APPENDIX 'O': ROLL CAGES

1.0 GENERAL

1.1 APPLICATION

Roll cages are mandatory on all Cars, unless otherwise stated.

1.2 DESIGN

Roll cages may be of two designs, low front hoop (top of steering wheel, or high front hoop (top of windshield). Specific installations are subject to the approval of the Chief Scrutineer at each Event. (Refer to Diagrams herein)

2.0 BASIC DESIGN CONSIDERATIONS

2.1 PURPOSE

The basic purpose of the roll cage is to protect the Driver if the Car rolls over or is involved in a serious accident.

2.2 INSIDE DIMENSIONS

The top of main hoop of the roll cage shall be a minimum of 2in above the top of the Driver's helmet when the Driver is sitting in a normal driving position, or shall be located as near the roof as possible in closed Cars. The top of the main hoop shall not be more than 10in behind the back of the Driver's helmet when the Driver is sitting in a normal driving position. A straight line drawn from the top of the main hoop to the top of the front hoop shall pass over the Driver's helmet.

2.3 OPERATION

The roll cage shall be designed to withstand compression forces resulting from the weight of the Car coming down on the roll cage and to take fore/aft and lateral loads resulting from the Car skidding along on the roll cage.

2.4 HEAD RESTRAINT

2.4.1 A system of head restraint to prevent whiplash and rebound and to prevent the Driver's head from striking the underside of the roll cage shall be provided.

2.4.2 The head restraint shall be capable of withstanding a force of 200 pounds in a rearward direction.

2.4.3 The headrest shall have an area of 36 square inches and be padded with a non-resilient material such as Ethafoam or Ensolite or other similar material with a minimum thickness of 1in.

2.4.4 The head restraint support shall be such that it continues rearward or upward from the top edge of the pad such that the Driver's helmet cannot hook over the pad.

2.4.5 The padded surface shall touch the helmet and shall not be under fibreglass or other hard material.

2.5 PADDING

Parts of the cage subject to contact with the Driver shall be padded with non-resilient material such as Ethafoam or Ensolite or other similar material with a minimum thickness of 1/2in.

2.6 AERODYNAMIC RESTRICTIONS

No portion of the roll cage shall have an aerodynamic effect by creating a vertical thrust.

2.7 ENGINE INTRUSION

Roll cage or chassis design shall prevent engine intrusion into the Driver compartment.

3.0 DIMENSIONS AND MATERIALS

3.1 MATERIALS

3.1.1 The roll cage shall be of seamless or ERW or DOM mild steel tubing (SAE 1010, 1020, 1025) or equivalent, or alloy steel tubing (SAE 4125, 4130). It is recommended that mild steel tubing be used as alloys present difficulties in welding and must be normalized to relieve stress.

3.1.2 Proof of the use of alloy steel is the responsibility of the Entrant.

3.2 DIMENSIONS

Unless otherwise specified herein, the minimum size of tubing to be used shall be as follows: (all dimensions are in inches).

CAR WEIGHT	MILD STEEL	ALLOY STEEL
Up to 1500 lbs.	1.375x.095	1.375x.080
1500-2500 lbs.	1.500x.095	1.375x.095
Over 2500 lbs.	1.500x.120	1.500x.095
Or	1.750x.095	

ERW tubing may be used in the following sizes only:

CAR WEIGHT	ERW TUBING
Up to 2500 lbs.	1.500x.120
over 2500lbs.	1.750x.120

3.3 WEIGHT

For purposes of determining tubing size, the Car weight is as raced, without fuel, Driver, or rewards weight.

3.4 MINUS TOLERANCE

The minus tolerance for wall thickness shall not be more than .010 below the nominal thickness.

3.5 INSPECTION HOLE

An inspection hole of at least 3/16in diameter shall be drilled in a non-critical area of all tubing with a specified dimension, to facilitate verification of wall thickness.

4.0 FABRICATION

4.1 BENDS

One continuous length of tubing shall be used for the main hoop with smooth continuous bends and no evidence of crimping or wall failure. The radius of bends in roll cages (measured at centerline of the tubing) shall not be less than three (3) times the diameter of the tubing,

4.2 MAIN HOOPS

Whenever possible, roll cage hoops should start from the floor of the Car and in the case of tube frame construction, be attached to the chassis tubes by means of gussets or sheet metal webs with support tubes beneath the joints to distribute the loads. It is recommended that gussets be used at all joints.

4.3 JOINTS

All joints shall be fully welded. All welding shall be of the highest possible quality with full penetration and shall be done according to A.S.T.M. specifications for the material used. Arc welding, particularly heliarc, should be used whenever possible. Welds should be inspected by magnaflux or dye penetrant after fabrication. Alloy steels shall be normalized after welding.

4.4 BRAZING

Aluminum bronze or silicon bronze welding techniques are permitted, but extreme care shall be used in preparation of parts before welding and in the design of the attaching joints.

5.0 FORMULA AND SPORTS RACING CARS

5.1 GENERAL

5.1.1 Two-seat Sports Racing Cars shall have full cockpit width roll cages.

5.1.2 On Cars of full monocoque construction, a fabricated front hoop may be recognized by CASC-OR upon specific application.

5.2 MAIN AND FRONT HOOPS

5.2.1 On Formula Cars and single seat Sports Racing Cars the two vertical members forming the sides of the main hoop shall not be less than 15in apart, inside dimension, at their attachment points to the chassis. If the hoop does not go to the belly pan, it shall be attached to the chassis with proper gussets and tube triangulation to spread the loads. On monocoque chassis the main hoop shall be welded to mounting plates not less than .080in thick. These plates shall be attached to the chassis in a manner, which distributes the loads over a wide area. There shall be a plate of equal thickness on the inside of the monocoque with bolts of 5/16in minimum diameter through the non-ferrous material.

5.2.2 Low front hoops shall be no lower than the top of the steering wheel. If the hoop does not go to the belly pan, it shall be attached to the chassis with proper gussets and tube triangulation to spread the loads. NOTE: Some early model F1200, FF1st, F1600 and F4 cars do not conform to this rule. These Cars may be recognized by CASC-OR on an individual exception basis only.

5.2.3 High front hoops shall be similar in shape to the rear hoop and have two horizontal tubes connecting the top of the front hoop to the top of the main hoop. In Cars with full height monocoque or composite construction (to top of steering wheel), a steel cap plate, not less than .080in thick shall be attached as a rubbing block.

5.3 BRACING

5.3.1 The main hoop shall have two fore/aft braces of tubing equal in dimensions and wall thickness to the tubing of the main hoop. This bracing shall be attached as near as practical to the top of the main hoop, no more than 6in below the top, and at an included angle of at least 30 degrees.

If these braces do not extend to the front hoop, an additional brace or gusset shall be installed at the point of attachment to the main rear roll hoop or lower frame rail, or other frame member, in such a manner as to reinforce the attachment point to help prevent collapse of the frame rail at the point of attachment. These tubes shall be 1.00in x 0.080in minimum and gussets shall be 3/16 in minimum.

5.3.2 Two seat Sports Racing Cars shall have a diagonal lateral brace of tubing equal in dimensions and wall thickness to the tubing of the main hoop to prevent lateral distortion of the main hoop.

5.3.3 Formula and single seat Sports Racing Cars under 1500lbs. may use bracing of tubing with a minimum dimension of 1.00in diameter and .080in wall thickness. When monocoque construction is used as bracing for a front hoop it shall be approved by CASC-OR on an individual basis.

5.3.4 If the fore/aft bracing is removable, the connection between the main hoop and the brace shall be of the double lug type fabricated from material at least 3/16in thickness and welded through a doubler or gusset arrangement to avoid distortion or excessive strains caused by welding. Details of the attachment of removable braces are shown in the diagrams herein.

It is recommended that the fore/aft brace, if removable, be attached to a rear chassis member through a double lug connection as described above. If attached to the engine, it shall mount to a major component such as a head stud or a combination of head studs.

6.0 ALL CLOSED-WHEEL CARS

6.1 GENERAL

6.1.1 Cars shall have full width roll cages either removable or welded to the Car. Roll cages shall be contained within the Driver/passenger compartment.

6.1.2 Removable roll cages shall be very carefully designed and constructed to be at least as strong as a welded installation. If one tube fits inside another tube to facilitate removal, the removable portion shall fit tightly and shall bottom on the permanent mounting, and at least two 3/8in diameter SAE grade 5 bolts shall be used to secure the joint. The telescope section shall be at least 8in in length.

6.2 MAIN AND FRONT HOOPS

6.2.1 The main hoop shall extend the full width of the Driver/passenger compartment.

6.2.2 The front and side hoops shall follow the line of the front pillars to the top of the windshield as close to the roof as possible then horizontally to the main hoop. A tube shall connect these two hoops over the top of the windshield.

Alternatively a front hoop following the lines of the front pillars and connected to the main hoop on each side at the top may be used.

6.2.3 Open Cars without full windshields may have a low front hoop.

6.3 BRACING

6.3.1 The main hoop shall have two braces of tubing extending to the rear attaching to the frame or chassis. This bracing shall be attached as near as practical to the top of the main hoop, no more than 6in below the top, and at an included angle of at least 30 degrees. The main hoop shall have a diagonal brace to prevent lateral distortion.

6.3.2 RECOMMENDATIONS

A horizontal lateral tube connecting the right and left legs of the main hoop, as close to the floor of the Car as possible, is highly recommended.

A horizontal lateral under dash tube connecting the right and left legs of the front hoop is highly recommended.

A lateral tube, shaped over the tunnel, connecting the bottom of the right and left legs of the front hoop is highly recommended. A vertical tube may be installed between the under dash tube and this tube to strengthen the shaped section over the tunnel.

6.4 SIDE PROTECTION

6.4.1 Two horizontal tubes, or one horizontal tube and one angled tube, or a fully gusseted “X” brace, connecting the front and main hoops across the Driver's door are mandatory. Vertical tubes in this structure are highly recommended. Gussets shall be a minimum of 2 inches on the shortest side and made of plate steel twice the thickness of the tube wall, or formed from tubing of the same thickness and diameter as the cage, split and formed into gussets, or formed to a shape similar to the split tube from sheet steel the same thickness as the roll cage tubing. All gussets shall be fully welded all around.

6.4.2 One or more horizontal tubes or one diagonal tube connecting the front and main hoops across the passenger door are mandatory.

6.4.3 Interior door panels may be altered, replaced or removed to allow for installation of side protection tubes or NASCAR-style door bars. Where door panels are removed, all sharp edges or projections shall be protected.

6.4.4 If NASCAR-style door bars are installed, they should be constructed in the following manner: They should be constructed of several horizontal tubes attached to the main and front hoop, angled out into the door cavity as far as possible, spaced equally at intervals no more than 15 cm centre to centre, with the top tube no lower than 1/3 of the height from floor to roof, but at no time higher than the top of the dashboard. Vertical tubes should be inserted between these tubes at equal intervals no greater than 30 cm centre to centre. A straight tube should be placed as close to the floor as possible but allowing the vertical tubes to connect from this tube to the lowest tube angling into the door.

6.4.5 The two lateral tubes recommended in 6.3 should be installed when a NASCAR-style door bar assembly is used.

6.4.6 All tubing shall be the same size as that which is specified for the weight of the car.

6.5 MOUNTING PLATES

6.5.1 Mounting plates shall be no thinner than 1/8in and no thicker than 3/16in with no single edge longer than 6in and with back-up plates of equal size and thickness on the opposite side of the panel with the plates through-bolted together using a minimum of three bolts per mounting plate. The minimum acceptable bolts shall be SAE Grade 5 of 3/8in diameter. Mounting plates may be welded to the car. Wherever possible the mounting plate should be shaped to and welded to a vertical portion of the car. Mounting plates shall not penetrate the firewall at any point. When the roll cage is attached to the floor, no contact plate on the Car shall measure less than 20 sq. in on any given plane.

6.5.2 On specific models of Cars where the floor construction will not permit a contact plate of this minimum area to be installed application shall be made to CASC-OR for a waiver to this rule. This will be noted in the Car logbook.

6.6 SEAT BACK MOUNTING

Seat backs shall be securely mounted and fastened. In order to provide secure seat back fastening, a section of tubing equal to the roll cage tubing shall be installed horizontally from the main hoop upright to the diagonal brace. This tube shall be no higher than shoulder height.

7.0 ALTERNATIVE ROLL CAGE DESIGNS

The scrutineer may accept roll cages not complying with these specifications provided that the Entrant can produce a certificate complying with the following requirements:

7.1 LOAD CERTIFICATION

The certificate shall prove that the construction is capable of withstanding three simultaneously applied loads, the induced loads being carried over into the primary structure.

1.5 (*x*) laterally
5.5 (*x*) longitudinally in either direction
7.5 (*x*) vertically

(*x*) shall be the weight of the Car in starting order with the Driver aboard and full fuel tanks.

7.2 ILLUSTRATION

The certificate shall be accompanied by a drawing or photograph of the roll cage and shall be signed by a Professional Engineer or other qualified technical person recognized by CASC-OR.

7.3 COMPOSITES

Safety structures of composite materials shall be recognized on an individual basis by CASC-OR.

8.0 INCREASING ROLL CAGE HEIGHT

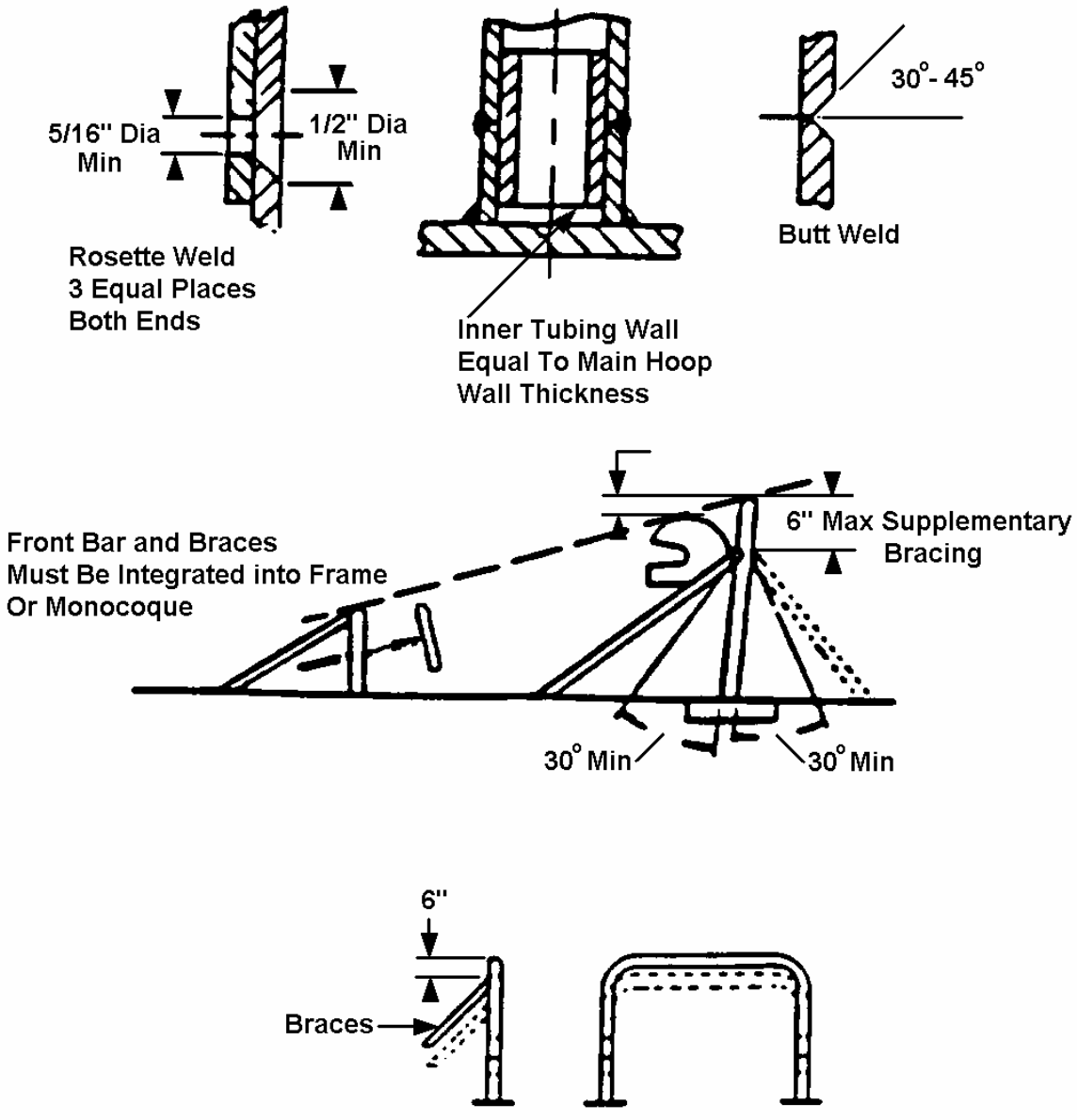
The following procedure is approved for increasing the height of existing roll cages not meeting the 2 inch helmet clearance requirement:

8.1 PROCEDURE

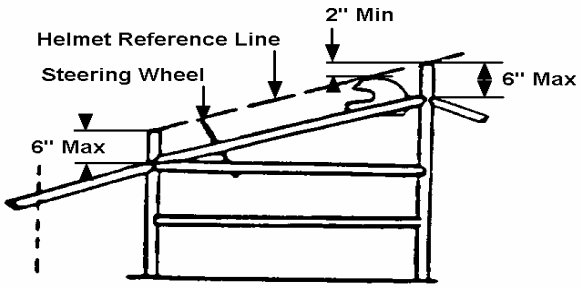
The old main hoop shall be cut off near the chassis mounting and either a new main hoop of equal tube size or a section of equal sized tubing may be added. Inner tubing shall be used to mate all sections together. All braces shall be a minimum distance of 6in from the top of the hoop. The inner tubes shall be rosette welded at three points near the top and three points near the bottom. Refer to the diagrams herein.

9.0 ROLL CAGE DIAGRAMS

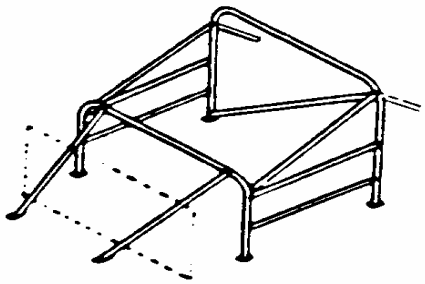
9.1 FORMULA CARS

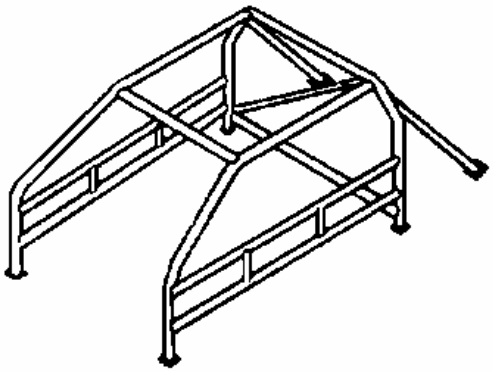


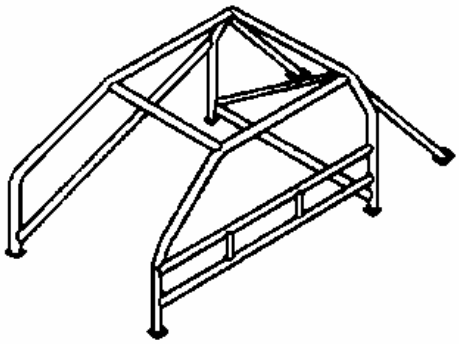
9.2 GT, OPEN GT CARS, AND SPORTS RACERS

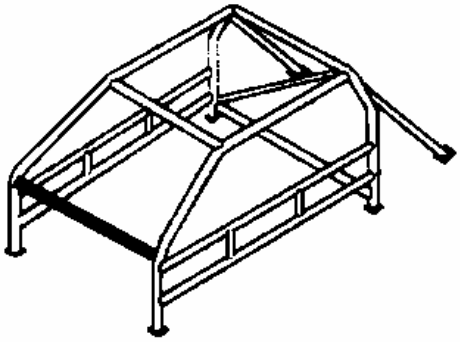


Side View-Low Front Bar Forward Bracing









9.3 REMOVABLE BRACE DETAILS