



QUALITY ASSURANCE SPECIFICATIONS™

SFI SPECIFICATION 45.1

EFFECTIVE: AUGUST 11, 2005*

PRODUCT: Roll Cage Padding

1.0 GENERAL INFORMATION

- 1.1 This SFI Specification establishes uniform test procedures and minimum standards for evaluating and determining performance capabilities for Roll Cage Padding used by individuals engaged in competitive motorsports.
- 1.2 The procedures, test evaluations and standards contained herein, are intended only as minimum guidelines for construction and evaluation of products. Certification that products meet such minimum standards is made by the product manufacturer and products are not certified, endorsed or approved by SFI under this program.
- 1.3 Use of the "This Manufacturer Certifies That This Product Meets SFI Specification 45.1" logo/designation, the authorized artwork style, or conventional lettering by a manufacturer, on a subject product, is intended only to indicate that the manufacturer of the product has represented that they have submitted the product to the recommended tests, with positive results, in compliance with the standards established herein.
- 1.4 This SFI Specification requires a demonstration that the product of a manufacturer meets or exceeds the requirements when the manufacturer enters the program; and on a periodic basis thereafter. Any manufacturer may participate in the program by providing Roll Cage Padding that meets or exceeds the SFI Specification 45.1 test standards, by complying with the requirements of the SFI Specification 45.1 program, and by signing a licensing agreement with the SFI Foundation, Inc.

- 1.5 Compliance with this specification is entirely voluntary. However, when a manufacturer provides Roll Cage Padding in compliance with all requirements of the SFI Specification 45.1 and enters into the licensing agreement with the SFI Foundation, Inc., they may certify that compliance with such standards is in accordance with the guidelines established herein.
- 1.6 Manufacturers wishing to participate in the program, in addition to the other requirements of this specification, must label each of their products with the manufacturer's name, trademark or symbol as well as the date of manufacture of the product.
- 1.7 No manufacturer may display the SFI logo/designation on their product unless the manufacturer has signed a licensing agreement with SFI and has successfully complied with all the requirements of this specification and the self-certification program.

2.0 DEFINITIONS

- 2.1 Roll Cage Padding: Material placed on the exterior of the roll bars that provides energy absorption.
- 2.2 Test headform: A testing device representing the shape and mass of the human head.
- 2.3 After-flame time: The time an object continues to flame after the thermal load is removed.
- 2.4 EAM: Energy Absorbing Material
- 2.5 Gadd Severity Index: A weighted impulse criterion. The index may be obtained by breaking down the deceleration-time curve into sufficient time intervals to define the curve, and raising the peak "g" value of the midpoint of the interval to the 2.5 power, and multiplying the number obtained by the time increment in seconds. The sum of all the values obtained gives the severity index. The mathematical formula is :

$$SI = \sum a^{2.5}t$$

SI = severity index a = acceleration t = time (milliseconds)

3.0 CONSTRUCTION

The primary function of the roll bar padding is to attenuate impact energy. The padding can be made of various materials. The requirements, beside passing the tests herein, are those of attachment. Padding material shall be secured in such a manner that ensures their retention at high speeds. The EAM shall substantially cover the outside surface of the roll bar. The thickness of the EAM can be reduced in the areas opposite the driver area.

4.0 MODEL CLASSIFICATION

Roll Cage Padding models are primarily based on materials, method of manufacturer and diameter and thickness dimensions. Any change of materials or thickness dimensions constitutes a model change.

5.0 TESTING

Test samples shall be fully processed new padding which are representative of padding currently produced or to be produced. If mounting hardware and/or mounting instructions are included with the padding, they shall also be supplied.

Calibration and procedures shall conform to NHTSA TP-218-03 if not otherwise specified. It is recommended that the tests be conducted in the order listed. Two tests will be performed on each padding sample. The first test shall measure impact attenuation and the second flammability resistance.

5.1 IMPACT ATTENUATION

Impact attenuation shall be determined by measuring acceleration of an instrumented test headform.

5.1.1 SAMPLES

For initial design validation, three samples shall be tested from each conditioning environment. At least 6 padding samples of 25cm(10") length shall be supplied. For annual revalidation, padding samples shall be tested at ambient conditions only. At least 3 padding samples of 25cm(10") length shall be supplied for annual revalidation.

5.1.2 SAMPLE PREPARATION

Samples shall be tested at two temperatures; ambient and high.

A. AMBIENT TEMPERATURE

Expose three padding samples to a temperature of 21 ± 2 degrees Celsius $\{^{\circ}\text{C}\}$ (70 ± 4 degrees fahrenheit $\{^{\circ}\text{F}\}$) for 1 hour.

B. HIGH TEMPERATURE

Three padding samples shall be exposed to a temperature of $43(+2-0)^{\circ}\text{C}$ ($110 +3-0^{\circ}\text{F}$) for 1 hour.

5.1.3 SAMPLE PLACEMENT

Padding samples shall be mounted on the roll bar anvil per installation instructions provided by the manufacturer.

5.1.4 APPARATUS

A. TEST HEADFORMS¹

The test headform shall conform to the specifications contained in FMVSS 218. The size shall be medium. The headform shall be made of a rigid, low resonance material and shall not exhibit any resonant frequencies below 2,000 hertz. The material shall be a magnesium alloy, e.g. K-1A, or a material with functionally equivalent dynamic characteristics.

B. TEST HEADFORM ASSEMBLY

The test headform assembly shall consist of a test headform of the medium size, a supporting structure and a transducer. The supporting structure shall be attached to the headform in such a manner as to allow the entire assembly to be dropped vertically with a minimum of friction while enabling the headform to be impacted on the test area. The center of gravity of the test headform assembly shall lie within the rectangular volume as defined in FMVSS 218. The weight of the test headform assembly shall correspond to the test headform size as listed in Table 1, FMVSS 218.

¹Headforms may be obtained from Controlled Castings Corporation, 31 Commercial Court, Plainview, NY 11803.

1. TRANSDUCER AND DATA CHANNEL

The transducer shall be mounted at the center of gravity of the test headform. The sensitive axis of the transducer shall be aligned to within five degrees of the vertical when the test headform assembly is in the impact position. The acceleration data channel shall comply with the Society of Automotive Engineers recommended practice J211, October 1988, requirements for channel class 1,000.

2. HEADFORM POSITIONING

The headform shall be positioned in the test fixture so that the "face" is up. Additionally, the headform assembly shall be positioned in a fashion that results in an impact at the center of the roll bar anvil. (See Figure A)

Roll Bar Anvil/Headform Positioning

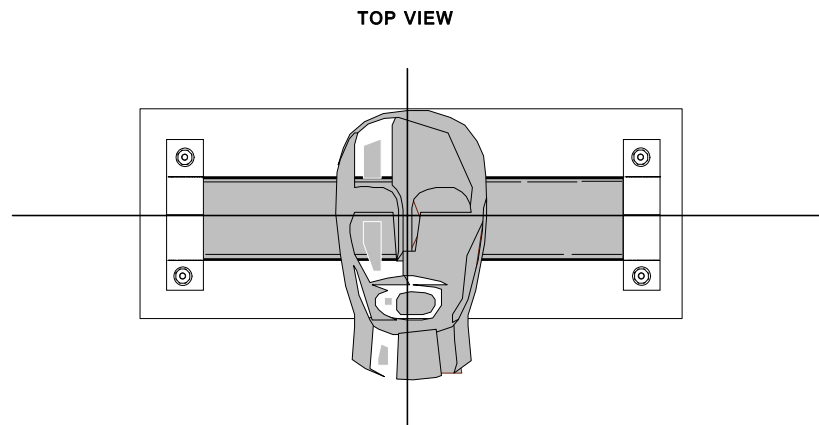


FIGURE A

C. TEST FIXTURE

The test fixture shall enable the test headform assembly to be dropped in guided free fall onto the roll bar anvil. The drop height shall be sufficient enough to allow 1m (3.3') between the top of the roll bar anvil and the bottom of the headform assembly. The mount for the roll bar anvil shall consist of a rigid, solid weight of at least 1,334 N (300lbs), the upper surface of which shall consist of a steel plate with a minimum thickness of 25mm(0.98") and a minimum surface area of 0.093m² (144in²).

D. ROLL BAR ANVIL

Padding samples shall be mounted on a Roll Bar Anvil (See Figure B). The fixture shall consist of a rectangular metal base plate approximately 30cm X 10cm and 2cm thick. Attached to this base plate, welded or bolted, are two roll bar supports. The roll bar supports shall allow for removal/replacement of a roll bar segment. The supports will be capable of firmly securing a 1.75"OD x .097" wall thickness roll bar. Because some padding samples are not available in 1.75" diameters; the supports can be fitted with a reduction sleeve that has a 1.75"OD and a 1.5"ID. These sleeves will allow a 1.5"OD roll bar segment to be supported. A 1.0"OD roll bar segment could be fitted in a similar manner. The roll bar segment should be representative of current materials used in roll cage construction. Additionally, the roll bar shall be held approximately 5cm (2.0") above the base plate.

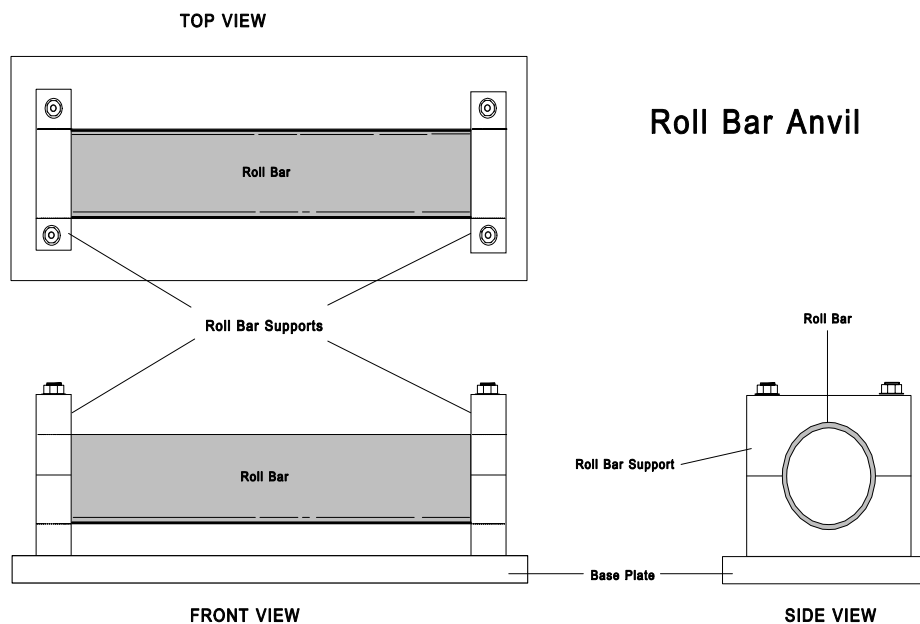


FIGURE B

1. ROLL BAR ANVIL POSITIONING

The roll bar anvil shall be positioned such that the long axis of the roll bar is perpendicular ($\pm 5^\circ$) to the long axis of the headform (See Figure A). Once positioned, the fixture shall be secured to the drop apparatus's base plate.

5.1.5 IMPACT METHOD

All impacts are initially based on a zero friction height and a minimum impact velocity. The height of the headform above the anvil, before dropping, is given. An appropriate increase in height shall be necessary since this height assumes no friction in the guiding mechanism. The actual drop height shall be verified by measuring the terminal velocity of the test headform assembly and comparing it to the minimum impact velocity required.

5.1.6 PROCEDURE

Position and secure the roll bar anvil in the test fixture. Install the padding sample on the roll bar anvil. Install the test headform assembly in the test fixture. Raise the headform assembly above the roll bar anvil. The minimum impact velocity shall be 4.4m/sec. Release the headform assembly and record impact data. Determine peak G levels and calculate the Severity Index. Raise the assembly and repeat procedures for a total of three drops at the same site per sample for all six samples, 3 ambient and 3 high temperature.

5.2 FLAME RESISTANCE

The test shall be conducted at an ambient temperature between 10°C (50°F) and 30°C (86°F).

5.2.1 SAMPLES

Three samples at ambient temperature shall be tested. These samples shall be the same three samples used in 5.1.2.A.

5.2.2 APPARATUS

A. THERMAL LOAD

The thermal load shall be a propane flame, at the flame location generating a measured temperature of 790 \pm 40 °C (1454 \pm 85 °F).

B. TIMING DEVICE

A timing device with an accuracy of \pm 0.5 seconds shall be used to measure the after-flame times.

C. FIXTURE

A fixture shall be used to support the padding sample. The fixture shall consist of two vertical uprights which support two 11" sections of roll bar (steel tubing) 1.5" and 1.75" O.D. Padding samples shall be affixed to the proper size bar depending on the size of the samples provided by the manufacturer. Samples should be mounted on the correct sized roll bar with the thickest dimension facing outward. See Figure C.

5.2.3 PROCEDURE

The flame shall be adjusted to 3-4" in length and positioned perpendicular to the padding surface which faces the interior of the driver area, the thickest dimension. The padding shall be subjected to the thermal load for a period of 15 ± 1 seconds at a distance of 1-1½" (surface of padding to flame tip). Simultaneous with the removal of the flame, the timing device shall be activated. Determine the after-flame time.

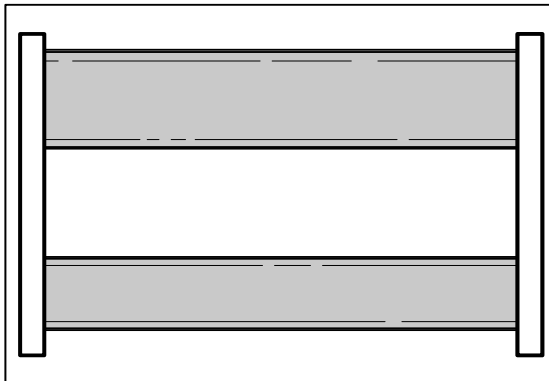
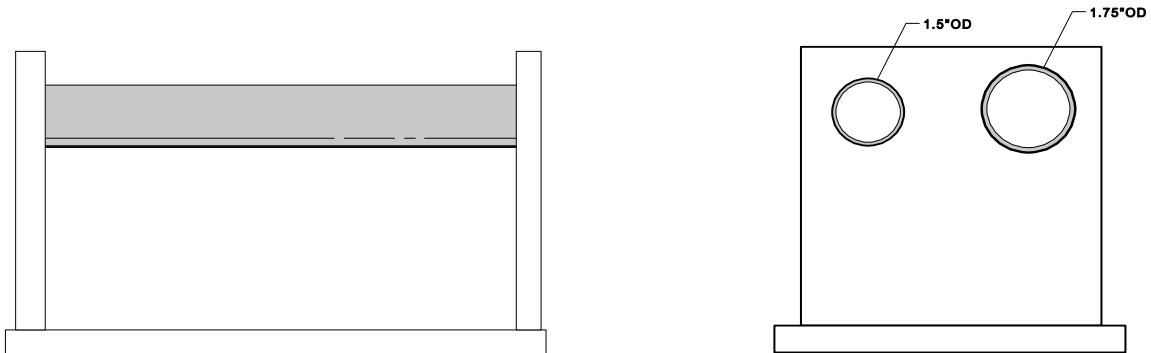


FIGURE C



ROLL BAR FLAME RESISTANCE FIXTURE

6.0 PROOF OF COMPLIANCE

Roll Cage Padding manufacturers are required to provide the following information to enroll in this program:

6.1 TEST RESULTS

Test results shall be documented in a test report. All tests that padding is subjected to must be passed.

6.1.1 IMPACT ATTENUATION

The peak acceleration shall not exceed 200 times the force of gravity (g) for any first impact. Second and third impacts shall not exceed 225g's. The Severity Index value shall not exceed 1250 for any impact.

6.1.2 FLAMMABILITY

The after-flame time shall be ten seconds or less. Additionally, no melting or dripping may occur.

7.0 TEST REPORTS

A separate test report, or set of test reports if required, shall be submitted for each product model. If more than one test facility is required to complete all necessary tests, then a separate test report shall be submitted from each one. A test report shall be submitted for each component, if tested separately. The test facility shall assign a unique number to each test report. This number along with the report date and page number shall appear on each page. Each test report shall include:

7.1 RELEVANT INFORMATION

- 7.1.1 Manufacturer's name, contact name, address and telephone number.
- 7.1.2 Name, address and telephone number of the test facility.
- 7.1.3 Name and signature of the responsible test supervisor.
- 7.1.4 Actual date of the test.
- 7.1.5 Specification number and effective date.
- 7.1.6 Product name, description and model designation.

7.1.7 Component name and description.

7.2 TESTS

Each test conducted shall be listed showing the test name, apparatus used, procedure used and test results obtained along with any other appropriate information.

7.3 AUTHENTICATION

Test reports shall be authenticated and stamped by a Professional Engineer who is registered in the state in which the testing is conducted. If necessary, SFI may allow an equivalent entity to provide authentication.

8.0 INITIAL DESIGN VALIDATION

To receive initial recognition from SFI as a participant in the SFI Specification 45.1 Program, the manufacturer must submit to SFI all information delineated in the Proof of Compliance section. This information shall be provided for each Roll Cage Padding model offered by the applicant that is to be included in the program. Any change in design, materials and/or methods of manufacturing not specifically excluded is considered a model change and, therefore, requires initial design validation.

9.0 PERIODIC REVALIDATION

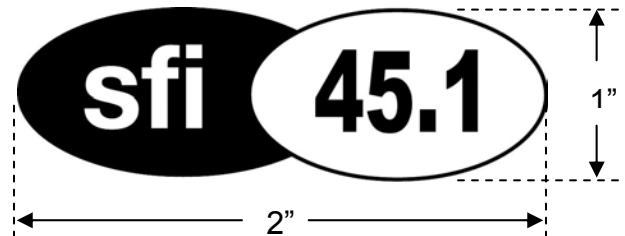
Test reports with successful test results must be submitted to SFI at least once every 24 month period following the date of the initial design validation test for each model of Roll Cage Padding manufactured by the participant. If multiple test reports are required to obtain all test results, then the earliest test date shall be used to determine when the periodic revalidation reports are due. Also, SFI shall retain the option to conduct random audit reviews. SFI shall purchase the product on a commercial basis and test for compliance to the specification. The submitting manufacturer shall reimburse SFI for all audit costs.

10.0 CERTIFICATION OF COMPLIANCE

Upon demonstration of successful compliance with all the requirements of the specification and the self-certification program and upon entering the licensing agreement with SFI, the manufacturer may advertise, present and offer the Roll Cage Padding for sale with the representation that their product meets the SFI Specification 45.1. Continuing certification is contingent upon the following additional considerations: (1) the product shall be resubmitted for testing following any change in design, materials and/or methods of manufacturing not specifically excluded, and (2) periodic revalidation test reports are submitted when due to SFI.

11.0 CONFORMANCE LABELS

The conformance marking is a repeating SFI logo permanently molded or branded on the outer surface of the padding, visible when the padding is mounted. The name or logo of the participating manufacturer must also appear repeatedly on the outer surface of the padding. The SFI logo must appear at least every 12" along the length of the padding and must be approximately 1" high x 2" long. A digital file may be obtained from SFI by request:



12.0 DECERTIFICATION

Participating manufacturers are subject to decertification when not in compliance with the requirements of this program or when their products are not in compliance with the requirements of this specification. Decertification will provide SFI the right to effect any and all remedies which are available to SFI in the licensing agreement.

13.0 APPEAL PROCEDURE

In the event of decertification, the manufacturer is entitled to an appeal of the decision of SFI. Requests for appeal must be received by SFI no later than thirty days following receipt of the notice of decertification. Appeals of such decisions will be heard at the next meeting of the Board of Directors of SFI.

14.0 STATEMENT OF LIMITATIONS

Testing procedures and/or standards contained in this specification are intended for use only as a guide in determining compliance with the minimum performance requirements as defined herein. The granting and assignment of the "This Manufacturer Certifies That This Product Meets SFI Specification 45.1" logo/designation is in no way an endorsement or certification of product performance or reliability by SFI. SFI, its officers, directors and/or members assume no responsibility, legal or otherwise, for failure or malfunctions of a product under this program.

15.0 COSTS

All costs involved in this program will be absorbed by the submitting manufacturer.

16.0 COMPLIANCE PERIOD

As this specification is revised to reflect changes in technology and/or field conditions, to remain current, participating manufacturers in the SFI Specification 45.1, Roll Cage Padding, Program, must demonstrate full compliance with the requirements of this specification within ninety (90) days of the latest effective date.

*	Original Issue:	February 2, 1995
	Reviewed:	December 7, 1996
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