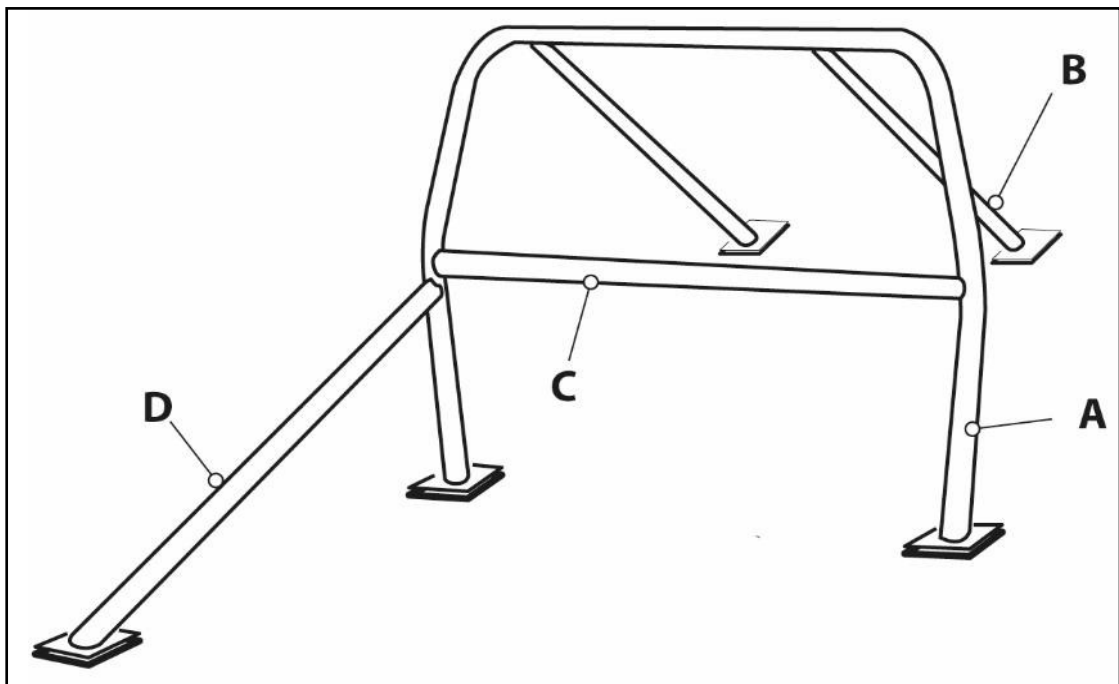
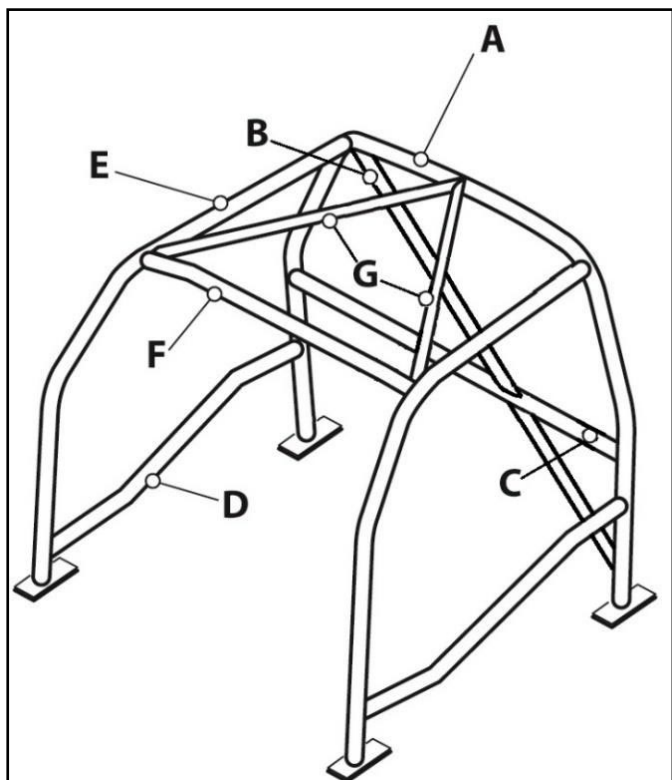


Figure 1: Single Roll Over Hoop.

## 8.0 Rollcage Classification – Four Point Rollcage

- 8.1 A Four Point Rollcage (Figure 2) is the minimum rollcage specification that is required in the following vehicles.
- a) An Unmodified Modern Car based Utility Vehicle (Pick-Up), or Panel Vans based on Ute platform, with an ET of between 8.000 and 9.999 seconds (1/4 mile or equivalent).
  - b) An Unmodified Car based Utility Vehicle (Pick-Up), or Panel Vans based on Ute platforms, with an ET of between 8.000 and 10.499 seconds (1/4 mile or equivalent).
  - c) 1930s style “Chop-Top” Coupes, Hot Rods and/or “T-Bucket” style vehicles where the fitment of Rear Stays is restrictive, with an ET of between 8.000 and 10.499 seconds (1/4 mile or equivalent).
- 8.2 A Four Point Rollcage must have the following components, in the positions illustrated in Figure 2, as a minimum.
- A. One Main Hoop
  - B. One Diagonal Brace (one-piece recommended)
  - C. One Taxi Bar (can be one-piece, two-piece or more where Diagonal Support/s are used)
  - D. Two Side Intrusion Bars
  - E. Two Forward Supports
  - F. One Front Roof Support
- 8.3 Roof Braces (G) are required if the rollcage has a removable Front Roof Support (F).
- 8.4 A back-set Taxi Bar may be fitted to a Four Point Rollcage, as per Figure 8, component C.

A back-set Taxi Bar must be fitted with Taxi Bar Upper Supports (Figure 8, components H2). It is recommended to also fit Taxi Bar Lower Supports (Figure 8, components H1) to a back-set Taxi Bar.



**Figure 2: Four Point Rollcage.**

## 9.0 Rollcage Classification – Six Point Rollcage

- 9.1 A Six Point Rollcage (Figure 3) is the minimum rollcage specification that is required in the following vehicles.
- a) Unmodified Modern Cars and Unmodified Cars with an ET of between 8.000 and 9.999 seconds (1/4 mile or equivalent).
  - b) Modified Cars with an ET of between 8.000 and 10.999 seconds (1/4 mile or equivalent).
- 9.2 A Six Point Rollcage must have the following components, in the positions illustrated in Figure 3, as a minimum.
- A. One Main Hoop
  - B. Two Rear Stays
  - C. One Taxi Bar (can be one-piece, two-piece or more where Diagonal Support/s are used)
  - D. Two Side Intrusion Bars
  - E. Two Forward Supports
  - F. One Front Roof Support
  - G. A one-piece Diagonal Support within the Main Hoop is highly recommended, see Fig 7, component B.
- 9.3 Roof Braces (G) are required if the rollcage has a removable Front Roof Support (F).
- 9.4 A back-set Taxi Bar may be fitted to a Six Point Rollcage, as per Figure 8, component C.

A back-set Taxi Bar must be fitted with Taxi Bar Upper Supports (Figure 8, components H2). It is recommended to also fit Taxi Bar Lower Supports (Figure 8, components H1) to a back-set Taxi Bar.

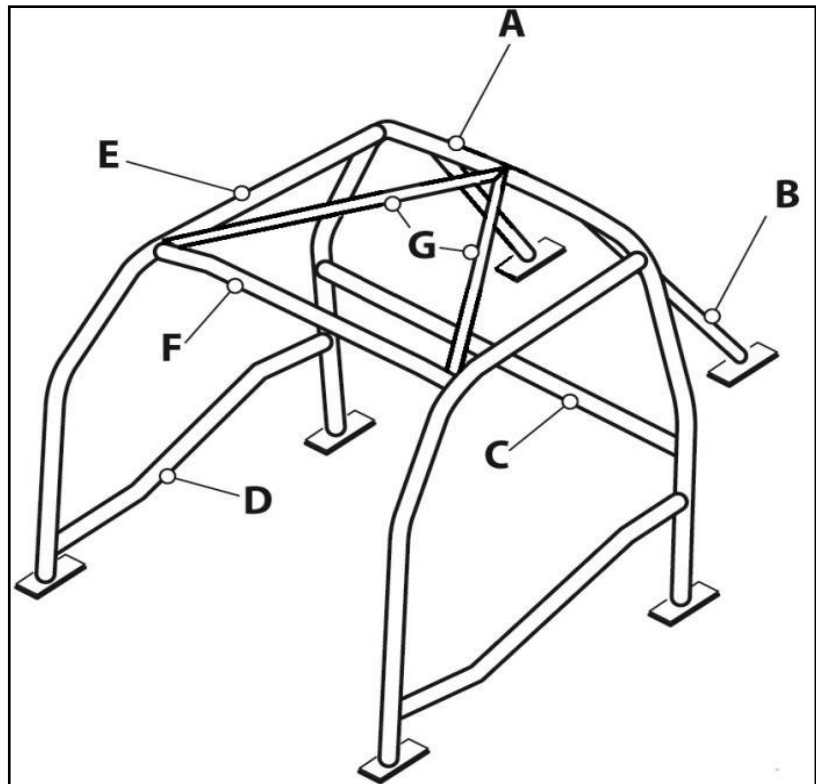


Figure 3: Six Point Rollcage.

## 10.0 Rollcage Components – Main Hoop

- 10.1 The driver's helmet centreline must not be behind the centreline of the Main Hoop.
- 10.2 The Main Hoop must be placed rearwards of any occupant's head, when their seat is in the rearmost position, to a maximum horizontal distance of 150mm (6") between the rear of the helmet and the front of the Main Hoop tube.
- 10.3 The Main Hoop should be near vertical and may have a maximum angle of +/-10 degrees to the vertical.
- 10.4 In closed vehicles, the Main Hoop must follow, as close as is practical, the profile of the vehicle's interior.
- 10.5 In closed vehicles the Main Hoop tube should be within 25mm (1") of the roof/ headliner in the area above the driver's helmet.
- 10.6 In open vehicles there must be a minimum of 75mm (3") clearance between the top of the driver's helmet and the bottom of the Main Hoop.

## 11.0 Rollcage Components – Rear Stays

- 11.1 Single Rollover Hoop and Six Point Rollcages require a minimum of two Rear Stays and in all rollcages, where possible, Rear Stays should be straight.
- 11.2 If Rear Stays are bent, a Stiffening Tube (Figure 8 component K) must be fitted in between the Rear Stays within 100mm (4") of the bend in the Rear Stay.
- 11.3 If the Rear Stay Stiffening Tube is not positioned within 100mm (4") of the top of the rear window then an additional Rear Roof Support Tube must also be fitted in between the Rear Stays within 100mm of the top of the rear window.
- 11.4 The Rear Stay Stiffening Tube **may** have a maximum of two bends with the bend/s not exceeding 20 degrees. The Rear Stay Stiffening Tube must be straight in side view.
- 11.5 The Rear Roof Support Tube **may** have a maximum of two bends with the bend/s not exceeding 20 degrees. The Rear Roof Support Tube must be straight in side view.
- 11.6 A Rear Stay should be mounted onto the vehicle structure at its rear termination by an approved Mounting Pad and/or Mounting Plate. Rear Stay tubing may be welded directly onto an OEM chassis rail, or onto a non-OEM chassis rail, or via Mounting Plate onto a reinforced floor area providing all have been fabricated/ reconstructed with 3mm thickness 4130N Chromoly, or 3mm thickness 350N/mm<sup>2</sup> minimum tensile strength Mild Steel plate, at a minimum.
- 11.7 A Rear Stay must make an angle of between 30-60 degrees from horizontal at its rear termination/ attachment point (e.g., the Mounting Pad).
- 11.8 A Rear Stay must be connected to the top section of the Main Hoop, within 100mm (4") of the centreline of the upper bend.

**Alternative Rear Stay Mounting Design**

11.9 Rear Stays should be mounted/ welded to a substantial chassis component, or by any of the methods described in section 11.9, 17.0 and/or 18.0 of this specification. To do this, Rear Stays can be split in design, as per Figures 4 and 5.

**Note: Requirement 11.7 does not need to be met with a split Rear Stay design.**

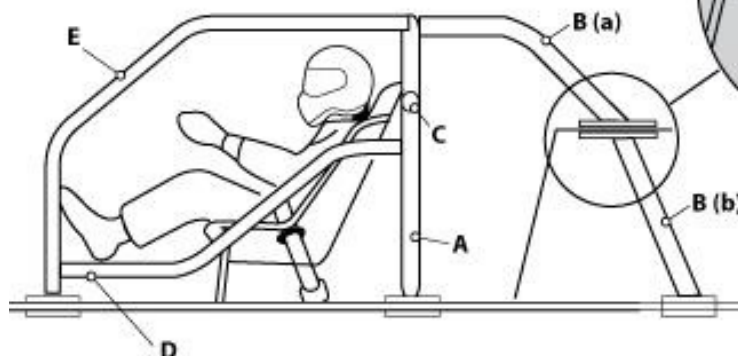
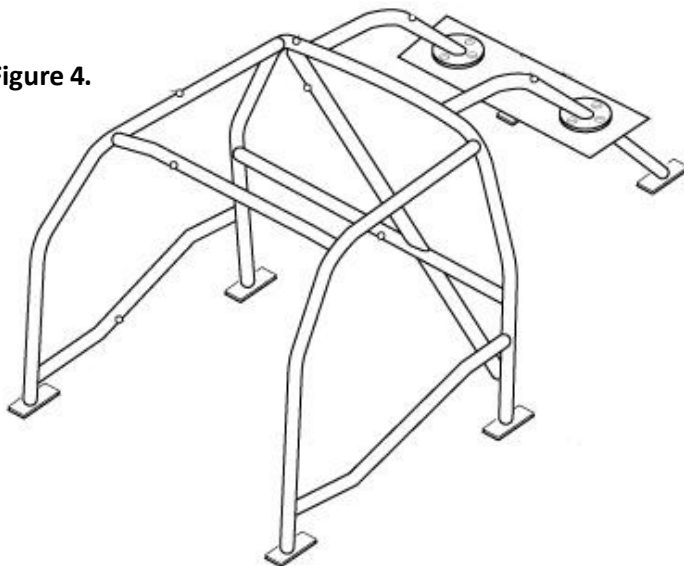
11.10 Split Rear Stay fabrication involves the fitting of Mounting Plates on the rear parcel shelf, with a supporting structure under the parcel shelf, which is mounted to a substantial chassis component.

11.11 Mounting Plates must be designed and fabricated following the diagrams in Figures 14-21 and the associated description in the rollcage to chassis mounting section of this document.

11.12 The supporting structure under the parcel shelf may be designed and fabricated following the two examples below.

- a) Two straight support tubes each connected to the underside of the parcel shelf and a substantial chassis component.
- b) Two straight support tubes, with cross bracing, each connected to the underside of the parcel shelf and a substantial chassis component. The cross bracing must be welded to the supports no further than 100mm (4") from the ends of the support tubes.

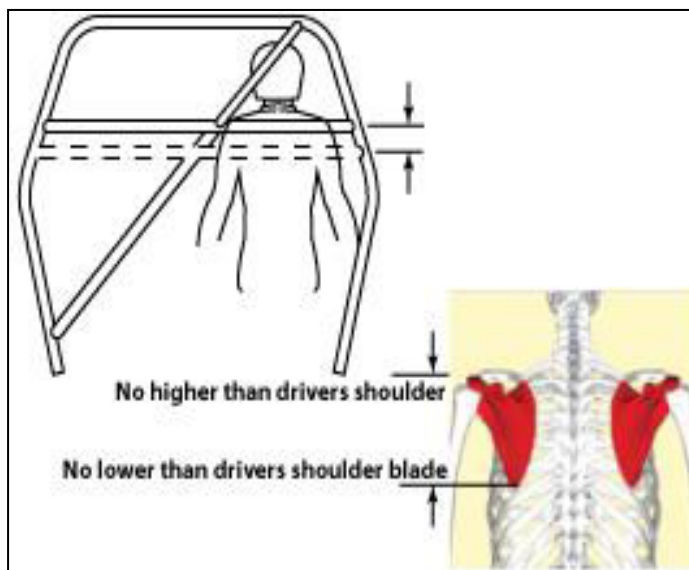
**Figure 4.**



**Figure 5.**

## 12.0 Rollcage Components – Taxi Bar

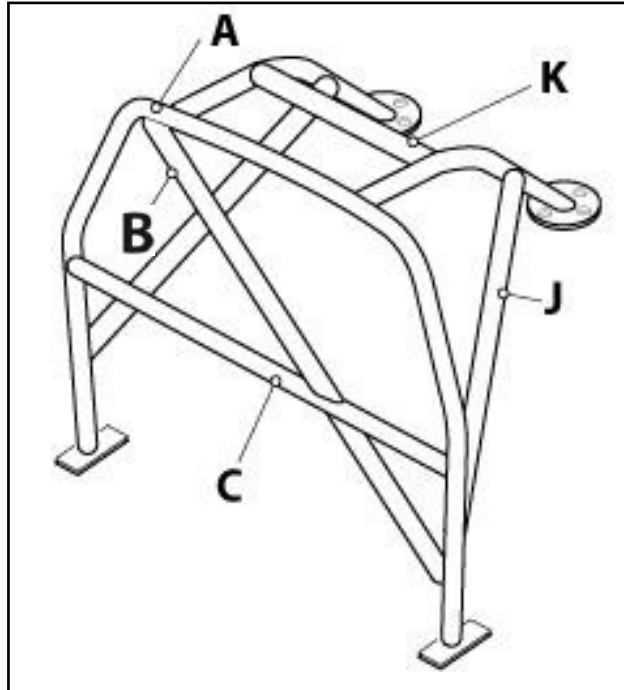
- 12.1 A Taxi Bar must be fitted between the uprights of the Main Hoop spanning the full width of the [Main Hoop](#).
- 12.2 The Taxi Bar must be positioned horizontally such that it passes behind the driver between their shoulder height and the lowest point of their shoulder blades.
- 12.3 Harnesses may be mounted to a removable Main Hoop, but not a removable Taxi Bar.



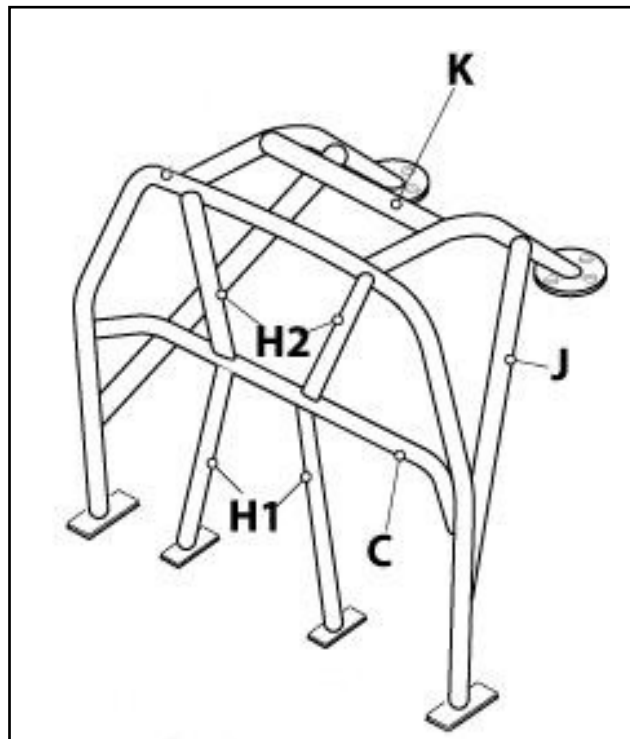
### Taxi-Bar Bracing

- 12.4 In a Four Point Rollcage, a straight Taxi Bar must be reinforced with a Diagonal Brace as per Figure 7, component B. This is optional but **highly** recommended for a Six Point Rollcage and a Single Rollover Hoop.
- 12.5 The Diagonal Brace must be fitted between the Main Hoop horizontal tube behind the driver and the opposite Main Hoop vertical tube, via the Taxi-Bar.
- 12.6 The upper connection of the Diagonal Brace to the Main Hoop must be no further than 100mm (4") from the centreline of the Main Hoop upper bend on the driver's side of the vehicle.
- 12.7 The lower connection of the Diagonal Brace to the Main Hoop upright must be no further than 100mm (4") from the Main Hoop Mounting Pad on the opposite side of the vehicle.
- 12.8 Passengers are not allowed in the vehicle unless two Diagonal Braces are present in a cross formation to the dimension specifications above.
- 12.9 In a Six Point Rollcage, an alternative to a Diagonal Brace is the fitting of a Diagonal Member between the two Rear Stays. The Diagonal Member must be straight.
- 12.10 The Diagonal Member must be joined to the driver's side Rear Stay no further than 100mm (4") from the Rear Stay to Main Hoop joint.
- 12.11 The Diagonal Member must be joined to the Rear Stay on the opposite side no further than 100mm (4") from the Rear Stay mounting point.
- 12.12 Passengers are not allowed in a vehicle with a Diagonal Member fitted between the two Rear Stays unless two Diagonal Members are fitted in a cross formation to the dimensions specified.
- 12.13 If the Taxi Bar is back-set (Figure 8, component C) two Taxi Bar Upper Supports fixed to the horizontal section of the Main Hoop and the Taxi Bar are required (Figure 8, components H2).

12.14 It is also recommended to use Taxi Bar Lower Supports that are fixed to the Taxi Bar and the floorplan or transmission tunnel (Figure 8, components H1).



**Figure 7 (above): Component K is required if Rear Stays are bent. Component B is required in a 4-point Rollcage but optional in a 6-point Rollcage. Component J is additional and optional.**



**Figure 8 (above): Component K is required if Rear Stays are bent. Components H2 are required if the Taxi Bar (C) is back-set. Components H1 are recommended but optional. Components J is additional and optional.**



### **13.0 Rollcage Components – Side Intrusion Bar**

- 13.1 A Side Intrusion Bar must be designed and fabricated to ensure that it does not unduly impede egress from the vehicle when it is in place.
- 13.2 A Side Intrusion Bar must be as straight as is practical, both laterally and vertically, but may be curved/bent to avoid internal door fittings (e.g., arm rests and window winders).
- 13.3 A Side Intrusion Bar must pass the driver's/ passenger's body midway between their shoulder and elbow when seated in racing position and must connect to the Main Hoop upright at a similar height.
- 13.4 In a Four Point and Six Point Rollcage a Side Intrusion Bar must have its forward connection to a Forward Support tube no higher than half the height of the door opening.
- 13.5 In a Single Rollover Hoop Rollcage a Side Intrusion Bar must extend forward as far as possible and should be mounted/ welded to a substantial chassis component, or by any of the methods described above 17.0 and/or 18.0 of this specification.
- 13.6 In a Single Rollover Hoop Rollcage a Side Intrusion Bar mount must meet the size requirements detailed in 17.11.

### **14.0 Rollcage Components – Forward Supports**

- 14.1 A Forward Support must be connected to the Main Hoop upright no further than 100mm (4") from the upper Main Hoop bend on both sides of the vehicle.
- 14.2 A Forward Support must follow the vehicle's body line across the top of the front window and the A-Pillar as close as is practical.
- 14.3 There **may** only be one bend in the **lower** section\* of a Forward Support (\*under the dash).
- 14.4 Forward Support tubing may be welded directly onto an OEM chassis rail, or onto a non-OEM chassis rail, or via Mounting Plate onto a reinforced floor area providing all have been fabricated/ reconstructed with 3mm thickness 4130N Chromoly, or 3mm thickness 350N/mm<sup>2</sup> minimum tensile strength Mild Steel plate, at a minimum.  
  
Forward Stays should be mounted/ welded to a substantial chassis component, or by any of the methods described above 17.0 and/or 18.0 of this specification.
- 14.5 Four Point and Six Point Rollcages require a minimum of two Forward Supports.

## 15.0 Rollcage Components – Roof Support and Roof Braces (Diagonals)

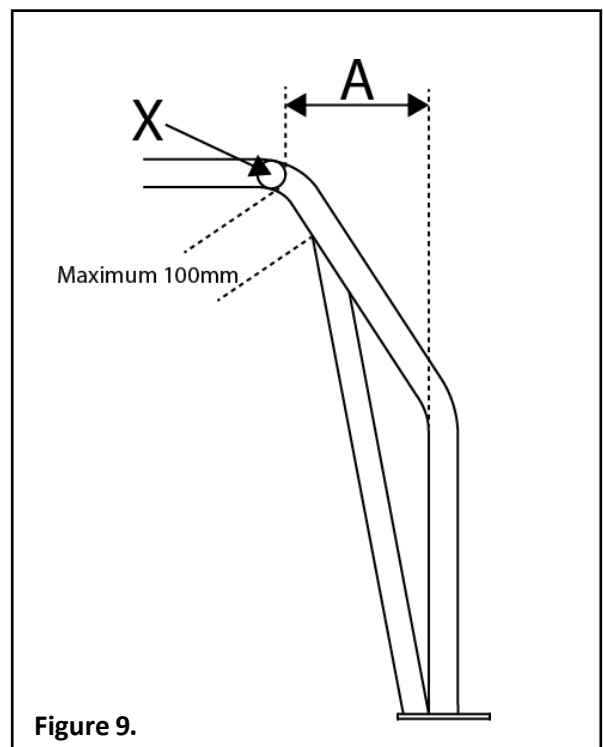
- 15.1 A Front Roof Support Tube must be fitted to a Four Point and a Six Point Rollcage.
- 15.2 A Front Roof Support Tube must be connected to a Forward Support no further than 100mm (4") from the upper bend in the Forward Support Tube.
- 15.3 The Front Roof Support Tube may have a maximum of two bends with the bend/s not exceeding 20 degrees.
- 15.4 The Front Roof Support Tube must be straight in side view.
- 15.5 If the Front Roof Support Tube is removable, Roof Braces must be fitted (see Figures 2 and 3, components G).
- 15.6 Roof Braces must be fitted in either a forward or reverse "V" configuration between the Front Roof Support and the top of the Main Hoop.
- 15.7 The angle between the "V" of the Roof Braces must be as great as is practical.

## 16.0 Rollcage Components – Additional Tubing

- 16.1 The addition of tubing or gussets that reinforce a rollcage is encouraged.
- 16.2 Additional tubing is such as Figure 8, component J.
- 16.3 Any rollcage tubing which is added beyond the minimum requirements (and is therefore considered as "additional tubing") need not meet the minimum material specifications as detailed in Table 1 of this specification.

### Forward Support Reinforcement (optional)

- 16.4 If dimension 'A' in Figure 9 is greater than 200mm (7 7/8"), it is recommended that a Forward Support Reinforcement be fitted.
- 16.5 The Forward Support Reinforcement may be bent, on condition that it is straight in side view and that the angle of the bend does not exceed 20 degrees.
- 16.6 The Forward Support Reinforcement should have its upper attachment no further than 100mm (4") from the Front Roof Support to Forward Support joint (Figure 9, component X).
- 16.7 The Forward Support Reinforcement should be welded 360 degrees around the tube.



16.8 The Forward Support Reinforcement should have its lower attachment in one of the two suggested configurations or as per the designs presented in the ANDRA Removable Rollcage Specification v2.01. (Figure 10 & 11 below).

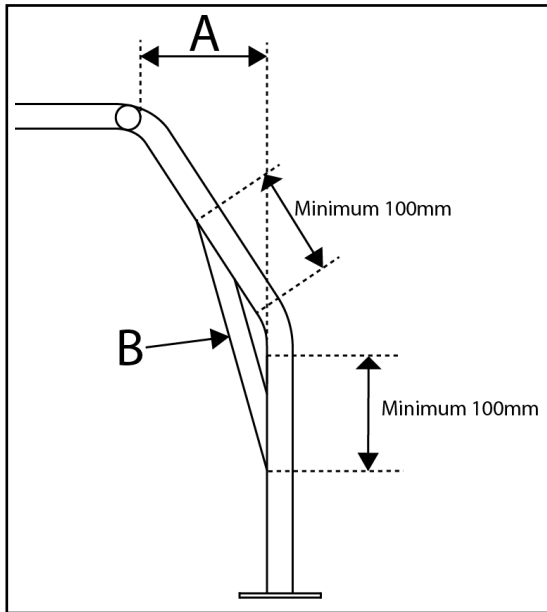


Figure 10.

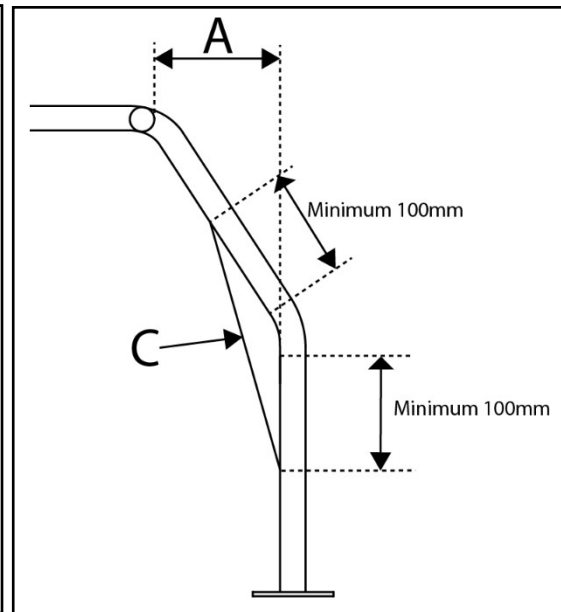


Figure 11.

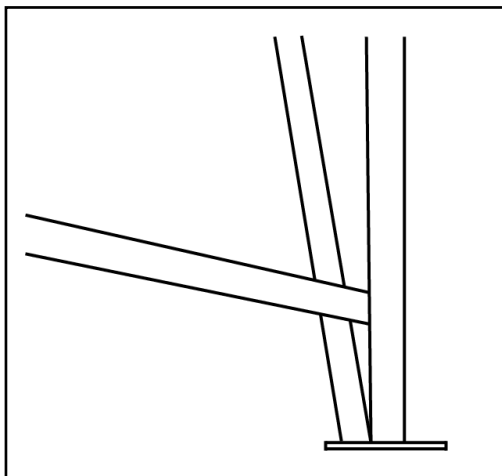


Figure 12.

Configuration 1 (Figure 12).

The centreline of the Forward Support Reinforcement tube must be coincident (intersect) with the centreline of the Forward Support tube and the centreline of the Side Intrusion Bar tube at a single point. Welded 360 degrees around the tube.

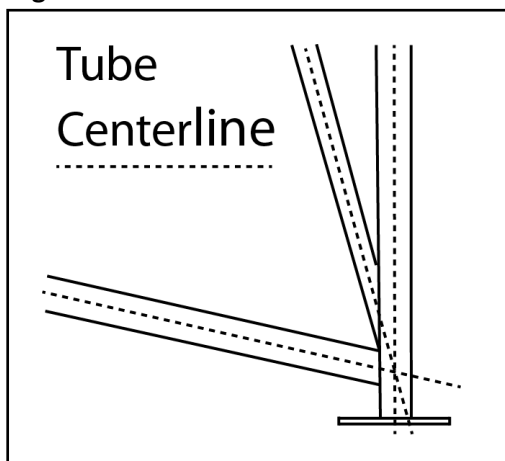


Figure 13.

Configuration 2 (Figure 13).

Attached to the Mounting Pad of the Forward Support no further than 100mm from the Forward Support tube to pad connection. If the Forward Support Reinforcement tube intersects the Side Intrusion Bar it must be split in several parts. The Forward Support Reinforcement Tube may be placed either side of the Side Intrusion Bar.

## 17.0 Rollcage to Chassis Mounting

- 17.1 Mounting Plate: A metal plate welded to the vehicle.  
Mounting Pad: A metal plate welded to the rollcage tube.
- 17.2 Mountings for the Main Hoop, Rear Stays and Forward Supports may comprise of a Mounting Pad welded to the tubing which is then bolted to an approved Mounting Plate.
- Main Hoop, Rear Stay and Forward Support tubing may be welded to an approved Mounting Plate as per section 17.0 of the ANDRA Welded Rollcage Specification v4.0.
- Main Hoop, Rear Stay and Forward Support tubing may be welded directly onto an OEM chassis rail, or onto a non-OEM chassis rail, or via Mounting Plate onto a reinforced floor area providing all have been fabricated/ reconstructed with 3mm thickness 4130N Chromoly, or 3mm thickness 350N/mm<sup>2</sup> minimum tensile strength Mild Steel plate, at a minimum.
- 17.3 All removable Mounting Pads which mount to a vehicle must be reinforced with a Mounting Plate of at least 120cm<sup>2</sup> (19 in<sup>2</sup> (square inches)) in surface area which must be in contact between the Mounting Plate and bodyshell.
- 17.4 Mounting Plates may be of any shape, provided the minimum width and area dimensions are maintained or exceeded.
- 17.5 If the mounting type requires two plates, one beneath the floor and one on top, the lower plate must be larger or smaller than the upper plate by at least 20mm all around the upper plates' perimeter. The minimum surface area specification must be maintained or exceeded by both plates.
- 17.6 It is preferential to have the thickness of the pad/ plate material as close as possible to that of the material to which it is welded to whilst staying within the minimum material specifications.
- 17.7 Mounting Plates must be designed and fabricated such that they can withstand minor deformation during a roll over, the Mounting Plates must not be designed and fabricated so that they shear through the supporting chassis/body material during a roll over.
- 17.8 Mounting Plates must be fabricated to reinforce the material which they are welded to.
- 17.9 A Mounting Plate must be attached to the body (including transmission tunnel) of a vehicle as close as possible to the chassis beams or a substantial chassis component.
- 17.10 Mounting Plates should be stitch welded to the vehicle around their whole perimeter. Acceptable stitch sizes are 25mm (1") weld with a 25mm (1") gap.

17.11 Mounting Pads must meet the sizing dimensions as per Table 2 below.

**Table 2**

Mounting Pad Location	Minimum Surface Area	Minimum Single Dimension
Forward Support	100cm <sup>2</sup> / 15.5 in <sup>2</sup>	7.5cm / 3"
Main Hoop	100cm <sup>2</sup> / 15.5 in <sup>2</sup>	7.5cm / 3"
Rear Stays	60cm <sup>2</sup> / 9.3 in <sup>2</sup>	7.5cm / 3"
Additional Supports*	100cm <sup>2</sup> / 15.5 in <sup>2</sup>	7.5cm / 3"
Side Intrusion Bar**	100cm <sup>2</sup> / 15.5 in <sup>2</sup>	7.5cm / 3"

\* e.g., Taxi Bar Lower Supports "H2"

\*\* Single Roll Over Hoop only.

17.12 Tube to Mounting Pad welding must be continuous (not stitched) around the whole perimeter of the tube.

17.13 All corners of Mounting Pads and Plates should be radiused to a minimum of 25mm (1") radius.

17.14 There must be a minimum of three (3) bolts in each removable mount.

17.15 The distance from the centre of a bolt hole to the edge of a removable Mounting Pad and/or Mounting Plate must be a minimum of two times the bolt hole diameter.

e.g., if using M8 bolts the distance from the centre of a bolt hole to the edge of the removable Mounting Pad and/or Mounting Plate must be a minimum of 16mm.

17.16 The distance from the centre of the bolt holes to the tubing on a removable Mounting Pad must be a minimum of two times the bolt hole diameter.

e.g., if using M8 bolts the distance from the centre of the bolt holes to the tubing must be a minimum of 16mm.

17.17 Bolt hole internal diameter (ID) should be as close as practical to the outside diameter (OD) of the bolt being used and should be no more than 0.5mm difference.

17.18 Bolt hole centres must not be less than 60 degrees from each other, as measured from the tube axis at the level of the Mounting Pad, Figure 14.

17.19 Bolts should be fitted with nylon insert nuts that if used must be replaced with new nuts after each removal. Alternatives to this are to use a spring washer and a semi-permanent nut locking adhesive or captively weld the nuts to the lower Mounting Plate.

17.20 Note: Nylon insert nuts should not be tightened or loosened with a powered tool.

17.21 Nuts/ bolts must be appropriately torqued to the manufacturer's specification, ensuring that they do not come undone in normal operation or in the instance of a crash.

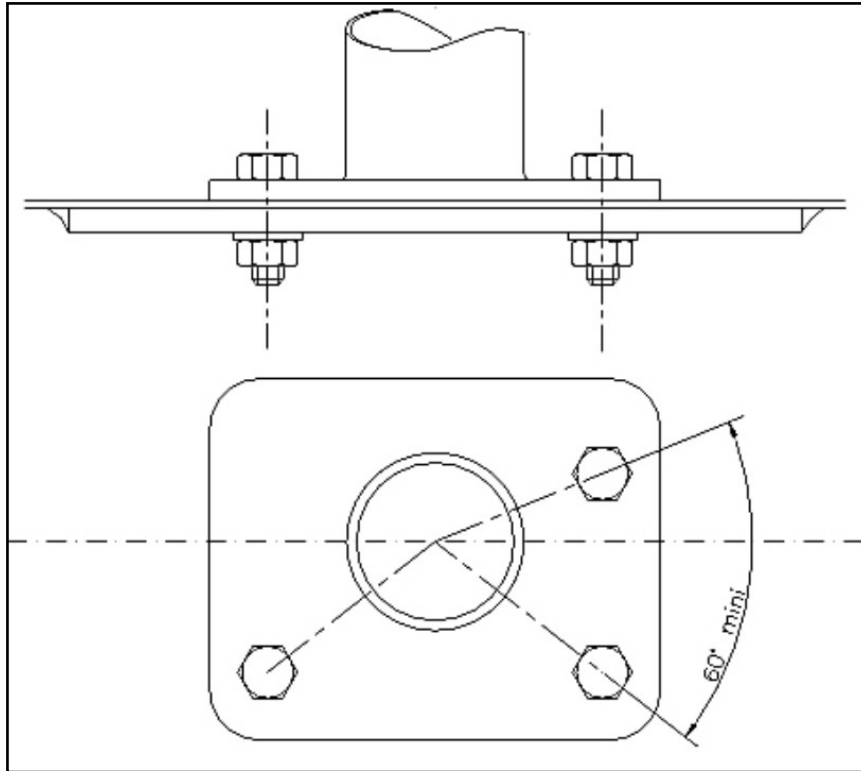


Figure 14.

## 18.0 Mounting Pad Designs

18.1 A Mounting Pad should be fabricated to one of six designs as per Figures 14 – Figure 20.

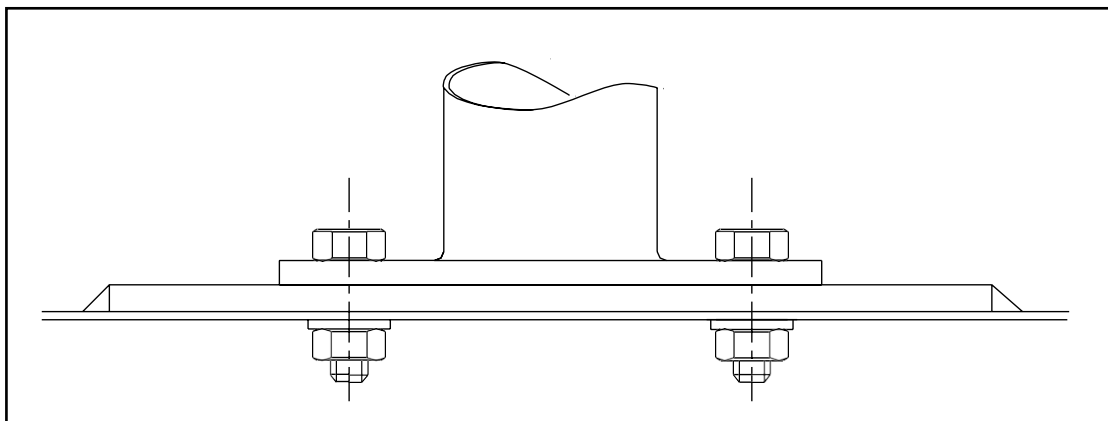
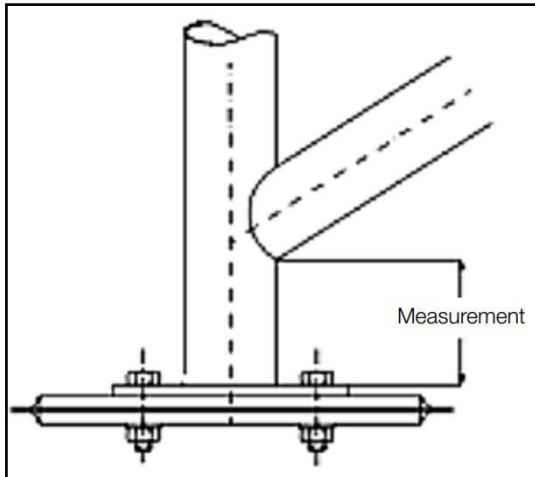


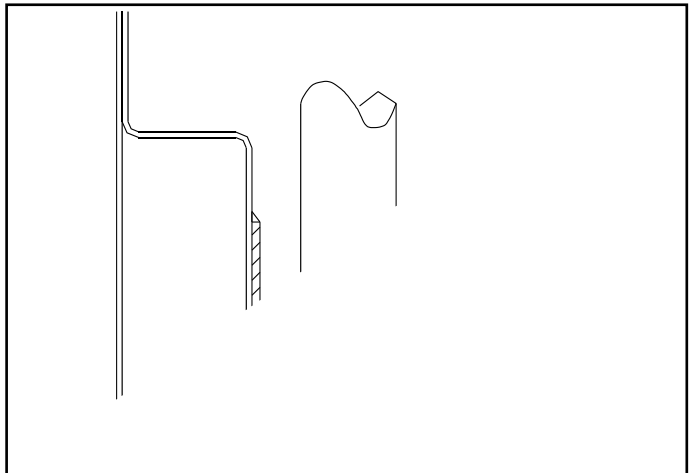
Figure 15.

18.2 Bolts shown in Figures 17 – 19 are external to the rollcage tube.

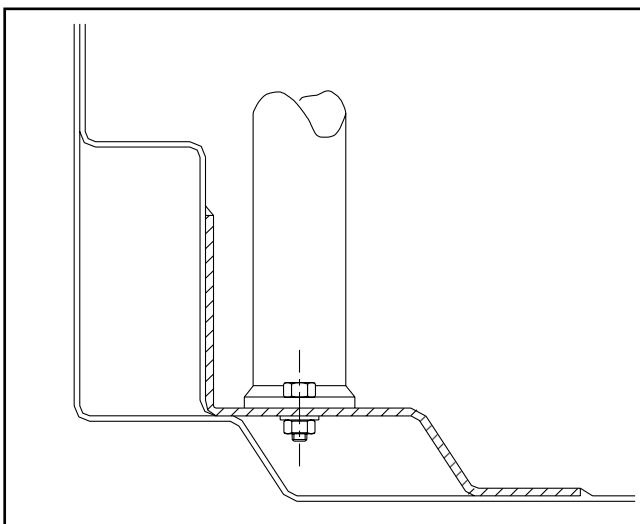
18.3 The sides of the raised hollow section Mounting Plate, Figure 18 and 19, may be fully enclosed with a welded plate of the same material specification as the Mounting Plate.



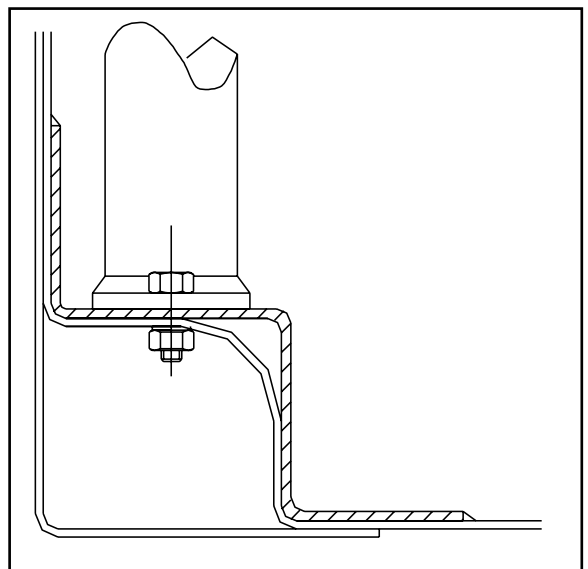
**Figure 16.**



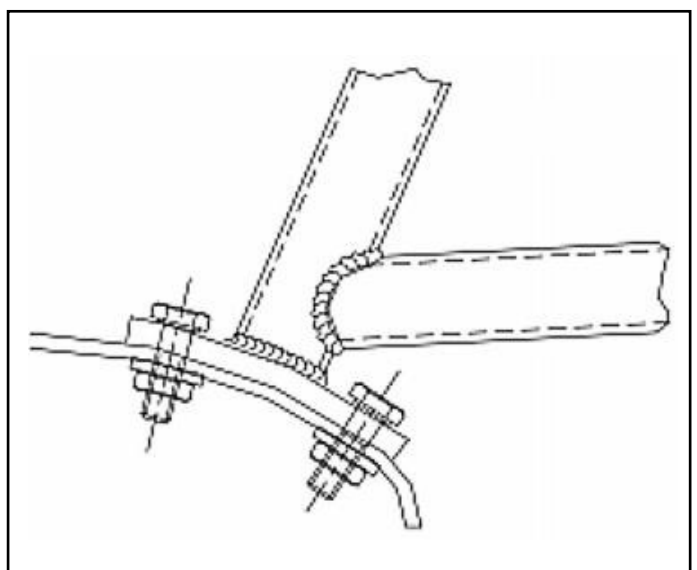
**Figure 17.**



**Figure 18.**



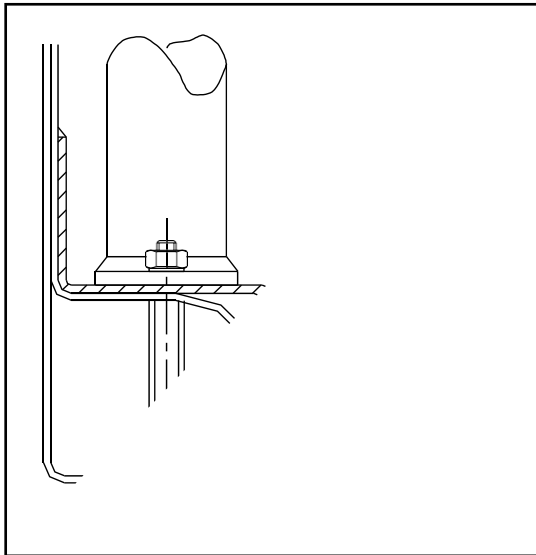
**Figure 19.**



**Figure 20.**

## 19.0 Crush Tubes

- 19.1 Where a removable rollcage mounting bolt passes through a hollow section a Crush Tube must be used.
- 19.2 A Crush Tube must be welded within the hollow section at both ends.
- 19.3 The ID of the Crush Tube must be no more than 2mm greater than the OD of the mounting bolt.
- 19.4 The OD of the Crush Tube must be, as a minimum, no less than the width of the head of the bolt which passes through it.
- 19.5 Crush tube minimum wall thickness 2mm
- 19.6 Figure 21 shows the use of a Crush Tube through a hollow section.



**Figure 21**



## 20.0 Rollcage Joints

- 20.1 For all removable rollcage tube components, it is recommended to use any of the homologated joints as detailed in section 21.3.
- 20.2 Joints within a removable rollcage may also be fabricated to one of the designs in Figures 32-36.
- 20.3 Taper Lock Joints (Figure 33) and Sleeve Joints (Figure 34) are not permitted to join Side Intrusion Bars.
- 20.4 ANDRA also allow 'Dismountable' joints as homologated by the FIA.

## 21.0 Homologated Joints

- 21.1 ANDRA undertakes a homologation program for removable rollcage joints. The homologation of rollcage joints is undertaken on a joint-by-joint basis, with each manufacturer requiring a separate homologation for each of their rollcage joints. ANDRA undertakes this program to ensure that its members are purchasing and using rollcage joints that are fit for purpose.
- 21.2 Homologated joint manufacturer's contact details.

Billet Race Craft  
8 Sturt Reserve Road  
Murray Bridge  
South Australia 5253

Phone: 0427 324 977  
Email: [sales@billetracecraft.com.au](mailto:sales@billetracecraft.com.au)  
Web: [www.billetracecraft.com.au](http://www.billetracecraft.com.au)

Brad Stacy Fabrication  
6 Ashford Rd  
High Wycombe  
Western Australia 6057

Phone: 0404 125 744  
Email: [bradstacy@bigpond.com](mailto:bradstacy@bigpond.com)  
Web: [www.bradstacyfabrication.com.au](http://www.bradstacyfabrication.com.au)

Pro9  
160 Thistlethwaite Street  
South Melbourne  
Victoria 3205

Phone: 03 9699 4946  
Mobile: 0407 074 783  
Email: [pro9drag@gmail.com](mailto:pro9drag@gmail.com)

- 21.3 The following is a list of homologated removable rollcage joints.

- A. Pro9-R1000KIT – Etched with ANDRA **RRJ001**.
- B. Brad Stacy 1 5/8" Joint – Non-etched, not for retail.
- C. Billet Race Craft 1 5/8" Joint – Etched with ANDRA **RRJ002** (etched and non-etched).
- D. Billet Race Craft 1 3/4" Joint – Etched with ANDRA **RRJ003**.
- E. Billet Race Craft 1 1/2" Joint – Etched with ANDRA **RRJ004**.
- F. Billet Race Craft 1 5/8" Joint (left hand thread) – Etched with ANDRA **RRJ005**.
- G. Billet Race Craft 1 5/8" Joint (right hand thread) – Etched with ANDRA **RRJ006**.
- H. Billet Race Craft 1 5/8" Notchable Joint – Etched with ANDRA **RRJ007**.
- I. [Billet Race Craft 1 1/2" Notchable Joint – Etched with ANDRA \*\*RRJ008\*\*](#).
- J. [Billet Race Craft 1 3/4" Notchable Joint – Etched with ANDRA \*\*RRJ009\*\*](#).

### 21.3 A Pro9-R1000KIT – ANDRA RRJ001.



Figure 22: Pro9-R1000KIT Rollcage Joint – ANDRA RRJ001.

Fitting of the Pro9-R1000KIT joint (ANDRA RRJ001) must adhere to the following regulations.

- RRJ001 may be used to connect all rollcage tube components.
- RRJ001 must not be used to connect a rollcage tube to a Floor Mounting.
- Bolts must be M8 SAE with a minimum grade of Grade 12.9.
- Bolts must be tightened to the manufacturer’s specified torque.
- RRJ001 joints must not be modified from the original manufacture’s specification.
- A 1mm gap between the end of the tube and the chamfer of the RRJ001 joint should be left when welding to ensure appropriate weld penetration into the RRJ001 joint and tube.
- **NOTE: Owners of Pro9-R1000KIT joints without ANDRA RRJ001 etching are required to provide evidence of joint purchase from Pro9 and evidence of the joint’s comparable specification to the ANDRA RRJ001 etched joints, (e.g., a statement from Pro9 that the joint purchased is identical as the ANDRA tested joint). Owners of these joints must comply with all regulations in this document.**

**21.3 B Brad Stacy 1 5/8" Rollcage Joint (non-etched).**



**Figure 23: Brad Stacy 1 5/8" Joint (non-etched).**

Fitting of the Brad Stacy 1 5/8" joint must adhere to the following regulations.

- Brad Stacy 1 5/8" joints may be used to connect all rollcage tube components.
- Brad Stacy 1 5/8" joints must not be used to connect a rollcage tube to a Floor Mounting.
- Bolts must of Grade 12.9 or imperial equivalent.
- Bolts must be tightened to the manufacturer's specified torque.
- Brad Stacy 1 5/8" joints must not be modified from the original manufacture's specification.
- A 1mm gap between the end of the tube and the chamfer of the Brad Stacy 1 5/8" joint should be left when welding to ensure appropriate weld penetration into the joint and tube.

**21.3 C Billet Race Craft 1 5/8" Joint – ANDRA RRJ002 (etched & non-etched).**



**Figure 24: Billet Race Craft 1 5/8" Joint – ANDRA RRJ002 etched and non-etched.**

Fitting of the BRC 1 5/8" joint (ANDRA RRJ002) must adhere to the following regulations.

- RRJ002 may be used to connect all rollcage tube components.
- RRJ002 must not be used to connect a rollcage tube to a Floor Mounting.
- Bolts must of Grade 12.9 or imperial equivalent.
- Bolts must be tightened to the manufacturer's specified torque.
- RRJ002 must not be modified from the original manufacture's specification.
- A 1mm gap between the end of the tube and the chamfer of the RRJ002 joint should be left when welding to ensure appropriate weld penetration into the RRJ002 joint and tube.

**21.3 D Billet Race Craft 1 3/4" Joint – ANDRA RRJ003.**



**Figure 25: Billet Race Craft 1 3/4" Joint – ANDRA RRJ003.**

Fitting of the BRC 1 3/4" joint (ANDRA RRJ003) must adhere to the following regulations.

- RRJ003 may be used to connect all rollcage tube components.
- RRJ003 must not be used to connect a rollcage tube to a Floor Mounting.
- Bolts must of Grade 12.9 or imperial equivalent.
- Bolts must be tightened to the manufacturer's specified torque.
- RRJ003 must not be modified from the original manufacture's specification.
- A 1mm gap between the end of the tube and the chamfer of the RRJ003 joint should be left when welding to ensure appropriate weld penetration into the RRJ003 joint and tube.

**21.3 E Billet Race Craft 1 1/2" Joint – ANDRA RRJ004.**

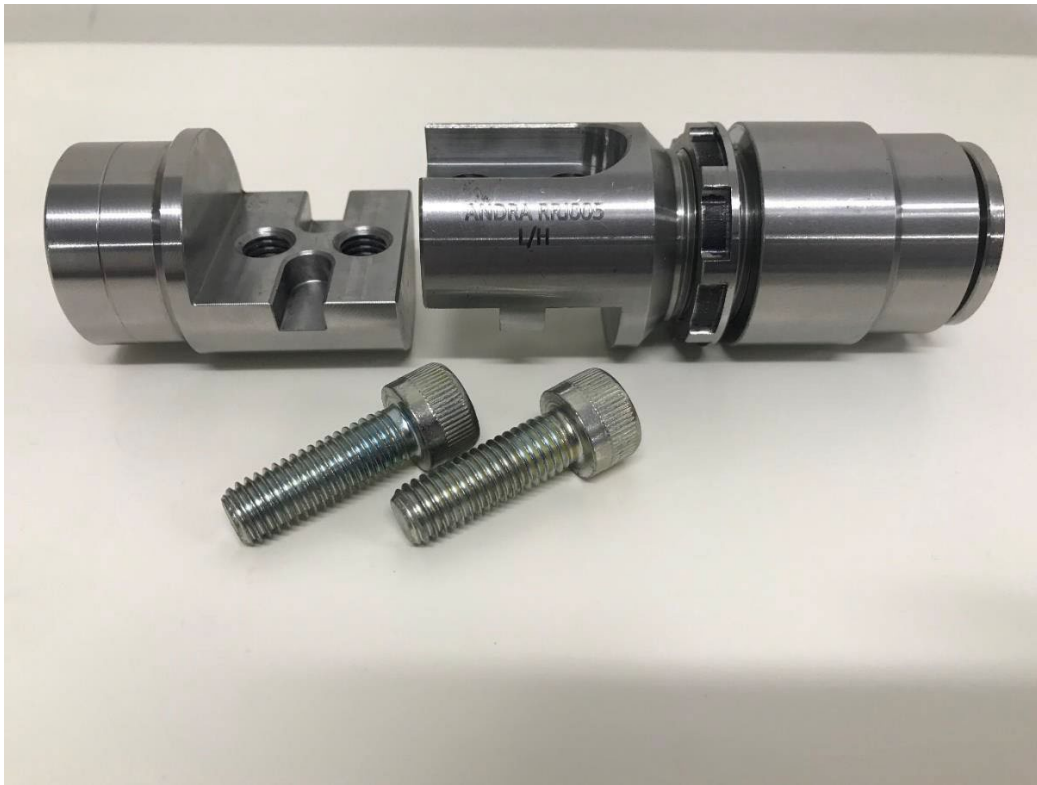


**Figure 26: Billet Race Craft 1 1/2" Joint – ANDRA RRJ004.**

Fitting of the BRC 1 1/2" joint (ANDRA RRJ004) must adhere to the following regulations.

- RRJ004 may be used to connect all rollcage tube components.
- RRJ004 must not be used to connect a rollcage tube to a Floor Mounting.
- Bolts must of Grade 12.9 or imperial equivalent.
- Bolts must be tightened to the manufacturer's specified torque.
- RRJ004 must not be modified from the original manufacture's specification.
- A 1mm gap between the end of the tube and the chamfer of the RRJ004 joint should be left when welding to ensure appropriate weld penetration into the RRJ004 joint and tube.

**23.1 F Billet Race Craft 1 5/8" Joint (left hand thread) – ANDRA RRJ005.**



**Figure 27: Billet Race Craft 1 5/8" Joint (left hand thread) – ANDRA RRJ005.**

Fitting of the BRC 1 5/8" (left hand thread) joint (ANDRA RRJ005) must adhere to the following regulations.

- RRJ005 may be used to connect all rollcage tube components.
- RRJ005 must not be used to connect a rollcage tube to a Floor Mounting.
- Bolts must of Grade 12.9 or imperial equivalent.
- Bolts must be tightened to the manufacturer's specified torque.
- RRJ005 must not be modified from the original manufacture's specification.
- A 1mm gap between the end of the tube and the chamfer of the RRJ005 joint should be left when welding to ensure appropriate weld penetration into the RRJ005 joint and tube.

**23.1 G Billet Race Craft 1 5/8" Joint (right hand thread) – ANDRA RRJ006.**



**Figure 28: Billet Race Craft 1 5/8" Joint (right hand thread) – ANDRA RRJ006.**

Fitting of the BRC 1 5/8" (right hand thread) joint (ANDRA RRJ006) must adhere to the following regulations.

- RRJ006 may be used to connect all rollcage tube components.
- RRJ006 must not be used to connect a rollcage tube to a Floor Mounting.
- Bolts must of Grade 12.9 or imperial equivalent.
- Bolts must be tightened to the manufacturer's specified torque.
- RRJ006 must not be modified from the original manufacture's specification.
- A 1mm gap between the end of the tube and the chamfer of the RRJ006 joint should be left when welding to ensure appropriate weld penetration into the RRJ006 joint and tube.



**23.1 H Billet Race Craft 1 5/8" Notchable Joint – ANDRA RRJ007.**



**Figure 29: Billet Race Craft 1 5/8" Notchable Joint – ANDRA RRJ007.**

Fitting of the BRC 1 5/8" notchable joint (ANDRA RRJ007) must adhere to the following regulations.

- RRJ007 may be used to connect all rollcage tube components.
- RRJ007 must not be used to connect a rollcage tube to a Floor Mounting.
- Bolts must of Grade 12.9 or imperial equivalent.
- Bolts must be tightened to the manufacturer’s specified torque.
- RRJ007 must not be modified from the original manufacture’s specification.
- A 1mm gap between the end of the tube and the chamfer of the RRJ007 joint should be left when welding to ensure appropriate weld penetration into the RRJ007 joint and tube.

23.1 I Billet Race Craft 1 1/2" Notchable Joint – Etched with ANDRA RRJ008.



Figure 30: Billet Race Craft 1 1/2" Notchable Joint – Etched with ANDRA RRJ008.

Fitting of the BRC 1 1/2" notchable joint (ANDRA RRJ008) must adhere to the following regulations.

- RRJ008 may be used to connect all rollcage tube components.
- RRJ008 must not be used to connect a rollcage tube to a Floor Mounting.
- Bolts must of Grade 12.9 or imperial equivalent.
- Bolts must be tightened to the manufacturer’s specified torque.
- RRJ008 must not be modified from the original manufacture’s specification.
- A 1mm gap between the end of the tube and the chamfer of the RRJ008 joint should be left when welding to ensure appropriate weld penetration into the RRJ008 joint and tube.

**23.1 J Billet Race Craft 1 3/4" Notchable Joint – Etched with ANDRA RRJ009.**



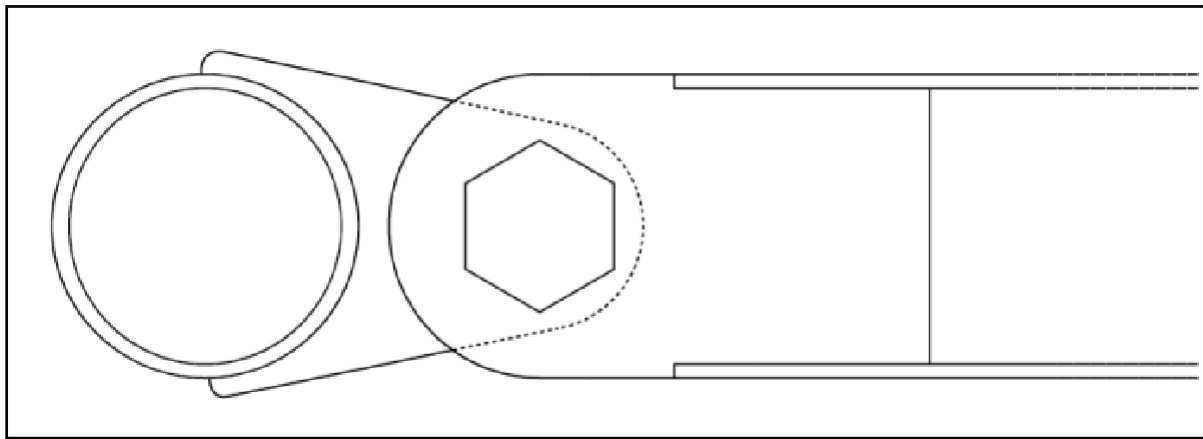
**Figure 31: Billet Race Craft 1 3/4" Notchable Joint – Etched with ANDRA RRJ009.**

Fitting of the BRC 1 3/4" notchable joint (ANDRA RRJ009) must adhere to the following regulations.

- RRJ009 may be used to connect all rollcage tube components.
- RRJ009 must not be used to connect a rollcage tube to a Floor Mounting.
- Bolts must of Grade 12.9 or imperial equivalent.
- Bolts must be tightened to the manufacturer’s specified torque.
- RRJ009 must not be modified from the original manufacture’s specification.
- A 1mm gap between the end of the tube and the chamfer of the RRJ009 joint should be left when welding to ensure appropriate weld penetration into the RRJ009 joint and tube.

## 22.0 Fabricated Joints – Double Tab Clevis Joint

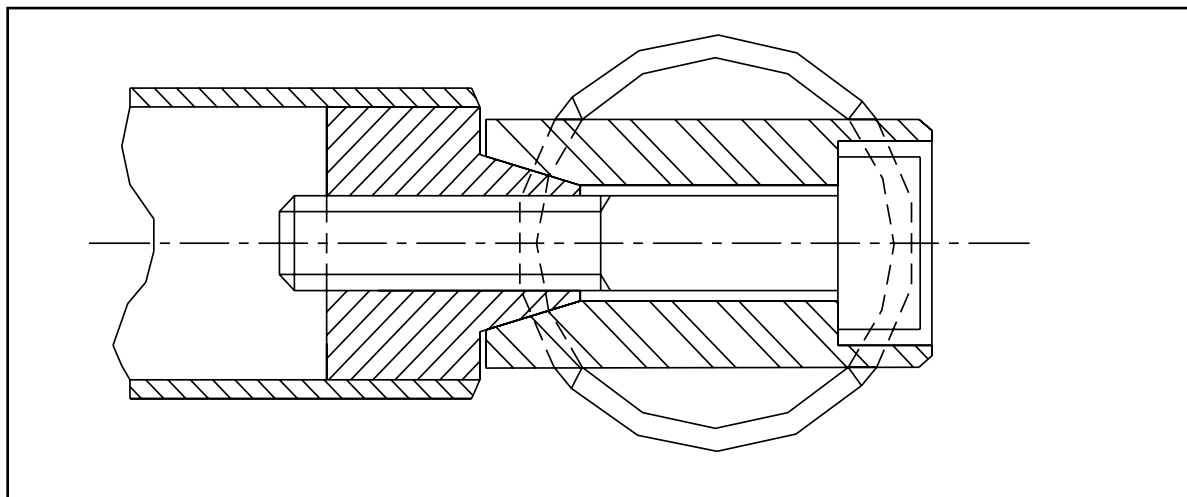
- 22.1 The bolt used in a Double Tab Clevis joint must be vertical in orientation, so are not recommended for use within a Side Intrusion Bar.
- 22.2 The clevis must be a snug fit in-between the double tabs.
- 22.3 Bolts should be fitted with nylon insert nuts that if used must be replaced with new nuts after each removal. Alternatives to this are to use a spring washer and a semi-permanent nut locking adhesive or captively weld the nuts to one of the tabs.
- 22.4 Note: Nylon insert nuts should not be tightened or loosened with a powered tool.
- 22.5 Nuts/ bolts must be appropriately torqued, to the manufacturer’s specification, ensuring that they do not come undone in normal operation or in the instance of a crash.



**Figure 32: Double Tab Clevis viewed vertically downwards.**

## 23.0 Fabricated Joints – Taper Lock Joint

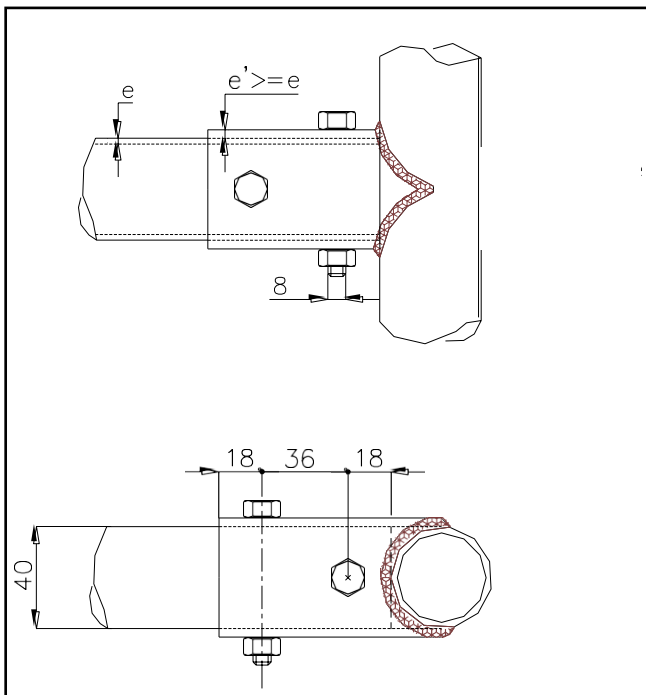
- 23.1 All Taper Lock components, excluding bolts, must be fabricated from 4130 or 4140 Chromoly.
- 23.2 The OD of the Taper Lock tube insert must be an interference fit with the ID of the rollcage tube housing it.
- 23.3 The thread length, measured longitudinally within the Taper Lock tube insert, must be a minimum of 25mm (1”).
- 23.4 Bolts used must be minimum of ISO (SAE) Class 8.8 and M12 in size and of a length to ensure that the bolt protrudes from the Taper Lock tube insert when fully tightened to manufacturer’s torque specification.
- 23.5 Bolts must be appropriately torqued, to the manufacturer’s specification, ensuring that they do not come undone in normal operation or in the instance of a crash.
- 23.6 The Taper Lock tube insert must be welded to the rollcage tube in one continuous (not stitched) weld, fully surrounding the whole circumference of the tube.
- 23.7 The Taper Lock tube insert must also be spot welded at four points around the tube with each point being 90 degrees to each other (Rosette welding).
- 23.8 The corresponding insert which passes perpendicularly through the rollcage tube, must be welded to the tube withholding it in one continuous (not stitched) weld around the full circumference of the insert on each side of the tube.



**Figure 33: Taper Lock Joint.**

## 24.0 Fabricated Joints – Sleeve Joints

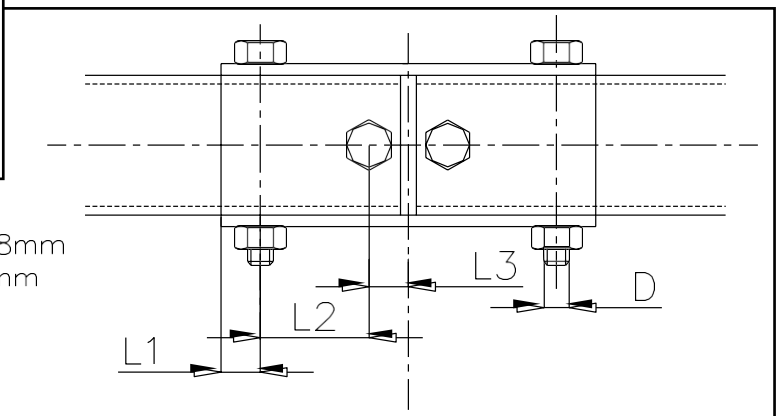
- 24.1 The outer sleeve must be fabricated from the same material specification as the rollcage tube within.
- 24.2 The outer sleeve must have an ID no greater than 0.4mm (1/64") than the rollcage tube OD within.
- 24.3 The tubes within a Double Butted Sleeved Joint must have straight cut ends and butt-up against each other within the sleeve.
- 24.4 A tube in a Sleeved Tee joint must butt to the face of the adjoining tube within the sleeve.
- 24.5 Minimum distance from the sleeve end to the bolt hole is 18mm (3/4").  
 Minimum distance between bolts is 36mm (1 1/2").  
 Minimum distance between a central sleeve bolt and the end of the sleeved tube is 18mm (3/4").
- 24.6 Bolts must be orientated at 90 degrees to each other.
- 24.7 Bolts should be fitted with nylon insert nuts that if used must be replaced with new nuts after each removal. Alternatives to this are to use a spring washer and a semi-permanent nut locking adhesive or captively weld the nuts to the sleeve.
- 24.8 Note: Nylon insert nuts should not be tightened or loosened with a powered tool.
- 24.9 Nuts/ bolts must be appropriately torqued, to the manufacturer’s specification, ensuring that they do not come undone in normal operation or in the instance of a crash.



**Figure 35 (above):  
Sleeved Tee Joint.**

$L1=L3>18\text{mm}$   
 $L2\geq 36\text{mm}$   
 $D=8\text{mm}$

**Figure 34 (below): Butted Sleeve Joint**



## 25.0 CAMS J-50 Joint

- 25.1 CAMS J-50 joint is only to be used to connect a removable Side Intrusion Bar to a Main Hoop tube and/or Forward Support tube.
- 25.2 Bolts should be fitted with nylon insert nuts that if used must be replaced with new nuts after each removal. Alternatives to this are to use a spring washer and a semi-permanent nut locking adhesive or captively weld the nuts to one of the tabs.
- 25.3 Note: Nylon insert nuts should not be tightened or loosened with a powered tool.
- 25.4 Nuts/ bolts must be appropriately torqued, to the manufacturer's specification, ensuring that they do not come undone in normal operation or in the instance of a crash.

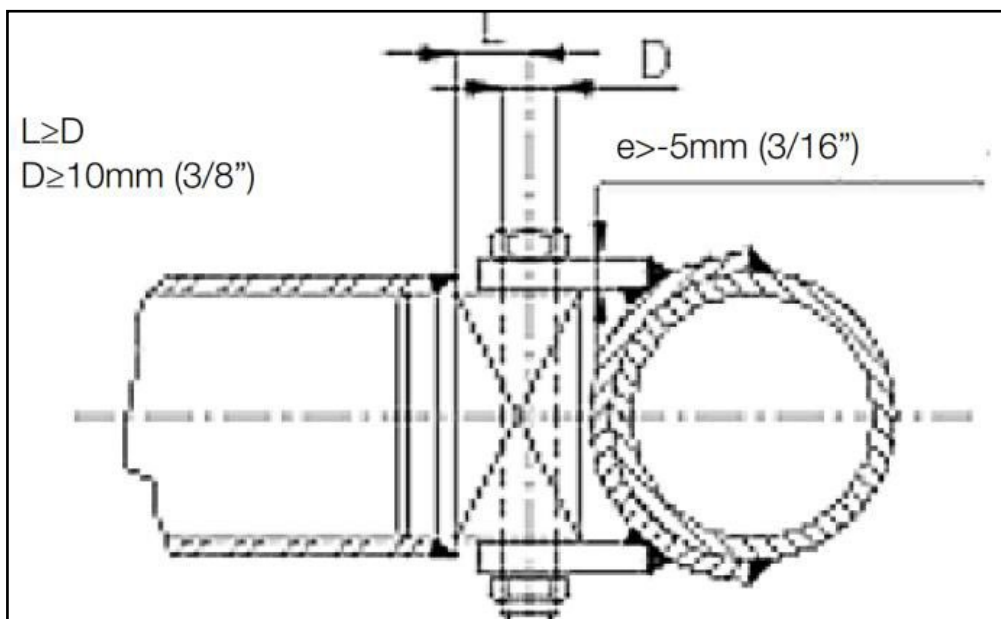


Figure 36: CAMS Joint J-50 viewed vertically downwards.