SURVEY OF THE STATE-OF-THE-ART IN FUEL SYSTEM FIRE SAFETY

PHASE 1

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PREFACE

This report constitutes the final deliverable for the "Methodology for Surveying the State-of-the-art In Fuel System Fire Safety". The work was performed at the request of Dr. Ken Digges of the Motor Vehicle Fire Research Institute (MVFRI) under MVFRI's purchase order dated December 20, 2001.

The opinions expressed herein are those of Biokinetics and Associates Ltd. and do not necessarily reflect those of the Motor Vehicle Fire Research Institute.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

1. INTRODUCTION

Post crash fires are the result of the ignition of flammable materials or fuels that may be expelled during a collision. In the automotive environment gasoline is the most volatile of such fuels and in the presence of an ignition source it poses the greatest risk of rapid conflagration. In a collision, gasoline may leak directly from a damaged fuel tank or from a torn or severed fuel line with possible sources of ignition resulting from:

- Hot vehicle components such as the exhaust system.
- Sparks generated from steel vehicle components scrapping the ground.
- Sparks generated from metal to metal contact with an opposing vehicle.
- Heat and sparks generated by the crush of a vehicle's structure.
- Electrical arcing from broken or exposed wires.
- Electrical heat generated from short circuits of primary and secondary wiring.
- Electrical heat generated from internal shorting of battery plates.

Although it is difficult to determine from existing accident statistics either the causes of vehicle fires or the incidents of fire related fatalities or injuries [Ref. 1,Ref. 2], one thing is certain and that is that burn injuries can be horribly disfiguring requiring long recuperation and rehabilitation.

An investigation of the state-of-the-art in fuel systems has been undertaken with a focus on identifying fuel system fire safety technologies for preventing and/or mitigating post crash fuel fires that may be in use today. An extensive survey will be conducted with in-vehicle evaluation and documentation of the various systems. Additionally, major fuel system components, such as the fuel tank itself, will be evaluated.

The project is divided into two phases:

- Phase 1 defines the overall scope of the investigation and establishes procedures for carrying out the more specific review of individual tank systems. Included is a review of existing automotive fuel system standards.
- Phase 2 comprises the in depth evaluation of the fuel systems from vehicles identified in Phase 1.

The work performed under Phase 1 of the project is discussed herein.

2. REVIEW OF STANDARDS

A review of available fuel system performance standards was conducted as part of the investigation into the state-of-the-art in fuel systems. Both component standards and vehicles standards pertaining to fuel system performance were reviewed. The features of the various standards that were identified are summarized in the following sections. Where indicated the complete standard is contained in an Appendix. Note that only standards that can be obtained free of charge will be included in the appendices.

2.1 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

The American Society for Testing and Materials (ASTM) is a non-profit organization that provides a forum for the development and publication of standards for materials, products and services. A search with standard keywords did not yield any relevant documents to automotive fuel safety. The ASTM standards related to testing of the mechanical and chemical properties of materials are often referenced in other documents, like the SAE standards.

2.2 CANADIAN MOTOR VEHICLE SAFETY STANDARDS (CMVSS)

The Canadian Motor Vehicle Safety Standards (CMVSS) are regulations written in terms of minimum safety performance requirements for motor vehicles which are issued by the Transport Canada.

2.2.1 STANDARD NO. 301 – FUEL SYSTEM INTEGRITY

CMVSS No. 301 is functionally equivalent to FMVSS Part 571.301 (see Section 2.5.1).

2.2.2 STANDARD NO. 302 – FLAMMABILITY

CMVSS No. 302 is functionally equivalent to FMVSS Part 571.302 (see Section 2.3.1).

2.3 DEPARTMENT OF DEFENCE (DOD)

The Department of Defence (DoD) maintains a database of standards that have either been developed or accepted by the DoD and those related to fuel systems have been reviewed. Some documents, besides those reviewed below, were identified but disregarded due to a recent inactivation of that standard. The Department of Defence standards can be found in Appendix A.

2.3.1 MIL-PRF-14442E – TANK, FUEL, ENGINE: NON-METALLIC, NON-SELF-SEALING, FOR MILITARY VEHICLES

Non-metallic fuel tanks, similar to the fuel cell type, are covered by this specification, which includes classification, requirements, verification and packaging. The section on requirements lists the general specifications for such tests as leakage and strength. The verification section describes in detail the type of test to be conducted as well as the performance corridors that must be met. This includes various tests for leakage including basic tests like standing and low temperature. Other leak tests are conducted with an internal pressure and rocking apparatus intended to slosh the fuel inside the tank. Material tests are performed for compatibility and permeability of fuel. There is a tensile strength requirement and a puncture resistance test that specifies a minimum load of 15 lb. with a specific piercing instrument. Basic testing methods and illustrations of apparatus are included.

A copy of this standard can be found in Appendix A.

2.3.2 MIL-C-45300B – CAP, FUEL TANK: FOR MILITARY COMBAT AND TACTICAL TRANSPORT VEHICLES

This Military specification covers the classification, requirements, quality and packaging of three types of fuel tank caps. There are two types of vented caps, one with a relief valve and float assembly and one with a relief valve and fording valve. The third type of cap is non-vented. Some of the performance requirements are as follows. The torque to either install or remove the cap is specified. The cap shall not leak with a pressure of 2 psi more than 0.5 ounce per minute. The cap must withstand a shear test of 25 foot-pounds. In addition to the requirements, basic test procedures are described.

A copy of this standard can be found in Appendix A.

2.4 EUROPEAN COMMUNITY (EC)

The European Community (EC) publishes numerous Directives that outline standards and regulations for many products and services including the automotive industry. A EC marking on a product is a manufacturer's claim that the product meets the essential requirements for all applicable EC Directives.

The EC standards can be found in Appendix B.

2.4.1 DIRECTIVE 70/221 – FUEL TANKS

Published in March 1970, this document provides information regarding the compliance and acceptance of fuel tanks. The requirements themselves are very brief and simple, with basic design and testing methods. For instance, the tank

must be corrosion resistant. The tank vents must be designed to prevent fire risks. The placement of the tank is also addressed and it is suggested that the tank should be protected from the consequences of an impact. As far as testing, a leakage test must be carried out by the manufacturer using an internal pressure test.

A copy of this standard can be found in Appendix B.

2.4.2 DIRECTIVE 2000/08 – ADAPTATION OF FUEL TANKS (PLASTIC TANKS)

In March 2000, the original document (70/221) was amended with Directive 2000/08 in order to stay current with new tank technologies and standards. This was accomplished by the adaptation of UN/ECE Regulation No. 34 into the current Directive. Review of this Directive revealed that the Reg. No. 34 was simply re-written, often word-for-word, into the standard section of Directive 2000/08. As such, a review is not presented here but the reader is referred to the review of UN/ECE Regulation No. 34.

A copy of this standard can be found in Appendix B.

2.5 FEDERAL MOTOR VEHICLE SAFETY STANDARDS (FMVSS)

The Federal Motor Vehicle Safety Standards (FMVSS) are regulations written in terms of minimum safety performance requirements for motor vehicles which are issued by the National Highway Traffic Safety Administration (NHTSA). The standards listed below are taken from the Code of Regulations (CFR) 49 – Transportation, Part 571 – Federal Motor Vehicle Safety Standards.

All the FMVSS standards can be found in Appendix C.

2.5.1 PART 571.301 – FUEL SYSTEM INTEGRITY

This standard specifies the requirements of vehicle fuel systems. The intention of such requirements are to reduce death and injury by reducing the likelihood of fuel spillage and fire resulting from a crash. The standard describes the type of full-scale crash to be conducted as well as the requirements for the amount of fuel leakage allowed immediately following the crash. The crashed vehicle must then be subjected to a static rollover test and further fuel leakage limitations are tested.

The frontal barrier crash requires the vehicle to strike a fixed collision barrier at 48 km/h. For the rear moving barrier crash, the vehicle is struck from the rear by a rigid barrier moving at 48 km/h. A lateral moving barrier crash is conducted by striking the vehicle laterally by a barrier moving at 32 km/h. For all tests, the fuel spillage must not exceed 28 g during the collision and 142 g in the 5-minute period following the cessation of motion of the vehicle. For the remaining 25

minutes, fuel spillage is limited to 28 g for any given 1 minute interval. The standard also describes the full details on conducting the test as well as the common specifications for the moving barrier.

The NHTSA has undertaken research into modifying the existing FMVSS 301 standard to be more representative of crashes involving fire related injuries and fatalities [Ref. 3]. A comparison of the proposed changes to the existing standard are summarized in the Table 1.

Table 1: Proposed changes to FMVSS 301 Fuel System Integrity Test

Impact Direction	**Test Parameter**	**FMVSS 301**	**Proposed FMVSS 301**
Frontal	Barrier	fixed / rigid	No changes
	Impact speed	48 km / h (30 mph)	No changes
Rear	Barrier	Moving / rigid	Moving / deformable
	Barrier mass	1,814 kg (4,000 lbs)	1,368 kg (3,015 lbs)
	% vehicle contact	100	70
	Impact speed	48 km / h (30 mph)	80 km / h (50 mph)
Side	Barrier	Moving / rigid	Moving / deformable
	Barrier mass	1,814 kg (4,000 lbs)	1,368 kg (3,015 lbs)
	Impact site	Centred at the driver's seating reference point	As defined in FMVSS 214
	Impact direction	90^{o}	Crabbed
	Impact speed	32 km / h (20 mph)	53.6 km / h (33.5 mph)
Note: The side test is the same as the FMVSS 214 test which is run anyway.			

A copy of the existing FMVSS 301 standard is contained in Appendix C.

2.5.2 PART 571.302 – FLAMMABILITY OF INTERIOR MATERIALS

This standard is designed to reduce death and injury due to fires by specifying the burn resistance of materials used in the occupant compartment of a vehicle.

The focus, however, is on fires that originate from inside the occupant compartment, from a cigarette for example, and not external, like a fuel fire. The standard specifies the test procedure for determining the material burn rate and the pass criteria that must be met.

A copy of this standard is contained in Appendix C.

2.5.3 PART 393.65 – ALL FUEL SYSTEMS

This is a very brief standard that covers general rules for fuel tanks. For instance, the location shall be such that any fuel spilled vertically from the tank should not contact any part of the exhaust system. Further guidelines are presented for the location of the tank as well as the installation, the fuel feed system and the fuel lines are presented. No tests procedures are included.

A copy of this standard is contained in Appendix C.

2.5.4 PART 393.67 – LIQUID FUEL TANKS

Providing more detailed information than Part 393.65, this standard provides additional construction information as well as tests to evaluate performance of a fuel tank not yet installed in a vehicle. A safety venting system test, for tanks with a capacity greater than 25 gallons, requires that the pressure in the tank does not exceed 50 psi when the tank is enveloped in a flame causing the temperature of the fuel to rise by 6 ^{O}F to 8 ^{o}F per minute. A leakage test requires that a filled tank rotated about any axis to an angle of 150° shall not leak more than one ounce of fuel per minute. The standard lists two different drop tests, one for the tank and one for the filler pipe. The procedure for the tank performance calls for a 30 foot drop onto an unyielding surface with the tank filled with a quantity of water. A similar test is done from only 10 feet and the tank is dropped squarely on its fill-pipe. In either case, the required performance is that the leakage does not exceed one ounce per minute. Further information, such as fittings and markings, are also included in this standard.

This standard is contained in Appendix C.

2.6 FEDERATION INTERNATIONALE DE L'AUTOMOBILE (FIA)

The Federation Internationale de l'Automobile (FIA) governs standards for several racing series including Formula One, Formula 3000, Grand Touring and Rallies.

A copy of the FIA standard can be found in Appendix D.

2.6.1 FIA STANDARDS FOR SAFETY FUEL BLADDERS

The standards for fuel bladders are divided into three levels of performance, which, in ascending order, are FT3-1999, FT3.5-1999 and FT5-1999. These standards are not only used by the race series within FIA but other racing organizations throughout the world. The standard covers strictly the safety fuel bladders themselves and includes several tests for bladder material as well as construction guidelines. Any manufacturer wishing to obtain FIA approval must have their material tested against this standard by a recognized test facility.

The four strength tests are summarized in the Table 2 below. The minimum strength for each performance standard is included.

Table 2: Summary of FIA strength tests.

Test	Description	FT3-1999	FT3.5-1999	FT5-1999
Tensile	Tensile load applied to sample until breakage occurs.	2.00 kN	4.45 kN	8.90 kN
Puncture	Piercing instrument applied to sample until puncture occurs.	0.78 kN	0.89 kN	1.78 kN
Seam	Load applied to sample until seam breakage occurs.	2.00 kN	4.45 kN	8.90 kN
Tear	Load applied to sample that is pre-cut to propagate a tear.	0.25 kN	0.89 kN	1.56 kN

FIA specifies that the fuel bladder must be filled with a fuel resistant polyurethane foam balling to act as an explosion suppressant and that conforms to Mil Spec MIL-B-83054. The standard also includes guidelines for all fittings and connections that are to be added to the bladder. The life span of any approved fuel bladder is restricted to 5 years, unless inspected and re-certified by the manufacturer, for an additional 2 years.

A copy of this standard is contained in Appendix D.

2.6.2 2001 FORMULA ONE TECHNICAL REGULATIONS

The Technical Regulations for Formula One cover all systems on a Formula One car, including bodywork, engine, suspension, brakes and television cameras. The sections of interest to fuel safety are the fuel system, impact testing and static load testing. Starting with the fuel tank section, each fuel tank must be a single rubber bladder that conforms to the FIA FT5-1999 standard. There are also strict limitations to the size and placement of the fuel tank within the vehicle. The fuel tank must then be completely surrounded by a crushable structure as part of the survival cell. All fuel lines between the fuel tank and the engine must have a self-

sealing, breakaway valve that separate at less than 50% of load required to break the fuel line. There are further regulations related to the refuelling of the tank, though these are specific to racing.

The survival cell is a continuous closed structure containing the fuel tank and the cockpit. There are a several dynamic tests described in the regulation but the survival cell needs only to pass the frontal and side tests. Although the fuel cell must be fitted and filled with water during the test, the pass criteria does not include the performance of the fuel cell. The regulation further outlines a list of static tests that involve applying a force to specific areas of the survival cell. The fuel tank floor test applies a vertical upward load of 12.5 kN on the centre area of the fuel tank floor. This, however, is a structural test of the survival cell and has little effect on the safety of the fuel tank.

A copy of this regulation can be found in Appendix D.

2.7 GERMAN INSTITUTE FOR STANDARDIZATION (DIN)

The German Institute for Standardization or Deutches Institut fur Normung (DIN) is a national standards body. A search through the document database revealed that the majority of DIN documents are simple adoptions from other standard bodies. While searching for documents related to fuel systems, the result yielded many standards pertaining to vehicles fuelled by propane. The DIN database listed only a few documents concerning regular gasoline vehicles and these were references or translations of ISO standards and UN/ECE Regulation No. 34.

2.8 INDY RACING LEAGUE (IRL)

The Indy Racing League (IRL) is a race series with open-wheel, open-cockpit race cars. The engines produce about 650 Hp and, in a given race, the cars can average over 200 mph.

2.8.1 2002 RULE BOOK

The technical specifications for the fuel system specify that the fuel must be contained in a single fuel cell. The fuel cell is located directly behind the driver and must be contained on all sides and the top by a tub or other rigid system. The fuel lines must utilize self-sealing breakaway valves at the connections where the lines meet the engine and fuel tank. The fuel tank must be electrically grounded and the tank vent must have a check valve.

The fuel cell specifications in the IRL Rule Book are very general and do not include any performance criteria, although the Rule Book does suggest that further specifications are available from IRL. A representative from IRL was

contacted and stated that it is the fuel cell manufacturer that ensures that a fuel cell meets the required criteria, which is set out by the FIA.

The IRL rule book may be obtained from the Indy Racing League at (317) 484-6526.

2.9 INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

The International Organization for Standardization (ISO) is a non-governmental group promoting standardization in the world to facilitate the international exchange of goods.

Complete copies of the ISO standards summarized below may be obtained from the ISO Web page http://www.iso.ch

2.9.1 ISO 3560 – ROAD VEHICLES – FRONTAL FIXEDBARRIER COLLISION TEST METHOD

This is a test procedure to ensure any front fixed barrier and pole impacts are conducted under the same conditions. It includes procedures for aligning, preparing and propelling the test vehicle as well as the set-up and installation of the test dummy. The velocity of the impacting vehicle is not specified as this is intended to be a test procedure that may be used with any test requirement.

2.9.2 ISO 3984 – ROAD VEHICLES – MOVING BARRIER REAR COLLISION TEST METHOD

This standard specifies a test method for a moving barrier rear collision for passenger cars. The test equipment and alignment of the moving barrier and the method of propelling the barrier are described. The test method states that the impact velocity should be taken from the appropriate test requirement.

2.9.3 ISO 3437 – ROAD VEHICLES – DETERMINATION OF FUEL LEAKAGE IN THE EVENT OF A COLLISION

This standard describes the method of measuring any fuel leakage immediately following a frontal or rear barrier collision described in ISO 3560 and ISO 3984. The first sample is taken as soon as possible after the collision for a duration of 5 minutes. An average rate of fuel loss per minute is then calculated. Two more samples are taken, for 1 minute each. The leakage rate for all three samples is recorded in the test report.

2.9.4 ISO 4639-1 – RUBBER TUBING AND HOSES FOR FUEL CIRCUITS FOR INTERNAL COMBUSTION ENGINES – SPECIFICATIONS

This standard is Part 1 and deals specifically with hoses designed for use with conventional liquid fuels in automotive applications. It specifies the requirements for the rubber used as well as the performance of hose itself. The physical specifications include such tests as hardness, tensile strength and elongation, chemical resistance, burst pressure and tear resistance. Sizing and marking requirements are also presented.

2.9.5 ISO 8535 – COMPRESSION-IGNITION ENGINES – STEEL TUBES FOR HIGH-PRESSURE FUEL INJECTION PIPES

ISO 8535 is divided into two parts, both of which describe the dimensional and mechanical requirements for high-pressure fuel injection lines. Part 1 is specific to seamless cold-drawn, single-wall tubes while Part 2 deals with composite tubes. The physical specifications include tests for bending, corrosion resistance, surface quality, inside pressure, tensile strength and elongation. Sizing and marking requirements are also presented.

2.9.6 ISO 9534 – ROAD VEHICLES – FUEL PUMP ELECTRIC CONNECTIONS

The specifications for electrical connectors used in automotive fuel pumps are presented in this standard. This includes the dimensional requirements for several types of terminals as well as the physical properties like tightening torque and resistance to corrosion and water penetration.

2.9.7 ISO 13331 – ROAD VEHICLES – FILLER PIPES AND OPENINGS OF MOTOR VEHICLE FUEL TANKS – VAPOUR RECOVERY SYSTEM

The purpose of this standard is to ensure that the fuel filler pipes of new vehicles are compatible with re-fuelling nozzles. The dimensions and specifications presented in this document are based on the SAE J1140 standard.

2.9.8 ISO 13775-2 – THERMOPLASTIC TUBING AND HOSES FOR AUTOMOTIVE USE – PART 2: PETROLEUM-BASED-FUEL APPLICATIONS

This specification defines the test requirements for extruded thermoplastic tubing for use in vehicles as part of the fuel system and is intended for use by original equipment manufacturers (OEMs). It lists the material classification, dimensional requirements and marking guidelines as well as a series of performance tests. The performance tests include tests such as burst pressure, cold impact resistance, chemical and electrical resistance, adhesion, flame resistance and resistance to kinking. Basic test methods are also provided.

2.10 JAPAN AUTOMOBILE MANUFACTURERS ASSOCIATION (JAMA)

The Japan Automobile Manufacturers Association (JAMA) is a non-profit trade association for Japanese car, truck, bus and motorcycle manufacturers. They reference two Japanese Automotive Standard Organization (JASO) standards. Referenced in the JASO documents are two additional standards from the Japanese Industrial Standard (JIS).

2.10.1 JASO M 316-80 – FUEL HOSES FOR AUTOMOBILES

The purpose of this standard is to present physical and performance guidelines for rubber hoses used in the fuel system of an automobile. The performance tests include pressure resistance, adhesion, high and low heat resistance and resistance to chemicals. Sizing and marking is also presented.

A copy of this standard is contained in Appendix E.

2.10.2 JASO B 301-89 TEST PROCEDURE ON SAFETY OF FUEL SYSTEMS FOR PASSENGER CARS

The purpose of this standard is to provide a test procedure to evaluate the performance of a automotive fuel system during turning, panic braking and in a collision. Initially, the turning test required that the vehicle be driven within a specified turning radius but for improved repeatability, the vehicle can be alternatively subjected to a sideways tilt. Similarly, the panic breaking tests can be simulated with a forward tilting test. In any case, there is no critical value for the fuel leakage and the test results simply indicate whether or not leakage occurred.

For evaluating the crashworthiness of the fuel system, two collision tests are required, a frontal and a rear. The frontal collision is performed at 50 km/h into a fixed barrier. The speed of the rear collision is between 35-38 km/h using a moving barrier colliding with a stationary vehicle.

Two documents from the Japanese Industrial Standard, JIS D 1042 and JIS D 1060, are referenced for the specific method of conducting these tests. These standards deal with measuring fuel leakage and collision procedures, respectively. A specific criteria for the rate of leakage is not presented.

A copy of this standard is contained in Appendix E?

2.10.3 JIS D 1042 – DETERMINATION OF FUEL LEAKAGE IN THE EVENT OF A COLLISION FOR PASSENGER CARS

JIS D 1042 is a Japanese Industrial Standard (JIS) that specifies the method for measuring the fuel leakage following a collision test for either a frontal or rear

test. Similar to ISO 3437, this test procedure requires that any fuel leakage be collected for five minutes immediately following the collision.

A complete copy of this standard may be obtained from the America National Standards Institute's (ANSI) Web page at http://webstore.ansi.org

2.10.4 JIS D 1060 – Frontal and Rear Vehicle Collision Test Procedure

This JIS standard specifies the methods for crash-testing vehicles in either frontal or rear configurations and corresponds to ISO documents of equivalent nature. The standard lists the physical specifications of both the fixed and movable barriers as well as methods for measuring speed and other data. The actual speed requirement of the test is determined by the original test requirement, for example, the test procedure for fuel systems.

A complete copy of this standard may be obtained from the America National Standards Institute's (ANSI) Web page at http://webstore.ansi.org

2.11 National Association for Stock Car Racing (NASCAR)

The National Association for Stock Car Racing (NASCAR) offers racing from 13 divisions which include trucks to open-wheel class cars. The premier circuit is the Winston Cup Series that features cars rated at about 750 hp that can reach speeds of 200 mph.

The NASCAR Rule Books are only available to participants holding a valid NASCAR license. A representative from NASCAR stated that the rulebook does not specify any standards but simply defines a product that is available from a list of recommended suppliers. Aero Tec Laboratories (ATL) is one such supplier that builds fuel cells that are approved products for use in NASCAR racing and are built in accordance with the FIA standards.

2.12 National Institute of Standards and Technology (NIST)

The National Institute of Standards and Technology is a non-regulatory federal agency that develops and promotes measurements and technology but do not specify standards. There is a sub-group within NIST, called Building and Fire Research Laboratory (BFRL), that is interested in fire cause and prevention. Although the majority of the work by BFRL is related to buildings and construction testing, some studies of automotive fires have been conducted.

2.13 Society of Automotive Engineers (SAE)

The Society of Automotive Engineers (SAE) publishes several documents regarding fuel tanks in passenger cars and light trucks. The purpose of the

guidelines and standards are to suggest design practices that the SAE has deemed reasonable, practical and appropriate. In addition, the guidelines also ensure compatibility with existing systems, for example, fuel dispensing equipment.

A copy of each of the SAE recommended practices summarized below can be obtained directly from the Society of Automotive Engineers at (877) 606-7323 at or from their Web page http://www.sae.org

2.13.1 SAE J30 – Fuel and Oil Hoses

This standard tests the mechanical properties for fuel and oil hose that is used with gasoline, diesel, oil or vapour that may be present in an internal combustion engine for either passenger cars or marine applications. The tests cover such properties as tensile strength, elongation, burst strength, vacuum collapse, cold flexibility and fuel resistance. There are many specifications depending on the size and application of each hose.

2.13.2 SAE J398 – Fuel Tank Filler Conditions

This recommended practice is used to evaluate the compatibility of vehicle fuel tanks and filler pipes with standard fuel dispensing facilities. This is based on the physical size and engagement of the nozzle as well as the required flow rate of fuel.

2.13.3 SAE J829 – Fuel Tank Filler Cap and Cap Retainer

This standard provides the dimensions for vented, non-vented and pressure-vacuum fuel tank filler caps and cap retainers for different filler pipe sizes.

2.13.4 SAE J1114 – Fuel Tank Filler Cap and Cap Retainer Threaded

This is a recommended practice that provides the dimensions for threaded fuel tank filler caps and cap retainers.

2.13.5 SAE J1140 – Filler Pipes and Openings of Motor Vehicle Fuel Tanks

This is a recommended practice to ensure the compatibility between vehicles and refuelling vapour recovery nozzles by listing the dimensions and specifications of such nozzles.

2.13.6 SAE J1664 – Passenger Car and Light Truck Fuel Containment

This document is an SAE Information Report that describes the containment of liquid fuel on passenger cars and light trucks, covering issues like useful life, durability and fuel compatibility. Suggestions are made to subject tanks to fatigue and leak tests as well as pressure resistance. In terms of tank integrity, the document refers to FMVSS 301 and then provides a short list of typical causes of fuel tank failures as a result of a crash. UN/ECE Regulation No. 34 is mentioned regarding resistance to open flame. It is important to remember that this document is an information package and not a standard.

2.13.7 SAE J1958 – Diesel Engines – Steel Tubes for High-pressure Fuel Injection Pipes (Tubing)

This standard specifies the dimensional requirements for single-wall steel tubing as well as testing such as bending, surface quality and pressure.

2.13.8 SAE J2027 – Standard for Protective Covers for Gasoline Fuel Line Tubing

This SAE standard includes performance requirements for protective covers for flexible, non-metallic fuel tubing. The performance requirements include such tests as thermal resistance, resistance to combustion, stone-impingement resistance and a cold temperature impact.

2.13.9 SAE J2043 – Nonmetallic Fuel System Tubing

This is a standard that covers the requirements for nonmetallic tubing for use on gasoline or diesel fuel engines. It includes tests for burst strength, flexibility, chemical resistance, tensile strength and elongation, resistance to kinking and cold temperature impact.

2.13.10 SAE J2044 – Quick Connector Specification for Liquid Fuel and Vapor/Emissions Systems

This is a recommended practice that defines the functional and dimensional requirements for quick connectors used in fuel lines with flexible-tubing. Among the test procedures, there is a leak test at both a high pressure and a low pressure. There are tests to evaluate the effort required to assemble and pull apart the connector. A side load test applies a load to the side of the connector and tests for leaking as well as fracture. Further tests are included for corrosion, fuel compatibility, burst strength and flow restriction.

2.13.11 SAE J2045 – Performance Requirements for Fuel System Tubing Assemblies

This standard encompasses the technical and performance standards for fuel tubing assemblies and lists several recommended tests, procedures and criteria. These recommendations cover leak resistance, fitting pull-off, flow restriction, internal cleanliness, life cycle, flame and heat resistance, burst strength and electrical and chemical resistance. In many cases, a reference is made to more specific test procedures defined in other SAE documents.

2.13.12 SAE J2046 – Personal Watercraft Fuel Systems

Although this recommended practice is intended for fuel systems of personal watercraft, it is being considered here as a means to identify additional testing and performance requirements. In this document, there are common requirements such as those specified for fuel hoses as well as those specific to the intended use. For instance, the fuel system shall be designed not to leak when the watercraft is overturned and the fuel system shall automatically stop the supply of fuel when the engine is not running.

The document outlines a static pressure test and a shock test that cycles the tank through 1000 cycles of a 25 g vertical acceleration. Leakage shall not occur after either test. A fire test has an amount of fuel poured over the engine and ignited. Following a minimum burn period, the fuel system is pressurized to check for leaks.

2.13.13 SAE J2260 – Nonmetallic Fuel System Tubing with One or More Layers

This Standard covers the requirements for non-metallic tubing, either single- or multi-layered, for use with gasoline or diesel fuel. It is a very general standard that includes materials, installation, colour and identification. The performance requirements include a low and high temperature burst test, resistance to kinking, chemical resistance and tensile strength and elongation.

2.14 Underwriters Laboratories Inc. (UL)

Underwriters Laboratories Inc. (UL) is an independent, not-for-profit organization interested in testing and certification of product safety.

2.14.1 UL 395 - Standard for Automotive Fuel Tanks

This standard covers construction, performance and manufacturing of fuel tanks that may be mounted outside the frame on trucks, tractors or trailers. The construction requirements cover fittings, fill pipes and caps, and vents but are

very vague descriptions. For example, "The fill pipe shall be designed and located to minimize the probability of being torn loose in the event of an accident."

There are three performance tests described in the standard. The hydrostatic strength test specifies that the tank shall withstand an internal pressure of 150 percent of the vapour pressure of commercial gasoline. The relief vent test checks its operation by placing the vent in a water bath and gradually increasing the temperature.

There are two conditions under which a drop test is performed. First, the tank, containing water, must withstand, without rupture, a drop of 30 feet (9.1m) onto concrete. This is done such a manner to impact the juncture of the longitudinal and head seams of the tank. The test is repeated, this time from 10 feet (3m), so as to strike the fill pipe.

Under the manufacturing and production tests, each tank must be checked for leakage using an internal pressure of 5 psi (34.5 Kpa) and a soap solution applied to all joints.

This standards may be obtained from the Underwriters Laboratory Inc.'s Web page at http://ulstandardsinfonet.ul.com

2.15 UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE (UN/ECE)

The activities of the United Nations Economic Commission for Europe (UN/ECE) among many other things, includes the development of regulations and standards and providing technical assistance.

2.15.1 REGULATION NO. 34 – PREVENTION OF FIRE RISKS

Regulation No. 34 covers a variety of test standards concerning the fuel systems. The last approved amendment was in 1979 though the most recent was the 19th of January 2001. Although not yet approved, the most recent draft was reviewed due to it's link with the EC Directive 2000/08. Also, the proposed amendment does not change the functionality of the tests or the performance requirements.

The section of this document pertaining specifically to the performance of a fuel tank can be divided into two main parts. The first section lists various requirements of a tank. For example, the tank must be corrosion resistant. The vents on the tank must be designed to prevent risks of fire. The tank must not be located such that it is immediately beside a wall or surface of the occupant compartment. The regulation lists many more of such design guidelines that are very general in nature. A more detailed guideline for the tank installation is included.

The second part of interest with regards to tank performance are the sections describing the tests. Leakage and strength of the tank are evaluated during the first test which uses internal pressure. The overturn test ensures that the tank will not leak in the event of a roll-over.

A frontal impact of the vehicle, similar to the UN/ECE regulation of occupant safety, is used to evaluate the crashworthiness of the fuel system. After the vehicle strikes the barrier at approximately 50 km/h, the fuel system must not leak more than 30 g/min. The same requirements apply for the rear impact test that is done with either a moveable barrier or equivalent impacting pendulum at 35-38 km/h.

There is also a series of tests that are specific to fuel tanks made of plastic materials. A pendulum impact is used to test the impact resistance of a plastic tank. The tank is filled to its capacity with a water-glycol mixture and then chilled to a temperature of –40 ^{O}C. The cold conditioned tank is then impacted by a 1 m long pendulum with a steel pyramid-type face, the vertex and edges of which are rounded to a radius of 3 mm. The mass of the pendulum must be 15 kg with the centre of percussion coinciding with the centre of gravity of the pyramid. The energy of the pendulum at impact must be as close as possible to, but not less than, 30 Nm. The tank is not permitted to leak following this impact.

A plastic tank must also undergo an internal pressure test as well as a permeability test for fuel loss and chemical resistance to fuel.

Finally, a plastic tank must undergo a test that evaluates the tank's resistance to open flame and extreme heat. This test consists of four steps:

1. A pan containing fuel must be ignited at a distance of at least 3 m from the tank being tested. After 60 seconds the pan is moved under the tank.
2. Direct exposure to the flames from the burning fuel is maintained for 60 seconds.
3. Immediately after step 2, a screen is placed over the burning fuel in the pan and the tank is exposed to the reduced flame for an additional 60 seconds.
4. The burning pan with the screen is removed from beneath the tank. If the tank continues to burn the flames must be extinguished.

To pass, the tank must not show signs of leaking nor be seriously deformed.

A complete copy of this regulation can be found in Appendix F.

3. *FUEL SYSTEM FIRE SAFETY TECHNOLOGIES*

Various design strategies or technologies associated with the fuel system, which includes the evaporative emissions hardware, have been identified as potential countermeasures for preventing or mitigating the likelihood of post crash vehicle fires. These strategies or technologies, which may already be employed in existing vehicles, include:

- **Filler check valve**: If the filler hose is torn from the tank a check valve located at the spout on the tank would prevent excessive fuel loss.
- **Shielding**: Shields may be used to increase the fuel system's resistance to damage resulting from direct contact by providing an additional layer of protection.
- **Tank materials, thickness**: The choice of tank materials and its thickness will affect the its resistance to punctures, tearing or bursting.
- **Multiple layered tanks:** Although principally used to address emission issues, multiple layered construction may improve robustness.
- **Tank bladders**: Compliant and tear resistant bladders contained inside a tank prevent fuel leaks if the rigid outer shell of the tank system is compromised.
- **Tear away fuel line connections with check valves:** These connections are designed to disengage and seal if excessive tension is applied to the fuel lines.
- **Fire shields/blankets:** Fire retardant shields, affixed to the hood fall into place to smother engine compartment fires.
- **Anti-siphoning:** The routing of fuel line are such that if severed they would not continue to siphon fuel from the tank.
- **EFI Fuel Pump shut off:** The fuel pump would be deactivated if a crash is detected.
- **Active fire suppression systems:** Fire detectors would trigger the release of fire suppressant chemicals.
- **Tank additives:** Reticulate materials placed inside the tank to prevent explosions of the tank.
- **Location, tank environment and routing of fill and delivery lines**: Placement of fuel system components relative to potentially intrusive or aggressive components to minimise damage in the event of a collision.
- **Slip-in-tube drive shaft**: In a frontal collision of a rear wheel drive vehicle, the drive shaft would collapse along its length to minimize damage to a rear mounted tank.

4. VEHICLE SELECTION CRITERIA

There are over three hundred makes and models of vehicles available to the consumer, this includes sister/clones and corporate cousins. At this time an inspection of each vehicle is beyond the intended scope of the fuel system fire safety project. At this time is intended to obtain a cross section view of the best practices in use in the North American fleet of vehicles, therefor, the fuel systems of only a subset of all the makes and models of vehicles will be inspected in detail.

The initial vehicles to be included in the review are those that are known or suspected of incorporating in their design any of the fuel system fire safety technologies described in Section 3. The number of vehicles meeting this criteria is relatively small as this information is not readily available. The information currently available was obtained through discussions with dealerships, parts suppliers, parts manufacturers and service technicians. These vehicles are presented in Table 3.

Table 3: Preliminary list of vehicles that incorporate fuel system fire technologies.

Technology	**Vehicle**
Filler check valve	Daewoo: Lanos Toyota: Avalon, Sienna Honda: Odyssey
EFI Fuel Pump shut off	Toyota Avalon Ford: many models are believed to incorporate this feature. Hyundai: Accent, Elantra and Tiburon
Multiple layered tanks	Honda: Odyssey
Tank bladders	Chevrolet Corvette
Fire shields/blankets in the engine compartment	Toyota: Sienna
Notes: 1- This list is anticipated to grow quickly once the review is underway. 2- It is suspected that most if not all vehicles are using an EFI fuel pump shut off. This will be verified in the review.	

The information presented in Table 3 will be verified during the upcoming review and the list will be expanded as the use of any of the fuel system fire safety technologies is discovered.

Vehicles which have been involved in fuel system recalls that may pose a fire safety risk were added to the list of vehicles to be inspected. The focus will not be on the defect per se but on the solution or "fix" to the problem, as these presumably highlight considerations for a fuel system design. Presently known fire / fuel system related vehicle recalls are summarized in Table 4.

Table 4: Recent fuel system related recalls.

Vehicle	Year	Manufacturer	Nature of Problem
Elantra	96 to 97	Hyundai	evaporative emission control system can apply excessive vacuum to tank resulting in a crack
Tiburon	1997	Hyundai	evaporative emission control system can apply excessive vacuum to tank resulting in a crack
Audi A8	2000	Audi	"blind cover " at the filler neck may not seal properly resulting in vapour leak
Malibu	2000	Chevrolet	fuel fitting not properly secured to the tank could result in excessive fuel leak
Windstar	1995	Ford	fuel tank can develop cracks in the forward strap area of the standard 20 gal tank.
Quest	93 to 98	Nissan	Cracks have developed in the vent hose
E350	2001	Ford	Crack in mid-ship tank when vehicle operated at near gross vehicle weight and involving twisting
Jeep Grand Cherokee	2002	DaimlerChrysler	Misrouted hoses may cause water to enter the canister and result in gasoline spills during refuelling

The model years of some of the vehicles in Table 4 predate 2002 models years of interest. However, 2002 models of those vehicles will be included and particular attention will be given to the solutions to the problems indicated.

To add to the list further, the vehicles that were tested in the development and evaluation of the proposed FMVSS 301 upgrade will also be included in the

review. Of the 13 different vehicles from this research nine vehicles are still produced: They include:

- Dodge Neon
- Geo Prizm / Toyota Corolla
- Ford Mustang
- Chevrolet Blazer
- Honda Civic
- Chevrolet Cavalier
- Nissan Sentra
- VW Jetta
- Mazda Miata

The final suggested list of vehicles to be inspected is obtained by combining the vehicles from Table 3 and Table 4 and those from the research into the proposed upgrade to FMVSS 301. Additionally, to ensure that a reasonable cross section of vehicles are included in the review, the list will be expanded to ensure a sampling of vehicles from various price ranges and classes such as, SUVs, pickup trucks, vans, mini vans and passenger cars. The suggested list, totalling seventy, is presented in Appendix G. It should be noted that the composition of this list may change if information gained during the inspection process highlights alternate vehicles with particular features that would be of interest to this research.

5. INSPECTION PROTOCOL AND DOCUMENTATION

The survey of the fuel system of each vehicle listed in Appendix G will consist of three components: vehicle inspection, tank system component inspection and tank component testing.

5.1 VEHICLE INSPECTION

Access to the seventy vehicles from the suggested inspection list (Appendix G) has been established through collaboration of automotive dealerships. The dealerships have pledged to provide vehicles and a hoist to aid in the examination of their fuel systems. In some cases, in exchange for their efforts, the dealerships will be compensated for their time at established shop rates. Understandably, the inspections of the vehicles will be limited to tape measurements and photographs. The vehicles will not be altered in any way during the course of the inspection to obtain clearer view or to determine use of any particular fuel system fire safety technology that may not be visibly apparent.

The information to be gained from the inspections includes, but is not limited to, such information as:

- Placement of the tank relative to the extents of the vehicle.
- Presence of any of the fire safety related technologies identified in Section 3.
- Routing of the fuel lines.
- Proximity of potentially aggressive vehicle components.

In addition to the visual inspection, each vehicle's shop manual will be reviewed with particular emphasis on obtaining further details regarding the fuel systems. For each vehicle inspected a "Vehicle Fuel System Review Checklist/Report" will be completed.

A trial vehicle inspection was performed with a 2002 Honda Odyssey van as the subject vehicle. The completed inspection checklist/report for the Odyssey can be found in Appendix H. The trial inspection highlighted procedural and documented deficiencies in the "Vehicle Fuel System Review Checklist/Report", which were addressed and the checklist/report updated. A photograph of the tank on the Odyssey is shown in Figure 1.

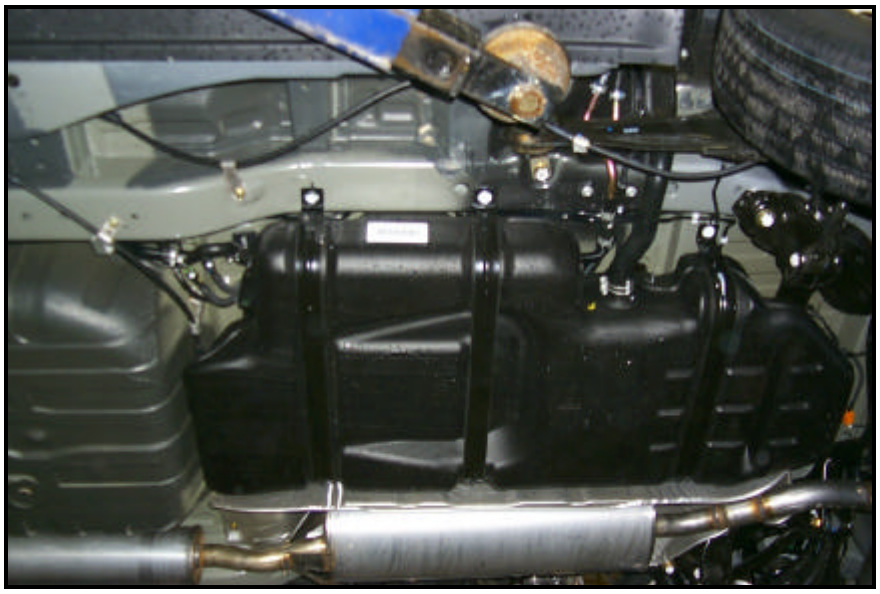

Figure 1: Tank in the 2002 Honda Odyssey

The information in the inspection reports will be entered into a Microsoft® Access database for ease of future analysis. This database has been prepared and is ready for use. The information entered will include vehicle specifics (make, model, GVW etc.), measurements, observations and photographs. The hardcopy of each vehicle will be kept on file for reference if required.

5.2 TANK SYSTEM COMPONENT INSPECTION

As indicated, the vehicles to be inspected can not be altered to obtain clearer views or to determine the use of any particular fuel system fire safety technology. Thus to gain information on the tank's construction and components, a tank system's components must be purchased. This would allow for measurements of the tank's wall thickness, to determine the presence of baffling and to determine the presence of any internal fire safety features such as check valves that may not be identified in the shop manuals.

5.2.1 TRIAL INSPECTION OF A HONDA ODYSSEY TANK

The components of the Honda Odyssey fuel system were purchased for inspection which confirmed that it is constructed of at least two different layers of materials and that a check valve is installed in the filler spout. A photograph of the tank is shown in Figure 2. The tank was not cut open to inspect the interior or to measure wall thickness as this tank will be tested in Phase 2 of the work, at which time the internal inspection will be performed. The information that has been obtained from inspection of the tank system components are also

contained in the "Vehicle Fuel System Review Checklist/Report" contained in Appendix H.

Figure 2: Honda Odyssey tank and filler.

5.3 TANK COMPONENT TESTING

Although beyond the scope of the current work, two component tests are suggested to gain a relative measure of the durability of the various system to be reviewed. The tests, that were extracted from amongst the standards that were reviewed in Section 2, are: a drop test from the Code of Regulations (CFR) 49 – Transportation, Part 571.393.67 and an impact pendulum with pyramidal face from the UN/ECE Regulation 34. Schematics of these two tests are presented in Figure 3 and Figure 4 respectively.

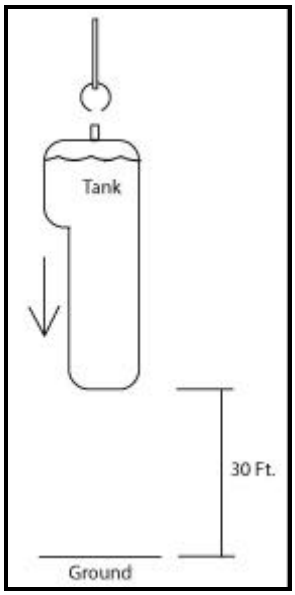

Figure 3: Drop test from the Code of Regulations (CFR) 49 – Transportation, Part 571.393.67.

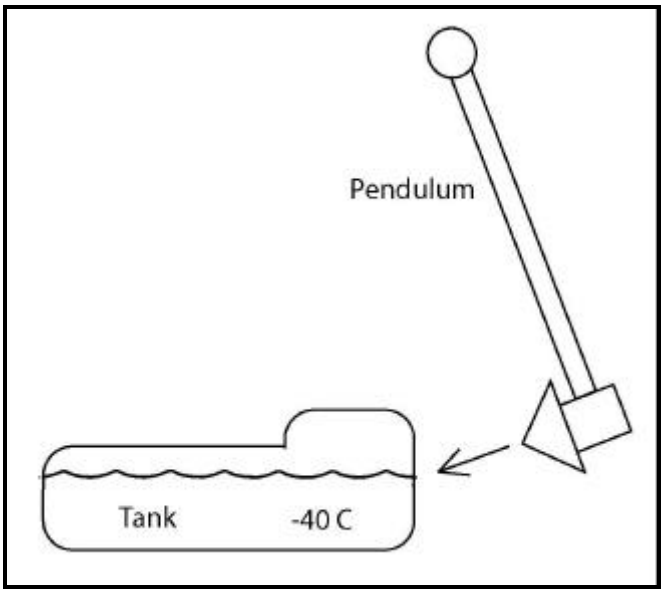

Figure 4: Impact pendulum test with pyramidal face from the UN / ECE Regulation 34.

A third test, the exact details of which have not yet been established, would evaluate a systems resistance to siphoning. In general terms it is anticipated that the test would comprise of creating a mock-up of the in vehicle tank installation with particular attention given to the height of the fuel lines relative to the tank. The fuel line would then be severed and the rate of leakage would be measured. A schematic of the siphon test set-up is shown in Figure 5.

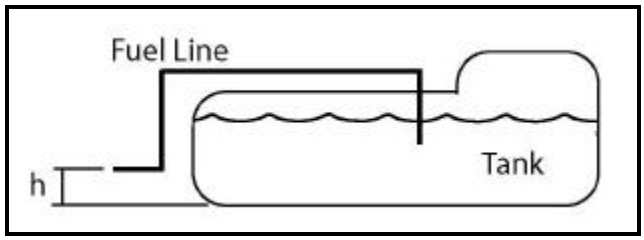

Figure 5: Siphon test set-up.

6. SUMMARY

The intention of the Survey of the State-of-the-art In Fuel System Fire Safety is to determine the best practices, related to fuel system fire safety design, in use in the 2002 North American fleet of vehicles. This includes a review of standards and tank fire safety technologies.

Forty two different fuel system performance standards from world wide standards agencies and governing bodies were reviewed as part of the investigation into the state-of-the-art in fuel systems. Copies of these component standards and vehicles standards were obtained for future reference.

Various fuel system fire safety technologies were identified as potential countermeasures for preventing or mitigating the likelihood of post crash vehicle fires. The use of these technologies in the 2002 North American fleet of vehicles will, in a large part, be the focus of the proposed survey.

The 2002 North American fleet comprises over three hundred makes and models of vehicles. The inspection of each one is beyond the current scope of the review which intends to gain a cross-section view of the best practices in fuel system fire safety design. A subset of these vehicles is proposed that consists of: vehicles known to use any of the fuel system fire safety technologies that have been identified, vehicles that have been involved in recent fuel system related recalls and vehicles that have been tested in the research investigating potential upgrades to the existing FMVSS 301 performance standard. To ensure a reasonable cross section of vehicles are included in the review, the suggested list of vehicles was expanded to ensure a sampling of vehicles from various price ranges and classes. A total of seventy vehicles have been identified for inclusion in the review.

Access to the seventy vehicles for inspection has been established through automotive dealerships that have pledged to provide the vehicles and a hoist for the inspection. An inspection checklist/report was prepared to ensure complete documentation of each vehicles inspection A trial run of the inspection process was carried out on a Honda Odyssey, which highlighted minor changes required to the inspection process. These changes were reflected in an updated vehicle checklist/report.

It is suggested that three component tests be included in the fuel system review in addition to the vehicle inspection. The tests provide a relative measure of the durability of the various tank systems to be reviewed. The three tests include: a drop test, localized pendulum impact and a siphon test.

Phase 1 of the Survey of the State-of-the-art In Fuel System Fire Safety has defined the scope and the methodology for conducting the more comprehensive review of fuel systems in 2002 North American fleet. A work plan to continue with Phase 2 of the project has been prepared under separate cover in “Review of

the State-of-the-art In Fuel Tank Systems In Use In The Current North American Fleet – Phase 2", Biokinetics and Associates Proposal No. P02-20 April, 2002.

7. REFERENCES

Ref. 1: Griffin, L. I.,"An Assessment of the Reliability and Validity of the Information on Vehicle Fires Contained in the Fatal Accident Reporting System (FARS)", Safety Division Texas Transportation Institute, November 1997.

Ref. 2: Lavelle, J. P., Kononen, D. W., Nelander, J. R., "Field Data Improvements for Fire Safety Research", General Motors Corporation, Paper 98-S6-W-45

Ref. 3: "Preliminary Regulation Evaluation FMVSS No. 301 Upgrade", National Highway Traffic Safety Administration, November 2000.

APPENDIX A : DEPARTMENT O F DEFENCE

- MIL-PRF-14442E- Tank, Fuel, Engine: Non-Metallic, Non-Self-Sealing, for Military Vehicles.
- Mil-C-45300B – Cap, Fuel Tank: For Military Combat and Tactical Transport Vehicles.

INCH-POUND
MIL-PRF-14442E(AT)
21 November 1997
SUPERSEDING
MIL-T-14442D(AT)
28 June 1990

PERFORMANCE SPECIFICATION

TANK, FUEL, ENGINE: NON-METALLIC, NON-SELF-SEALING, FOR MILITARY VEHICLES

This specification is approved for use within the U.S. Army Tank-automotive and Armaments Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers one type of non-metallic, non-self-sealing fuel tanks (fuel cell type) for use in military tactical vehicles and combat vehicles.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirement documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-TR-E/BLUE, Warren, MI 48397-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

AMSC N/A FSC 2910

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D381	- Existent Gum in Fuels by Jet Evaporation, Test Method for (DoD Adopted).
ASTM D412	- Rubber Properties in Tension, Test Methods for (DoD Adopted).
ASTM D413	- Rubber Property-Adhesion to Flexible Substrate, Test Methods for (DoD Adopted).
ASTM D471	- Standard Test Method for Rubber Property - Effect of Liquids (DoD Adopted).
ASTM D5486	- Standard Specification for Pressure-Sensitive Tape for Packaging, Box Closure, and Sealing (DoD Adopted).

(Copies of ASTM publications may be obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.3.

3.2 Design, materials, and manufacturing process. Unless otherwise specified (see 6.2), the design, materials, and manufacturing process selection is the prerogative of the contractor as long as all articles submitted to the government fully meet the interface and interoperability, environmental, support and ownership, and operating requirements specified herein.

3.2.1 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.3 Interface and interoperability. The fuel tank shall be of flexible construction, and shall consist generally of a nonmetallic carcass of unit construction, with openings or fittings satisfactory for the necessary attachment of parts and accessories in accordance with applicable drawings. Fuel tanks shall conform to the envelope dimensions, contours, fitting and mounting interfaces as shown on applicable drawings (see 6.2).

3.3.1 Installation. The location of all fittings and the tank dimensions needed for installation shall be within the allowable tolerances specified on the applicable drawings.

3.3.2 Stand. The fuel tank shall show no evidence of leakage as a result of standing.

3.3.3 Fuel contamination. The nonvolatile material, for a sample of the inner layers of fuel tank, shall not exceed 60 milligrams (mg) per 100 milliliters (ml) of the contaminated fluid. The stoved gum residue shall not exceed 20 mg per 100 ml of the contaminated fluid.

3.4 Environmental.

3.4.1 Humidity (hydrolytic stability) at elevated temperature. The specimen shall show no corrosion, peeling, cracking, warping, blistering, delamination, or discoloration as a result of exposure to high humidity at elevated temperatures.

3.4.2 Humidity (hydrolytic stability) at room temperature. The specimen shall show no visible cracks, blisters or eruptions after exposure to high humidity at room temperature.

3.4.3 Low temperature leakage. The fuel tank shall show no evidence of leakage as a result of exposure to low temperatures.

3.5 Support and ownership.

3.5.1 Hazardous materials. The fuel tank shall not produce any hazards to personnel or the environment resulting from the use of asbestos or cadmium.

3.5.2 Protective treatments.

3.5.2.1 Fittings. Fittings shall be corrosion resistant or appropriately treated for corrosion resistance.

3.5.2.2 Openings. All openings to tanks shall be fitted with fully cured Buna-N or equally fuel resistant material which shall be resistant to cutting, and to gouging as a result of sealing pressure generated by torquing hold-down bolts.

3.5.3 Access opening. Each fuel tank shall be provided with a hand hole and cover to permit arm access to the tank interior for inspection and repair.

3.5.4 Handling. The fuel tank shall show no evidence of cracks, loosening of fittings, or failure of seams when it is folded and unfolded 40 times in accordance with standard procedure for shipment.

3.5.5 Fluid resistance of exterior surfaces. The exterior surfaces of the fuel tanks shall show no swelling, separation, blistering, or dissolution when exposed to fuel.

3.5.6 Permeability. Fuel tank permeability shall be less than 0.025 fluid ounces (fl-oz) per square foot (ft^2) per 24 hours for each specimen tested.

3.5.7 Tensile strength. The inner layer ply of the tank, without barrier, shall have a tensile strength not less than 80 percent (%) of the value calculated, based on the original cross sectional area of the ply.

3.5.8 Seam adhesion. The seam adhesion of the inner ply of the fuel tank shall be not less than 12 pounds (lb). There shall be no failure of the seam.

3.5.8.1 Wet seam adhesion. The wet seam adhesion shall be not less than 50% of the dry adhesion value.

3.5.9 Puncture resistance. The force required to puncture the fuel tank wall shall be not less than 15 lb.

3.5.10 Identification marking. Each fuel tank shall have the following information permanently and legibly marked on the face or surface in which the opening for the fuel-level gage sending unit is located:

Army part number.
Vehicle nomenclature.
Name of manufacturer.
Date of manufacture (year and quarter).
Manufacturer's serial number.
Manufacturer's construction number.
Specification MIL-PRF-14442.
Date of acceptance.
Contract or order number.

3.5.10.1 Filler cap. The external surface of the filler cap shall be formed and painted with diesel fuel (DF-A, DF-1, DF-2, and JP-8) resistant lacquer, and legibly marked in white lettering: "Fuel (*) US Gal." (* to be filled in with usable capacity taken as the average capacity of the first 10 production tanks).

3.5.10.2 Hand-hole cover. The exterior surface of the hand-hole cover of each fuel tank shall be legibly and permanently marked "OUTSIDE".

3.5.10.3 Torque values. The torque values required for assembly shall be marked on, or adjacent to, each fitting or accessory involved, on the side torque wrench is applied. If the torque required is the same for each such item, that value may be stenciled in only one place on the surface of tank in a conspicuous location.

3.6 Operating. When installed in the vehicle structure for which it is designed, the fuel tank shall be capable of withstanding the loads incident to road shock and vibrations common to off-the-road and high speed highway operation of the vehicle.

3.6.1 Capacity. The nominal capacity of the fuel tanks shall be as specified with a tolerance of ± 3.0% (see 6.2).

3.6.2 Leakage. The fuel tank shall show no evidence of leakage.

3.6.3 Slosh. The fuel tank shall show no evidence of leakage or other failure such as chafing, disengaged hangers, or liner breaks as a result of content sloshing.

4. VERIFICATION

4.1 Classification of inspection. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.3).
b. Conformance inspections (CI) (see 4.4).

4.2 Inspection conditions. Unless otherwise specified (see 6.2), all inspections shall be conducted under the following conditions:

a. Air temperature: 73 ± 3 degrees Fahrenheit (°F)
b. Barometric pressure: 28.5 (+2, -3) inches (in.) mercury
c. Relative humidity: 50 ± 5%

4.2.1 Test structure. When specified (see 6.2), the test structure shall be a simulation of the actual vehicle structure. It shall duplicate the shape, dimensions and material of the tank supporting structure in the vehicle. The necessary stops, cushions, and pads, identical with those used in the finished vehicle, for mounting and supporting the tank, shall be provided. It shall be constructed so that the test tank can be installed in and removed from the structure in an identical manner to that used in the actual vehicle installation.

4.2.2 Support jig. The jig shall support the tank test structure specified in 4.2.1, to simulate the actual vehicle installation. The support jig shall be a strongly constructed framework of metal, for carrying the mounted test tank and designed for bolting to the rocker assembly

specified in 4.9.2. The jig shall be designed so that removal of the tank test structure may be accomplished with a minimum effort.

4.3 First article inspection. When a first article sample is required (see 3.1), samples shall be inspected as specified in table I. First article samples shall be selected as follows:

Three full size tanks complete with necessary fittings.
Three 12 by 12 in. specimens of composite tank construction.
One specimen of inner layer ply, without barrier, approximately 900 square inches (in^2) in area, including seam.
One specimen of 6 by 6 in. inner layer ply, without barrier.
Three permeability specimens in accordance with 4.8.3.2.

TABLE I. Classification of inspections.

Title	Requirement	Verification	Title	Requirement	Verification
Interface and interoperability	3.3	4.6	Fluid resistance of exterior surfaces	3.5.5	4.8.2
Installation	3.3.1	4.6.1	Permeability	3.5.6	4.8.3
Stand	3.3.2	4.6.2	Tensile strength	3.5.7	4.8.4
Fuel contamination	3.3.3	4.6.3	Seam adhesion	3.5.8	4.8.5, 4.8.5.1
Environmental	3.4	4.7	Wet seam adhesion	3.5.8.1	4.8.5.2
Humidity at elevated temperature	3.4.1	4.7.1	Puncture resistance	3.5.9	4.8.6
Humidity at room temperature	3.4.2	4.7.2	Identification marking	3.5.10	4.8
Low temperature leakage	3.4.3	4.7.3	Filler cap	3.5.10.1	4.8
Support and ownership	3.5	4.8	Hand-hole cover	3.5.10.2	4.8
Hazardous materials	3.5.1	4.8	Torque values	3.5.10.3	4.8
Protective treatments	3.5.2	4.8	**Operating**	3.6	4.9
Fittings	3.5.2.1	4.8	Capacity	3.6.1	4.9
Openings	3.5.2.2	4.8	Leakage	3.6.2	4.9.1
Access opening	3.5.3	4.8	Slosh	3.6.3	4.9.2
Handling	3.5.4	4.8.1			

4.4 Conformance inspection. Conformance inspection shall include the applicable tests of table I as specified in the contract (see 6.2).

4.5 Verification methods. The types of verification methods included in this section are examination of contractor records, visual inspection, measurement, sample tests, full-scale demonstration tests, simulation, modeling, engineering evaluation, component properties analysis, and similarity to previously-approved or previously-qualified designs.

4.5.1 Verification alternatives. The manufacturer may propose alternative test methods, techniques, or equipment, including the application of statistical process control, tool control, or cost-effective sampling procedures, to verify performance.

4.6 Interface and interoperability. Conformance to 3.3 through 3.3.3 shall be determined using appropriate verification methods specified in 4.5 or 4.5.1 and the tests specified in 4.6.1 through 4.6.3.2.

4.6.1 Installation.

4.6.1.1 First article sample. For first article testing, conformance to 3.3.1 shall be determined using the test structure specified in 4.2.1.

4.6.1.2 Quality conformance. For conformance testing, conformance to 3.3.1 shall be determined, using a test jig (see 4.2.2) or registered metal templates fabricated in accordance with design requirements furnished by the vehicle manufacturer for the particular vehicle.

4.6.2 Stand. To determine conformance to 3.3.2, the tank shall be tested as specified in 4.6.2.1 or 4.6.2.2, as applicable.

4.6.2.1 First article. Upon completion of the low temperature test specified in 4.7.3, the cavity shall be completely lined with brown paper. The tank shall be refilled with fluid conforming to reference fuel B of ASTM D471. The tank shall be allowed to stand at the standard ambient temperature for a period of 30 days, at which time the paper shall be examined for any stains indicating a fluid leakage.

4.6.2.2 Conformance testing. Each tank selected for conformance inspection shall be collapsed and held for 30 minutes in a position comparable to that encountered prior to installation in its respective vehicle cavity. Prior to the installation of the tank, the test structure shall be completely lined with brown paper and held in place with tape conforming to ASTM D5486. Then the tank shall be installed in its test structure. The tank shall then be filled with fluid conforming reference fuel B of ASTM D471 and shall be stand tested for 30 days. The tank may be inspected at 10-day intervals during the test. At the conclusion of the 30-day test, the tank shall be drained and removed from the test cavity. The test cavity shall be inspected for evidence of leakage as indicated by stains on the brown paper. After the examination, if stains are present on the brown paper, evaluation shall be made in accordance with the test procedure specified in 4.9.2.

4.6.3 Fuel contamination.

4.6.3.1 Nonvolatile gum residue. A 5 gram sample of the inner layers, up to the barrier, shall be diced into approximately 0.06 in. squares and shall be placed in a flask containing 230 ml

of fluid conforming to reference fuel B of ASTM D471. The samples shall be allowed to stand for 48 hours at 77 ± 5°F. The contaminated test fluid shall be decanted off, and the nonvolatile gum residue shall be determined by the method specified in ASTM D381. The total evaporation time shall be 45 minutes.

4.6.3.2 Stoved gum residue. Stoved gum residue content shall be determined after necessary corrections have been made for performed gums, originally present in the test fluid. The beakers containing the nonvolatile material shall be placed in an appropriate bath maintained at a constant temperature of 572 ± 9°F for 30 minutes, and then weighed after being cooled in a closed container.

4.7 Environmental.

4.7.1 Humidity (hydrolytic stability) at elevated temperature. To determine conformance to 3.4.1, one 6 by 6 in. specimen of the composite tank construction shall be examined after being exposed to a temperature of 158 ± 2°F and 100% relative humidity for a period of 15 days.

4.7.2 Humidity (hydrolytic stability) at room temperature. To determine conformance to 3.4.2, two specimens 1 by 6 by 0.075 ± 0.025 in. shall be examined under 7-power magnification after being exposed to room temperature and 100% relative humidity for 30 days. When practical, these specimens shall be mounted on an appropriate fixture in a manner to cause a stretch of 20%, measured between gage marks 4 in. apart, centered in the middle section of each strip.

4.7.3 Low temperature leakage. To determine conformance to 3.4.3, the fuel tank shall be emptied, after the test specified in 4.9.2, and the interior of the cavity in which the tank is installed shall be completely lined with brown paper. The tank shall be refilled with a test fluid conforming to reference fuel B of ASTM D471 containing a staining agent, and allowed to stand for a period of 7 days at 110 ± 10°F. The tank shall then be emptied and subjected to an air dry-out at 160 ± 10°F for 7 days. Following the air dry-out, the tank shall be refilled with the same test fluid specified and cooled to a temperature of -67 ± 3.6°F and allowed to remain at this temperature for a minimum period of 3 days. The tank shall then be brought back to room temperature and allowed to stand until completely drained and then examined for leakage as indicated by staining the brown paper.

4.8 Support and ownership. Conformance to 3.5 through 3.5.10.3 shall be determined using appropriate verification methods specified in 4.5 or 4.5.1 and the tests specified in 4.8.l through 4.8.6.

4.8.1 Handling. To determine conformance to 3.5.4, the fuel tank shall be folded and unfolded as specified and then installed and removed from the test structure five times.

Applicable service procedures shall be followed in tank installation and removal. All fittings shall be fastened to corresponding structure and interconnect fittings upon each installation in the test structure, and the tank shall then be examined.

4.8.2 Fluid resistance of exterior surfaces. To determine conformance to 3.5.5, a 6 by 6 in. specimen of composite tank construction shall be submerged in a container of test fluid conforming to reference fuel B of ASTM D471 at standard ambient temperature for 24 hours.

4.8.3 Permeability. To determine conformance to 3.5.6, the fuel tank shall be tested as specified in 4.8.3.1 through 4.8.3.3.

4.8.3.1 Test apparatus. The test apparatus shall include a permeability cup and ring constructed in accordance with figure 1. A nylon solution shall be used for sealing the test disk to the permeability cup.

4.8.3.2 Preparation of test specimen. The uncured liner shall be applied to a 10 by 10 in. piece of corrugated fiberboard coated on one side with a suitable water soluble breakaway agent. The exposed surface of the inner liner shall be coated with prime cement and barrier resin, if required, in accordance with applicable manufacturing specifications. The assembly shall be wrapped with cellophane and covered with a waterproof bag. The assembly shall be vulcanized using the same method as in regular production. After vulcanization, the waterproof bag and cellophane shall be removed, and the inner liner shall be removed from the fiberboard, using water if necessary. Free moisture shall be wiped from the assembly, and the assembly shall be conditioned for 24 hours at a constant temperature of 77 $\pm$ 50°F and a relative humidity of 40 $\pm$ 5%. Two disks, each 2.5 in. in size, shall be cut from the vulcanized panel. One hundred ml of the test fluid conforming to reference fuel B of ASTM D471, shall be placed in the diffusion cup shown in figure 1. A nylon solution shall be applied to the face of the cup flange covering the area inside the bolt circle. The nylon solution shall be allowed to come almost to dryness, then the test disk shall be applied to the cup with the barrier, if any, facing outward. The assembly shall be completed by attaching the bolting ring and tightening the bolts in accordance with the following schedule:

Inner liner type	Bolt torque, pound-inches (lb-in)
Gum stock	5 to 10
Coated fabrics	15 to 20
Unsupported plastic films	20 to 25

4.8.3.3 Method of conducting test. Permeability cups, prepared as specified in 4.8.3.2, shall be placed in a rack in a constant temperature of 77 $\pm$ 5°F and relative humidity of 40 $\pm$ 5%. After allowing one hour for equilibration, the cup shall be weighed to the nearest 0.005 gram (g) and placed in the rack with the cup facing upward. The cup shall be kept at the above constant

temperature for 24 hours, then weighed to check for excessive vapor loss. The bolts shall be retorqued if necessary. The cup shall be inverted (test disk down) in a rack that permits free access of air to the test disk. Cups shall be weighed at the end of the third, fifth, and eighth day after inverting. Defective films or leaks caused by faulty assembly will usually be found when weighing on the third day. The diffusion rate calculation shall be made on the fifth to the eighth day period, and the permeability shall then be determined. Diffusion expressed in fl-oz per ft^2 per 24 hours equals the gram loss of the test specimen per 24 hours multiplied by a factor K which is defined as follows:

$$K = \frac{144}{(\text{sp. gr.})\ (29.573)\ (3.1416)\ (R)^2}$$

Where:

sp. gr. = specific gravity of the test fluid at 77°F.
R = inside radius of test cup expressed in inches.

4.8.4 Tensile strength. To determine conformance to 3.5.7, the tensile strength of a sample of inner layer ply, without barrier, shall be determined in accordance with the test specified in ASTM D412, when coated fabric liners are used. The sample shall then be immersed in water at 180 ± 4°F for 72 hours, after which the specified tensile strength test shall be repeated. The change in tensile strength shall be reported as the after-immersion strength, calculated as a percentage of the original value.

4.8.5 Seam adhesion. To determine conformance to 3.5.8, the seam adhesion of the inner layer ply to itself shall be tested along the length of the seam in accordance with the test specified in ASTM D413, using the strip specimen.

4.8.5.1 Seam adhesion (alternative procedure). To determine conformance to 3.5.8, the seam adhesion of the inner layer ply to itself may be tested by cutting a strip of inner-layer material one in. wide, having a seam made in the same manner as is used in the tanks submitted under 4.3. This seam shall be perpendicular to, and midway in, the length of the strip. A tensile load shall be applied parallel to the length of the strip, of sufficient magnitude to break the strip.

4.8.5.2 Wet seam adhesion. To determine conformance to 3.5.8.1, a specimen shall be prepared in accordance with the test of 4.8.5 or 4.8.5.1, and soaked in a test fluid conforming to referenced fuel B of ASTM D471, for a period of 48 hours, at 75 ± 5°F. The specimen shall be removed from the test fluid and wiped dry. No other means of drying shall be used. Within 4 hours after removing the specimen from the fluid, it shall be subjected to one of the above tests. The value by the strip method shall be no less than 50% of the dry test value. The results using the alternative procedure shall require the breaking of the strip outside of seam area.

4.8.6 Puncture resistance. To determine conformance to 3.5.9, a test specimen of tank wall construction shall be fastened in a specimen holder as shown in figure 2. A piercing instrument, with its piercing end as shown in figure 2, shall be forced against the specimen in the holder at approximately the center of the area enclosed by the specimen holder. The force required to puncture the specimen shall be not less than specified.

4.9 Operating. Conformance to 3.6 through 3.6.3 shall be determined using appropriate verification methods specified in 4.5 or 4.5.1 and the tests in 4.9.1 and 4.9.2.

4.9.1 Leakage. To determine conformance to 3.6.2, the tank shall be covered with brown paper and shall be filled with a stoddard solvent (or equivalent) containing a staining agent. The tank and supported systems shall be subjected to an internal pressure of 1.5 times the maximum operating pressure of the intended system and allowed to stand for 30 minutes. Tanks intended for use in non-pressurized systems shall be subjected to an internal pressure equivalent to the normal head pressure measured at the bottom of the tank multiplied by a factor of 1.5 and shall be allowed to stand for 30 minutes. The brown paper shall then be examined for stains.

4.9.2 Slosh. To determine conformance to 3.6.3, the test tank, complete with all fittings and other parts or accessories, shall be mounted in the support jig (see 4.2.2) and installed on a rocker assembly. It shall be mounted in such a manner that the major (longer) horizontal axis of the tank shall be 90 degrees (°) to the center line of the axis of the rocker assembly platform. The interior of the compartment shall be lined with brown paper in the fitting areas and held in place with tape conforming to ASTM D5486. The test specimen shall be filled two-thirds full with test fluid conforming to reference fuel B of ASTM D471. In addition, twice the sump capacity of water shall be added to the tank. The tank shall then be subjected to rocking at approximately 15° angle from the vertical (30° total rocking for 24 hours at a frequency of 16 to 20 cycles per minute (cpm)), or for 40 hours at 10 to 16 cpm. The temperature of the test fluid during the test shall be 110 $\pm$ 10°F. Tanks intended for use in pressurized fuel systems shall be subjected to an internal pressure of 1.5 times the maximum operating pressure of the intended vehicle system during the entire test. Tanks intended for use in non-pressurized fuel systems shall be tested at normal atmospheric pressure. When testing non-pressurized tanks, a vent opening shall be provided equal to the vent opening in the intended vehicle. The vent shall be connected to a line and so positioned that any test fluid escaping through the vent shall be carried away from the test specimen. At the conclusion of the 24 or 40 hours rocking period, as applicable, the tank shall be completely filled with the specified test fluid and allowed to stand for 1 hour. The test fluid shall then be drained and the test tank removed from the structure. The paper lining shall be thoroughly examined for leakage as indicated by stains on the paper. Indication of stains on the liner paper shall be considered as test failure, except minor stainage due to improperly torqued bolts, damaged equipment not considered a part of the tank assembly, or minor stainage resulting from physical damage to the tank at the time of installation.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature which may be helpful, but is not mandatory.)

6.1 Intended use. The nonmetallic, non-self-sealing fuel tanks covered by this specification are intended for installation in military tactical vehicles including trucks, truck-tractors, and similar thin-skinned wheeled vehicles, as reservoirs for compression ignition fuel. They may also be installed on combat vehicles, to provide corrosion-resistant fuel storage reservoirs. The fuel tanks are intended for use with fuel which does not exceed 30% aromatics content.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.
b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2).
c. First article inspection, if required (see 3.1 and 6.6).
d. Design, materials, or manufacturing processes, if other than specified (see 3.2).
e. Title, number, and date of applicable drawings (see 3.3).
f. Capacity of the fuel tank (see 3.6.1).
g. If inspection conditions should be other than specified (see 4.2).
h. A test structure to support first article inspection, when applicable (see 4.2.1).
i. Conformance tests to be performed (see 4.4 and 6.7).
j. Selection of applicable level and packaging requirements (see 5.1).

6.3 Rubber material. Satisfactory results have been obtained with fuel tanks constructed with fabric-reinforced nitrate rubber.

6.4 Surface treatment for steel fittings. Refer to SAE AIR4160 for information regarding possible alternatives to the use of cadmium plating on fittings.

6.5 Tanks. Following is a partial list of drawings which describe the fuel tank shells which the items covered by this specification are intended to fit.

Drawing number	Title	Vehicle applications
7993036	Gas Tank Cell, Right	M53, M55
7993037	Gas Tank Cell, Left	M53, M55
8340664	Fuel Cell Assembly	M59, M84
10918604	Tank, Fuel, Engine	M114, M114A1, M114A1E1, M114E2
10952618	Cell Assembly, Fuel, Engine (Center)	M551A1
11633639	Tank, Fuel, Engine	M132, XM806
11647693	Bladder, Fuel	M741

6.6 First article. When requiring a first article inspection, contracting documents should provide specific guidance to offerors. This guidance should cover whether the first article is a first article sample, a first production item, or the number of test items. These documents should also include specified instructions regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Pre-solicitation documents should provide Government waiver rights for samples for first article inspection to bidders offering a previously acquired or tested product. Bidders offering such products who wish to rely on such production testing must furnish evidence with the bid that prior Government approval is appropriate for the pending contract.

6.7 Conformance inspection. Affordable conformance inspection with confidence varies depending upon a number of procurement risk factors. Some of these factors include: Contractor past performance, government schedules and budget, product material and design maturity, manufacturing capital equipment and processes applied, the controlled uniformity of those processes, labor skill and training, and the uniformity of measuring processes and techniques. During the solicitation, contracting documents should indicate those tests desired from table I and their designated frequency based on a risk assessment for the procurement.

6.8 Subject term (key word) listing.

Carcass
Cell type
Diesel
Fluid container
Gasoline

6.9 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

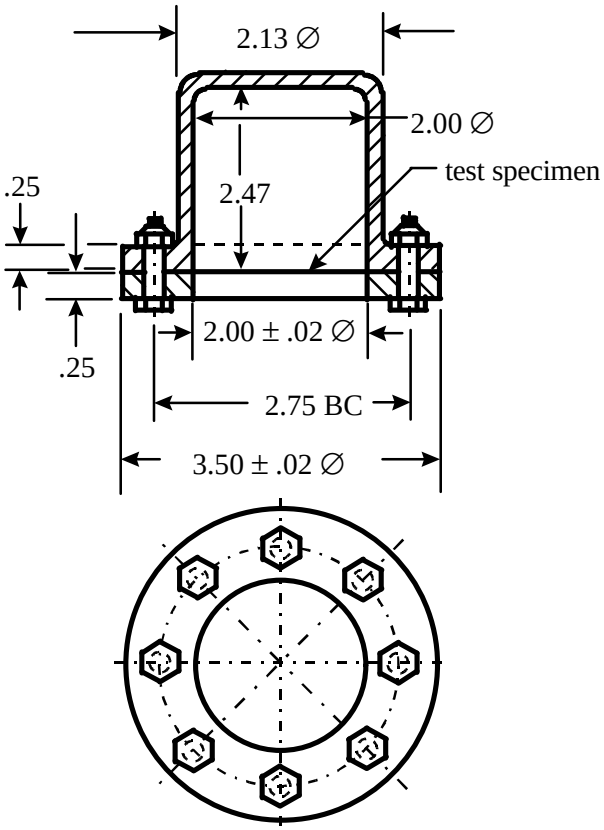

FIGURE 1. Diffusion cup assembly.

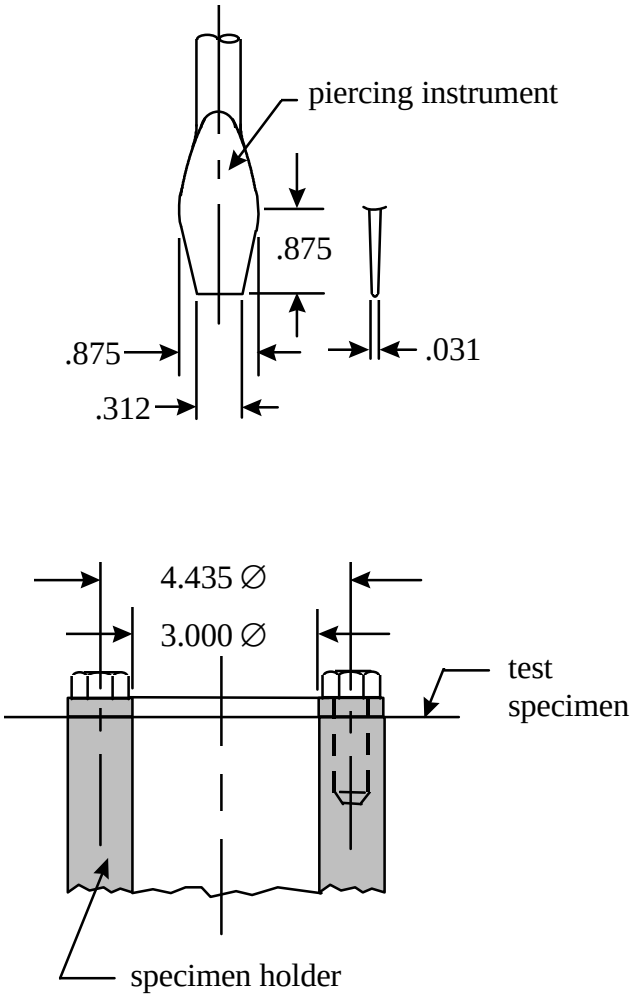

FIGURE 2. Piercing instrument and specimen holder.

Custodian:
Army - AT

Preparing Activity:
Army - AT

(Project 2910-A012)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	**1. DOCUMENT NUMBER** MIL-PRF-14442E(AT)	**2. DOCUMENT DATE *(YYMMDD)*** 971121

3. DOCUMENT TITLE

Tank, Fuel, Engine: Non-Metallic, Non-Self-Sealing, For Military Vehicles

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	**b. ORGANIZATION**	
c. ADDRESS *(Include Zip Code)*	**d. TELEPHONE *(Include Area Code)*** **(1) Commercial** **(2) AUTOVON** ***(If applicable)***	**7. DATE SUBMITTED *(YYMMDD)***

8. PREPARING ACTIVITY

a. NAME	**b. TELEPHONE *(Include Area Code)*** **(1) Commercial** **(2) AUTOVON** **(810) 574-8745** **786-8745**
c. ADDRESS *(Include Zip Code)* **Commander** **U.S. Army Tank-automotive and Armaments Command** **ATTN: AMSTA-TR-E/BLUE** **Warren, MI 48397-5000**	**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:** **Defense Quality and Standardization Office** **5203 Leesburg Pike, Suite 1403** **Falls Church, VA 22041-3466** **Telephone (703) 756-2340 AUTOVON 289-2340**

MILITARY SPECIFICATION

CAP, FUEL TANK: FOR MILITARY COMBAT AND TACTICAL TRANSPORT VEHICLES

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers three types of fuel tank caps intended for use on military vehicles. The type I and type XI fuel tank caps are vented, while the type III fuel tank cap is nonvented (see 6.1).

1.2 Classification. Fuel tank caps, hereinafter referred to as "caps", shall be of the following types, as specified (see 6.2):

Type I	Vented cap with pressure relief valve and float assembly (MS51300).
Type II	Vented cap with pressure relief valve and fording valve (MS35645).
"Type III	Nonvented cap (MS3507S).

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DOT)ISS) and supplement thereto, cited in the solicitation.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Tank-Automotive Command, ATTN: AMSTA-GDS, Warren, MI 48397-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

AMSC N/A FSC 2910

SPECIFICATIONS
FEDERAL

PPP-B-566	- Boxes, Folding, Paperboard.
PPP-B-601	- Boxes, Wood, Cleated-Plywood.
PPP-B-621	- Boxes, Wood, Nailed and Lock-Corner.
PPP-B-636	- Boxes, Shipping Fiberboard
PPP-B-640	- Boxes, Fiberboard, Corrugated, Triple-Wall.
PPP-B-665	- Boxes, Paperboard, Metal Edged and Components.
PPP-B-676	- Boxes, Setup.

MILITARY

MIL-P-116	- Preservation, Methods of.
MIL-B-117	- Bags, Sleeves and Tubing-Interior Packaging.

STANDARDS
MILITARY

MIL-STD-105	- Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129	- Marking for Shipment and Storage.
MIL-STD-130	- Identification Marking of US Military Property.
MIL-STD-45662	- Calibration Systems Requirements.
MS35644	- Filler Neck Assembly, Fuel Tank - Military Vehicles.
MS35645	- Cap, Fuel Tank: Tactical Vehicles, Fording.
MS51300	- Cap, Fuel Tank: Combat Vehicle, Spill Proof .
MS53075	- Cap, Fuel Tank: Tactical Vehicle, Non-Vented.

(Copies of specifications and standards required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following document forms a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D3951 - Commercial Packaging, Practice for.

(Application for copies should be addressed to American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA, 19103.)

(Nongovernment standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this 'specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. Unless otherwise specified (see 6.2), the contractor shall furnish caps, of the specified type (see 6.2), which shall be subjected to first article inspection (see 4.4). First article inspection samples, properly marked with identifying information shall be representative of the caps co 'be furnished to the Government. All subsequent caps delivered to the Government shall conform to these samples in all of their pertinent physical and performance attributes.

3.2 Materials (all types). Materials shall be as specified herein and in referenced specifications, standards and drawings. Materials shall be free of defects which adversely affect performance or serviceability of the finished product (see 4.6.1).

3.2.1 Recycled, virgin and reclaimed materials. There are no requirements for the exclusive use of virgin materials. The use of recycled or reclaimed (recovered) materials is acceptable provided that all other requirements of this specification are met (see 6.3.1).

3.3 Construction (all types) (see 4.6.1 and 4.6.2).

3.3.1 Type I. Type I caps shall conform to MS51300.

3.3.2 Type II. Type II caps shall conform to MS35645.

3.3.3 Type III. Type III caps shall conform to MS53075.

3.4 Performance.

3.4.1 Torque.

3.4.1.1 Caps (all types). When connecting the cap to a filler neck conforming to MS35644 at temperatures of plus 125 to minus 65 degrees Fahrenheit (°F), the torque shall be no greater than 70 inch-pounds attained before the cap hits the stop limit. The torque required to disconnect the cap from the filler neck at temperatures of plus 125 to minus 65°F shall be not greater than 70 nor less than 25 inch-pounds. There shall be no visible evidence of binding (see 4.6.3.1).

3.4.1.2 Fording valve (type 11 only). The torque required to move the fording valve out of closed or open position shall be not less than 10 inch-ounces (see 4.6.3.2).

3.4.2 Leakage (all types). When tested as specified in 4.6.4, with a pressure of 2 pounds per square inch (psi) for type I and 1 psi for type II (with fording value closed) and type III caps, the leakage shall not exceed 0.5 ounce per minute.

3.4.3 Pressure relief valve opening.

3.4.3.1 Type I. When tested as specified in 4.6.5.1, the pressure relief valve for type I caps shall open at between 4 to 5 psi, when the float is in the actuated condition.

3.4.3.2 Type II. When tested as specified in 4.6.5.2, the pressure relief valve for type II caps shall open at between 2 to 3 psi, when the fording valve is in the closed position.

3.4.4 Free breathing (types I and II). When tested as specified in 4.6.6, type I and type 11 caps (type II cap with fording valve open) shall have an air flow through them of not less than 0.010 cubic foot per minute (cfm), at room temperature with 1 psi vacuum.

3.4.5 Shear strength (all types). When tested as specified in 4.6.7, type I caps shall withstand not less than 25 foot-pounds of applied torque before showing any rotation of the inner member with respect to the outer shell. Type II and type 111 caps shall withstand not less than 25 foot-pounds of applied torque before showing any rotation of cup on inner plate or inner plate on shell.

3.4.6 External pressure (types II and 111). When tested as specified in 4.6.8, type 11 (with fording valves closed) and type III caps shall not leak.

3.5 Finish (all types). Unless otherwise specified (see 6.2), caps shall be finished on the interior or exterior as specified in the applicable MS standard (see 3.3 and 4.6.2).

3.6 Identification marking (all types). Caps shall be marked in accordance with the applicable MS standard and the requirements of MIL-STD-130 (see 3.3 and 4.6.2).

3.7 Workmanship (all types). The workmanship of the cap shall be of such quality as to assure a product free of defects affecting its serviceability and appearance (see 4.6.2).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform or witness any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.1.2 Inspection equipment. Unless otherwise specified in the contract (see 6.2), the contractor is responsible for the provision and maintenance of all inspection equipment necessary to assure that supplies and services conform to contract requirements. Inspection equipment must be capable of repetitive measurements to an accuracy of 10 percent (%) of the measurement tolerance. Calibration of inspection equipment shall be in accordance with MIL-STD-45662.

4.2 Classification of inspection:

a. First article inspection (see 4.4).
b. Quality conformance inspections (see 4.5).
    1. Examination (see 4.5.2).
    2. Tests (see 4.5.3).
c. Inspection of packaging (see 4.7).

4.3 Inspection conditions. Unless otherwise specified (see 6.2), all inspections shall be conducted under the following conditions:

a. Air temperature 73 ± 18°F
b. Barometric pressure 28.5 + 2 inches mercury (Hg)
- 3
c. Relative humidity 50 ± 30%

4.3.1 Cleaning. The caps and all cap parts in contact with fuel shall be cleaned prior to tests.

4.3.2 Filler neck. When the use of a filler neck is specified during testing, the filler neck shall conform to MS35644.

4.4 First article inspection. Unless otherwise specified (see 6.2), the Government shall select five sample caps, of the specified type, produced under the production contract for first article inspection. First article samples shall be inspected as specified in table I. Approval of the first article sample by the Government shall not relieve the contractor of his obligation to supply caps that are fully representative of those inspected as a first article sample. Any changes or deviation of the production units from the first article sample shall be subject to the approval of the contracting officer. The applicability of cap types to tests shall be as specified in table II.

TABLE X. Classification of inspections.

Title	Requirement	Inspection	First article 1/	Quality conformance	
				Examination	Tests 1/
Materials and construction	3.2 and 3.3	4.6.1	X		
Defects (see table III)	3.3, 3.5 thru 3.7	4.6.2	X	X	
Torque, cap	3.4.1.1	4.6.3.1	X		X
Torque, fording valve	3.4.1.2	4.6.3.2	X		X
Leakage	3.4.2	4.6.4	X		X
Pressure relief valve opening	3.4.3	4.6.5	X		X
Free breathing	3.4.4	4.6.6	X		X
Shear strength	3.4.5	4.6.7	X		X
External pressure	3.4.6	4.6.8	X		X
Packaging	5.1	4.7			

1/ See table II.

TABLE II. Applicability of cap types to tests.

Tests	Cap type		
	I	II	III
4.6.3.1	X	X	X
4.6.3.2		X	
4.6.4	X	X	X
4.6.5.1	X		
4.6.5.2		X	
4.6.6	X	X	
4.6.7	X	X	X
4.6.8		X	X

4.4.1 First article inspection failure. Deficiencies found during, or as a result of, first article inspection shall be cause for rejection of the first article samples until evidence has been provided by the contractor that corrective action has been taken to eliminate the deficiency. Any deficiency found during, or as a result of, first article inspection, shall be evidence that all items already produced prior to completion of first article inspection are similarly deficient unless contrary evidence satisfactory to the contracting officer is furnished by the contractor. Such deficiencies on all items shall be corrected by the contractor. The Government shall not accept products until first article inspection is completed to the satisfaction of the Government.

4.5 Quality conformance inspection

4.5.1 Sampling.

4.5.1.1 Lot formation. An inspection lot shall consist of all the caps of one type and part number, from an identifiable production periods from one manufacturer, submitted at one time for acceptance.

4.5.1.2 Sampling for examination. Samples for quality conformance examination shall be selected in accordance with general inspection level II of MIL-STD-105.

4.5.1.3 Sampling for tests. Samples for quality conformance tests shall be selected in accordance with level S-3 of MIL-STD-105.

4.5.2 Examination.

4.5.2.1 Acceptable quality level. Each sample selected in accordance with 4.5.1.2 shall be examined to determine conformance to the following acceptable quality levels (AQL):

Classification	AQL
Major	1.0
Minor	2.5

4.5.2.2 Classification of defects. For examination purposes, defects shall be classified as listed in table III.

TABLE III. Classification of defects.

Category	Defect	Method of examination
Critical	None	
Major	AQL 1.0% Defective	
101	Dimensions, out of tolerance affecting interchangeability (see 3.3).	SIE 1/
102	Faulty workmanship affecting performance (see 3.7).	Visual
Minor	AQL 2.5% Defective	
201	Dimensions, out of tolerance not affecting interchangeability (see 3.3).	SIE
202	Finish, improper (see 3.5).	Visual
203	Identification marking, improper (see 3.6).	Visual
204	Faulty workmanship affecting appearance (see 3.7).	Visual

1/ SIE = Standard Inspection Equipment.

4.5.3 Tests. Sample caps selected as specified in 4.5.1.3 shall be subjected to the quality conformance tests specified in table I, using an AQL of 6.5 on the basis of percent defective. The applicability of cap types to tests shall be as specified in table 11.

4.6 Methods of inspection.

4.6.1 Materials and construction (all types). Conformance to 3.2 and 3.3, shall be determined by inspection of contractor records providing proof or certification that design, construction, processing, and materials conform to requirements. Applicable records shall include drawings, specifications, design data, receiving inspection records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports, and rating data.

4.6.2 Defects (all types). Conformance to 3.3, 3.5, 3.6 and 3.7 shall be determined by examination for the defects listed in table III. Examination shall be visual or by measurement with standard inspection equipment.

4.6.3 Torque.

4.6.3.1 Caps (all types). To determine conformance to 3.4.1.1, the cap shall be connected to and then disconnected from the filler neck using a torque wrench. This procedure shall be repeated five times, observing the torque required. In connecting the cap, the maximum torque value shall be attained before the cap reaches the end of travel.

4.6.3.2 Fording valve (type II only). To determine conformance to 3.4.1.2, actuate the fording valve control from the “open” to the “closed” position and from the “closed” to the “open” position, using a torque wrench and noting the torque required.

4.6.4 Leakage (all types). To determine conformance to 3.4.2, a filler neck, with cap mounted, shall be placed in an airtight chamber (see figure 1). The chamber shall be 3/4 filled with a liquid of the viscosity of gasoline. It shall be rotated to place the cap below the liquid level. An internal pressure of 2 psi shall be applied for type I and 1 psi for types 11 and III caps and any leakage shall be recorded.

4.6.5 Pressure relief valve opening.

4.6.5.1 Type 1. To determine conformance to 3.4.3.1, fabricate an air pressure chamber from a MS35644 filler neck assembly. Gradually increase the air pressure to verify that the relief valve opens at 4 to 5 psig. The vent opening may be plugged with a rubber stopper. For safety reasons, the air supply system should be designed to preclude exceeding 10 psig. Since the effective area of the relief valve is approximately 1 square inch, an equivalent mechanical force may be used in lieu of air pressure. Visually observe the relief valve opening with a 4 to 5 lb force applied to the ball chamber by a suitable means, such as a spring scale.

4.6.5.2 Type II. To determine conformance to 3.4.3.2, the cap shall be placed on a filler neck and the fording valve shall be closed. Internal pressure of the filler neck shall be increased at a rate not exceeding 0.1 psi per second until pressure relief valve opens at a maximum of 6 psi is obtained.

4.6.6 Free breathing (types I and II). To determine conformance to 3.4.4, the cap shall be installed on a filler neck that is mounted on testing apparatus conforming to figure 2. One psi of vacuum shall be applied and the air flow meter shall be checked for resulting air flow through the cap.

4.6.7 Shear strength (all types). To determine conformance to 3.4.5, the cap shall be mounted on a filler neck. Torque shall be applied with a torque wrench until the rotation of the inner member of the type I cap with respect to its outer shell and until rotation of cup on inner plate or inner plate on shell for type II and type III caps occur* The value of torque in foot-pounds shall be recorded.

4.6.8 External pressure (types I and II). To determine conformance to 3.4.6, the cap shall be mounted on a filler neck. The assembly shall be inverted and placed in an airtight container (see figure 1) fiiled 3/4 full of water. The cap shall be below the water surface and the filler neck shall be vented to atmospheric pressure. A pressure of 5 psi shall be applied to the airtight container and maintained for 60 to 70 seconds after which the assembly shall be disassembled and inspected for leakage.

4.7 Inspection of packaging.

4.7.1 Army. Packaging shall be inspected as specified in the packaging requirement (see 5.1).

4.7.2 Navy and Air Force. The Government shall at unscheduled intervals inspect the packaging to determine conformance to the requirements of 5.2. Any evidence of deviation from specified requirements shall be cause for refusal to conduct further inspection until objective evidence has been provided by the contractor that corrective action has been taken.

5. PACKAGING

5.1 Preservation, packaging, packing, and marking (for Army use). Preservation, packaging, packing, and marking for the desired level shall be in accordance with the applicable packaging requirements specified by the contracting authority (see 4.7.1 and 6.2).

5.2 Preservation, packaging, packing, and marking (for Navy and Air Force use) (see 4.7.2).

5.2.1 Preservation and packaging. Preservation and packaging shall be level A, or commercial, as specified (see 6.2).

5.2.1.1 Level A.

5.2.1.1.1 Cleaning. Each cap shall be cleaned by any applicable process or combination of processes in accordance with MIL-P-116.

5.2.1.1.2 Drying. Immediately after cleaning, each cap shall be dried by any applicable procedure in accordance with MIL-P-116.

5.2.1.1.3 Unit packaging. Each cap shall be packaged in accordance with IC-2 of MIL-P-116, except a contact preservative is not required. Each cap shall be placed in a snug-fitting box conforming to the requirements of PPP-B-566, PPP-B-665, or PPP-B-676 and the box shall be enclosed in a heat-sealed bag conforming to class b of MIL-B-117.

5.2.1.1.4 Intermediate packaging. The packaged caps shall be packaged in an intermediate container conforming to PPP-B-636, type CF, class-domestic, variety DW and shall not exceed 20 pounds gross weight and 1.5 cubic feet in size. Intermediate container quantities shall be in multiples of 5 or 10.

5.2.1.2 Commercial. Cleaning, drying, preservation and packaging shall be in accordance with ASTM D3951.

5.2.2 Packing. Packing shall be level A, B or commercial, as specified (see 6.2).

5.2.2.1 Level A. The packaged caps shall be packed in overseas-type containers conforming to PPP-B-621 or PPP-B-601. The gross weight shall not exceed the weight limitation specified in the applicable container specification. The containers shall be closed in accordance with the' applicable container specification or appendix thereto. Strapping shall be zinc coated.

5.2.2.2 Level B. The packaged caps shall be packed in domestic-type containers conforming to PPP-B-621, or PPP-B-601, or PPP-B-640 or PPP-B-636. The gross weight shall not exceed the weight limitations specified in the applicable container specification. The container shall be closed and strapped in accordance with the applicable container specification or appendix thereto.

5.2.2.3 Commercial. Packing shall be in accordance with ASTM D3951.

5.2.3 Marking. Marking shall be level A, B or commercial, as specified (see 6.2).

5.2.3.1 Levels A and B. Marking for levels A and B shall be in accordance with MIL-STD-129 and any special marking specified in the acquisition document (see 6.2).

5.2.3.2 Commercial. Marking shall be in accordance with ASTM D3951.

6. NOTES

6.1 Intended use. Caps covered by this specification are used on the following vehicles.

6.1.1 Type I. The cap is used on military tactical vehicles which are not used in fording operations.

6.1.2 Type II. The cap is used on military tactical vehicles with fuel supply systems designed for atmospheric venting through the fuel cap (fording valve open) and fuel systems incorporating a vacuum relief valve or combination vacuum and pressure relief valve (fording valve closed).

6.1.3 Type III. The cap is used on military combat and tactical vehicles with fuel supply systems designed for atmospheric venting by way of the engine air induction system or direct-to-atmospheric above the water line on fording.

6.2 Ordering data. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. Type of cap required (see 1.2).
c. If first article inspection is not required (see 3.1).
d. If cap finish shall be other than as specified (see 3.5).
e. If responsibility for inspection shall be other than as specified (see 4.1).
f. If responsibility for inspection equipment shall be other than as specified (see 4.1.2).
g. If inspection conditions shall be other than as specified (see 4.3).
h. If first article inspection sample size shall be other than as specified (see 4.4).
i. For Army use specify the applicable level and packaging standard requirements (see 5.1).
j. For Navy and Air Force use specify commercial or applicable level of preservation, packaging, packing and marking (see 5.2.1, 5.2.2 and 5.2.3).
k. Whether special marking is required (see 5.2.3.1).

6.3 Definitions.

6.3.1 Recovered materials. "Recovered materials" means materials that have been collected or recovered from solid waste (see 6.3.2).

5.3.2 Solid waste. "Solid waste" means (a) any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility; and (b) other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities. It does not include solid or dissolved material in domestic sewage, or solid or dissolved material in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Clean Water Act, (33 U.S.C. 1342 et seq.) or source nuclear, or byproduct material as defined by the atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) (Source: Federal Acquisition Regulations, section 23.402).

6.4 Subject term (key word) listing.

Fuel tank cap
Tank, fuel cap

6.5 Changes from previous issue. Asterisks (or vertical lines) are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

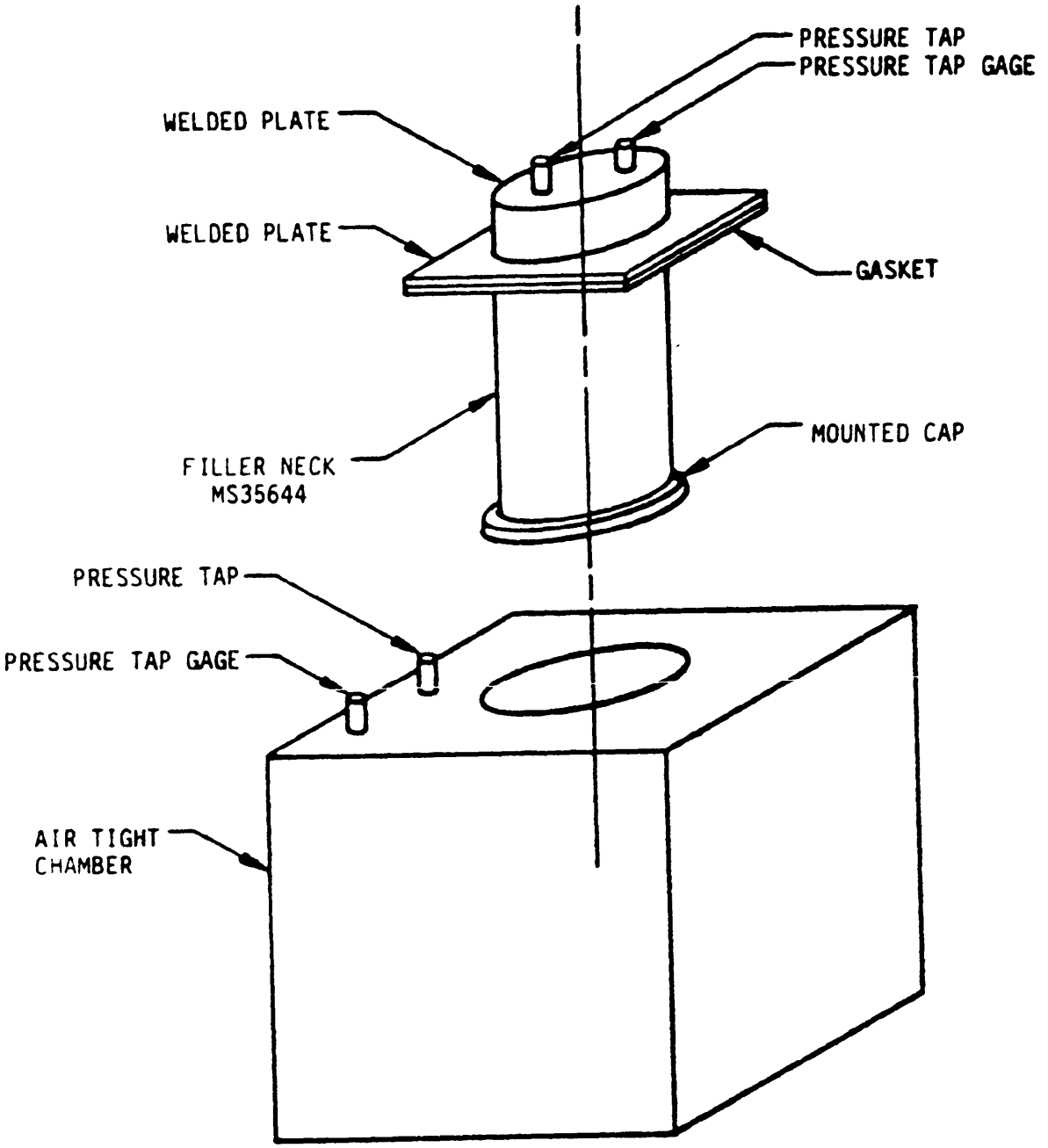

FIGURE 1. Schematic diagram of air tight chamber and modified filler neck.

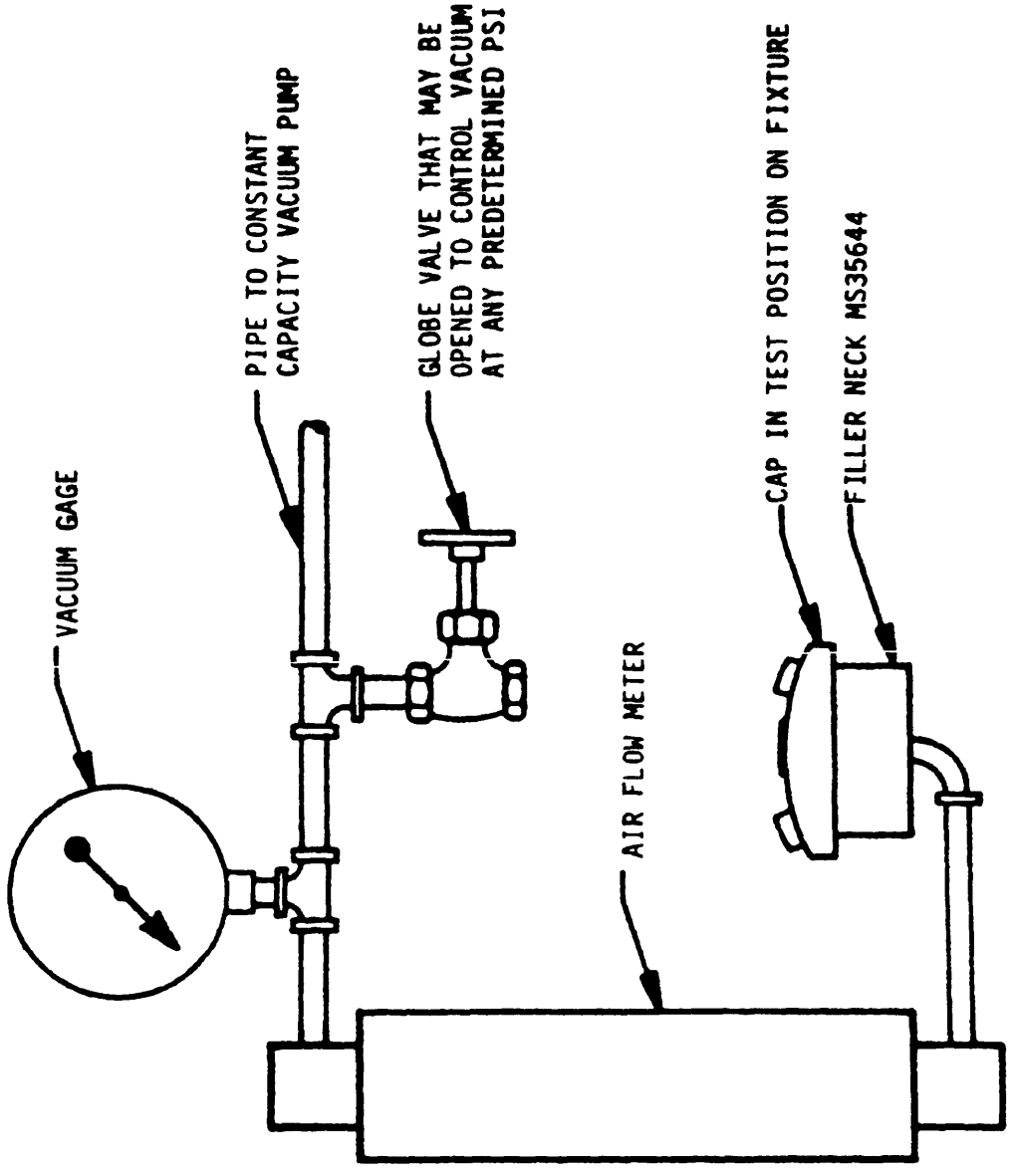

FIGURE 2. Set up for determining air flow through the type II cap.

Custodians:
Army - AT
Navy - MC
Air Force - 99

Review activities:
Army - MI, GL
DLA - CS

User activity:
Navy - YD

Preparing activity:
Army - AT

(Project 2910-0192)

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

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1. DOCUMENT NUMBER	2 DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

DD FORM 82 MAR 1426

PREVIOUS EDITION IS OBSOLETE.

APPENDIX B : EUROPEAN COMMUNITY (EC)

- Directive 70 / 221 – Fuel Tanks
- Directive 2000 / 08 – Adaptation of Fuel Tanks (Plastic Tanks)

Community legislation in force

Document 370L0221

370L0221 Consolidated Disclaimer

Council Directive 70/221/EEC of 20 March 1970 on the approximation of the laws of the Member States relating to liquid fuel tanks and rear protective devices for motor vehicles and their trailers

Official Journal L 076 , 06/04/1970 p. 0023 - 0024
Danish special edition ....: Series-I 70(I) p. 170
English special edition...: Series-I 70(I) p. 192
Greek special edition ....: Chapter 13 Volume 1 p. 89
Spanish special edition...: Chapter 13 Volume 1 p. 217
Portuguese special edition Chapter 13 Volume 1 p. 217
Finnish special edition....: Chapter 13 Volume 1 p. 135
Swedish special edition...: Chapter 13 Volume 1 p. 135

Amendments:

*Amended by **172B***
*Amended by **379L0490** (OJ L 128 26.05.1979 p.22)*
*Incorporated by **294A0103(52)** (OJ L 001 03.01.1994 p.263)*
*Amended by **397L0019** (OJ L 125 16.05.1997 p.1)*
*Amended by **300L0008** (OJ L 106 03.05.2000 p.7)*

Text:

COUNCIL DIRECTIVE of 20 March 1970 on the approximation of the laws of the Member States relating to liquid fuel tanks and rear protective devices for motor vehicles and their trailers (70/221/EEC)

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community and in particular Article 100 thereof;

Having regard to the proposal from the Commission;

Having regard to the Opinion of the European Parliament (1);

Having regard to the Opinion of the Economic and Social Committee (2);

Whereas the technical requirements which motor vehicles must satisfy pursuant to national laws relate, inter alia to their liquid fuel tanks and rear protective devices;

Whereas those requirements differ from one Member State to another ; whereas it is therefore necessary that all Member States adopt the same requirements either in addition to or in place of their existing rules, in order, in particular, to allow the EEC type approval procedure which was the subject of the Council Directive (3) of 6 February 1970 on the approximation of the laws of the Member States relating to the type approval of motor vehicles and their trailers to be applied in respect of each type of vehicle;

HAS ADOPTED THIS DIRECTIVE:

Article 1

For the purposes of this Directive, "vehicle" means any motor vehicle intended for use on the road, with or without bodywork, having at least four wheels and a maximum design speed exceeding 25 kilometres per hour, and its trailers, with the exception of vehicles which run on rails, agricultural tractors and machinery and public works vehicles.

Article 2

No Member State may refuse to grant EEC type approval or national type approval of a vehicle on grounds relating to liquid fuel tanks or rear protective devices if these satisfy the requirements set out in the Annex.

Article 3

The amendments necessary for adjusting the requirements of the Annex so as to take account of technical progress, with the exception of the requirements set out under item I, shall be adopted in accordance with the procedure laid down in Article 13 of the Council Directive of 6 February 1970 on the type approval of

motor vehicles and their trailers.

Article 4
1. Member States shall put into force the provisions containing the requirements needed in order to comply with this Directive within eighteen months of its notification and shall forthwith inform the Commission thereof.
2. Member States shall ensure that the texts of the main provisions of national law which they adopt in the field covered by this Directive are communicated to the Commission.

Article 5
This Directive is addressed to the Member States.

Done at Brussels, 20 March 1970.
For the Council
The President
P. HARMEL (1)OJ No C 160, 18.12.1969, p. 7. (2)OJ No C 48, 16.4.1969, p. 16. (3)OJ No L 42, 23.2.1970, p. 1.

ANNEX
I. Tanks and reserve tanks for liquid fuel I. 1. Fuel tanks must be made so as to be corrosion resistant. They must satisfy the leakage tests carried out by the manufacturer at a pressure equal to double the working pressure but in any event not less than 1.3 bars. Any excess pressure or any pressure exceeding the working pressure must be automatically compensated by suitable devices (vents, safety valves, etc.). The vents must be designed in such a way as to prevent any fire risks. The fuel must not escape through the fuel tank cap or through the devices provided to compensate excess pressure, even if the tank is completely overturned : a drip shall be tolerated.
I. 2. Fuel tanks must be installed in such a way as to be protected from the consequences of an impact to the front or to the rear of the vehicle ; there shall be no protruding parts, sharp edges, etc., near the tanks.
II. Rear protective devices II. 1. The ground clearance throughout the width of the rear of the chassis or of the main parts of the body may not exceed 70 cm, where the centre of the rearmost axle and the rearmost point of the vehicle are more than 1 metre apart.
II. 2 If this requirement is not met, the vehicle must be equipped with a rear protective device fitted in accordance with the specifications listed below.
II. 3 Specifications for fitting rear protective devices: II. 3.1. The underside of the rear protective device must be less than 70 cm from the ground when the vehicle is unladen.
II. 3.2. At the place where the rear protective device is fitted its width may not exceed the width of the vehicle or be less than the width of the vehicle by more than 10 cm on either side.
II. 3.3. The rear protective device must be placed as closely as possible to the rear of the vehicle and in no case more than 60 cm from the rearmost point of the vehicle.
II. 3.4. The ends of the rear protective device must not be bent backwards.
II. 3.5. The rear protective device must be firmly fixed to the chassis side-members or to whatever replaces them.
II. 3.6. The rear protective device must have a bending strength at least equivalent to that of a steel beam whose cross-section has a bending strength modulus of 20 cm3.
II. 4. By way of derogation from the preceding requirements, vehicles of the following types need not be fitted with a rear protective device: - tractors for semi-trailers;
- "slung" trailers and other similar trailers for the transport of logs or other very long items;
- vehicles for which a rear protective device is incompatible with their use.

Community legislation in force

Document 300L0008

Directory chapters where this document can be found:
[13.30.10 - Motor vehicles]

Instruments amended:
370L0221 *(Modification)*

300L0008
Directive 2000/8/EC of the European Parliament and of the Council of 20 March 2000 amending Council Directive 70/221/EEC on the approximation of the laws of the Member States relating to liquid fuel tanks and rear underrun protection of motor vehicles and their trailers
Official Journal L 106 , 03/05/2000 p. 0007

Text:

Directive 2000/8/EC of the European Parliament and of the Council
of 20 March 2000
amending Council Directive 70/221/EEC on the approximation of the laws of the Member States relating to liquid fuel tanks and rear underrun protection of motor vehicles and their trailers

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,
Having regard to the Treaty establishing the European Community, and in particular Article 95 thereof,
Having regard to the proposal from the Commission(1),
Having regard to the opinion of the Economic and Social Committee(2),
Acting in accordance with the procedure laid down in Article 251 of the Treaty(3),
Whereas:
(1) Council Directive 70/221/EEC of 20 March 1970 on the approximation of the laws of the Member States relating to liquid fuel tanks and rear underrun protection for motor vehicles and their trailers(4), is one of the separate directives within the EC type-approval procedure which was established by Council Directive 70/156/EEC of 6 February 1990 on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers(5); consequently, the provisions and definitions laid down in Directive 70/156/EEC concerning vehicles, vehicles systems, components and separate technical units apply to Directive 70/221/EEC; it is necessary to adapt Article 1 of Directive 70/221/EEC to the definitions of Directive 70/156/EEC.
(2) In order to take account of technical progress, it is advisable to adapt Directive 70/221/EEC to the technical requirements adopted by the United Nations Economic Commission for Europe in its Regulation No 34 relating to the approval of vehicles with regard to the prevention of fire risk, in particular, to the provisions of fuel tanks made of plastic material.
(3) The accidental spillage of fuel (especially diesel) on to the road is a significant hazard for riders of two-wheeled motor vehicles and pedal cycles.
(4) There is increasing interest in gaseous fuels for the propulsion of motor vehicles, in particular for environmental reasons; whereas therefore, in future, Directive 70/221/EEC should also contain provisions for tanks for fuels other than liquid fuels; for this purpose the title and the scope of Directive 70/221/EEC should be amended accordingly; technical specifications for tanks for gaseous fuels will be introduced through later amendments of the said Directive.
(5) Furthermore, it is more and more common for original fuel tanks to be replaced by larger fuel tanks or for additional, unapproved fuel tanks to be installed; provision should consequently be made at the earliest opportunity for Community type-approval of liquid and gas fuel tanks as separate technical units, in order to maintain a high level of safety in motor-vehicle traffic.
(6) Amendments to the provisions relating to fuel tanks have to be adopted by the European Parliament and the Council; whereas it is expedient that, in the future, amendments necessary for adjusting the technical requirements of Directive 70/221/EEC relating to fuel tanks to technical progress should be adopted in

accordance with the procedure laid down in Article 13 of Directive 70/156/EEC.
(7) The amendments made by this Directive relate in particular to fuel tanks made of a plastic material; it is unnecessary therefore to invalidate existing approvals granted under Directive 74/60/ EEC(6) and to prevent the sale, registration and entry into service of new vehicles having metal liquid fuel tanks covered by such approvals.
(8) Given the scale and impact of the action proposed in the sector in question, the Community measures which are the subject of this Directive are necessary, or even indispensable, to attain the objective set, namely Community vehicle type-approval; this objective cannot be adequately achieved by the Member States individually,
HAVE ADOPTED THIS DIRECTIVE:

Article 1
Directive 70/221/EEC is hereby amended as follows:
1. The title shall be replaced by the following:
"Council Directive of 20 March 1970 on the approximation of the laws of the Member States relating to fuel tanks and rear underrun protection of motor vehicles and their trailers".
2. Article 1 shall be replaced by the following:
"Article 1
For the purpose of this Directive, 'vehicle' means any motor vehicle and its trailers as defined in Annex II Section A to Directive 70/156/EEC."
3. Article 2(1) shall be replaced by the following:
"1. No Member State may refuse to grant EC type-approval or national type-approval for a vehicle on grounds relating to its fuel tanks if such vehicle satisfies the requirements set out in this Directive concerning fuel tanks."
4. Article 2a(1) shall be replaced by the following:
"1. No Member State may refuse or prohibit the sale, registration, entry into service or use of a vehicle on grounds relating to its fuel tanks if such a vehicle satisfies the requirements set out in this Directive concerning fuel tanks."
5. Article 3 shall be replaced by the following:
"Article 3
Any amendments necessary to adapt the requirements of the Annexes to technical progress, shall be adopted in accordance with the procedure laid down in Article 13 of Directive 70/156/EEC."
6. The list of Annexes and Annex I to Directive 70/221/EEC are hereby amended in accordance with the Annex to this Directive.

Article 2
1. With effect from 3 May 2001, Member States shall accept compliance with the requirements of Directive 70/221/EEC, as amended by this Directive, for the purposes of Articles 4(1) and 7(1) of Directive 70/156/EEC.
2. With effect from 3 May 2002, Member States:
- shall no longer grant EC type-approval in accordance with Article 4(1) of Directive 70/156/EEC, and
- may refuse national type-approval,
for a new type of vehicle on grounds related to its fuel tanks if it fails to comply with the provisions of Directive 70/221/EEC, as amended by this Directive.
3. With effect from 3 May 2003, Member States
- shall consider certificates of conformity which accompany new vehicles in accordance with the provisions of Directive 70/156/EEC as no longer valid for the purposes of Article 7(1) of that Directive, and
- may refuse the sale, registration or entry into service of new vehicles which are not accompanied by a certificate of conformity valid in accordance with Directive 70/156/EEC, except where the provisions of Article 8(2) of that Directive are invoked,
on grounds relating to the fuel tanks, if the requirements of Directive 70/221/EEC, as amended by this Directive, are not fulfilled.
4. This Directive shall not invalidate any approval previously granted to vehicles having metal liquid fuel tanks nor prevent extensions of such approvals under the terms of the directive under which they were originally granted.

Article 3
1. Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive before 3 May 2001 and shall forthwith inform the Commission thereof. When Member States adopt these measures, they shall contain a reference to this Directive or shall be accompanied by such reference on the occasion of their official publication. The methods of making such reference shall be laid down by Member States.
2. Member States shall communicate to the Commission the text of the main provisions of national law which they adopt in the field governed by this Directive.

Article 4
This Directive shall enter into force on the 20th day following its publication in the Official Journal of the European Communities.

Article 5
This Directive is addressed to the Member States.

Done at Brussels, 20 March 2000.

For the European Parliament
The President
N. Fontaine

For the Council
The President
J. Gama

(1) OJ C 164, 29.5.1998, p. 16.
(2) OJ C 407, 28.12.1998, p. 58.
(3) Opinion of the European Parliament of 10 February 1999 (OJ C 150, 28.5.1999, p. 168), Council common position of 12 July 1999 (OJ C 249, 1.9.1999, p. 25), decision of the European Parliament of 27 October 1999 (not yet published in the Official Journal).
(4) OJ L 76, 6.4.1970, p. 23. Directive as last amended by Commission Directive 97/19/EC (OJ L 125, 16.5.1997, p. 1).
(5) OJ L 42, 23.2.1970, p. 1. Directive as last amended by Directive 98/91/EC of the European Parliament and of the Council (OJ L 11, 16.1.1999, p. 25).
(6) OJ L 38, 11.2.1974, p. 2. Directive as last amended by Directive 78/632/EEC (OJ L 206, 29.7.1978, p. 26).

ANNEX

AMENDMENTS TO THE LIST OF ANNEXES AND TO ANNEX I TO DIRECTIVE 70/221/EEC
List of Annexes
The indication regarding Annex I shall be replaced by the following:
">TABLE POSITION>"
Annex I
Annex I shall be replaced by the following:
"ANNEX I

TANKS FOR LIQUID FUEL
1. SCOPE
1.1. This Annex applies to vehicles to which Directive 70/156/EEC applies.
2. DEFINITIONS
For the purpose of this Annex:
2.1. "Vehicle type with regard to fuel tanks", means vehicles which do not differ essentially in such respects as:

2.1.1. The structure, shape, dimensions and materials (metal/plastic) of the tank(s);
2.1.2. In vehicles of category M1(1) the position of the tank(s) in the vehicle in so far as it has a negative effect on the requirements of Section 5.10 of this Annex.
2.2. "Occupant compartment", means the space for occupant accommodation bounded by the roof, floor, side walls, doors, outside glazing, front bulkhead and rear bulkhead.
2.3. "Unladen mass", means the mass of the vehicle in running order as defined in Section 2.6 of Annex I to Directive 70/156/EEC.
2.4. "Tank", means the tank(s) designed to contain the liquid fuel, as defined in Section 2.6, used primarily for the propulsion of the vehicle excluding its accessories (filler pipe (if it is a separate element), filler hole, cap, gauge, connections to the engine or to compensate interior excess pressure, etc).
2.5. "Capacity of the tank", means the tank capacity as specified by the manufacturer.
2.6. "Liquid fuel", means a fuel which is liquid in normal ambient conditions.
3. APPLICATION FOR EC TYPE-APPROVAL
3.1. The application for type-approval of a type of vehicle with regard to its fuel tanks pursuant to Article 3(4) of Directive 70/156/EEC shall be submitted by the vehicle manufacturer.
3.2. A model for the information document is given in Appendix 3.
3.3. The following must be submitted to the technical service responsible for conducting the type-approval tests:
3.3.1. A vehicle representative of the vehicle type to be approved or the parts of the vehicle which the technical service deems necessary for approval tests;
3.3.2. In the case of a vehicle equipped with a tank made of a plastic material: seven additional tanks, with their accessories;
3.3.3. In the case of a vehicle equipped with a tank made of another material: two additional tanks, with their accessories.
4. GRANTING OF EC TYPE-APPROVAL
4.1. If the relevant requirements are satisfied, EC type-approval pursuant to Article 4(3) and, if applicable, Article 4(4) of Directive 70/156/EEC shall be granted.
4.2. A model for the EC type-approval certificate is given in Appendix 4.
4.3. An approval number in accordance with Annex VII to Directive 70/156/EEC shall be assigned to each type of vehicle approved. The same Member State shall not assign the same number to another type of vehicle.
5. SPECIFICATIONS
5.1. Tanks must be made so as to be corrosion-resistant.
5.2. Tanks must satisfy, when equipped with all accessories which are normally attached to them, the leakage tests carried out according to Section 6.1 at a relative internal pressure equal to double the working excess pressure, but in any event not less than an excess pressure of 0,3 bar.
Tanks for vehicles made of a plastic material are considered as meeting this requirement if they have passed the test described in Section 6.3.2.
5.3. Any excess pressure or any pressure exceeding the working pressure must be compensated automatically by suitable devices (vents, safety valves, etc).
5.4. The vents must be designed in such a way as to prevent any fire risk. In particular, any fuel which may leak when the tank(s) is (are) being filled must not be able to fall on the exhaust system. It shall be channelled to the ground.
5.5. The tank(s) must not be situated in, or form, a surface (floor, wall, bulkhead) of the occupant compartment or other compartment integral with it.
5.6. A partition must be provided to separate the occupant compartment from the tank(s). The partition may contain apertures (e. g. to accommodate cables) provided they are so arranged that fuel cannot flow freely from the tank(s) into the occupant compartment or other compartment integral with it during normal conditions of use.
5.7. Every tank must be securely fixed and so placed as to ensure that any fuel leaking from the tank or its accessories will escape to the ground and not into the occupant compartment during normal conditions of use.
5.8. The filler hole must not be situated in the occupant compartment, in the luggage compartment or in the engine compartment.
5.9. The fuel must not escape through the tank cap or through the devices provided to compensate excess pressure during the foreseeable course of operation of the vehicle. In the case of overturning of the vehicle,

a drip may be tolerated provided that it does not exceed 30 g/min; this requirement must be verified during the test prescribed in Section 6.2.
5.9.1. The tank cap must be fixed to the filler pipe: the seal must be retained securely in place, the cap must latch securely in place against the seal and filler pipe when closed.
5.9.1.1. The requirements of Section 5.9.1 will e deemed to be satisfied if the vehicle meets the requirements of Section 5.1.3 of Annex I to Directive 70/220/EEC(2), subject to the proviso that the examples listed in the third indent of that section do not apply to vehicles in categories other than M1 or N1.
5.10. Tanks must be installed in such a way as to be protected from the consequences of an impact to the front or the rear of the vehicle; there shall be no protruding parts, sharp edges, etc. near the tank.
5.11. The fuel tank and the filler neck shall be designed and installed in the vehicles in such a way as to avoid any accumulation of static electricity charges on their entire surface. If necessary, they shall be discharged into the metallic structure of the chassis or any major metallic mass by means of a good conductor.
5.12. Moreover, tanks made of plastic material must also be tested according to the specific procedure set out in Section 6.3.
6. TESTS
6.1. Hydraulic test
The tank must be subjected to a hydraulic internal pressure test which must be carried out on an isolated unit complete with all its accessories. The tank must be completely filled with a non-flammable liquid (water, for example). After all communication with the outside has been cut off, the pressure must be gradually increased, through the pipe connection through which fuel is fed to the engine, to a relative internal pressure equal to double the working pressure used and in any case to not less than an excess pressure of 0,3 bar, which must be maintained for one minute. During this time the tank shell must not crack or leak; however, it may be permanently deformed.
6.2. Overturn test
6.2.1. The tank and all its accessories must be mounted on to a test fixture in a manner corresponding to the mode of installation on the vehicle for which the tank is intended; this also applies to systems for the compensation of the interior excess pressure.
6.2.2. The test fixture shall rotate about an axis lying parallel to the longitudinal vehicle axis.
6.2.3. The test will be carried out with the tank filled to 90 % of its capacity and also 30 % of its capacity with a non-flammable liquid having a density and a viscosity close to those of the fuel normally used (water may be accepted).
6.2.4. The tank must be turned from its installed position 90° to the right. The tank must remain in this position for at least five minutes.
The tank must then be turned 90° further in the same direction. The tank must be held in this position, in which it is completely inverted, for at least another five minutes.
The tank must be rotated back to its normal position. Testing liquid which has not flowed back from the venting system into the tank must be drained and replenished if necessary.
The tank must be rotated 90° in the opposite direction and left for at least five minutes in this position.
The tank must be rotated 90° further in the same direction. This completely inverted position must be maintained for at least five minutes. Afterwards, the tank must be rotated back to its normal position.
6.3. Additional tests for tank(s) for vehicles made of a plastic material
6.3.1. Impact resistance
6.3.1.1. The tank must be filled to its capacity with a water-glycol mixture or with another liquid having a low freezing point which does not change the properties of the tank material, and must then be subjected to a perforation test.
6.3.1.2. During this test the tank temperature must be 233 K ± 2 K (- 40 °C ± 2 °C).
6.3.1.3. A pendulum impact testing fixture must be used for the test. The impact body must be of steel and have the shape of a pyramid with equilateral-triangle faces and a square base, the summit and the edges being rounded to a radius of 3 mm. The centre of percussion of the pendulum must coincide with the centre of gravity of the pyramid; its distance from the axis of rotation of the pendulum must be 1 m. The total mass of the pendulum must be 15 kg. The energy of the pendulum at the moment of impact must be not less than 30 Nm and as close to that value as possible.
6.3.1.4. The tests must be made on the points of the tank which are regarded as vulnerable to frontal or rear collisions. The points regarded as vulnerable are those which are most exposed or weakest having regard to

the shape of the tank or the way in which it is installed on the vehicle. The points selected by the laboratories must be indicated in the test report.
6.3.1.5. During the test, the tank must be held in position by the fittings on the side or sides opposite the side of impact. No leak must result from the test.
6.3.1.6. At the choice of the manufacturer, all the impact tests may be carried out on one tank or each may be carried out on a different tank.
6.3.2. Mechanical strength
The tank must be tested under the conditions prescribed in Section 6.1 for leaks and for rigidity of shape. The tank and all its accessories must be mounted onto a test fixture in a manner corresponding to the mode of installation on the vehicle for which the tank is intended. Water at 326 K (53 °C) must be used as the testing fluid and must fill the tank to its capacity. The tank must be subjected to a relative internal pressure equal to double the working pressure and in any case to not less than 0,3 bar at a temperature of 326 K ± 2 K (53 °C ± 2 °C) for a period of five hours. During the test, the tank and its accessories must not crack or leak; however, it may be permanently deformed.
6.3.3. Fuel permeability
6.3.3.1. The fuel used for the permeability test must be either the reference fuel specified in Annex VIII to Directive 70/220/EEC or a commercial premium-grade fuel. If the tank is only designed for installation on vehicles with a compression-ignition engine, the tank shall be filled with diesel fuel.
6.3.3.2. Prior to the test, the tank must be filled to 50 % of its capacity with testing fuel and stored, without being sealed, at an ambient temperature of 313 K ± 2 K (40 °C ± 2 °C) until the weight loss per unit time becomes constant.
6.3.3.3. The tank must then be emptied and refilled to 50 % of its capacity with test fuel, after which it must be hermetically sealed and be stored at a temperature of 313 K ± 2 K (40 °C ± 2 °C). The pressure must be adjusted when the contents of the tank have reached the testing temperature. During the ensuing test period of eight weeks, the loss of weight due to diffusion during the test period shall be determined. The maximum permissible average loss of fuel is 20 g per 24 hours of testing time.
6.3.3.4. If the loss due to diffusion exceeds the value indicated in Section 6.3.3.3, the test described there must be carried out again, on the same tank, to determine the loss by diffusion at 296 K ± 2 K (23 °C ± 2 °C), but under the same conditions otherwise. The loss so measured shall not exceed 10 g per 24 hours.
6.3.4. Resistance to fuel
After the test referred to in Section 6.3.3, the tank must still meet the requirements set out in Sections 6.3.1 and 6.3.2.
6.3.5. Resistance to fire
The tank must be subjected to the following tests.
6.3.5.1. For two minutes the tank, fixed as on the vehicle, must be exposed to flame. There must be no leakage of liquid fuel from the tank.
6.3.5.2. Three tests must be made on different tanks filled with fuel as follows:
6.3.5.2.1. If the tank is designed for installation on vehicles equipped with either a positive ignition engine or a compression ignition engine, three tests must be carried out with tanks filled with premium-grade gasoline;
6.3.5.2.2. If the tank is only designed for installation on vehicles equipped with a compression-ignition engine, three tests must be carried out with tanks filled with diesel fuel;
6.3.5.2.3. For each test the tank must be installed in a testing fixture simulating actual installation conditions as far as possible. The method whereby the tank is fixed in the fixture must correspond to the relevant specifications for the vehicle. Vehicle parts which protect the tank and its accessories against exposure to flame or which affect the course of the fire in any way, as well as specified components installed on the tank and plugs, must be taken into consideration. All openings must be closed during the test, but venting systems must remain operative. Immediately prior to the test the tank must be filled with the specified fuel to 50 % of its capacity.
6.3.5.3. The flame to which the tank is exposed must be obtained by burning commercial fuel for positive-ignition engines (hereafter called "fuel") in a pan. The quantity of fuel poured into the pan shall be sufficient to permit the flame, under free-burning conditions, to burn for the whole test procedure.
6.3.5.4. The pan dimensions must be chosen so as to ensure that the sides of the fuel tank are exposed to the flame. The pan must therefore exceed the horizontal projection of the tank by at least 20 cm, but not more then 50 cm. The side walls of the pan must not project more than 8 cm above the level of the fuel at the start of the test.

6.3.5.5. The pan filled with fuel must be placed under the tank in such a way that the distance between the level of the fuel in the pan and the tank bottom corresponds to the design height of the tank above the road surface at the unladen mass (see Section 2.3). Either the pan, or the testing fixture, or both, must be freely movable.
6.3.5.6. During phase C of the test, the pan must be covered by a screen placed 2 cm ± 1 cm above the fuel level. The screen must be made of a refractory material, as prescribed in Appendix 2. There must be no gap between the bricks and they must be supported over the fuel pan in such a manner that the holes in the bricks are not obstructed. The length and width of the frame must be 2 cm to 4 cm smaller than the interior dimensions of the pan so that a gap of 1 cm to 2 cm exists between the frame and the wall of the pan to allow ventilation.
6.3.5.7. When the tests is carried out in the open air, sufficient wind protection must be provided and the wind velocity at fuel-pan level must not exceed 2,5 km/h. Before the test the screen must be heated to 308 K ± 5 K (35 °C ± 5 °C). The fire bricks may be wetted in order to guarantee the same test conditions for each successive test.
6.3.5.8. The test must comprise four phases (see Appendix 1).
6.3.5.8.1. Phase A: Pre-heating (figure 1)
The fuel in the pan must be ignited at a distance of at least 3 m from the tank being tested. After 60 seconds pre-heating, the pan must be placed under the tank.
6.3.5.8.2. Phase B: Direct exposure to flame (figure 2)
For 60 seconds the tank must be exposed to the flame from the freely burning fuel.
6.3.5.8.3. Phase C: Indirect exposure to flame (figure 3)
As soon as phase B has been completed, the screen must be placed between the burning pan and the tank. The tank must be exposed to this reduced flame for a further 60 seconds.
6.3.5.8.4. Phase D: End of test (figure 4)
The burning pan covered with the screen must be moved back to its original position (phase A). If, at the end of the test, the tank is burning, the fire must be extinguished forthwith.
6.3.5.9. The results of the test shall be considered satisfactory if no liquid fuel is leaking from the tank.
6.3.6. Resistance to high temperature
6.3.6.1. The fixture used for the test must match the manner of installation of the tank on the vehicle, including the way in which the tank vent works.
6.3.6.2. The tank filled to 50 % of its capacity with water at 293 K (20 °C) must be subjected for one hour to an ambient temperature of 368 K ± 2 K (95 °C ± 2 °C).
6.3.6.3. The results of the test shall be considered satisfactory if, after the test, the tank is not leaking or seriously deformed.
6.3.7. Markings on the fuel tank
6.3.7.1. The trade name or mark must be affixed to the tank; it must be indelible and clearly legible on the tank when the latter is installed on the vehicle.
7. AMENDMENTS TO APPROVAL
7.1. In the case of amendments to approvals granted pursuant to this Directive, the provisions of Article 5 of Directive 70/156/EEC shall apply.
8. CONFORMITY OF PRODUCTION
8.1. Measures to ensure the conformity of production shall be taken in accordance with the provisions laid down in Article 10 of Directive 70/156/EEC.

(1) As defined in Annex II, Part A to Directive 70/156/EEC.
(2) OJ L 76, 6.4.1970, p. 1.
Appendix 1

TEST OF RESISTANCE TO FIRE
Figure 1
>PIC FILE= "L_2000106EN.001602.EPS">
Figure 2
>PIC FILE= "L_2000106EN.001603.EPS">
Figure 3
>PIC FILE= "L_2000106EN.001604.EPS">
Figure 4

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Appendix 2

DIMENSIONS AND TECHNICAL DATA OF FIREBRICKS
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>TABLE POSITION>

Appendix 3

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Appendix 4

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>PIC FILE= "L_2000106EN.002001.EPS">
>PIC FILE= "L_2000106EN.002002.EPS">"

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APPENDIX C : FEDERAL MOTOR VEHICLE SAFETY STANDARD (FMVSS)

- Part 571.301 – Fuel System Integrity
- Part 571.302 – Flammability of Interior Materials
- Part 393.65 – All Fuel Systems
- Part 393.67 – Liquid Fuel Tanks

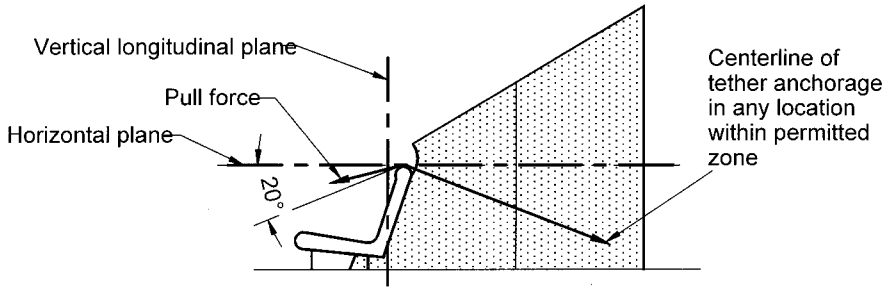


Figure 19 – Side View, Optional Tether Anchorage Test for Passenger Cars until September 1, 2004

[64 FR 10823, Mar. 5, 1999, as amended at 64 FR 47587, Aug. 31, 1999]

§571.301 Standard No. 301; Fuel system integrity.

S1. *Scope.* This standard specifies requirements for the integrity of motor vehicle fuel systems.

S2. *Purpose.* The purpose of this standard is to reduce deaths and injuries occurring from fires that result from fuel spillage during and after motor vehicle crashes, and resulting from ingestion of fuels during siphoning.

S3. *Application.* This standard applies to passenger cars, and to multipurpose passenger vehicles, trucks and buses that have a GVWR of 4,536 kg or less and use fuel with a boiling point above 0 °C, and to school buses that have a GVWR greater than 4,536 kg and use fuel with a boiling point above 0 °C.

S4. *Definition. Fuel spillage* means the fall, flow, or run of fuel from the vehicle but does not include wetness resulting from capillary action.

S5. *General requirements.*

S5.1 *Passenger cars, and multipurpose passenger vehicles, trucks, and buses with a GVWR of 10,000 pounds or less.* Each passenger car and each multipurpose passenger vehicle, truck, and bus with a GVWR of 10,000 pounds or less shall meet the requirements of S6.1 through S6.4. Each of these types of vehicles that is manufactured to use alcohol fuels shall also meet the requirements of S6.6.

S5.2 [Reserved]

S5.3 [Reserved]

S5.4 *Schoolbuses with a GVWR greater than 10,000 pounds.* Each schoolbus with a GVWR greater than 10,000 pounds shall meet the requirements of S6.5. Each schoolbus with a GVWR greater than 10,000 pounds that is manufactured to use alcohol fuels shall meet the requirements of S6.6.

S5.5 *Fuel spillage; Barrier crash.* Fuel spillage in any fixed or moving barrier crash test shall not exceed 28 g from impact until motion of the vehicle has ceased, and shall not exceed a total of 142 g in the 5-minute period following cessation of motion. For the subsequent 25-minute period, fuel spillage during any 1 minute interval shall not exceed 28 g.

S5.6 *Fuel spillage; rollover.* Fuel spillage in any rollover test, from the onset of rotational motion, shall not exceed a total of 142 g for the first 5 minutes of testing at each successive 90° increment. For the remaining test period, at each increment of 90° fuel spillage during any 1 minute interval shall not exceed 28 g.

S5.7. *Alcohol fuel vehicles.* Each vehicle manufactured to operate on an alcohol fuel (e.g., methanol, ethanol) or a

fuel blend containing at least 20 percent alcohol fuel shall meet the requirements of S6.6.

S6. *Test requirements.* Each vehicle with a GVWR of 4,536 kg or less shall be capable of meeting the requirements of any applicable barrier crash test followed by a static rollover, without alteration of the vehicle during the test sequence. A particular vehicle need not meet further requirements after having been subjected to a single barrier crash test and a static rollover test.

S6.1 *Frontal barrier crash.* When the vehicle travelling longitudinally forward at any speed up to and including 48 km/h impacts a fixed collision barrier that is perpendicular to the line of travel of the vehicle, or at any angle up to 30° in either direction from the perpendicular to the line of travel of the vehicle, with 50th-percentile test dummies as specified in part 572 of this chapter at each front outboard designated seating position and at any other position whose protection system is required to be tested by a dummy under the provisions of Standard No. 208, under the applicable conditions of S7., fuel spillage shall not exceed the limits of S5.5.

S6.2 *Rear moving barrier crash.* When the vehicle is impacted from the rear by a barrier moving at 48 km/h, with test dummies as specified in part 572 of this chapter at each front outboard designated seating position, under the applicable conditions of S7., fuel spillage shall not exceed the limits of S5.5.

S6.3 *Lateral moving barrier crash.* When the vehicle is impacted laterally on either side by a barrier moving at 32 km/h with 50th-percentile test dummies as specified in part 572 of this chapter at positions required for testing to Standard No. 208, under the applicable conditions of S7., fuel spillage shall not exceed the limits of S5.5.

S6.4 *Static rollover.* When the vehicle is rotated on its longitudinal axis to each successive increment of 90°, following an impact crash of S6.1, S6.2, or S6.3, fuel spillage shall not exceed the limits of S5.6.

S6.5 *Moving contoured barrier crash.* When the moving contoured barrier assembly traveling longitudinally forward at any speed up to and including 48 km/h impacts the test vehicle (school bus with a GVWR exceeding 4,536 kg) at any point and angle, under the applicable conditions of S7.1 and S7.5, fuel spillage shall not exceed the limits of S5.5.

S6.6 *Anti-siphoning test for alcohol fuel vehicles.* Each vehicle shall have means that prevent any hose made of vinyl plastic or rubber, with a length of not less than 1200 millimeters (mm) and an outside diameter of not less than 5.2 mm, from contacting the level surface of the liquid fuel in the vehicle's fuel tank or fuel system, when the hose is inserted into the filler neck attached to the fuel tank with the fuel tank filled to any level from 90 to 95 percent of capacity.

S7. *Test conditions.* The requirements of S5.1 through S5.6 and S6.1 through S6.5 shall be met under the following conditions. Where a range is specified, the vehicle must be capable of meeting the requirements at all points within the range.

S7.1 *General test conditions.* The following conditions apply to all tests.

S7.1.1 The fuel tank is filled to any level from 90 to 95 percent of capacity with Stoddard solvent, having the physical and chemical properties of type 1 solvent, Table I ASTM Standard D484–71, ''Standard Specifications for Hydrocarbon Dry Cleaning Solvents.''

S7.1.2 The fuel system other than the fuel tank is filled with Stoddard solvent to its normal operating level.

S7.1.3 In meeting the requirements of S6.1 through S6.3, if the vehicle has an electrically driven fuel pump that normally runs when the vehicle's electrical system is activated, it is operating at the time of the barrier crash.

S7.1.4 The parking brake is disengaged and the transmission is in neutral, except that in meeting the requirements of S6.5 the parking brake is set.

S7.1.5 Tires are inflated to manufacturer's specifications.

S7.1.6 The vehicle, including test devices and instrumentation, is loaded as follows:

(a) Except as specified in S7.1.1, a passenger car is loaded to its unloaded vehicle weight plus its rated cargo and luggage capacity weight, secured in the luggage area, plus the necessary test dummies as specified in S6., restrained

only by means that are installed in the vehicle for protection at its seating position.

(b) Except as specified in S7.1.1, a multipurpose passenger vehicle, truck, or bus with a GVWR of 4,536 kg or less is loaded to its unloaded vehicle weight, plus the necessary test dummies, as specified in S6., plus 136 kg or its rated cargo and luggage capacity weight, whichever is less, secured to the vehicle and distributed so that the weight on each axle as measured at the tire-ground interface is proportional to its GAWR. If the weight on any axle, when the vehicle is loaded to unloaded vehicle weight plus dummy weight, exceeds the axle's proportional share of the test weight, the remaining weight shall be placed so that the weight on that axle remains the same. Each dummy shall be restrained only by means that are installed in the vehicle for protection at its seating position.

(c) Except as specified in S7.1.1, a school bus with a GVWR greater than 4,536 kg is loaded to its unloaded vehicle weight, plus 54 kg of unsecured mass at each designated seating position.

S7.2 *Lateral moving barrier crash test conditions.* The lateral moving barrier crash test conditions are those specified in S8.2 of Standard No. 208, 49 CFR 571.208.

S7.3 *Rear moving barrier test conditions.* The rear moving barrier test conditions are those specified in S8.2 of Standard No. 208, 49 CFR 571.208, except for the positioning of the barrier and the vehicle. The barrier and test vehicle are positioned so that at impact—

(a) The vehicle is at rest in its normal attitude;

(b) The barrier is traveling at 48 km/h with its face perpendicular to the longitudinal centerline of the vehicle; and

(c) A vertical plane through the geometric center of the barrier impact surface and perpendicular to that surface coincides with the longitudinal centerline of the vehicle.

S7.4 *Static rollover test conditions.* The vehicle is rotated about its longitudinal axis, with the axis kept horizontal, to each successive increment of 90°, 180°, and 270° at a uniform rate, with 90° of rotation taking place in any time interval from 1 to 3 minutes. After reaching each 90° increment the vehicle is held in that position for 5 minutes.

S7.5 *Moving contoured barrier test conditions.* The following conditions apply to the moving contoured barrier crash test.

S7.5.1 The moving barrier, which is mounted on a carriage as specified in Figure 1, is of rigid construction, symmetrical about a vertical longitudinal plane. The contoured impact surface, which is 629 mm high and 1,981 mm wide, conforms to the dimensions shown in Figure 2, and is attached to the carriage as shown in that figure. The ground clearance to the lower edge of the impact surface is 133 mm ± 13 mm. The wheelbase is 3,048 mm ± 50 mm.

S7.5.2 The moving contoured barrier, including the impact surface, supporting structure, and carriage, has a mass of 1,814 kg ± 23 kg with the mass distributed so that 408 kg ± 11 kg is at each rear wheel and 499 kg ± 11 kg is at each front wheel. The center of gravity is located 1,372 mm ± 38 mm rearward of the front wheel axis, in the vertical longitudinal plane of symmetry, 401 mm above the ground. The moment of inertia about the center of gravity is:

$I_x = 367\ kgm^2 \pm 18.4\ kgm^2$

$I_z = 4{,}711\ kgm^2 \pm 236\ kgm^2$

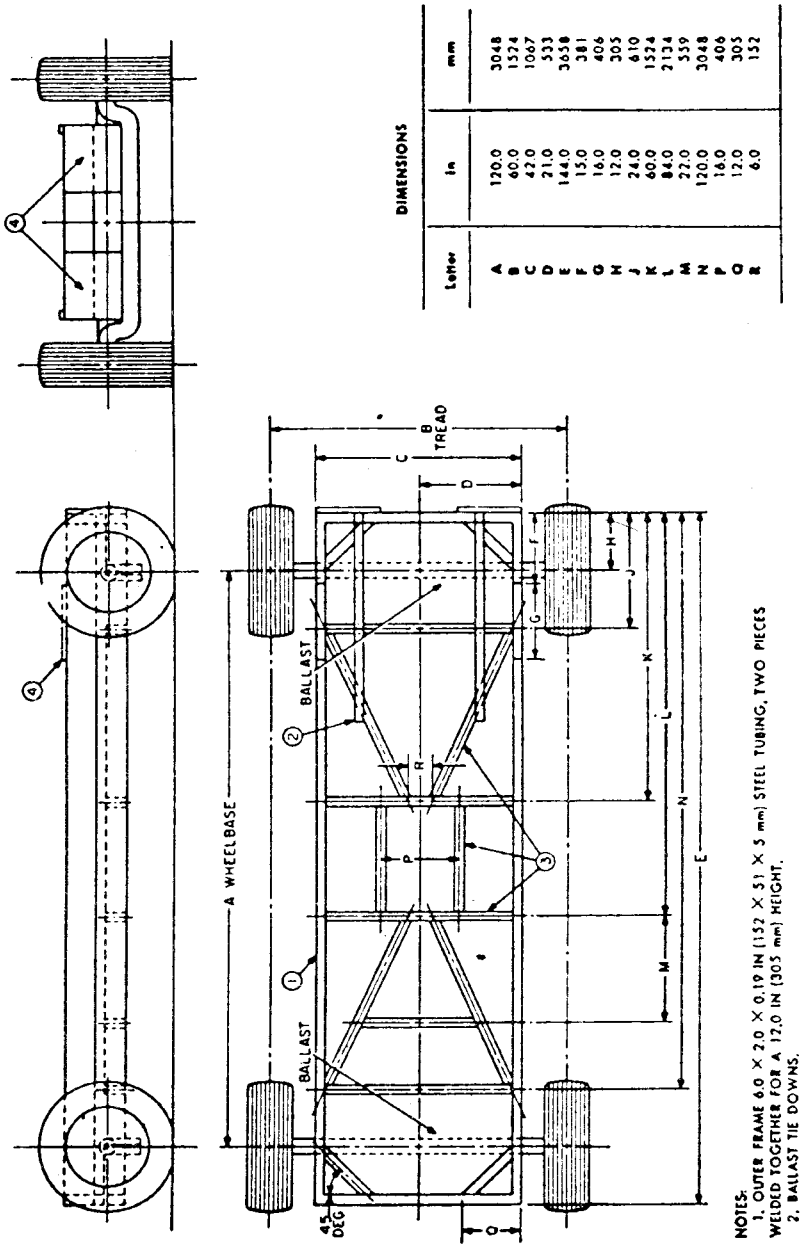
S7.5.3 The moving contoured barrier has a solid nonsteerable front axle and fixed rear axle attached directly to the frame rails with no spring or other type of suspension system on any wheel. (The moving barrier assembly is equipped with a braking device capable of stopping its motion.)

S7.5.4 The moving barrier assembly is equipped with G78–15 pneumatic tires with a tread width of 152 mm ± 25 mm, inflated to 165 kPa.

S7.5.5 The concrete surface upon which the vehicle is tested is level, rigid, and of uniform construction, with a skid number of 75 when measured in accordance with American Society of Testing and Materials Method E: 274–65T at 64 km/h, omitting water delivery as specified in paragraph 7.1 of that method.

S7.5.6 The barrier assembly is released from the guidance mechanism

immediately prior to impact with the vehicle.



NOTES:
1. OUTER FRAME 6.0 × 2.0 × 0.19 IN (152 × 51 × 5 mm) STEEL TUBING, TWO PIECES WELDED TOGETHER FOR A 12.0 IN (305 mm) HEIGHT.
2. BALLAST TIE DOWNS.
3. ALL INNER REINFORCEMENTS AND FRAME GUSSETS OF 4.0 × 2.0 × 0.19 IN (102 × 51 × 5 mm) STEEL TUBING.
4. REINFORCED AREAS FOR BOLTING ON FACE PLATES.

FIG. 1–COMMON CARRIAGE FOR MOVING BARRIERS

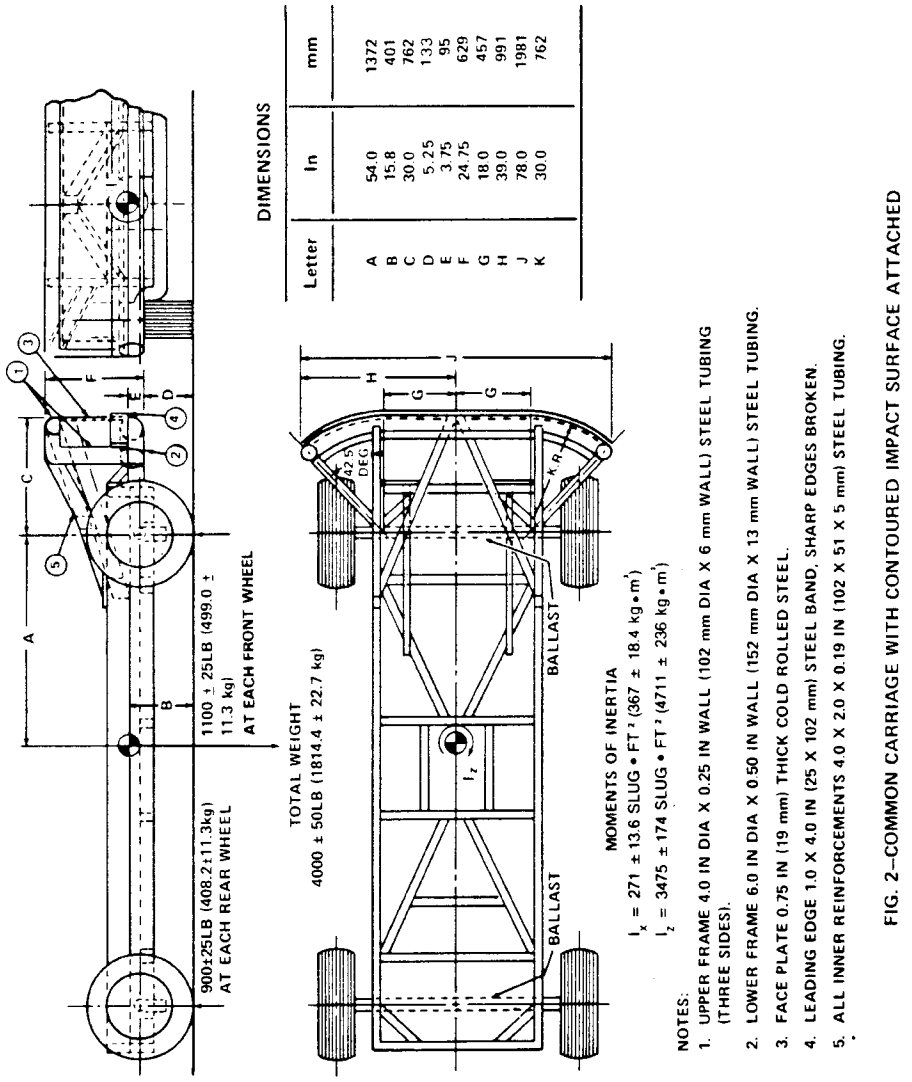


FIG. 2–COMMON CARRIAGE WITH CONTOURED IMPACT SURFACE ATTACHED

[40 FR 48353, Oct. 15, 1975. Redesignated and amended at 41 FR 9350, Mar. 4, 1976; 41 FR 36026, 36027, Aug. 26, 1976; 53 FR 8204, Mar. 14, 1988; 53 FR 49990, Dec. 13, 1988; 58 FR 5638, Jan. 22, 1993; 61 FR 19202, May 1, 1996; 63 FR 28953, May 27, 1998]

§571.302 Standard No. 302; Flammability of interior materials.

S1. *Scope.* This standard specifies burn resistance requirements for materials used in the occupant compartments of motor vehicles.

S2. *Purpose.* The purpose of this standard is to reduce the deaths and injuries to motor vehicle occupants caused by vehicle fires, especially those originating in the interior of the

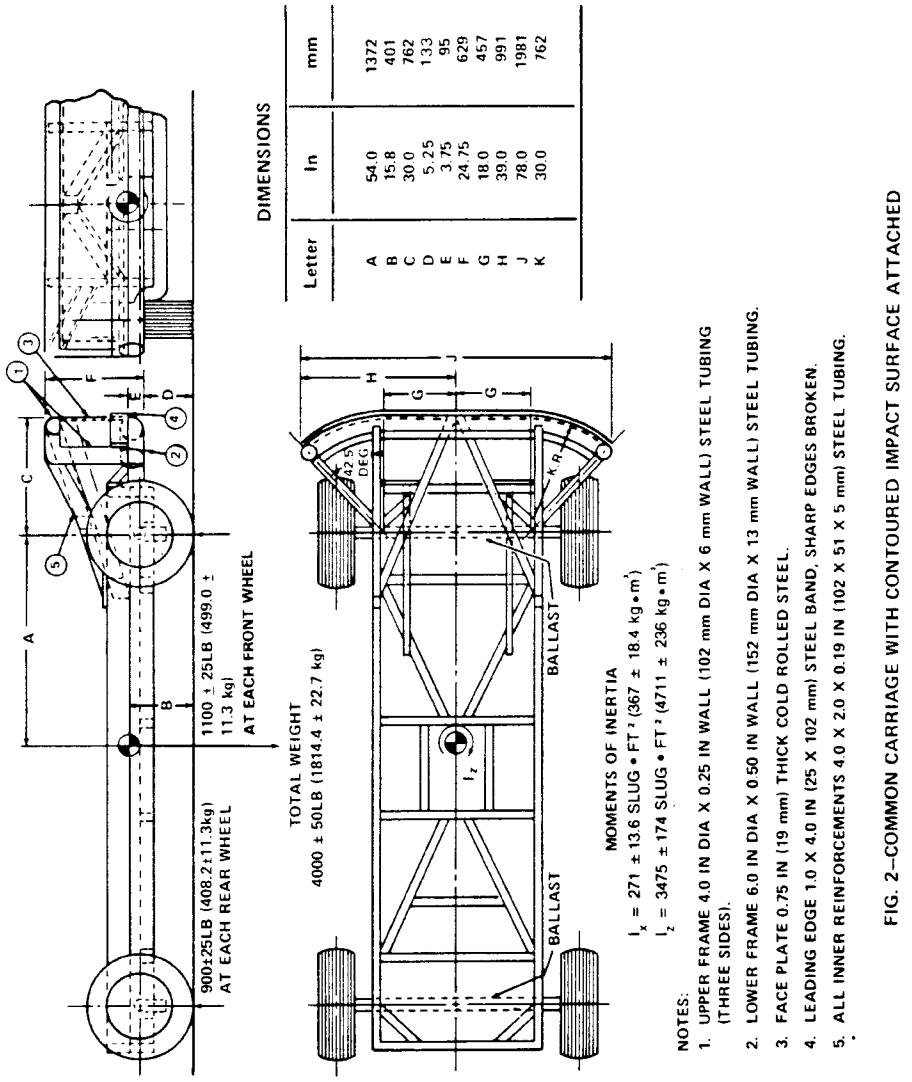


FIG. 2–COMMON CARRIAGE WITH CONTOURED IMPACT SURFACE ATTACHED

[40 FR 48353, Oct. 15, 1975. Redesignated and amended at 41 FR 9350, Mar. 4, 1976; 41 FR 36026, 36027, Aug. 26, 1976; 53 FR 8204, Mar. 14, 1988; 53 FR 49990, Dec. 13, 1988; 58 FR 5638, Jan. 22, 1993; 61 FR 19202, May 1, 1996; 63 FR 28953, May 27, 1998]

§571.302 Standard No. 302; Flammability of interior materials.

S1. *Scope.* This standard specifies burn resistance requirements for materials used in the occupant compartments of motor vehicles.

S2. *Purpose.* The purpose of this standard is to reduce the deaths and injuries to motor vehicle occupants caused by vehicle fires, especially those originating in the interior of the

vehicle from sources such as matches or cigarettes.

S3. *Application.* This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses.

S3A. *Definitions. Occupant compartment air space* means the space within the occupant compartment that normally contains refreshable air.

S4. *Requirements.*

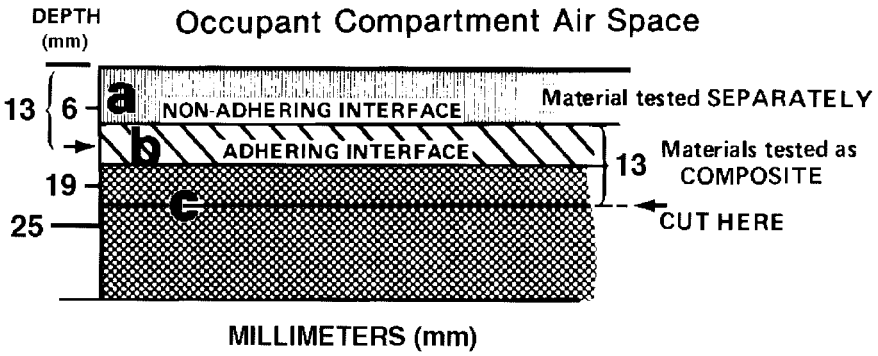
S4.1 The portions described in S4.2 of the following components of vehicle occupant compartments shall meet the requirements of S4.3: Seat cushions, seat backs, seat belts, headlining, convertible tops, arm rests, all trim panels including door, front, rear, and side panels, compartment shelves, head restraints, floor coverings, sun visors, curtains, shades, wheel housing covers, engine compartment covers, mattress covers, and any other interior materials, including padding and crash-deployed elements, that are designed to absorb energy on contact by occupants in the event of a crash.

S4.1.1 [Reserved]

S4.2 Any portion of a single or composite material which is within 13 mm of the occupant compartment air space shall meet the requirements of S4.3.

S4.2.1 Any material that does not adhere to other material(s) at every point of contact shall meet the requirements of S4.3 when tested separately.

S4.2.2 Any material that adheres to other materials at every point of contact shall meet the requirements of S4.3 when tested as a composite with the other material(s).



Occupant Compartment Air Space
All Dimensions in Millimeters (mm)

Material A has a non-adhering interface with material B and is tested separately. Part of material B is within 13 mm of the occupant compartment air space, and materials B and C adhere at every point of contact; therefore, B and C are tested as a composite. The cut is in material C as shown, to make a specimen 13 mm thick.

S4.3(a) When tested in accordance with S5, material described in S4.1 and S4.2 shall not burn, nor transmit a flame front across its surface, at a rate of more than 102 mm per minute. The requirement concerning transmission of a flame front shall not apply to a surface created by cutting a test specimen for purposes of testing pursuant to S5.

(b) If a material stops burning before it has burned for 60 seconds from the start of timing, and has not burned more than 51 mm from the point where the timing was started, it shall be considered to meet the burn-rate requirement of S4.3(a).

S5.1 *Conditions.*

S5.1.1 The test is conducted in a metal cabinet for protecting the test specimens from drafts. The interior of the cabinet is 381 mm long, 203 mm deep, and 356 mm high. It has a glass observation window in the front, a closable opening to permit insertion of the specimen holder, and a hole to accommodate tubing for a gas burner. For ventilation, it has a 13 mm clearance space around the top of the cabinet, ten holes in the base of the cabinet, each hole 19 mm in diameter and legs to elevate the bottom of the cabinet by 10 mm, all located as shown in Figure 1.

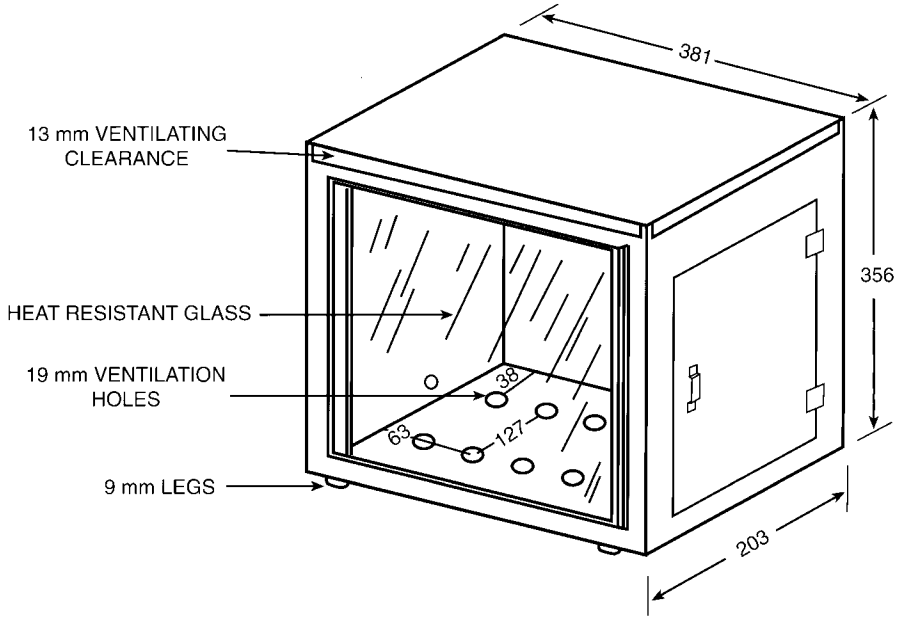


Figure 1
All dimensions in millimeters (mm)

S5.1.2 Prior to testing, each specimen is conditioned for 24 hours at a temperature of 21 °C, and a relative humidity of 50 percent, and the test is conducted under those ambient conditions.

S5.1.3 The test specimen is inserted between two matching U-shaped frames of metal stock 25 mm wide and 10 mm high. The interior dimensions of the U-shaped frames are 51 mm wide by 330 mm long. A specimen that softens and bends at the flaming end so as to cause erratic burning is kept horizontal by supports consisting of thin, heat-resistant wires, spanning the width of the U-shaped frame under the specimen at 25 mm intervals. A device that may be used for supporting this type of material is an additional U-shaped frame, wider than the U-shaped frame containing the specimen, spanned by 10-mil wires of heat-resistant composition at 25 mm intervals, inserted over the bottom U-shaped frame.

S5.1.4 A bunsen burner with a tube of 10 mm inside diameter is used. The gas adjusting valve is set to provide a

flame, with the tube vertical, of 38 mm in height. The air inlet to the burner is closed.

S5.1.5 The gas supplied to the burner has a flame temperature equivalent to that of natural gas.

S5.2 *Preparation of specimens.*

S5.2.1 Each specimen of material to be tested shall be a rectangle 102 mm wide by 356 mm long, wherever possible. The thickness of the specimen is that of the single or composite material used in the vehicle, except that if the material's thickness exceeds 13 mm, the specimen is cut down to that thickness measured from the surface of the specimen closest to the occupant compartment air space. Where it is not possible to obtain a flat specimen because of surface curvature, the specimen is cut to not more than 13 mm in thickness at any point. The maximum available length or width of a specimen is used where either dimension is less than 356 mm or 102 mm, respectively, unless surrogate testing is required under S4.1.1.

S5.2.2 The specimen is produced by cutting the material in the direction that provides the most adverse test results. The specimen is oriented so that the surface closest to the occupant compartment air space faces downward on the test frame.

S5.2.3 Material with a napped or tufted surface is placed on a flat surface and combed twice against the nap with a comb having seven to eight smooth, rounded teeth per 25 mm.

S5.3 *Procedure.*

(a) Mount the specimen so that both sides and one end are held by the U-shaped frame, and one end is even with the open end of the frame. Where the maximum available width of a specimen is not more than 51 mm, so that the sides of the specimen cannot be held in the U-shaped frame, place the specimen in position on wire supports as described in S5.1.3, with one end held by the closed end of the U-shaped frame.

(b) Place the mounted specimen in a horizontal position, in the center of the cabinet.

(c) With the flame adjusted according to S5.1.4, position the bunsen burner and specimen so that the center of the burner tip is 19 mm below the center of the bottom edge of the open end of the specimen.

(d) Expose the specimen to the flame for 15 seconds.

(e) Begin timing (without reference to the period of application of the burner flame) when the flame from the burning specimen reaches a point 38 mm from the open end of the specimen.

(f) Measure the time that it takes the flame to progress to a point 38 mm from the clamped end of the specimen. If the flame does not reach the specified end point, time its progress to the point where flaming stops.

(g) Calculate the burn rate from the formula:

$B = 60 \times (D/T)$

Where:

B = Burn rate in millimeters per minute

D = Length the flame travels in millimeters, and

T = Time in seconds for the flame to travel D millimeters.

[36 FR 22902, Dec. 2, 1971, as amended at 40 FR 14319, Mar. 31, 1975; 40 FR 42747, Sept. 16, 1975; 40 FR 56667, Dec. 4, 1975; 63 FR 28954, 28956, May 27, 1998; 63 FR 51003, Sept. 24, 1998]

§ 571.303 Standard No. 303; Fuel system integrity of compressed natural gas vehicles.

S1. *Scope.* This standard specifies requirements for the integrity of motor vehicle fuel systems using compressed natural gas (CNG), including the CNG fuel systems of bi-fuel, dedicated, and dual fuel CNG vehicles.

S2. *Purpose.* The purpose of this standard is to reduce deaths and injuries occurring from fires that result from fuel leakage during and after motor vehicle crashes.

S3. *Application.* This standard applies to passenger cars, multipurpose passenger vehicles, trucks and buses that have a gross vehicle weight rating (GVWR) of 10,000 pounds or less and use CNG as a motor fuel. This standard also applies to school buses regardless of weight that use CNG as a motor fuel.

S4. *Definitions.*

Bi-fuel CNG vehicle means a vehicle equipped with two independent fuel systems, one of which is designed to supply CNG and the second to supply a fuel other than CNG.

§ 393.63 Windows, markings.

(a) On a bus manufactured before September 1, 1973, each bus push-out window and any other bus escape window glazed with laminated safety glass required in § 393.61 shall be identified as such by clearly legible and visible signs, lettering, or decalcomania. Such marking shall include appropriate wording to indicate that it is an escape window and also the method to be used for obtaining emergency exit.

(b) On a bus manufactured on and after September 1, 1973, emergency exits required in § 393.61 shall be marked to conform to Federal Motor Vehicle Safety Standard No. 217 (§ 571.217), of this title.

(c) A bus manufactured before September 1, 1973, may mark emergency exits to conform to Federal Motor Vehicle Safety Standard No. 217 (§ 571.217), of this title in lieu of conforming to paragraph (a) of this section.

[37 FR 11678, June 10, 1972]

Subpart E—Fuel Systems

AUTHORITY: Sec. 204, Interstate Commerce Act, as amended, 49 U.S.C. 304; sec. 6, Department of Transportation Act, 49 U.S.C. 1655; delegation of authority at 49 CFR 1.48 and 389.4.

§ 393.65 All fuel systems.

(a) *Application of the rules in this section.* The rules in this section apply to systems for containing and supplying fuel for the operation of motor vehicles or for the operation of auxiliary equipment installed on, or used in connection with, motor vehicles.

(b) *Location.* Each fuel system must be located on the motor vehicle so that—

(1) No part of the system extends beyond the widest part of the vehicle;

(2) No part of a fuel tank is forward of the front axle of a power unit;

(3) Fuel spilled vertically from a fuel tank while it is being filled will not contact any part of the exhaust or electrical systems of the vehicle, except the fuel level indicator assembly;

(4) Fill pipe openings are located outside the vehicle's passenger compartment and its cargo compartment;

(5) A fuel line does not extend between a towed vehicle and the vehicle that is towing it while the combination of vehicles is in motion; and

(6) No part of the fuel system of a bus manufactured on or after January 1, 1973, is located within or above the passenger compartment.

(c) *Fuel tank installation.* Each fuel tank must be securely attached to the motor vehicle in a workmanlike manner.

(d) *Gravity or syphon feed prohibited.* A fuel system must not supply fuel by gravity or syphon feed directly to the carburetor or injector.

(e) *Selection control valve location.* If a fuel system includes a selection control valve which is operable by the driver to regulate the flow of fuel from two or more fuel tanks, the valve must be installed so that either—

(1) The driver may operate it while watching the roadway and without leaving his/her driving position; or

(2) The driver must stop the vehicle and leave his/her seat in order to operate the valve.

(f) *Fuel lines.* A fuel line which is not completely enclosed in a protective housing must not extend more than 2 inches below the fuel tank or its sump. Diesel fuel crossover, return, and withdrawal lines which extend below the bottom of the tank or sump must be protected against damage from impact. Every fuel line must be—

(1) Long enough and flexible enough to accommodate normal movements of the parts to which it is attached without incurring damage; and

(2) Secured against chafing, kinking, or other causes of mechanical damage.

(g) *Excess flow valve.* When pressure devices are used to force fuel from a fuel tank, a device which prevents the flow of fuel from the fuel tank if the fuel feed line is broken must be installed in the fuel system.

[36 FR 15445, Aug. 14, 1971, as amended at 37 FR 4341, Mar. 2, 1972; 37 FR 28752, Dec. 29, 1972]

§ 393.67 Liquid fuel tanks.

(a) *Application of the rules in this section.* (1) A liquid fuel tank manufactured on or after January 1, 1973, and a side-mounted gasoline tank must conform to all the rules in this section.

(2) A diesel fuel tank manufactured before January 1, 1973, and mounted on a bus must conform to the rules in paragraphs (c)(7)(iii) and (d)(2) of this section.

(3) A diesel fuel tank manufactured before January 1, 1973, and mounted on a vehicle other than a bus must conform to the rules in paragraph (c)(7)(iii) of this section.

(4) A gasoline tank, other than a side-mounted gasoline tank, manufactured before January 1, 1973, and mounted on a bus must conform to the rules in paragraphs (c) (1) through (10) and (d)(2) of this section.

(5) A gasoline tank, other than a side-mounted gasoline tank, manufactured before January 1, 1973, and mounted on a vehicle other than a bus must conform to the rules in paragraphs (c) (1) through (10), inclusive, of this section.

(6) Private motor carrier of passengers. Motor carriers engaged in the private transportation of passengers may continue to operate a commercial motor vehicle which was not subject to this section or 49 CFR 571.301 at the time of its manufacture, provided the fuel tank of such vehicle is maintained to the original manufacturer's standards.

(b) *Definitions.* As used in this section—

(1) The term *liquid fuel tank* means a fuel tank designed to contain a fuel that is liquid at normal atmospheric pressures and temperatures.

(2) A *side-mounted* fuel tank is a liquid fuel tank which—

(i) If mounted on a truck tractor, extends outboard of the vehicle frame and outside of the plan view outline of the cab; or

(ii) If mounted on a truck, extends outboard of a line parallel to the longitudinal centerline of the truck and tangent to the outboard side of a front tire in a straight ahead position. In determining whether a fuel tank on a truck or truck tractor is side-mounted, the fill pipe is not considered a part of the tank.

(c) *Construction of liquid fuel tanks*—(1) *Joints.* Joints of a fuel tank body must be closed by arc-, gas-, seam-, or spot-welding, by brazing, by silver soldering, or by techniques which provide heat resistance and mechanical securement at least equal to those specifically named. Joints must not be closed solely by crimping or by soldering with a lead-based or other soft solder.

(2) *Fittings.* The fuel tank body must have flanges or spuds suitable for the installation of all fittings.

(3) *Threads.* The threads of all fittings must be Dryseal American Standard Taper Pipe Thread or Dryseal SAE Short Taper Pipe Thread, specified in Society of Automotive Engineers Standard J476, as contained in the 1971 edition of the ''SAE Handbook,'' except that straight (nontapered) threads may be used on fittings having integral flanges and using gaskets for sealing. At least four full threads must be in engagement in each fitting.

(4) *Drains and bottom fittings.* (i) Drains or other bottom fittings must not extend more than three-fourths of an inch below the lowest part of the fuel tank or sump.

(ii) Drains or other bottom fittings must be protected against damage from impact.

(iii) If a fuel tank has drains the drain fittings must permit substantially complete drainage of the tank.

(iv) Drains or other bottom fittings must be installed in a flange or spud designed to accommodate it.

(5) *Fuel withdrawal fittings.* Except for diesel fuel tanks, the fittings through which fuel is withdrawn from a fuel tank must be located above the normal level of fuel in the tank when the tank is full.

(6) [Reserved]

(7) *Fill pipe.* (i) Each fill pipe must be designed and constructed to minimize the risk of fuel spillage during fueling operations and when the vehicle is involved in a crash.

(ii) The fill pipe and vents of a fuel tank having a capacity of more than 25 gallons of fuel must permit filling the tank with fuel at a rate of at least 20 gallons per minute without fuel spillage.

(iii) Each fill pipe must be fitted with a cap that can be fastened securely over the opening in the fill pipe. Screw threads or a bayonet-type joint are methods of conforming to the requirements of this subdivision.

(8) *Safety venting system.* A liquid fuel tank with a capacity of more than 25 gallons of fuel must have a venting system which, in the event the tank is subjected to fire, will prevent internal tank pressure from rupturing the tank's body, seams, or bottom opening (if any).

(9) *Pressure resistance.* The body and fittings of a liquid fuel tank with a capacity of more than 25 gallons of fuel must be capable of withstanding an internal hydrostatic pressure equal to 150 percent of the maximum internal pressure reached in the tank during the safety venting systems test specified in paragraph (d)(1) of this section.

(10) *Air vent.* Each fuel tank must be equipped with a nonspill air vent (such as a ball check). The air vent may be combined with the fill-pipe cap or safety vent, or it may be a separate unit installed on the fuel tank.

(11) *Markings.* If the body of a fuel tank is readily visible when the tank is installed on the vehicle, the tank must be plainly marked with its liquid capacity. The tank must also be plainly marked with a warning against filling it to more than 95 percent of its liquid capacity.

(12) *Overfill restriction.* A liquid fuel tank manufactured on or after January 1, 1973, must be designed and constructed so that—

(i) The tank cannot be filled, in a normal filling operation, with a quantity of fuel that exceeds 95 percent of the tank's liquid capacity; and

(ii) When the tank is filled, normal expansion of the fuel will not cause fuel spillage.

(d) *Liquid fuel tank tests.* Each liquid fuel tank must be capable of passing the tests specified in paragraphs (d) (1) and (2) of this section.[1]

(1) *Safety venting system test*—(i) *Procedure.* Fill the tank three-fourths full with fuel, seal the fuel feed outlet, and invert the tank. When the fuel temperature is between 50 °F. and 80 °F., apply an enveloping flame to the tank so that the temperature of the fuel rises at a rate of not less than 6 °F. and not more than 8 °F. per minute.

(ii) *Required performance.* The safety venting system required by paragraph (c)(8) of this section must activate before the internal pressure in the tank exceeds 50 pounds per square inch, gauge, and the internal pressure must not thereafter exceed the pressure at which the system activated by more than five pounds per square inch despite any further increase in the temperature of the fuel.

(2) *Leakage test*—(i) *Procedure.* Fill the tank to capacity with fuel having a temperature between 50 °F. and 80 °F. With the fill-pipe cap installed, turn the tank through an angle of 150° in any direction about any axis from its normal position.

(ii) *Required performance.* Neither the tank nor any fitting may leak more than a total of one ounce by weight of fuel per minute in any position the tank assumes during the test.

(e) *Side-mounted liquid fuel tank tests.* Each side-mounted liquid fuel tank must be capable of passing the tests specified in paragraphs (e) (1) and (2) of this section and the tests specified in paragraphs (d) (1) and (2) of this section.[1]

(1) *Drop test*—(i) *Procedure.* Fill the tank with a quantity of water having a weight equal to the weight of the maximum fuel load of the tank and drop the tank 30 feet onto an unyielding surface so that it lands squarely on one corner.

(ii) *Required performance.* Neither the tank nor any fitting may leak more than a total of 1 ounce by weight of water per minute.

(2) *Fill-pipe test*—(i) *Procedure.* Fill the tank with a quantity of water having a weight equal to the weight of the maximum fuel load of the tank and drop the tank 10 feet onto an unyielding surface so that it lands squarely on its fill-pipe.

(ii) *Required performance.* Neither the tank nor any fitting may leak more than a total of 1 ounce by weight of water per minute.

(f) *Certification and markings.* Each liquid fuel tank shall be legibly and permanently marked by the manufacturer with the following minimum information:

[1] The specified tests are a measure of performance only. Manufacturers and carriers may use any alternative procedures which assure that their equipment meets the required performance criteria.

(1) The month and year of manufacture,

(2) The manufacturer's name on tanks manufactured on and after July 1, 1988, and means of identifying the facility at which the tank was manufactured, and

(3) A certificate that it conforms to the rules in this section applicable to the tank. The certificate must be in the form set forth in either of the following:

(i) If a tank conforms to all rules in this section pertaining to side-mounted fuel tanks: ''Meets all FMCSA side-mounted tank requirements.''

(ii) If a tank conforms to all rules in this section pertaining to tanks which are not side-mounted fuel tanks: ''Meets all FMCSA requirements for non-side-mounted fuel tanks.''

(iii) The form of certificate specified in paragraph (f)(3) (i) or (ii) of this section may be used on a liquid fuel tank manufactured before July 11, 1973, but it is not mandatory for liquid fuel tanks manufactured before March 7, 1989. The form of certification manufactured on or before March 7, 1989, must meet the requirements in effect at the time of manufacture.

[36 FR 15445, Aug. 14, 1971, as amended at 37 FR 4341, Mar. 2, 1972; 37 FR 28753, Dec. 29, 1972; 45 FR 46424, July 10, 1980; 53 FR 49400, Dec. 7, 1988; 59 FR 8753, Feb. 23, 1994]

§ 393.69 Liquefied petroleum gas systems.

(a) A fuel system that uses liquefied petroleum gas as a fuel for the operation of a motor vehicle or for the operation of auxiliary equipment installed on, or used in connection with, a motor vehicle must conform to the ''Standards for the Storage and Handling of Liquefied Petroleum Gases'' of the National Fire Protection Association, Battery March Park, Quincy, MA 02269, as follows:

(1) A fuel system installed before December 31, 1962, must conform to the 1951 edition of the Standards.

(2) A fuel system installed on or after December 31, 1962, and before January 1, 1973, must conform to Division IV of the June 1959 edition of the Standards.

(3) A fuel system installed on or after January 1, 1973, and providing fuel for propulsion of the motor vehicle must conform to Division IV of the 1969 edition of the Standards.

(4) A fuel system installed on or after January 1, 1973, and providing fuel for the operation of auxiliary equipment must conform to Division VII of the 1969 edition of the Standards.

(b) When the rules in this section require a fuel system to conform to a specific edition of the Standards, the fuel system may conform to the applicable provisions in a later edition of the Standards specified in this section.

(c) The tank of a fuel system must be marked to indicate that the system conforms to the Standards.

[36 FR 15445, Aug. 14, 1971, as amended at 37 FR 4342, Mar. 2, 1972; 41 FR 53031, Dec. 3, 1976; 53 FR 49400, Dec. 7, 1988]

Subpart F—Coupling Devices and Towing Methods

§ 393.70 Coupling devices and towing methods, except for driveaway-towaway operations.

(a) *Tracking*. When two or more vehicles are operated in combination, the coupling devices connecting the vehicles shall be designed, constructed, and installed, and the vehicles shall be designed and constructed, so that when the combination is operated in a straight line on a level, smooth, paved surface, the path of the towed vehicle will not deviate more than 3 inches to either side of the path of the vehicle that tows it.

(b) *Fifth wheel assemblies*—(1) *Mounting*—(i) *Lower half*. The lower half of a fifth wheel mounted on a truck tractor or converter dolly must be secured to the frame of that vehicle with properly designed brackets, mounting plates or angles and properly tightened bolts of adequate size and grade, or devices that provide equivalent security. The installation shall not cause cracking, warping, or deformation of the frame. The installation must include a device for positively preventing the lower half of the fifth wheel from shifting on the frame to which it is attached.

(ii) *Upper half*. The upper half of a fifth wheel must be fastened to the motor vehicle with at least the same security required for the installation of the lower half on a truck tractor or converter dolly.

APPENDIX D : FEDERATION INTERNATIONALE DE L'AUTOMOBILE (FIA)

- FIA Standards for Safety Fuel Bladders
- 2001 Formula One Technical Regulations

STANDARDS FIA POUR RESERVOIRS D'ESSENCE DE SECURITE (STANDARDS FT3-1999, FT3.5-1999 ET FT5-1999)

Nouveau texte : **ainsi**
Texte supprimé : ~~ainsi~~

1) MATERIAU

1.1 Le flexible du réservoir de carburant doit être fabriqué à partir d'un matériau renforcé en polyamide, polyester, aramide ou équivalent, imprégné et enrobé, des deux côtés, d'un élastomère résistant au carburant.
Il doit être possible de comprimer le réservoir suivant son axe principal jusqu'à devenir plat sans provoquer de fissures ni de délaminage.

1.2 Toutes les propriétés physiques détaillées ci-dessous doivent être maintenues en tout endroit du réservoir fini, y compris les soudures, assemblages et accessoires.

1.3 Tous les tests détaillés des points 2.0 à 6.0 doivent être effectués sur des échantillons neufs de matériau de cellule de carburant.

1.4 Si le résultat de l'une des mesures lors de l'un des tests suivants se situe, de façon significative, en-dessous de la moyenne des résultats des tests de l'échantillon, il sera écarté et un autre échantillon sera testé.

1.5 Tous les tests doivent être réalisés sur une machine de tests étalonnée aux normes nationales.

1.6 Les tests décrits aux points 2 à 5 doivent être réalisés à une température ambiante de 20°C +/- 5°C sous une atmosphère non humide.

2) RESISTANCE A LA TRACTION

2.1 Matériaux de réservoirs de carburant FT3-1999 : Résistance minimale à la traction 2,00 kN

2.1.1 La résistance à la traction sera évaluée avant et **immédiatement** après immersion dans un carburant identique aux spécifications de l'article 2.1.7 **sans qu'aucun séchage n'ait été effectué**. Dix échantillons mesurant chacun 25 mm de large par 150 mm de long au minimum (la longueur étant mesurée entre les deux pinces) doivent être découpés dans le matériau de réservoir de carburant, cinq dans le sens de la chaîne et cinq dans le sens de la trame. Deux échantillons de chaîne ne pourront contenir les mêmes fils de chaînes et deux échantillons de trame ne pourront contenir les mêmes fils de trame.

2.1.2 La longueur doit toujours être parallèle à la direction du tissage.

2.1.3 Les extrémités de chaque échantillon sont ensuite pincées et la charge appliquée.

2.1.4 Au début du test, la distance entre les pinces doit être au minimum de 75 mm, et lorsque la charge est appliquée elles doivent se déplacer à une vitesse minimale de 30 cm/min.

2.1.5 La résistance à la traction du matériau de réservoir de carburant sera alors considérée comme la charge de rupture minimale des sens de la chaîne et de la trame.

2.1.6 Le test doit ensuite être réédité sur dix autres échantillons ayant été immergés dans le carburant pendant au moins 72 heures. Pendant l'immersion, seule une face de l'échantillon doit être exposée au carburant et ses tranches peuvent être protégées.
Une nouvelle fois, la charge de rupture minimale des sens de la chaîne et de la trame doit être supérieure à la résistance minimale requise à la traction.

2.1.7 Pour tous les tests nécessitant une immersion dans le carburant, le carburant utilisé doit être composé de 60% d'iso-octane et 40% de toluène.

2.1.8 Si l'échantillon de test glisse des pinces ou si les pinces se cassent à répétition, les pinces peuvent être recouvertes de caoutchouc ou d'autre matériau afin d'empêcher le glissement ou la cassure. Le glissement de l'échantillon des pinces de test invalidera le résultat. **Un autre type de système de maintien correspondant à la fig 7 ou équivalent est aussi possible pour éviter un glissement à répétition.**

2.2 Matériaux de réservoir de carburant FT-3.5-1999 : Résistance minimale à la traction 4,45 kN

2.2.1 Les même tests doivent être effectués et la charge de rupture minimale dans le sens de la chaîne et de la trame doit être supérieure à la résistance minimale requise à la traction de 4,45kN.

2.3 Matériaux de réservoir de carburant FT-5-1999 : Résistance minimale à la traction 8,90 kN

2.3.1 Les même tests doivent être effectués et la charge de rupture minimale dans le sens de la chaîne et de la trame doit être supérieure à la résistance minimale requise à la traction de 8,90kN.

3) RESISTANCE A LA PERFORATION

3.1 Matériaux de réservoir de carburant FT-3-1999 : Résistance minimale à la perforation 0,78 kN

3.1.1 Afin d'évaluer la résistance à la perforation, cinq échantillons circulaires, ayant chacun un diamètre de 150 mm, doivent être découpés dans le matériau du réservoir. Chacun d'eux doit être fixé sur un support pour échantillon (voir dessin 1). Les boulons de fixation doivent être serrés de façon à empêcher l'échantillon de test de glisser lorsque l'outil de perforation est appliqué.

3.1.2 L'outil de perforation (voir dessin 2) doit être placé au centre de la surface de l'échantillon, et lorsque la charge est appliquée, il doit se déplacer à une vitesse comprise entre 20 et 45 cm/min.

3.1.3 Cinq échantillons doivent être utilisés ; deux échantillons avec le fil dans le sens de la chaîne parallèles à l'outil de perforation, deux échantillons avec le fil dans le sens de la trame parallèles à l'outil de perforation et un avec le fil dans le sens de la chaîne à 45° par rapport à l'outil de perforation. L'outil de perforation doit être appliqué sur le côté de l'échantillon qui représente la surface externe du réservoir de carburant.

3.1.4 La résistance à la perforation du matériau sera ensuite considérée comme la charge de rupture minimale pour l'ensemble des cinq échantillons.

3.2 Matériaux de réservoir de carburant FT-3.5-1999 : Résistance minimale à la perforation 0,89kN

3.2.1 Les même tests doivent être effectués et la charge de rupture minimale de l'ensemble des cinq échantillons doit être supérieure à la résistance minimale requise à la traction de 0,89kN.

3.3 Matériaux de réservoir de carburant FT-5-1999 : Résistance minimale à la perforation 1,78kN

3.3.1 Les même tests doivent être effectués et la charge de rupture minimale de l'ensemble des cinq échantillons doit être supérieure à la résistance minimale requise à la traction de 1,78kN.

4) RESISTANCE DES ASSEMBLAGES

4.1 Matériaux de réservoir de carburant FT-3-1999 : Résistance minimale des assemblages 2,00kN

4.1.1 Afin d'évaluer la résistance des assemblages avant et **immédiatement** après immersion dans un carburant identique aux spécifications de l'article 2.1.7 **sans qu'aucun séchage n'ait été effectué,** le matériau de réservoir de carburant doit être testé de la même façon que pour la résistance à la traction (cf. 2.0), l'assemblage à tester devant se situer au milieu de l'échantillon.

4.1.2 La charge minimum de rupture doit être supérieure à la résistance minimale requise de 2.00kN.

4.2 Matériaux de réservoir de carburant FT-3.5-1999 : Résistance minimale des assemblages 4,45kN

4.2.1 Les mêmes tests de résistance des assemblages doivent être effectués et la charge minimum de rupture doit être supérieure à la résistance minimale requise de 4,45kN.

4.3 Matériaux de réservoir de carburant FT-5-1999 : Résistance minimale des assemblages 8,90kN

4.3.1 Les mêmes tests de résistance des assemblages doivent être effectués et la charge minimum de rupture doit être supérieure à la résistance minimale requise de 8,90kN.

5) RESISTANCE A LA DECHIRURE

5.1 Matériaux de réservoir de carburant FT-3-1999: Résistance minimale à la déchirure 0,25 kN

5.1.1 Afin d'évaluer la résistance à la déchirure, dix échantillons, mesurant chacun au minimum 75 mm x 200 mm, doivent être découpés dans le matériau du réservoir de carburant, cinq dans le sens de la chaîne et cinq dans le sens de la trame. Deux échantillons de chaînes ne pourront contenir les mêmes fils de chaîne et deux échantillons de trame ne pourront contenir les mêmes fils de trame.

5.1.2 Chaque échantillon est ensuite découpé sur une distance de 75 mm, perpendiculairement à un petit côté et au milieu de ce côté. Chaque languette est pincée avec la plus grande dimension de l'échantillon perpendiculaire à la direction d'application de la charge (voir figure 4).

5.1.3 La charge est ensuite appliquée à une vitesse minimale de 30 cm par minute et la résistance à la déchirure du matériau de réservoir de carburant sera considérée comme le minimum des cinq charges maximales, en excluant le premier maximum.
Les échantillons doivent se déchirer sur au moins 75 mm.

5.1.4 Les valeurs trouvées pour l'échantillon de trame et pour l'échantillon de chaîne doivent être supérieures à la charge de rupture de la résistance minimale à la déchirure de 0,25kN.

5.1.5 Si l'échantillon de test glisse des pinces, les pinces peuvent être recouvertes de caoutchouc ou d'autre matériau afin d'empêcher le glissement. Le glissement de l'échantillon des pinces de test invalidera le résultat.

5.2 Matériaux de réservoir de carburant FT-3.5-1999: Résistance minimale à la déchirure 0,89kN

5.2.1 Les mêmes tests doivent être effectués et la charge minimale de rupture doit passer à 0,89kN.

5.3 Matériaux de réservoir de carburant FT-5-1999: Résistance minimale à la déchirure 1,56kN

5.3.1 Les mêmes tests doivent être effectués et la charge minimale de rupture doit passer à 1,56kN.

6) PRODUIT DE SUPPRESSION D'EXPLOSION

6.1 Sauf dérogation spécifique de la FIA, tous les réservoirs de carburant doivent être équipés d'un cloisonnement de mousse de polyuréthanne résistant au carburant approprié, et conforme aux normes Mil Spec MIL-B-83054, SAE-AIR-4170 ou équivalentes. Cette mousse doit remplir un minimum de 80 % du volume du réservoir de carburant.

6.2 Lorsque des ravitaillements rapides doivent avoir lieu, une mousse anti-statique conforme à la norme Mil-Spec MIL-F-87260 (USAF) doit être utilisée comme décrit au paragraphe 6.1.

7) ACCESSOIRES ET RACCORDEMENTS

7.1 Toutes les ouvertures du réservoir de carburant doivent être fermées par des écoutilles ou accessoires fixés sur les anneaux de boulons métalliques ou composites soudés sur la face interne du réservoir.

Cependant, des raccordements du type correspondant à la Figure 5 sont autorisés lorsque l'espace disponible ne permet pas un assemblage d'anneaux de boulons.

Les raccordements du type correspondant à la Figure 6 sont également autorisés avec les restrictions suivantes :

- le matériau du raccordement doit être basé sur le matériau du réservoir et être conforme à la norme.
- les coutures du raccordement doivent être conformes à l'article 4 de la norme.
- le raccordement du réservoir à la goulotte de remplissage doit se faire conformément aux instructions du constructeur de façon à s'assurer qu'il n'y a pas de fuite.
- Ce type de raccordement ne peut pas être utilisé lorsque le règlement technique impose un clapet antiretour.

7.2 Toutes les ouvertures du réservoir de carburant doivent également être renforcées au minimum avec une épaisseur supplémentaire d'un matériau de réservoir semblable (Figure 3). Cette doublure doit être au moins aussi large que l'anneau de boulon (lorsqu'il existe).

7.3 Tous les boulons et ajouts filetés doivent être traités contre la corrosion.

7.4 Les bords des trous de boulons ne doivent pas être à moins de 5 mm du bord de la rondelle du boulon, de l'écoutille ou de l'accessoire.

7.5 Tous les réservoirs de carburant doivent être équipés d'assemblages, de surfaces d'étanchéité intégrales ou d'anneaux toriques d'étanchéité en élastomère résistant au carburant appropriés, fabriqués spécialement pour s'adapter à la zone de fixation.

8) MATERIAUX DE CELLULES DE CARBURANT HOMOLOGUES PAR LA FIA

8.1 Tous les réservoirs de carburant doivent être fabriqués à partir de matériaux homologués par la FIA. Afin d'obtenir l'homologation de la FIA, le fabricant doit soumettre un échantillon de tout matériau devant être utilisé dans la fabrication des réservoirs de carburant (FT-3-1999 ; FT-3.5-1999 ou FT-5-1999) pour être testés conformément à la présente norme.
L'ensemble de ces tests ainsi que le rapport des tests conforme à celui donné en annexe 1 devront être réalisés par un centre de tests approuvé. La liste de ces centres est disponible auprès de la FIA. L'original du rapport de tests signé par le centre de tests et le constructeur de réservoirs doit être envoyé à la FIA par l'intermédiaire de l'ASN accompagné d'un échantillon du matériau testé.
Les fabricants doivent s'engager à fournir à leurs clients des réservoirs de carburant conformes à ces spécifications.

8.2 Sur tous les réservoirs de carburant doivent être imprimés le nom du fabricant, la spécification selon laquelle le réservoir a été fabriqué, la date de fin de validité précédée de la mention "Not valid after:" ainsi qu'un numéro de série unique. Le numéro de série doit pouvoir être retrouvé en permanence à partir des registres de production des fabricants.

8.3 Tous les réservoirs de carburant doivent subir un test de pression chez le fabricant avant d'être livrés aux clients, la valeur de la pression à appliquer étant laissé à la charge du constructeur. La surface extérieure devra être contrôlée grâce à une solution savonneuse diluée ou un équivalent afin de s'assurer qu'il n'y a pas de fuite.

8.4 Tout nouveau réservoir doit être conforme au standard FIA applicable à la date de sa fabrication.

9) VIEILLISSEMENT DES RESERVOIRS DE CARBURANT

9.1 Aucun réservoir ne devra être utilisé plus de cinq ans après sa date de fabrication, à moins d'avoir été réinspecté et recertifié par le fabricant durant cette période des 5 ans pour une période supplémentaire maximale de 2 autres années.

10) REPARATIONS DES RESERVOIRS DE CARBURANT

10.1 Toute réparation de réservoir de carburant doit être conforme aux spécifications définies pour un nouveau réservoir et doit être effectuée par le fabricant.

11) NOUVELLE TECHNOLOGIE

11.1 La FIA examinera les nouvelles conceptions et les nouveaux matériaux des réservoirs de carburant de sécurité à condition qu'il soit clairement démontré que leurs performances sont égales ou supérieures à celles des conceptions et matériaux décrits dans le présent document.

11.2 Avant d'être utilisés, les autres principes, matériaux et méthodes de construction des réservoirs de carburant de sécurité doivent faire l'objet d'une vérification par le fabricant et être approuvés formellement par la FIA.

11.3 La FIA se réserve le droit de revoir et d'évaluer périodiquement n'importe quel réservoir de sécurité, préalablement approuvé quant à sa conformité, avec la spécification applicable.
En cas de non conformité du réservoir par rapport au standard applicable, l'homologation du fabricant pourra être retirée par la FIA.

Standard FIA pour les réservoirs de carburant

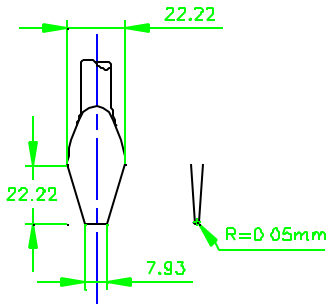


Figure 2 : Outil de perforation

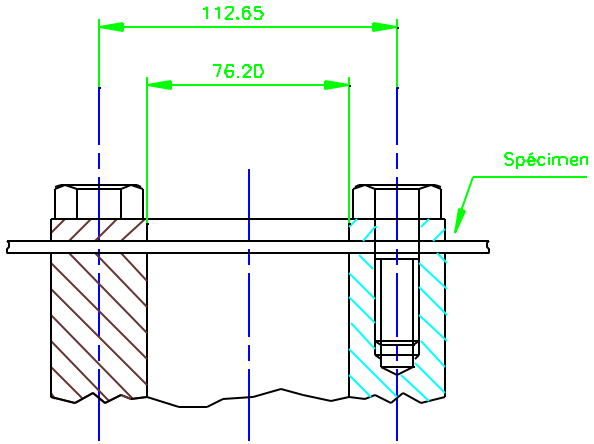


Figure 1 : Support pour échantillon

Les dimensions sont en mm

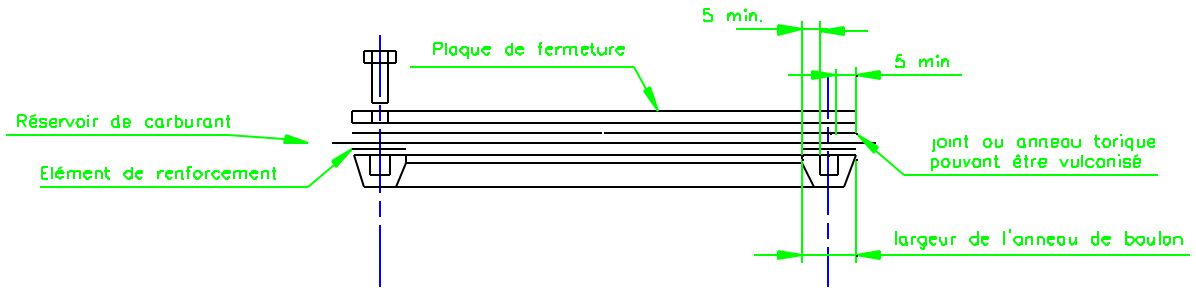


Figure 3 : Ouverture du réservoir de carburant et montage d'anneau de boulon typiques

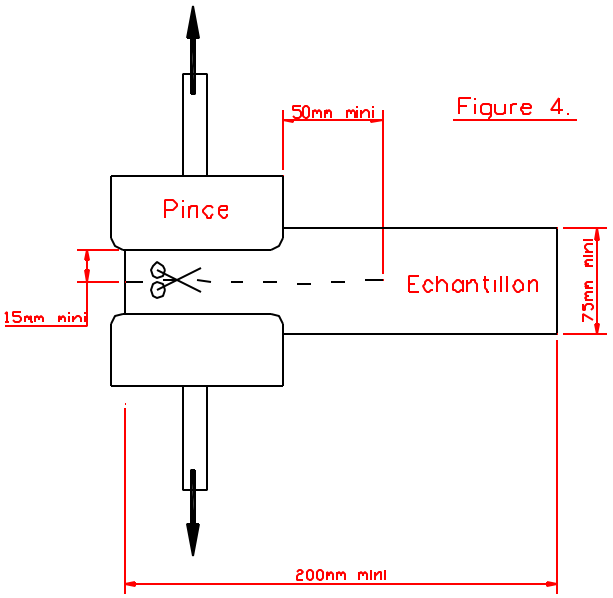


Figure 4.

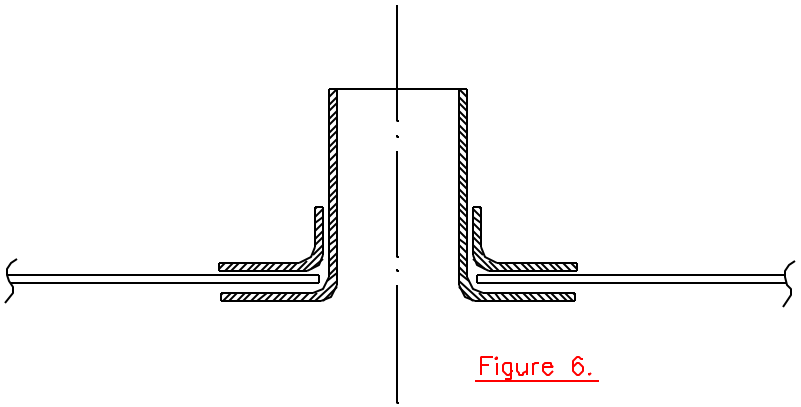


Figure 6.

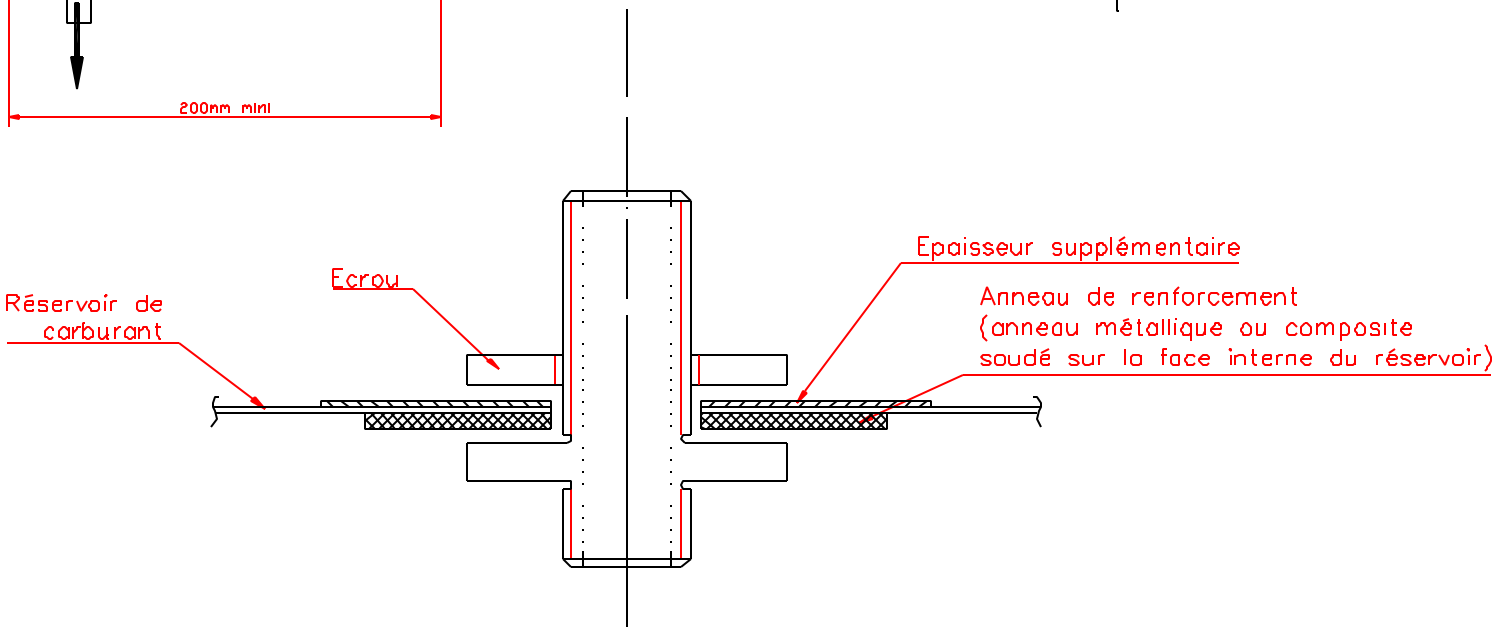


Figure 5.

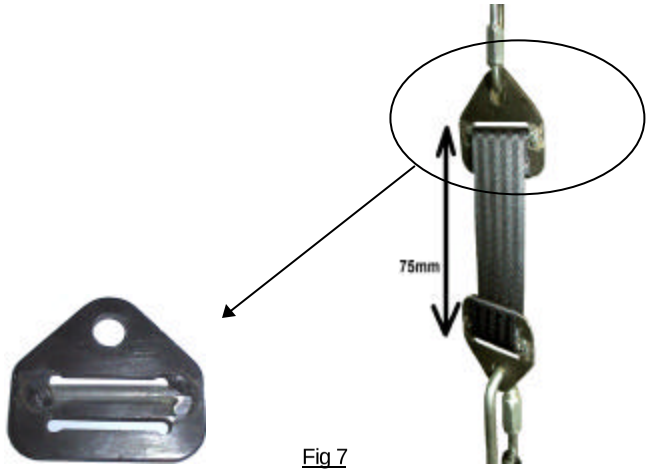


Fig 7

CONTROLES POST-HOMOLOGATION APPLIQUES AUX PRODUITS HOMOLOGUES PAR LA FIA

ARTICLE 1

ARTICLE 1.1 : ADHESION DU FABRICANT AUX CONTROLES POST-HOMOLOGATION

En demandant l'homologation de son produit, le fabricant adhère automatiquement au présent document et accepte toutes les procédures de contrôle que la FIA pourrait entreprendre pour garantir la conformité des produits homologués.

Les tests de contrôle post-homologation seront effectués conformément aux conditions indiquées dans la norme d'homologation. Le fabricant s'engage donc à ne pas contester les différences relatives aux conditions d'essai qui peuvent apparaître entre le test de contrôle post-homologation et le test initial d'homologation, dans la mesure où ces différences ne dépassent pas les tolérances autorisées par la norme.

ARTICLE 1.2 : ENGAGEMENT DU FABRICANT SUR LA STABILITE DE SON PRODUIT

Une fois la demande d'homologation déposée, le fabricant s'engage à ne pas modifier la conception du produit, les matériaux qui le composent ni sa méthode fondamentale de fabrication. Pour chaque produit, seuls les éléments expressément spécifiés dans la norme FIA correspondante peuvent être modifiés sans consultation de la FIA.

ARTICLE 2

A tout moment, la FIA pourra effectuer l'un ou l'autre des tests suivants :

ARTICLE 2.1 : ORGANISATION DES CONTROLES POST-HOMOLOGATION EFFECTUES PAR LA FIA : ESSAI DE PERFORMANCE

2.1.1. Un échantillon du produit sera prélevé par la FIA ou par toute autre personne nommée par la FIA, directement sur le lieu de production, lors d'une épreuve ou via les chaînes de distribution. Dans le cas d'un prélèvement à l'usine, le fabricant sera contacté à l'avance.

2.1.2. Les essais de performance seront effectués conformément à la norme s'appliquant à l'échantillon homologué, dans un laboratoire choisi et agréé par la FIA.

2.1.3. A la suite de ces tests, deux résultats sont possibles :

- Si le test est satisfaisant, le fabricant sera informé qu'un contrôle a été effectué et que l'échantillon répond à la norme.
- Si le test révèle que l'échantillon ne répond pas à la norme, la non-conformité du produit sera établie à partir de la simple constatation d'irrégularité de ce seul échantillon. Le fabricant sera averti par lettre recommandée de la non-conformité de son produit.

A la demande du fabricant par lettre recommandée, envoyée à la FIA dans les 20 jours suivant l'envoi de la notification de non-conformité, le même échantillon pourra être de nouveau testé par la FIA. Dans le cas d'un test destructif, un nouvel échantillon sera prélevé conformément au point 2.1.1. Le fabricant, ainsi qu'un représentant de son ASN, seront invités à assister à la contre-expertise. Dans la mesure du possible, les contre-expertises seront effectuées dans le laboratoire où les tests d'homologation initiaux avaient eu lieu .

Si cet échantillon ne répond toujours pas à la norme, la non-conformité du produit sera établie à partir de la simple constatation d'irrégularité de ce seul échantillon.

Si la contre-expertise révèle que l'échantillon répond à la norme, la conformité du produit sera de nouveau établie.

ARTICLE 2.2 : ORGANISATION DES CONTROLES QUALITE EFFECTUES PAR LA FIA : ESSAI COMPARATIF

2.2.1. Un échantillon du produit sera prélevé par la FIA ou par toute autre personne nommée par la FIA, directement sur le lieu de production, lors d'une épreuve ou via les chaînes de distribution. Dans le cas d'un prélèvement à l'usine, le fabricant sera contacté à l'avance.

2.2.2. Les essais comparatifs consisteront en une comparaison entre l'échantillon et le produit initialement homologué, afin de vérifier que le fabricant a respecté ses engagements, comme prévu à l'article 1.2.

2.2.3 A la suite de ces tests, deux résultats sont possibles :

- Si le test est satisfaisant, le fabricant sera informé qu'un contrôle a été effectué et que l'échantillon répond à la norme.
- Dans le cas où le fabricant n'aurait pas respecté ses engagements comme indiqué à l'article 1.2, et en particulier si l'échantillon se révélait différent du produit initialement homologué par la FIA, la non-conformité du produit sera établie à partir de la simple constatation d'irrégularité de ce seul échantillon, étant précisé que toute considération liée à la performance ne pourra être utilisée comme élément de défense. Le fabricant sera averti par lettre recommandée de la non-conformité de son produit.

A la demande du fabricant par lettre recommandée, envoyée à la FIA dans les 20 jours suivant l'envoi de la notification de non-conformité, le même échantillon pourra être de nouveau testé par la FIA. Dans le cas d'un test destructif, un nouvel échantillon sera prélevé conformément au point 2.2.1. Le fabricant, ainsi qu'un représentant de son ASN seront invités à assister à la contre-expertise. Dans la mesure du possible, les contre-expertises seront effectuées dans le laboratoire où les tests d'homologation initiaux avaient eu lieu.

S'il s'avère que le fabricant n'a pas respecté ses engagements, comme prévu à l'article 1.2, la non-conformité du produit sera établie à partir de la simple constatation d'irrégularité de cet échantillon, étant précisé que toute considération liée à la performance ne pourra être utilisée comme élément de défense.

S'il s'avère que le fabricant a respecté ses engagements, comme prévu à l'article 1.2, la conformité du produit sera de nouveau établie.

ARTICLE 3

ARTICLE 3.1 : ANNULATION DE L'HOMOLOGATION

Si la non-conformité de l'échantillon est établie conformément à l'article 2.1 ou 2.2, l'homologation pourra être annulée. Toutefois, la FIA appréciera la présence de circonstances particulières qui pourraient permettre que d'autres mesures de sanctions soient prises qui apportent les mêmes garanties en terme de sécurité qu'une annulation de l'homologation.

L'annulation de l'homologation se déroulera de la façon suivante :

- L'ASN du fabricant sera avertie de l'annulation de l'homologation FIA de son produit.
- Le fabricant sera responsable, à ses frais, de la mise en œuvre de la décision de la FIA.

La décision d'annulation de l'homologation entraînera le retrait immédiat de l'homologation du produit concerné. Par conséquent, ce produit ne sera plus accepté lors des épreuves régies par la FIA.

Parallèlement, la FIA rendra la sanction publique.

ARTICLE 3.2 : FACTURATION DES CONTROLES

Si la non-conformité du produit est établie, la FIA facturera au fabricant, par le biais de son ASN, l'ensemble des frais occasionnés par ces contrôles. Ces derniers comprennent les frais d'achat du produit, les frais de test, ainsi qu'une somme forfaitaire de CHF 2500 pour les prestations et les frais de déplacement de l'observateur FIA.

New text: **thus**
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1) MATERIAL

1.1. The flexible fuel bladder must be manufactured from a reinforced material in polyamide, polyester, aramid or equivalent impregnated and coated on both sides with a fuel resistant elastomer.
It must be possible to compress the fuel tank along its major axis, without causing cracking or delamination, until flat.

1.2. All physical properties detailed below must be maintained throughout all areas of the finished fuel bladder, including seams, joints and fittings.

1.3. All tests detailed in 2.0 to 6.0 below must be carried out on new specimens of fuel cell material.

1.4. If an individual measurement in any of the following tests falls significantly below the average test results for the sample unit, it will be discarded and another specimen tested.

1.5. All tests must be performed on test equipment which has been calibrated to national standards.

1.6 The tests described in points 2 to 5 must be carried out at an ambient temperature of 20°C
(+/- 5°C) in a dry atmosphere.

2) TENSILE STRENGTH

2.1. FT3-1999 Fuel bladder materials : Minimum tensile strength 2.00 kN

2.1.1. The tensile strength will be determined before and **immediately** after immersion **without any drying** in a fuel identical to the specifications of article 2.1.7. Ten specimens each measuring 25 mm in width and a minimum of 150 mm in length (the length being measured between the two clamps) must be cut from the fuel bladder material, five from the warp direction and five from the weft direction. No two warp specimens may contain the same warp yarns and no two weft specimens may contain the same weft yarns.

2.1.2 The long dimension must always be parallel to the direction of the weave.

2.1.3 The ends of each specimen must then be clamped and the load applied.

2.1.4. The distance between the clamps must be at least 75 mm at the start of the test and, when the load is applied they must move apart at a minimum rate of 30 cm per minute.

2.1.5 The tensile strength of the fuel bladder material will be then deemed to be the minimum failure load for both warp and weft directions.

2.1.6 The test must then be repeated on ten further samples which have been immersed in fuel for a minimum of 72 hours. During immersion, only one side of the sample need be exposed to fuel and its edges may be protected.
Again, the minimum failure load for both warp and weft directions must exceed the minimum required tensile strength.

2.1.7 All tests requiring fuel immersion must be performed with a fuel which comprises 60% iso-octane and 40% toluene.

2.1.8 If the test specimen slips from the jaws or persistent jaw breaks occur, the jaws may be faced with rubber or other material in order to prevent slippage or cutting. Any slippage of the test specimen in the test jaws will invalidate the result. **An alternative holding system as shown in fig 7 or equivalent is also possible to prevent persistent slippage.**

2.2. FT3.5-1999 Fuel bladder materials : Minimum tensile strength 4.45 kN

2.2.1 The same tests must be carried out and the minimum failure load for both warp and weft directions must exceed the minimum required tensile strength of 4.45 kN.

2.3. FT5-1999 Fuel bladder materials : Minimum tensile strength 8.90 kN

2.3.1 The same tests must be carried out and the minimum failure load for both warp and weft directions must exceed the minimum required tensile strength of 8.90 kN.

3) PUNCTURE STRENGTH

3.1. FT3-1999 Fuel bladder materials : Minimum puncture strength 0.78 kN

3.1.1 In order to assess puncture strength five specimens, each 150 mm in diameter, must be cut from the fuel bladder material and each one clamped in a specimen holder (see figure 1). The clamping bolts should be tightened so as to prevent the test specimen slipping when the piercing instrument is applied.

3.1.2 The piercing instrument (see figure 2), must be placed in the centre of area of the test specimen and when the load is applied, it must be travelling at a speed of between 20 and 45 cm per minute.

3.1.3 Five samples must be used; two samples with the warp yarn parallel to the piercing instrument, two samples with the weft yarn parallel to the piercing instrument and one with the warp yarn at 45° to the piercing instrument. The piercing instrument must be applied to the side of the specimen which would represent the exterior surface of the fuel bladder.

3.1.4 The puncture strength of the material will then be deemed to be the minimum failure load for all five specimens.

3.2. FT3.5-1999 Fuel bladder materials : Minimum puncture strength 0.89 kN

3.2.1 The same tests must be carried out and the minimum failure load for all five specimens must exceed the minimum required puncture strength of 0.89 kN.

3.3. FT5-1999 Fuel bladder materials : Minimum puncture strength 1.78 kN

3.3.1 The same tests must be carried out and the minimum failure load for all five specimens must exceed the minimum required puncture strength of 1.78 kN.

4) SEAM STRENGTH

4.1. FT3-1999 Fuel bladder materials : Minimum seam strength 2.00 kN

4.1.1 In order to assess seam strength before and **immediately** after the immersion **without any drying** in a fuel identical to the specifications of article 2.1.7, the fuel bladder material must be tested in the same way as for tensile strength (see 2.0) with the seam to be tested in the middle of the specimen.

4.1.2. The minimum failure load must be greater than the required minimum strength of 2.00 kN.

4.2. FT3.5-1999 Fuel bladder materials : Minimum seam strength 4.45 kN

4.2.1 The same seam strength tests must be carried out and the minimum failure load must be greater than the required minimum strength of 4.45 kN.

4.3. FT5-1999 Fuel bladder materials : Minimum seam strength 8.90 kN

4.3.1. The same seam strength tests must be carried out and the minimum failure load must be greater than the required minimum strength of 8.90 kN.

5) TEAR STRENGTH

5.1. FT3-1999 Fuel bladder materials : Minimum tear strength 0.25 kN

5.1.1 In order to assess the tear strength, ten samples each measuring a minimum of 75 mm x 200 mm must be cut from the bladder material, five from the warp direction and five from the weft direction. No two warp specimens may contain the same warp yarns and no two weft specimens may contain the same weft yarns.

5.1.2 Each sample must then be cut for a distance of 75 mm perpendicular to and in the middle of one short side. Each tongue will be clamped with its long dimension perpendicular to the direction of application of the load as indicated in figure 4.

5.1.3 The load will then be applied at a minimum rate of 30 cm per minute and the tear strength of the fuel bladder material will be deemed to be the minimum of the five highest peaks, excluding the first peak.
The samples must tear for at least 75 mm.

5.1.4 The values found in both the warp and weft specimens must exceed the minimum tear strength failure load of 0.25 kN.

5.1.5 If the test specimen slips from the jaws, they may be faced with rubber or other material in order to prevent slippage. Any slippage of the test specimen in the test jaws will invalidate the result.

5.2. FT3.5-1999 Fuel bladder materials : Minimum tear strength 0.89 kN

5.2.1 The same tear strength tests must be carried out and the minimum failure load increased to 0.89 kN.

5.3. FT5-1999 Fuel bladder materials : Minimum tear strength 1.56 kN

5.3.1 The same tear strength tests must be carried out and the minimum failure load increased to 1.56 kN.

6) EXPLOSION SUPPRESSANT

6.1 Unless specifically waived by the FIA, all fuel bladders must be supplied with a suitable fuel resistant polyurethane foam baffling, conforming to Mil Spec MIL-B-83054, SAE-AIR-4170 or equivalent. This foam must fill a minimum of 80 % of the volume of the fuel bladder.

6.2 Where rapid refuelling is expected, an anti-static foam conforming to Mil-Spec MIL-F-87260 (USAF) must be employed as in 6.1 above.

7) FITTINGS AND CONNECTIONS

7.1 All apertures in the fuel bladder must be closed by hatches or fittings which are secured to metallic or composite bolt rings bonded to the inside of the bladder.

Nevertheless, connections of the type corresponding to fig. 5 are authorised when space is not available for a bolt ring assembly:

Connections of the type corresponding to fig. 6 are also authorised with the following restrictions:

- the material of the connector must be based on the material of the tank and must comply with the standard
- the seams of the connector must be in conformity with article 4 of the standard.
- the joining of the tank and the filler neck must be carried out according to the manufacturer's instructions, to be sure there are no leaks.
- This type of connector is not usable when the technical regulations impose a non-return system.

7.2 All apertures in the fuel bladder must also be re-inforced with at least one extra ply of similar bladder material (see figure 3), this doubler must be at least as wide as the bolt ring (when applicable)

7.3 All threaded studs and inserts must be anti-corrosive.

7.4 Bolt hole edges must be no less than 5 mm from the edge of the bolt ring, hatch or fitting.

7.5 All fuel bladders must be supplied with suitable fuel resistant elastomeric gaskets, integral gasket surfaces or 'o' rings which have been specifically manufactured to fit the clamping area.

8) SAFETY FUEL CELL MATERIALS HOMOLOGATED BY THE FIA

8.1 All fuel bladders must be made from materials homologated by the FIA. In order to obtain the homologation of the FIA, the manufacturer must submit a sample of any material intended for use in the manufacture of fuel bladders (to either FT-3-1999, FT-3.5-1999 or FT5-1999) for testing to the above standards.
All the tests must be carried out by, and the test report in conformity with appendix 1 drawn up by, an approved test centre, a list of which is available from the FIA. The original of the test report, signed by the test centre and the tank manufacturer, must be sent to the FIA through the ASN together with a specimen of the material tested.
Manufacturers must undertake to deliver to their customers fuel bladders complying with these specifications.

8.2 All fuel bladders must be printed with the name of the manufacturer, the specification to which the bladder has been manufactured, the date of expiry of validity preceded by "Not valid after:" and a unique serial number. The serial number must be fully traceable from the manufacturer's production records.

8.3 All fuel bladders must be pressure tested by the manufacturer prior to being supplied to their customer, the pressure to be applied being left to the discretion of the manufacturer. The exterior surface must be checked with a dilute soap solution or equivalent to ensure there is no leakage.

8.4 Every new tank must comply with the FIA Standard in force on the date of its production.

9) AGEING OF FUEL BLADDERS

9.1 No bladders shall be used for more than 5 years after the date of manufacture, unless reinspected and recertified by the manufacturer during this 5 year period, for a supplementary period of up to another 2 years.

10) FUEL BLADDER REPAIRS

10.1 Any repairs to fuel bladders must meet the specifications defined for a new bladder and must be carried out by the manufacturer.

11) NEW TECHNOLOGY

11.1 The FIA will consider new designs and materials for safety fuel tanks if these are clearly demonstrated to have equal or superior performance to those described herein.

11.2 Alternative principles, materials and construction methods for safety fuel tanks must be functionally verified by the manufacturer and formally approved by the FIA before use.

11.3 The FIA reserves the right to periodically review and assess any and all previously approved safety tanks for compliance with the applicable specification.
In the event of the tank failing to comply with the applicable standard, the manufacturer's homologation may be withdrawn by the FIA.

FIA standard for fuel cells

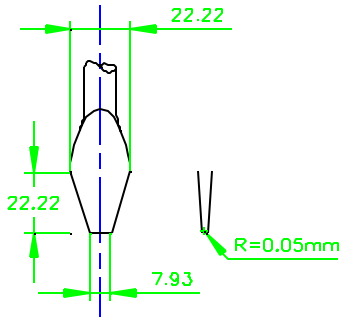

Figure 2 . Piercing instrument

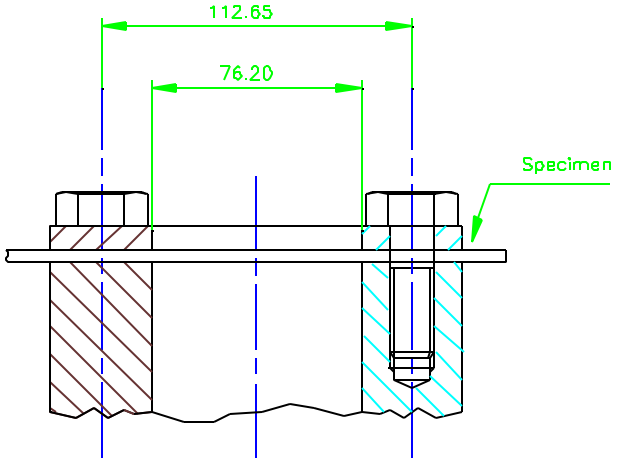

Figure 1 : Specimen holder

All dimensions in mm

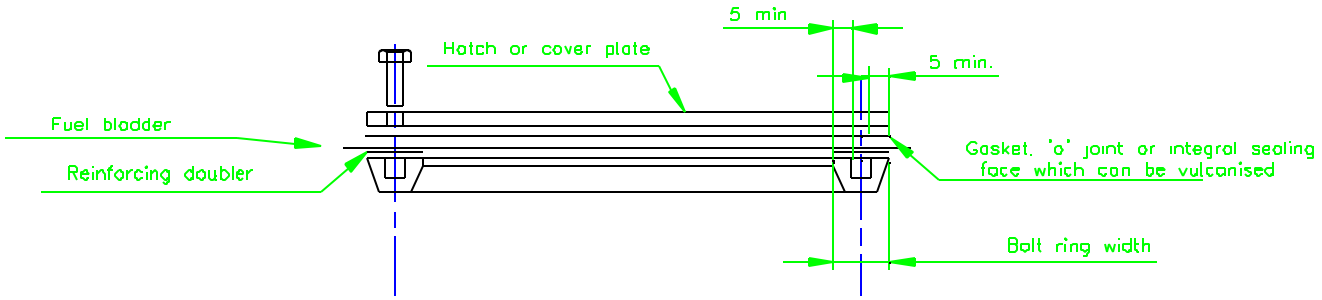

Figure 3 : Typical fuel bladder aperture and bolt ring assembly

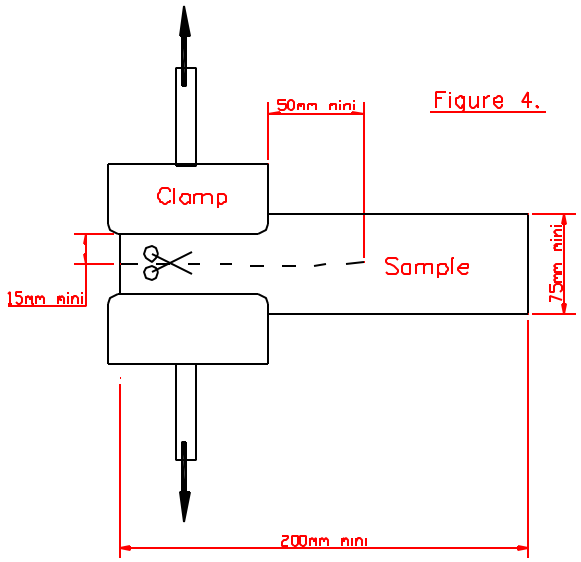

Figure 4.

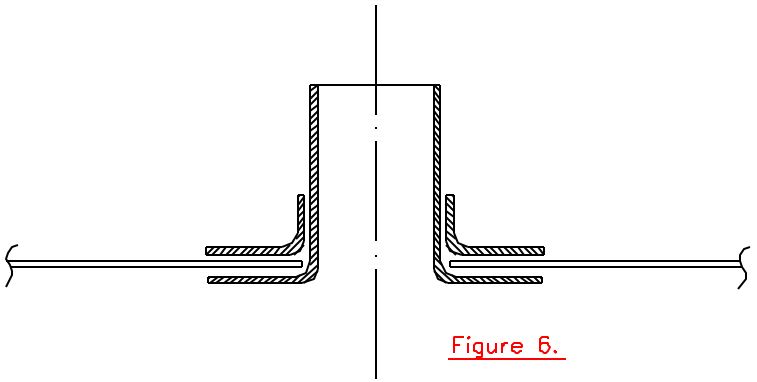

Figure 6.

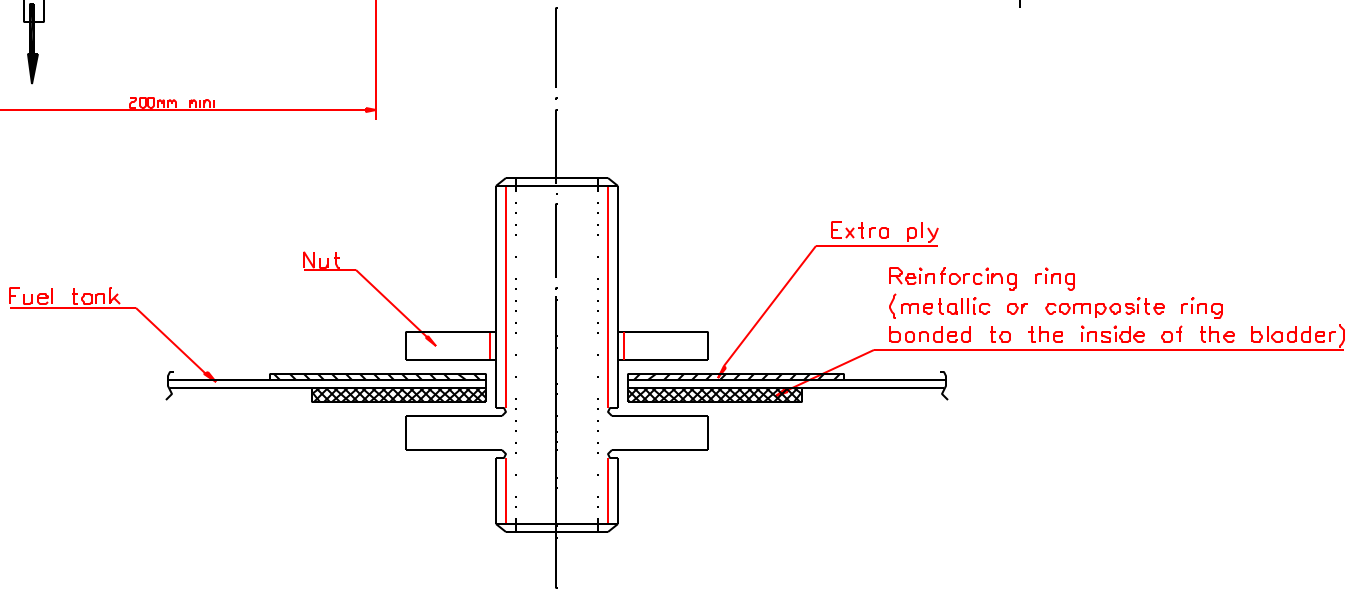

Figure 5.

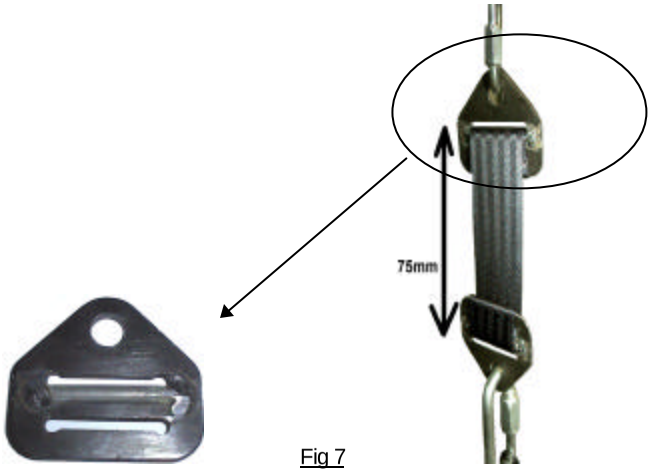

Fig 7

POST-HOMOLOGATION CONTROLS APPLIED TO THE PRODUCTS HOMOLOGATED BY THE FIA

ARTICLE 1

ARTICLE 1.1: MANUFACTURER'S ACCEPTANCE OF POST-HOMOLOGATION CONTROLS

In applying for the homologation of his product, the manufacturer automatically undertakes to respect the present document and accepts all the control procedures that the FIA might undertake to guarantee the conformity of the homologated products.

The post-homologation control tests will be carried out in conformity with the conditions set out in the homologation standard. The manufacturer therefore undertakes not to contest any differences in the test conditions that may appear between the post-homologation test and the initial homologation test, insofar as these differences do not exceed the tolerances authorised by the standard.

ARTICLE 1.2: MANUFACTURER'S UNDERTAKING FOR THE STABILITY OF HIS PRODUCT

When applying for the homologation, the manufacturer undertakes not to modify the design, materials and fundamental method of production of the product. The only parts that may be modified without consulting the FIA are those explicitly specified in the FIA standard applying to each product.

ARTICLE 2

At its own discretion, the FIA may conduct one or other of the following tests:

ARTICLE 2.1: ORGANISATION OF POST-HOMOLOGATION CONTROLS CARRIED OUT BY THE FIA: PERFORMANCE TEST

2.1.1. A sample of the product will be taken by the FIA, or by any other FIA appointed person, directly at the production site, at an event or via the distribution channels. In the case of a sample taken at the factory, the manufacturer will be contacted beforehand.

2.1.2. Performance tests will be carried out in compliance with the standard to which the sample is homologated, in an FIA-approved laboratory chosen by the FIA.

2.1.3. Following these tests, there are two possible outcomes:

- If the sample passes the test, the manufacturer will be notified that a control has been carried out and that the sample complied with the standard.
- If the sample is found not to comply with the standard, the non-conformity of the product will be established on the sole grounds that the irregularity of this single sample has been noted. The manufacturer will be notified by registered letter of the non-conformity of his product.

At the request of the manufacturer by registered letter, sent to the FIA within the 20 days following the sending of the notification of non-conformity, the same sample may be re-tested by the FIA. In the case of a destructive test, a new sample will be taken in accordance with 2.1.1. The manufacturer will be invited to attend the second test, together with a representative of his ASN. As far as possible, the second control tests will be carried out in the laboratory in which the initial homologation tests were conducted.

If this sample is again found not to comply with the standard, the non-conformity of the product will be established on the sole grounds that the irregularity of this single sample has been noted.

If the sample is found to comply with the standard, the conformity of the product will be re-established.

ARTICLE 2.2: ORGANISATION OF POST-HOMOLOGATION CONTROLS CARRIED OUT BY THE FIA: COMPARISON TEST

2.2.1. A sample of the product will be taken by the FIA, or by any other FIA appointed person, directly at the production site, at an event or via the distribution channels. In the case of a sample taken at the factory, the manufacturer will be contacted beforehand.

2.2.2. Comparison tests will consist in a comparison between the sample and the product initially homologated in order to check that the manufacturer has respected his commitments as set out in article 1.2.

2.2.3 Following these tests, there are two possible outcomes:

- If the sample passes the test, the manufacturer will be notified that a control has been carried out and that the sample complied.
- Should the manufacturer fail to respect his commitments as set out in article 1.2 and in particular if the sample proves not to be identical to the product initially homologated with the FIA, the non-conformity of the product will be established on the sole grounds that the irregularity of this single sample has been noted, it being specified that no performance-related considerations may be put forward in defence. The manufacturer will be notified by registered letter of the non-conformity of his product.

At the request of the manufacturer by registered letter, sent to the FIA within the 20 days following the sending of the notification of non-conformity, the same sample may be re-tested by the FIA. In the case of a destructive test, a new sample will be taken in accordance with 2.2.1. The manufacturer will be invited to attend the second test, together with a representative of his ASN. As far as possible, the second control tests will be carried out in the laboratory in which the initial homologation tests were conducted.

If it is found that the manufacturer has failed to respect his commitments as set out in article 1.2, the non-conformity of the product will be established on the sole grounds that the irregularity of this single sample has been noted, it being specified that no performance-related considerations may be put forward in defence.

If it is found that the manufacturer has respected his commitments as set out in article 1.2, the conformity of the product will be re-established.

ARTICLE 3

ARTICLE 3.1: CANCELLATION OF THE HOMOLOGATION

If the non-conformity of the sample is established in accordance with article 2.1 or 2.2, the homologation may be cancelled. However, the FIA will take into account the existence of special circumstances and may impose alternative sanctions which provide the same guarantees in terms of safety as the cancellation of the homologation would have done.

The following procedure will be used for the cancellation of the homologation:

- The manufacturer's ASN will be notified of the cancellation of the FIA homologation of the product.
- The manufacturer will be responsible for implementing the FIA's decision at his own expense.

Once the decision to cancel the homologation has been made, the homologation of the product concerned will immediately be withdrawn. It will therefore no longer be accepted for events governed by the FIA regulations.

At the same time, the FIA will announce the sanction publicly.

ARTICLE 3.2: INVOICING OF THE CONTROLS

If the non-conformity of the product is established, the FIA will invoice the manufacturer, via his ASN, for the entire costs occasioned by these control tests. These shall include the costs of purchasing the product, the costs of the tests, and a fixed sum of 2500 CHF for the services and travel expenses of the FIA Observer.

RAPPORT D'ESSAI /TEST REPORT

COMMENT REMPLIR LA FICHE D'HOMOLOGATION
HOW TO FILL IN THE HOMOLOGATION FORM

La fiche d'homologation doit être remplie successivement par trois organismes pour être validée/*The homologation form shall be filled in successively by three different bodies in order to be valid*

1. **Le laboratoire de test complète les parties 1 à 8 du rapport et conclut sur la conformité du réservoir à la norme FIA. /***The test laboratory completes parts 1 to 8 of the report and concludes whether the tank is in conformity with the FIA standard***.**

   Il est demandé de remplir chaque case soient par des valeurs si elles sont requises soit par tout commentaire que le centre juge utile de mentionner. /*Each box should be filled in, either with figures or tick box if these are required or with any comments which the centre may consider worth mentioning.*

   La(es) personne(s) certifiant les essais signe(nt) la dernière page de la fiche */The person(s) certifying the tests sign(s) the last page of the form.*

2. **Le représentant de l'ASN signe la dernière page de la fiche. /***The representative of the ASN signs the last page of the form.*

3 **La FIA attribue un numéro d'homologation à la vue du rapport dûment complété par tous les intervenants./***The FIA allocates a homologation number once it has seen the report, duly completed by all the parties concerned.*

FEDERATION INTERNATIONALE DE L'AUTOMOBILE

Rapport de tests pour l'homologation des réservoirs conformément au standard FIA
Tests report for the fuel cells homologation in accordance with the FIA standard

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TYPE DU RESERVOIR **FT3-1999** ☐ **FT3.5-1999** ☐ **FT5-1999** ☐
FUEL TANK TYPE

CONSTRUCTEUR
MANUFACTURER

REFERENCE DU TISSU UTILISE POUR FABRIQUE DES RESERVOIRS
FUEL BLADDER USED TO MANUFACTURE FUEL TANK

1. MATERIAU / MATERIAL

101. Matériau
Material

102. Photo du réservoir comprimé (Article 1.1)
Photo of a compress fuel tank (Article 1.1)

103. Résultat du test de compression (Délaminage, fissure, fuite)
Result of the compression test (Delamination, cracking, leakage) :

2. RESISTANCE A LA TRACTION/TENSILE STRENGTH

201. Photo d'un échantillon testé monté sur le dispositif de test
Photo of a sample tested mounted on a test dispositif

202. Vitesse de déplacement des pinces (Article 2.1.4)
Speed of the clamps' displacement (Article 2.1.4) _____ **cm/s**

203. Charge de rupture minimale des échantillons secs
Minimal failure load of the dry samples

Echantillon de chaine Sample in warp direction	Echantillon de trame Sample in weft direction
KN	KN
KN	KN
KN	KN
KN	KN
KN	KN

Valeur de la rupture minimale obtenue
Minimal load failure obtained _____ **KN**

Résistance minimale requise
Minimum resistance required _____ **KN**

Fabriquant		Réf du réservoir		Type du réservoir	
Manufacturer	**----------**	**Fuel tank réf.**	**----------**	**Fuel tank type**	**----------**

204. Charge de rupture minimale des échantillons immergés dans le carburant
Minimal failure load of the samples immerse in a fuel

Echantillons de chaîne Warp direction specimens	Echantillons de trame Weft direction specimens
KN	KN
KN	KN
KN	KN
KN	KN
KN	KN

Valeur de la rupture minimale obtenue
Minimal load failure obtained _____ **KN**

Résistance minimale requise
Minimum resistance required _____ **KN**

3. RESISTANCE A LA PERFORATION / PUNCTURE STRENGTH

301. Photo d'un échantillon testé monté sur le dispositif de test
Photo of a sample tested mounted on a test dispositif

302. Vitesse du déplacement de l'outil de perforation (Article 3.1.2)
Speed of the piercing instrument (Article 3.1.2) _____ **cm/min**

Fabriquant Manufacturer	----------	Réf du réservoir Fuel tank réf.	----------	Type du réservoir Fuel tank type	----------

303. Résistance à la perforation (Article 3.1.3)
Puncture strength (Article 3.1.3)

Echantillon de chaine Warp direction specimens	Echantillon de trame Weft direction specimens	Echantillon à 45° Specimen at 45°
KN	KN	KN
KN	KN	

Valeur de la rupture minimale obtenue
Minimal load failure obtained _____ **KN**

Résistance minimale requise
Minimum resistance required _____ **KN**

4. RESISTANCE DES ASSEMBLAGES/SEAM STRENGTH

401. Vitesse du déplacement des pinces (Article 2.1.4)
Speed of the clamps' displacement (Article 2.1.4) _____ **cm/s**

402. Charge de rupture minimale des échantillons secs
Minimal failure load of the dry samples

Echantillon de chaine Sample in warp direction	Echantillon de trame Sample in weft direction
KN	KN
KN	KN
KN	KN
KN	KN
KN	KN

Valeur de la rupture minimale obtenue
Minimal load failure obtained _____ **KN**

Résistance minimale requise
Minimum resistance required _____ **KN**

403. Charge de rupture minimale des échantillons immergés dans le carburant
Minimal failure load of the samples immerse in a fuel

Echantillons de chaîne Warp direction specimens	Echantillons de trame Weft direction specimens
KN	KN
KN	KN
KN	KN
KN	KN
KN	KN

Valeur de la rupture minimale obtenue
Minimal load failure obtained _____ **KN**

Fabriquant Manufacturer ----------	Réf du réservoir Fuel tank réf. ----------	Type du réservoir Fuel tank type ----------

Résistance minimale requise
Minimum resistance required _____ **KN**

5. RESISTANCE A LA DECHIRURE/TEAR STRENGTH

501. Photo d'un échantillon testé monté sur le dispositif de test
Photo of a sample tested mounted on a test dispositif

502. Vitesse d'application de la charge (Article 5.1.3)
Rate of the load (Article 5.1.3) _____ **cm/min**

503. Charge de rupture des échantillons
Failure load of the samples

Echantillon de chaîne	Echantillon de trame
KN	**KN**
KN	**KN**
KN	**KN**
KN	**KN**
KN	**KN**

Valeur minimale des 5 charges maximales, en excluant le premier maximum
Minimal value of the 5 highest peaks, excluding the first peak _____ **KN**

Résistance minimale requise
Minimum resistance required _____ KN

6. PRODUIT DE SUPPRESSION D'EXPLOSION/EXPLOSION SUPPRESSANT

Mousse utilisée
Foam used

7. ENGAGEMENT DU FABRICANT
MANUFACTURER ENGAGEMENT

Je m'engage à fournir à mes clients des réservoirs de carburant conformes aux spécifications de la FIA en vigueur à la date de fabrication du réservoir.
Sur chaque réservoir, il sera imprimé le nom du fabricant, sa spécification, sa date de ~~fabrication~~ **fin de validité** ainsi que son numéro de série, numéro qui pourra être retrouvé en permanence dans nos registres. Chaque réservoir subira, avant d'être livrés au client un test de pression ainsi qu'un test de solution savonneuse.

I undertake to supply my clients with fuel tanks complying with the FIA specifications in force on the date on which the tank was manufactured.
Each tank will be printed with the name of the manufacturer, the specification of the tank, its date of **expiry of validity** ~~manufacture~~, and its serial number which will be permanently listed in our registers. Before being delivered to the client, each tank will undergo a pressure test and a soap solution test.

DATE	NOM ET SIGNATURE DU FABRIQUANT NAME AND SIGNATURE OF THE MANUFACTURER

8. CONCLUSION DES TESTS / CONCLUSION OF THE TESTS

Le tissu testé est conforme aux spécifications de la FIA
The fuel bladder tested conforms with the FIA standard

OUI / YES	NON / NO
☐	☐

DATE	NOM ET SIGNATURE DU CENTRE DE TESTS NAME AND SIGNATURE OF THE TESTS CENTER

2001 FORMULA ONE TECHNICAL REGULATIONS

SUMMARY

ARTICLE 1: DEFINITIONS

1.1 Formula One Car :

An automobile designed solely for speed races on circuits or closed courses.

1.2 Automobile :

A land vehicle running on at least four non-aligned complete wheels, of which at least two are used for steering and at least two for propulsion.

1.3 Land vehicle :

A locomotive device propelled by its own means, moving by constantly taking real support on the earth's surface, of which the propulsion and steering are under the control of a driver aboard the vehicle.

1.4 Bodywork :

All entirely sprung parts of the car in contact with the external air stream, except cameras and the parts definitely associated with the mechanical functioning of the engine, transmission and running gear. Airboxes, radiators and engine exhausts are considered to be part of the bodywork.

1.5 Wheel :

Flange and rim.

1.6 Complete wheel :

Wheel and inflated tyre. **The complete wheel is considered part of the suspension system.**

1.7 Automobile Make :

In the case of Formula racing cars, an automobile make is a complete car. When the car manufacturer fits an engine which it does not manufacture, the car shall be considered a hybrid and the name of the engine manufacturer shall be associated with that of the car manufacturer. The name of the car manufacturer must always precede that of the engine manufacturer. Should a hybrid car win a Championship Title, Cup or Trophy, this will be awarded to the manufacturer of the car.

1.8 Event :

An event shall consist of official practice and the race.

1.9 Weight :

Is the weight of the car with the driver, wearing his complete racing apparel, at all times during the event.

1.10 Racing weight :

Is the weight of the car in running order with the driver aboard and all fuel tanks full.

1.11 Cubic capacity :

The volume swept in the cylinders of the engine by the movement of the pistons. This volume shall be expressed in cubic centimetres. In calculating engine cubic capacity, the number Pi shall be 3.1416.

1.12 Supercharging :

Increasing the weight of the charge of the fuel/air mixture in the combustion chamber (over the weight induced by normal atmospheric pressure, ram effect and dynamic effects in the intake and/or exhaust system) by any means whatsoever. The injection of fuel under pressure is not considered to be supercharging.

1.13 Cockpit :

The volume which accommodates the driver.

1.14 Sprung suspension :

The means whereby all complete wheels are suspended from the body/chassis unit by a spring medium.

1.15 Survival cell :

A continuous closed structure containing the fuel tank and the cockpit.

1.16 Camera :

Television cameras the dimensions of which are defined in Drawing 6.

1.17 Camera housing :

A device which is identical in shape and weight to a camera and which is supplied by the relevant Competitor for fitting to his car in lieu of a camera.

1.18 Cockpit padding :

Non-structural parts placed within the cockpit for the sole purpose of improving driver comfort and safety. All such material must be quickly removable without the use of tools.

1.19 Brake caliper :

All parts of the braking system outside the survival cell, other than brake discs, brake pads, caliper pistons, brake hoses and fittings, which are stressed when subjected to the braking pressure. Bolts or studs which are used for attachment are not considered to be part of the braking system.

ARTICLE 2 : GENERAL PRINCIPLES

2.1 Role of the FIA :

The following technical regulations for Formula 1 cars are issued by the FIA.

2.2 Amendments to the regulations :

Amendments to these regulations will be made in accordance with the Concorde agreement.

2.3 Dangerous construction :

The stewards of the meeting may exclude a vehicle whose construction is deemed to be dangerous.

2.4 Compliance with the regulations :

Automobiles must comply with these regulations in their entirety at all times during an Event.
Should a competitor feel that any aspect of these regulations is unclear, clarification may be sought from the FIA Formula One Technical Department. If clarification relates to any new design or system, correspondence must include :

- a full description of the design or system ;
- drawings or schematics where appropriate ;
- the Competitor's opinion concerning the immediate implications on other parts of the car of any proposed new design ;
- the Competitor's opinion concerning any possible long term consequences or new developments which may come from using any such new designs or systems ;
- the precise way or ways in which the Competitor feels the new design or system will enhance the performance of the car.

2.5 Measurements :

All measurements must be made while the car is stationary on a flat horizontal surface.

2.6 Duty of Competitor :

It is the duty of each Competitor to satisfy the FIA technical delegate and the Stewards of the Meeting that his automobile complies with these regulations in their entirety at all times during an Event.

ARTICLE 3 : BODYWORK AND DIMENSIONS

3.1 Wheel centre line :

The centre line of any wheel shall be deemed to be half way between two straight edges, perpendicular to the surface on which the car is standing, placed against opposite sides of the complete wheel at the centre of the tyre tread.

3.2 Height measurements :

All height measurements will be taken normal to and from the reference plane.

3.3 Overall width :

The overall width of the car, including complete wheels, must not exceed 1800mm with the steered wheels in the straight ahead position.

3.4 Width ahead of the rear wheel centre line :

3.4.1 Bodywork width ahead of the rear wheel centre line must not exceed 1400mm.

3.4.2 No lateral extremity of any bodywork forward of the front wheels may deflect more than 5mm vertically when a 50kg mass is placed on it. During such a test the centre of area of the mass will be placed 700mm forward of the front wheel centre line with its outer edge 700mm from the car centre line.

The precise dimensions of the mass which will be used are available from the FIA Technical Department.

3.4.3 In order to prevent tyre damage to other cars, the top and forward edges of the lateral extremities of any bodywork forward of the front wheels must be at least 10mm thick with a radius of at least 5mm.

3.5 Width behind the rear wheel centre line :

Bodywork width behind the rear wheel centre line must not exceed 1000mm.

3.6 Overall height :

No part of the bodywork may be more than 950mm above the reference plane.

3.7 Front bodywork height :

All bodywork situated forward of a point lying 330mm behind the front wheel centre line, and more than 250mm from the centre line of the car, must be no less than 100mm and no more than 300mm above the reference plane.

3.8 Height in front of the rear wheels :

3.8.1 Other than the rear view mirrors, each with a maximum area in plan view of 9000mm², no bodywork situated more than 330mm behind the front wheel centre line and more than 330mm forward of the rear wheel centre line, which is more than 600mm above the reference plane, may be more than 300mm from the centre line of the car.

3.8.2 No bodywork between the rear wheel centre line and a line 800mm forward of the rear wheel centre line, which is more than 500mm from the centre line of the car, may be more than 500mm above the reference plane.

3.8.3 No bodywork between the rear wheel centre line and a line 400mm forward of the rear wheel centre line, which is more than 500mm from the centre line of the car, may be more than 300mm above the reference plane.

3.9 Bodywork between the rear wheels :

3.9.1 No bodywork situated between the rear wheel centre line and a point lying 330mm forward of it may be more than 600mm above the reference plane.

3.9.2 No bodywork situated between the rear wheel centre line and a point lying 150mm behind it may be more than 450mm above the reference plane.

3.10 Height behind the rear wheel centre line :

3.10.1 Any part of the car more than 150mm behind the centre line of the rear wheels must not be more than 800mm above the reference plane.

3.10.2 No bodywork behind the centre line of the rear wheels, and more than 150mm each side of the longitudinal centre line of the car, may be less than 300mm above the reference plane.

3.10.3 **A**ny bodywork more than 150mm behind the rear wheel centre line which is more than 300mm above the reference plane, and between 75mm and 480mm from the car centre line, must lie in one of two areas when viewed from the side of the car. These areas are situated from 300mm to 375mm and 600mm to 800mm above the reference plane. When these areas are viewed from the side of the car, no longitudinal cross section may have more than three closed sections in the upper area or more than one in the lower.

3.11 Bodywork around the front wheels :

With the exception of brake cooling ducts, in plan view, there must be no bodywork in the area formed by two longitudinal lines parallel to and 400mm and 900mm from the car centre line and two transversal lines, one 350mm forward of and one 800mm behind the front wheel centre line.

3.12 Bodywork facing the ground :

3.12.1 All sprung parts of the car situated more than 330mm behind the front wheel centre line and more than 330mm forward of the rear wheel centre line, and which are visible from underneath, must form surfaces which lie on one of two parallel planes, the reference plane or the step plane. This does not apply to any parts of rear view mirrors which are visible, provided each of these areas does not exceed 9000mm² when projected to a horizontal plane above the car. The step plane must be 50mm above the reference plane.

3.12.2 The surface formed by all parts lying on the reference plane must :

- extend from a point lying 330mm behind the front wheel centre line to the centre line of the rear wheels;
- have minimum and maximum widths of 300mm and 500mm respectively ;
- be symmetrical about the centre line of the car ;
- have a 50mm radius (+/-2mm) on each front corner when viewed from directly beneath the car, this being applied after the surface has been defined.

3.12.3 The surface lying on the reference plane must be joined at its extremities to the surfaces lying on the step plane by a vertical transition. If there is no surface visible on the step plane vertically above any point around the extremity of the reference plane, this transition is not necessary.

3.12.4 The peripheries of the surfaces lying on the reference and step planes may be curved upwards with maximum radii of 25 and 50mm respectively. Where the vertical transition meets the surfaces on the step plane a radius, no greater than 25mm, is permitted.

A radius in this context will be considered as an arc applied perpendicular to the periphery and tangential to both surfaces.

The surface lying on the reference plane, the surfaces lying on the step plane and the vertical transitions between them, must first be fully defined before any radius can be applied or the skid block fitted. Any radius applied is still considered part of the relevant surface.

3.12.5 All parts lying on the reference and step planes, in addition to the transition between the two planes, must produce uniform, solid, hard, continuous, rigid (no degree of freedom in relation to the body/chassis unit), impervious surfaces under all circumstances.

Fully enclosed holes are permitted in these surfaces provided no part of the car is visible through them when viewed from directly below.

3.12.6 To help overcome any possible manufacturing problems, and not to permit any design which may contravene any part of these regulations, dimensional tolerances are permitted on bodywork situated between a point lying 330mm behind the front wheel centre line and the rear wheel centre line. A vertical tolerance of +/- 5mm is permissible across the surfaces lying on the reference and step planes and a horizontal tolerance of 5mm is permitted when assessing whether a surface is visible from beneath the car.

3.12.7 All sprung parts of the car situated behind a point lying 330mm forward of the rear wheel centre line, which are visible from underneath and are more than 250mm from the centre line of the car**,** must be at least 50mm above the reference plane.

3.13 Skid block :

3.13.1 Beneath the surface formed by all parts lying on the reference plane, a rectangular skid block, with a 50mm radius (+/-2mm) on each front corner, must be fitted. This skid block may comprise more than one piece but must :

a) extend longitudinally from a point lying 330mm behind the front wheel centre line to the centre line of the rear wheels.

b) be made from an homogeneous material with a specific gravity between 1.3 and 1.45.

c) have a width of 300mm with a tolerance of +/- 2mm.

d) have a thickness of 10mm with a tolerance of +/- 1mm.

e) have a uniform thickness when new.

f) have no holes or cut outs other than those necessary to fit the fasteners permitted by 3.13.2 or those holes specifically mentioned in g) below.

g) have seven precisely placed holes the positions of which are detailed in Drawing 1. In order to establish the conformity of the skid block after use, it's thickness will only be measured in the four 50mm diameter holes and the two forward 80mm diameter holes.

h) be fixed symmetrically about the centre line of the car in such a way that no air may pass between it and the surface formed by the parts lying on the reference plane.

3.13.2 Fasteners used to attach the skid block to the car must :

a) have a total area no greater than 40000mm² when viewed from directly beneath the car ;

b) be no greater than 2000mm² in area individually when viewed from directly beneath the car ;

c) be fitted in order that their entire lower surfaces are visible from directly beneath the car.

When the skid block is new, ten of the fasteners may be flush with it’s lower surface but the remainder may be no more than 8mm below the reference plane.

3.13.3 The lower edge of the periphery of the skid block may be chamfered at an angle of 30° to a depth of 8mm, the trailing edge however may be chamfered over a distance of 200mm to a depth of 8mm.

3.14 Overhangs :

No part of the car shall be more than 500mm behind the centre line of the rear wheels or more than 1200mm in front of the centre line of the front wheels.

No part of the bodywork more than 200mm from the centre line of the car may be more than 900mm in front of the front wheel centre line.

All overhang measurements will be taken parallel to the reference plane.

3.15 Aerodynamic influence :

Any specific part of the car influencing its aerodynamic performance (with the exception of the cover described in Article 6.5.2 in the pit lane only) :

- Must comply with the rules relating to bodywork.
- Must be rigidly secured to the entirely sprung part of the car (rigidly secured means not having any degree of freedom).
- Must remain immobile in relation to the sprung part of the car.

In order to ensure that this requirement is respected, the FIA reserves the right to introduce load/deflection tests on any part of the bodywork which appears to be (or is suspected of), moving whilst the car is in motion.

Any device or construction that is designed to bridge the gap between the sprung part of the car and the ground is prohibited under all circumstances.

No part having an aerodynamic influence and no part of the bodywork, with the exception of the skid block in 3.13 above, may under any circumstances be located below the reference plane.

3.16 Upper bodywork :

3.16.1 With the exception of the opening described in Article 3.16.3, when viewed from the side, the car must have bodywork in the triangle formed by three lines, one vertical passing 1330mm forward of the rear wheel centre line, one horizontal 550mm above the reference plane and one diagonal which intersects the vertical at a point 940mm above the reference plane and the horizontal 330mm forward of the rear wheel centre line.

The bodywork over the whole of this area must be arranged symmetrically about the car centre line and must be at least 200mm wide when measured at any point along a second diagonal line parallel to and 200mm vertically below the first.

Furthermore, over the whole area between the two diagonal lines, the bodywork must be wider than a vertical isosceles triangle lying on a lateral plane which has a base 200mm wide lying on the second diagonal line.

3.16.2 When viewed from the side, the car must have no bodywork in the triangle formed by three lines, one vertical 330mm forward of the rear wheel centre line, one horizontal 950mm above the reference plane, and one diagonal which intersects the vertical at a point 600mm above the reference plane and the horizontal at a point 1030mm forward of the rear wheel centre line.

3.16.3 In order that a car may be lifted quickly in the event of it stopping on the circuit, the principal rollover structure must incorporate a clearly visible unobstructed opening designed to permit a strap, whose section measures 60mm x 30mm, to pass through it.

ARTICLE 4 : WEIGHT

4.1 Minimum weight :

The weight of the car must not be less than 600kg.

4.2 Ballast :

Ballast can be used provided it is secured in such a way that tools are required for its removal. It must be possible to fix seals if deemed necessary by the FIA technical delegate.

4.3 Adding during the race :

With the exception of fuel, nitrogen and compressed air, no substance may be added to the car during the race. If it becomes necessary to replace any part of the car during the race, the new part must not weigh any more than the original part.

ARTICLE 5 : ENGINE

5.1 Engine specification :

5.1.1 Only 4-stroke engines with reciprocating pistons are permitted.

5.1.2 Engine capacity must not exceed 3000 cc.

5.1.3 Supercharging is forbidden.

5.1.4 All engines must have 10 cylinders and the normal section of each cylinder must be circular.

5.1.5 Engines may have no more than 5 valves per cylinder.

5.2 Other means of propulsion :

5.2.1 The use of any device, other than the 3 litre, four stroke engine described in 5.1 above, to power the car, is not permitted.

5.2.2 The total amount of recoverable energy stored on the car must not exceed 300kJ, any which may be recovered at a rate greater than 2kW must not exceed 20kJ.

5.3 Temperature and pressure of the charge :

5.3.1 Any device, system, procedure, construction or design the purpose and/or effect of which is any decrease whatsoever of the temperature of the intake air and/or of the charge (air and/or fuel) of the engine is forbidden.

5.3.2 Internal and/or external spraying of water or any substance whatsoever is forbidden (other than fuel for the normal purpose of combustion in the engine).

5.4 Exhaust system :

Variable geometric length exhaust systems are forbidden.

5.5 Engine materials :

5.5.1 The basic structure of the crankshaft and camshafts must be made from steel or cast iron.

5.5.2 Pistons, cylinder heads and cylinder blocks may not be composite structures which use carbon or aramid fibre reinforcing materials.

5.6 Starting the engine :

A supplementary device temporarily connected to the car may be used to start the engine both on the grid and in the pits.

5.7 Stall prevention systems :

If a car is equipped with a stall prevention system, and in order to avoid the possibility of a car involved in an accident being left with the engine running, all such systems must be configured to stop the engine no more than ten seconds after activation.

ARTICLE 6 : FUEL SYSTEM

6.1 Fuel tanks :

6.1.1 The fuel tank must be a single rubber bladder conforming to or exceeding the specifications of FIA/FT5-1999, the fitting of foam within the tank however is not mandatory.

6.1.2 All the fuel stored on board the car must be situated between the front face of the engine and the driver's back when viewed in lateral projection. When establishing the front face of the engine, no parts of the fuel, oil, water or electrical systems will be considered.

Furthermore, no fuel can be stored more than 300mm forward of the highest point at which the driver's back makes contact with his seat. However, a maximum of 2 litres of fuel may be kept outside the survival cell, but only that which is necessary for the normal running of the engine.

6.1.3 Fuel must not be stored more than 400mm from the longitudinal axis of the car.

6.1.4 All rubber bladders must be made by manufacturers recognised by the FIA. In order to obtain the agreement of the FIA, the manufacturer must prove the compliance of his product with the specifications approved by the FIA. These manufacturers must undertake to deliver to their customers exclusively tanks complying to the approved standards.

A list of approved manufacturers is available from the FIA.

6.1.5 All rubber bladders shall be printed with the name of the manufacturer, the specifications to which the tank has been manufactured and the date of manufacture.

6.1.6 No rubber bladders shall be used more than 5 years after the date of manufacture.

6.2 Fittings and piping :

6.2.1 All apertures in the fuel tank must be closed by hatches or fittings which are secured to metallic or composite bolt rings bonded to the inside of the bladder.

Bolt hole edges must be no less than 5mm from the edge of the bolt ring, hatch or fitting.

6.2.2 All fuel lines between the fuel tank and the engine must have a self sealing breakaway valve. This valve must separate at less than 50% of the load required to break the fuel line fitting or to pull it out of the fuel tank.

6.2.3 No lines containing fuel may pass through the cockpit.

6.2.4 All lines must be fitted in such a way that any leakage cannot result in the accumulation of fuel in the cockpit.

6.3 Crushable structure :

The fuel tank must be completely surrounded by a crushable structure, which is an integral part of the survival cell and must be able to withstand the loads required by the tests in Articles 18.2.1 and 18.3.

6.4 Fuel tank fillers :

Fuel tank fillers must not protrude beyond the bodywork. Any breather pipe connecting the fuel tank to the atmosphere must be designed to avoid liquid leakage when the car is running and its outlet must not be less than 250mm from the cockpit opening.

All fuel tank fillers and breathers must be designed to ensure an efficient locking action which reduces the risk of an accidental opening following a crash impact or incomplete locking after refuelling.

6.5 Refuelling :

6.5.1 All refuelling during the race must be carried out using equipment which has been supplied by the FIA designated manufacturer. This manufacturer will be required to supply identical refuelling systems, the complete specification of which will be available from the FIA no later than one month prior to the first Championship Event.

Any modifications to the manufacturer's specification may only be made following written consent from the FIA.

6.5.2 A cover must be fitted over the car connector at all times when the car is running on the track. The cover and it's attachments must be sufficiently strong to avoid accidental opening in the event of an accident.

6.5.3 Before refuelling commences, the car connector must be connected electrically to earth.

All metal parts of the refuelling system from the coupling to the supply tank must also be connected to earth.

6.5.4 Refuelling the car on the grid may only be carried out by using an unpressurised container which is no more than 2 metres above the ground.

6.5.5 No fuel on board the car may be more than ten degrees centigrade below ambient temperature.

6.5.6 The use of any device on board the car to decrease the temperature of the fuel is forbidden.

6.6 Fuel sampling :

6.6.1 Competitors must ensure that a one litre sample of fuel may be taken from the car at any time during the Event.

6.6.2 All cars must be fitted with a –2 'Symetrics' male fitting in order to facilitate fuel sampling. If an electric pump on board the car cannot be used to remove the fuel an externally connected one may be used provided it is evident that a representative fuel sample is being taken. If an external pump is used it must be possible to connect the FIA sampling hose to it and any hose between the car and pump must be -3 in diameter and not exceed 2m in length.

6.6.3 The sampling procedure must not necessitate starting the engine or the removal of bodywork (other than the cover over the refuelling connector).

ARTICLE 7 : OIL AND COOLANT SYSTEMS

7.1 Location of oil tanks :

All oil storage tanks must be situated between the front wheel axis and the rearmost gearbox casing longitudinally, and must be no further than the lateral extremities of the survival cell are from the longitudinal axis of the car.

7.2 Longitudinal location of oil system :

No other part of the car containing oil may be situated behind the complete rear wheels.

7.3 Catch tank :

In order to avoid the possibility of oil being deposited on the track, the engine sump breather must vent into the main engine air intake system.

7.4 Transversal location of oil system :

No part of the car containing oil may be more than 700mm from the longitudinal centre line of the car.

7.5 Oil replenishment :

No oil replenishment is allowed during a race.

7.6 Coolant header tank :

The coolant header tank on the car must be fitted with an FIA approved pressure relief valve which is set to a maximum of 3.75 bar gauge pressure. If the car is not fitted with a header tank, an alternative position must be approved by the FIA.

7.7 Cooling systems :

The cooling systems of the engine must not intentionally make use of the latent heat of vaporisation of any fluid.

7.8 Oil and coolant lines :

7.8.1 No lines containing coolant or lubricating oil may pass through the cockpit.

7.8.2 All lines must be fitted in such a way that any leakage cannot result in the accumulation of fluid in the cockpit.

7.8.3 No hydraulic fluid lines may have removable connectors inside the cockpit.

ARTICLE 8 : ELECTRICAL SYSTEMS

8.1 Software validation :

8.1.1 Prior to the start of each season the complete electrical system on the car must be examined and all on board and communications software must be validated by the FIA Technical Department.

The FIA must be notified of any changes prior to the Event at which such changes are intended to be implemented.

8.1.2 All microprocessors and their enclosures will be classified as either :

- Sealed and not re-programmable via any external connector ;
- Re-programmable via a direct connection but limited by an approved mechanism.
- Not re-programmable at an Event. This classification will be given if the microprocessor has no direct communication link to the external connectors of the unit that are capable of being used for re-programming during an Event.

8.1.3 All re-programmable microprocessors must have a mechanism that allows the FIA to accurately identify the software version loaded.

8.1.4 Reprogramming of electronic units during an event will be restricted by an approved mechanism that has been established before the electronic unit is first used at an event.

8.1.5 All set up and calibration data stored in microprocessor memory must be off-loadable by the FIA at any time. Appropriate communications equipment, software and analysis tools must be supplied by the team for FIA use.

8.1.6 The FIA will seal and identify all electronic units on the car that contain a programmable device.

8.1.7 All sealed units must be presented for inspection at the end of an Event.

8.1.8 No version of software will be approved for use at an Event if it is found to be capable of controlling any system on the car in a manner inconsistent with these technical regulations, even if the relevant control software may be disabled.

8.2 Start systems :

Any system, the purpose and/or effect of which is to detect when a race start signal is given, is not permitted.

8.3 Accident data recorders :

The recorder must be fitted :

- symmetrically about the car centre line and with its top facing upwards ;
- with each of its 12 edges parallel to an axis of the car ;
- less than 50mm above the reference plane ;
- in a position which is normally accessible at the start and finish of an Event ;
- in order that the entire unit lies between 40% and 60% of the wheelbase of the car ;
- with its main connector facing forwards ;
- in order that its status light is visible when the driver is in the cockpit ;
- in order that the download connector is easily accessible without the need to remove bodywork.

8.4 Marshal information display :

All cars must be fitted with cockpit lights to give drivers information concerning track signals or conditions. The precise specification of the lights and related components are available from the FIA Technical Department.

ARTICLE 9 : TRANSMISSION SYSTEM

9.1 Transmission types :

No transmission system may permit more than two wheels to be driven.

9.2 Clutch control :

All cars must be fitted with a means of disengaging the clutch for a minimum of fifteen minutes in the event of the car coming to rest with the engine stopped. This system must be in working order throughout the Event even if the main hydraulic, pneumatic or electrical systems on the car have failed.

In order that the driver or a marshal may activate the system in less than five seconds, the switch or button which operates it must :

- face upwards and be positioned on the survival cell no more than 150mm from the car centre line ;
- be less than 150mm from the front of the cockpit opening ;
- be marked with a letter "N" in red inside a white circle of at least 50mm diameter with a red edge.

9.3 Gear ratios :

9.3.1 The minimum number of forward gear ratios is 4 and the maximum is 7.

9.3.2 **Continuously variable transmission systems are not permitted.**

9.4 Reverse gear :

All cars must have a reverse gear operable any time during the Event by the driver when the engine is running.

9.5 Torque transfer systems ~~Electronically controlled differentials~~ :

Any system or device the design of which is capable of transferring or diverting torque from a slower to a faster rotating wheel is not permitted.

ARTICLE 10 : SUSPENSION AND STEERING SYSTEMS

10.1 Sprung suspension :

Cars must be fitted with sprung suspension. The springing medium must not consist solely of bolts located through flexible bushes or mountings.

There must be movement of the wheels to give suspension travel in excess of any flexibility in the attachments.

The suspension system must be so arranged that its response is consistent at all times and results only from changes in vertical load applied to the wheels save only for movement permitted by inherent and fixed physical properties.

10.2 Suspension geometry :

10.2.1 Suspension geometry must remain fixed at all times.

10.2.2 **Any powered device which is capable of altering the configuration or affecting the performance of any part of the suspension system is forbidden.**

10.2.3 **No adjustment may be made to the suspension system while the car is in motion.**

10.3 Suspension members :

10.3.1 **The cross-sections of e**ach member of every suspension component must **have** an aspect ratio no greater than 3.5:1 **and be symmetrical about its major axis**. All suspension components may however have sections with an aspect ratio greater than 3.5:1**, and be non-symmetrical,** provided these are adjacent to their inner and outer attachments and form no more than 25% of the total distance between the attachments of the relevant member.

All measurements will be made perpendicular to a line drawn between the inner and outer attachments of the relevant member.

10.3.2 No major axis of a cross section of a suspension member may subtend an angle greater than 5° to the reference plane when measured parallel to the centre line of the car.

10.3.3 Non-structural parts of suspension members are considered bodywork.

10.3.4 In order to help prevent a wheel becoming separated in the event of all suspension members connecting it to the car failing, two cables, each with separate attachments, must be fitted to connect each wheel/upright assembly to the main structure of the car. The cables and their attachments must be designed in order to help prevent a wheel making contact with the driver's head during an accident.

The length of each cable should be no longer than that required to allow normal suspension movement.

Each complete cable restraint system, including their attachments, must have a minimum tensile strength of 50kN and each cable must be flexible with a minimum diameter of 8mm.

10.4 Steering :

10.4.1 Any steering system which permits the re-alignment of more than two wheels is not permitted.

10.4.2 Power assisted steering systems are permitted but may not carry out any function other than reduce the physical effort required to steer the car.

If an electronically controlled power steering system is used the only permissible inputs are steering torque, steering angle and car speed. **If these inputs are filtered the cut-off frequencies must be approved and published by the FIA.** Additionally, the settings may not be changed whilst the car is in motion.

If faults or errors are detected by the driver or by on-board software, back-up sensors may be used and different settings may be manually or automatically selected. However, any back-up sensor or new setting chosen in this way must not enhance the performance of the car and the original setting may only be restored when the car is stationary in the pits.

10.4.3 No part of the steering wheel or column, nor any part fitted to them, may be closer to the driver than a plane formed by the entire rear edge of the steering wheel rim.

10.4.4 The steering wheel, steering column and steering rack assembly must pass an impact test, details of the test procedure may be found in Article 16.5.

ARTICLE 11 : BRAKE SYSTEM

11.1 Brake circuits and pressure distribution :

11.1.1 All cars must be equipped with **only** one brake system. **This system must comprise solely of** two separate hydraulic circuits operated by one pedal, one circuit operating on the two front wheels and the other on the two rear wheels. This system must be designed so that if a failure occurs in one circuit the pedal will still operate the brakes in the other.

11.1.2 The brake system must be designed in order that **the force exerted on the brake pads within** each circuit are the same at all times.

11.1.3 Any powered device which is capable of altering the configuration **or affecting the performance** of **any part of** the brake system is forbidden.

11.1.4 Any change to, or modulation of, the brake system whilst the car is moving must be made by the drivers direct physical input, may not be pre-set and must be under his complete control at all times.

11.2 Brake calipers :

11.2.1 All brake calipers must be made from aluminium materials with a modulus of elasticity no greater than 80Gpa.

11.2.2 No more than two attachments may be used to secure each brake caliper to the car.

11.2.3 No more than one caliper, with a maximum of six pistons, is permitted on each wheel.

11.2.4 The section of each caliper piston must be circular.

11.3 Brake discs :

11.3.1 No more than one brake disc is permitted on each wheel.

11.3.2 All discs must have a maximum thickness of 28mm and a maximum outside diameter of 278mm.

11.3.3 No more than two brake pads are permitted on each wheel.

11.4 Air ducts :

Air ducts for the purpose of cooling the front and rear brakes shall not protrude beyond :

- a plane parallel to the ground situated at a distance of 140mm above the horizontal centre line of the wheel ;
- a plane parallel to the ground situated at a distance of 140mm below the horizontal centre line of the wheel ;
- a vertical plane parallel to the inner face of the wheel rim and displaced from it by 120mm toward the centre line of the car.

Furthermore, when viewed from the side the ducts must not protrude forwards beyond the periphery of the tyre or backwards beyond the wheel rim.

11.5 Brake pressure modulation :

11.5.1 No braking system may be designed to prevent wheels from locking when the driver applies pressure to the brake pedal.

11.5.2 No braking system may be designed to increase the pressure in the brake calipers above that achievable by the driver applying pressure to the pedal under static conditions.

11.6 Liquid cooling :

Liquid cooling of the brakes is forbidden.

ARTICLE 12 : WHEELS AND TYRES

12.1 Location :

Wheels must be external to the bodywork in plan view, with the rear aerodynamic device removed.

12.2 Number of wheels :

The number of wheels is fixed at four.

12.3 Wheel material :

All wheels must be made from an homogeneous metallic material.

12.4 Wheel dimensions :

12.4.1 Complete wheel width must lie between 305 and 355mm when fitted to the front of the car and between 365 and 380mm when fitted to the rear.

12.4.2 Complete wheel diameter must not exceed 660mm when fitted with dry-weather tyres or 670mm when fitted with wet-weather tyres.

12.4.3 Complete wheel width and diameter will be measured horizontally at axle height when fitted with new tyres inflated to 1.4 bar.

12.4.4 Wheel bead diameter must lie between 328 and 332mm.

ARTICLE 13 : COCKPIT

13.1 Cockpit opening :

13.1.1 In order to ensure that the opening giving access to the cockpit is of adequate size, the template shown in Drawing 2 will be inserted into the survival cell and bodywork.

During this test the steering wheel, steering column, seat and all padding required by Articles 14.6.1-6 (including fixings), may be removed and :

- the template must be held horizontal and lowered vertically from above the car until its lower edge is 525mm above the reference plane ;
- referring to Drawing 2, the edge of the template which lies on the line d-e must be no less than 1800mm behind the line A-A shown in Drawing 5.

Any measurements made from the cockpit entry template (when referred to in Articles 13.1.3,15.2.2, 15.4.5, 15.4.6, 15.5.4, 16.3 and 18.4), must also be made whilst the template is held in this position.

13.1.2 The forward extremity of the cockpit opening, even if structural and part of the survival cell, must be at least 50mm in front of the steering wheel.

13.1.3 The driver must be able to enter and get out of the cockpit without it being necessary to open a door or remove any part of the car other than the steering wheel. When seated normally, the driver must be facing forwards and the rearmost part of his crash helmet may be no more than 125mm forward of the rear edge of the cockpit entry template.

13.1.4 From his normal seating position, with all seat belts fastened and whilst wearing his usual driving equipment, the driver must be able to remove the steering wheel and get out of the car within 5 seconds and then replace the steering wheel in a total of 10 seconds.

For this test, the position of the steered wheels will be determined by the FIA technical delegate and after the steering wheel has been replaced steering control must be maintained.

13.2 Steering wheel :

The steering wheel must be fitted with a quick release mechanism operated by pulling a concentric flange installed on the steering column behind the wheel.

13.3 Internal cross section :

13.3.1 A free vertical cross section, which allows the outer template shown in Drawing 3 to be passed vertically through the cockpit to a point 100mm behind the face of the rearmost pedal when in the inoperative position, must be maintained over its entire length.

The only things which may encroach on this area are the steering wheel and any padding that is required by Article 14.6.7.

13.3.2 A free vertical cross section, which allows the inner template shown in Drawing 3 to be passed vertically through the cockpit to a point 100mm behind the face of rearmost pedal when in the inoperative position, must be maintained over its entire length.

The only thing which may encroach on this area is the steering wheel.

13.3.3 The driver, seated normally with his seat belts fastened and with the steering wheel removed must be able to raise both legs together so that his knees are past the plane of the steering wheel in the rearward direction. This action must not be prevented by any part of the car.

13.4 Position of the driver's feet :

13.4.1 The survival cell must extend from behind the fuel tank in a rearward direction to a point at least 300mm in front of the driver's feet, with his feet resting on the pedals and the pedals in the inoperative position.

13.4.2 When he is seated normally, the soles of the driver's feet, resting on the pedals in the inoperative position, must not be situated forward of the front wheel centre line.

ARTICLE 14 : SAFETY EQUIPMENT

14.1 Fire extinguishers :

14.1.1 All cars must be fitted with a fire extinguishing system which will discharge into the cockpit and into the engine compartment.

14.1.2 Any AFFF which has been specifically approved by the FIA is permitted.

14.1.3 The quantity of extinguishant may vary according to the type of AFFF used, a list is available from the FIA.

14.1.4 When operated, the fire extinguishing system must discharge 95% of its contents at a constant pressure in no less than 10 seconds and no more than 30 seconds.

If more than one container with extinguishant is fitted, they must be released simultaneously.

14.1.5 Each pressure vessel must be equipped with a means of checking its pressure which may vary according to the type of AFFF used. A list is available from the FIA.

14.1.6 The following information must be visible on each container with extinguishant :

a) Type of extinguishant

b) Weight or volume of the extinguishant

c) Date the container must be checked which must be no more than two years after the date of filling.

14.1.7 All parts of the extinguishing system must be situated within the survival cell and all extinguishing equipment must withstand fire.

14.1.8 Any triggering system having its own source of energy is permitted, provided it is possible to operate all extinguishers should the main electrical circuits of the car fail.

The driver must be able to trigger the extinguishing system manually when seated normally with his safety belts fastened and the steering wheel in place.

Furthermore, a means of triggering from the outside must be combined with the circuit breaker switch described in Article 14.2.2. It must be marked with a letter "E" in red inside a white circle of at least 100mm diameter with a red edge.

14.1.9 The system must work in any position, even when the car is inverted.

14.1.10 All extinguisher nozzles must be suitable for the extinguishant and be installed in such a way that they are not directly pointed at the driver.

14.2 Master switch :

14.2.1 The driver, when seated normally with the safety belts fastened and the steering wheel in place, must be able to cut off the electrical circuits to the ignition, all fuel pumps and the rear light by means of a spark proof circuit breaker switch.

This switch must be located on the dashboard and must be clearly marked by a symbol showing a red spark in a white edged blue triangle.

14.2.2 There must also be an exterior switch, with a horizontal handle, which is capable of being operated from a distance by a hook. This switch must be situated at the base of the main roll over structure on the right hand side.

14.3 Rear view mirrors :

All cars must have at least two mirrors mounted so that the driver has visibility to the rear and both sides of the car.

The reflective surface of each mirror must be at least 120mm wide, this being maintained over a height of at least 50mm. Additionally, each corner may have a radius no greater than 10mm.

The FIA technical delegate must be satisfied by a practical demonstration that the driver, when seated normally, can clearly define following vehicles.

For this purpose, the driver shall be required to identify any letter or number, 150mm high and 100mm wide, placed anywhere on boards behind the car, the positions of which are detailed below :

Height : From 400mm to 1000mm from the ground.

Width : 2000mm either side of the centre line of the car.

Position : 10m behind the rear axle line of the car.

14.4 Safety belts

It is mandatory to wear two shoulder straps, one abdominal strap and two straps between the legs. These straps must be securely fixed to the car and must comply with FIA standard 8853/98.

14.5 Rear light :

All cars must have a red light in working order throughout the Event which :

- has been manufactured as specified by the FIA ;
- faces rearwards at 90° to the car centre line and the reference plane ;
- is clearly visible from the rear ;
- is not mounted more than 100mm from the car centre line ;
- is mounted between 300mm and 375mm above the reference plane ;
- is no less than 450mm behind the rear wheel centre line measured parallel to the reference plane ;
- can be switched on by the driver when seated normally in the car.

The three measurements above will be taken to the centre of the rear face of the light unit.

14.6 Headrests and head protection :

14.6.1 All cars must be equipped with three areas of padding for the driver's head which :

- are so arranged that they can be removed from the car as one part ;
- are located by two horizontal pegs behind the driver' head and two fixings, which are clearly indicated and easily removable without tools, at the front corners ;
- are made from a material specified by the FIA ;
- are fitted with a cover manufactured from 60-240gsm materials which use suitable thermo-setting resin systems ;
- are positioned so as to be the first point of contact for the driver's helmet in the event of an impact projecting his head towards them during an accident.

14.6.2 The first area of padding for the driver's head must be positioned behind him and be between 75mm and 90mm thick over an area of at least 40000mm².

14.6.3 The two further areas of padding for the driver's head must be positioned directly alongside each side of his helmet. The upper surfaces of these areas of padding must be at least as high as the survival cell over their entire length.

Each area of padding must be between 75mm and 90mm thick over an area of at least 25000mm² and may have a radius of 10mm along it's upper inboard edge. When calculating their area, any part which is greater than 75mm thick and which lies between the front face of the rear area of padding and the forward most part of the driver's helmet whilst he is seated normally, will be taken into account (area 'B' in Drawing 4). The thickness will be measured perpendicular to the car centre line.

14.6.4 Forward of the side areas of padding further cockpit padding must be provided on each side of the cockpit rim. The purpose of the additional padding is to afford protection to the driver's head in the event of an oblique frontal impact and must therefore be made from the same material as the other three areas of padding.

These extensions must :

- be symmetrically positioned about the car centre line and a continuation of the side areas of padding ;
- be positioned with their upper surfaces at least as high as the survival cell over their entire length;
- have a radius on their upper inboard edge no greater than 10mm ;
- be positioned in order that the distance between the two is no less than 360mm ;
- be as high as practicable within the constraints of driver comfort.

14.6.5 All of the padding described above must be so installed that if movement of the driver's head, in any expected trajectory during an accident, were to compress the foam fully at any point, his helmet would not make contact with any structural part of the car.

Furthermore, for the benefit of rescue crews all of the padding described above must be installed using the FIA approved system. The method of removal must also be clearly indicated.

14.6.6 No part of the padding described above may obscure sight of any part of the driver's helmet when he is seated normally and viewed from directly above the car.

14.6.7 In order to minimise the risk of leg injury during an accident, additional areas of padding must be fitted each side of, and above, the driver’s legs.

These areas of padding must :

- be made from a material specified by the FIA ;
- be no less than 25mm thick over their entire area ;
- cover the area situated between points lying 50mm behind the centre of the point at which the second roll structure test is carried out and100mm behind the face of the rearmost pedal when in the inoperative position, as shown in Drawing 4 ;
- cover the area above the line A-A shown in Drawing 3.

14.7 Wheel retention :

All cars, whilst under their own power, must be fitted with devices which will retain any wheel in the event of it coming loose.

After the wheel nut is fastened, these devices must be manually fitted in a separate action to that of securing the wheel nut.

14.8 Seat fixing and removal :

14.8.1 In order that an injured driver may be removed from the car in his seat following an accident, all cars must be fitted with a seat which, if it is secured, must be done so with no more than two bolts. If bolts are used they must :

- be clearly indicated and easily accessible to rescue crews ;
- be fitted vertically ;
- be removable with the same tool for all Teams and which is issued to all rescue crews.

14.8.2 The seat must be equipped with receptacles which permit the fitting of belts to secure the driver and one which will permit the fitting of a neck support.

14.8.3 The seat must be removable without the need to cut or remove any of the seat belts.

14.8.4 Details of the tool referred to above, the belt receptacles and the neck support are available from the FIA Technical Department.

ARTICLE 15 : SAFETY STRUCTURES

15.1 Materials :

15.1.1 The use of magnesium sheet less than 3mm thick is forbidden.

15.1.2 No parts of the car may be made from metallic materials which have a specific modulus of elasticity greater than 40 GPa / (g/cm^3).

15.2 Roll structures :

15.2.1 All cars must have two roll structures which are designed to help prevent injury to the driver in the event of the car becoming inverted.

The principal structure must be at least 940mm above the reference plane at a point 30mm behind the cockpit entry template. The second structure must be in front of the steering wheel but no more than 250mm forward of the top of the steering wheel rim in any position.

The two roll structures must be of sufficient height to ensure the driver's helmet and his steering wheel are at least 70mm and 50mm respectively below a line drawn between their highest points at all times.

15.2.2 The principal structure must pass a static load test details of which may be found in Article 17.2. Furthermore, each Team must supply detailed calculations which clearly show that it is capable of withstanding the same load when the longitudinal component is applied in a forward direction.

15.2.3 The second structure must pass a static load test details of which may be found in Article 17.3.

15.2.4 Both roll structures must have minimum structural cross sections of 10000mm², in vertical projection, across a horizontal plane 50mm below the their highest points.

15.3 Structure behind the driver :

The parts of the survival cell immediately behind the driver which separate the cockpit from the car's fuel tank, and which lie less than 150mm from the centre line of the car, may be situated no further forward than the line a-b-c-d-e shown in Drawing 2.

15.4 Survival cell specifications :

15.4.1 Every survival cell must incorporate three FIA supplied transponders for identification purposes. These transponders must be a permanent part of the survival cell, be positioned in accordance with Drawing 7 and must be accessible for verification at any time.

15.4.2 The survival cell must have an opening for the driver, the minimum dimensions of which are given in Article 13.1. Any other openings in the survival cell must be of the minimum size to allow access to mechanical components.

15.4.3 An impact absorbing structure must be fitted in front of the survival cell. This structure need not be an integral part of the survival cell but must be solidly attached to it.

Furthermore, it must have a minimum external cross section, in horizontal projection, of 9000mm² at a point 50mm behind its forward-most point.

15.4.4 Referring to Drawing 5 :

The external width of the survival cell between the lines B-B and C-C must be no less than 450mm and must be at least 60mm per side wider than the cockpit opening when measured normal to the inside of the cockpit aperture. These minimum dimensions must be maintained over a height of at least 350mm.

The width of the survival cell may taper forward of the line B-B but, if this is the case, it must do so at a linear rate to a minimum of 300mm at the line A-A.

Between the lines A-A and B-B the width of the survival cell must be greater than the width defined by the two lines a-b. This minimum width must be arranged symmetrically about the car centre line, must be maintained over a height of at least 400mm at the line B-B and may taper at a linear rate to 275mm at the line A-A. When assessing the minimum external cross-sections of the survival cell, radii of 50mm at the line B-B, and reducing at a linear rate to 25mm at the line A-A, will be permitted.

The minimum height of the survival cell between the lines A-A and B-B need not be arranged symmetrically about the horizontal centre line of the relevant section but must be maintained over its entire width.

The minimum height of the survival cell between the lines B-B and C-C is 550mm.

15.4.5 When the test referred to in Article 13.1.1 is carried out and the template is in position with its lower edge 525mm above the reference plane, the shape of the survival cell must be such that no part of it is visible when viewed from either side of the car.

The parts of the survival cell which are situated each side of the driver's helmet must be no more than 550mm apart and, in order to maintain good lateral visibility the driver, when seated normally with his seat belts fastened and looking straight ahead, must have his eyes above the sides of the survival cell.

15.4.6 In order to give additional protection to the driver in the event of a side impact a flat test panel of uniform construction, which is designed and constructed in order to represent a section of the survival cell sides, must pass a strength test. Details of the test procedure may be found in Article 18.6.

Referring to Drawing 5, with the exception of local re-enforcement and/or inserts, all parts of the survival cell which are as wide or wider than the minimum widths stipulated in Article 15.4.4, including any radii applied, must be manufactured to the same specification as the panel tested under Article 18.6. Furthermore, parts to this tested specification must cover an area which :

- begins at least 250mm high at line A-A ;
- tapers at a linear rate to at least 400mm high at line B-B and which remains at this height to the rear of the survival cell ;
- is no less than 100mm above the reference plane between the line B-B and the rear of the survival cell.

15.5 Survival cell safety requirements :

15.5.1 The survival cell and frontal absorbing structure must pass an impact test against a solid vertical barrier placed at right angles to the centre line of the car, details of the test procedure may be found in Article 16.2.

15.5.2 Between the front and rear roll structures, on each side of the survival cell, impact absorbing structures must be fitted and must be solidly attached to it. The purpose of these structures is to protect the driver in the event of a lateral impact and, in order to ensure this is the case, a lateral strength test in the vicinity of the driver's seating position must be carried out successfully. Details of the test procedure may be found in Article 18.2.2.

The survival cell and one of these impact absorbing structures must pass an impact test, details of the test procedure may be found in Article 16.3. If these structures are not designed and fitted symmetrically about the car centre line a successful impact test must be carried out on them both.

15.5.3 An impact absorbing structure must be fitted behind the gearbox symmetrically about the car centre line with its rearmost point no less than 480mm behind the rear wheel centre line. It must also have a minimum external cross section, in horizontal projection, of 9000mm² at a point 50mm forward of its rearmost point. When calculating this area only those parts situated less than 100mm from the car centre line may be considered and the cross section may not diminish forward of this point.

This structure must pass an impact test and must be constructed from materials which will not be substantially affected by the temperatures it is likely to be subjected to during use. Details of the test procedure may be found in Article 16.4.

15.5.4 The survival cell must also be subjected to five separate static load tests :

1) on a vertical plane passing through the centre of the fuel tank ;
2) on a vertical plane passing through the rearmost point at which the outer end of the front wheel tether would make contact with the survival cell when swung about the inner attachment ;
3) on a vertical plane 375mm forward of the rear edge of the cockpit entry template ;

4) from beneath the fuel tank ;

5) on each side of the cockpit opening.

Details of the test procedures may be found in Article 18.2.

15.5.5 To test the attachments of the frontal impact absorbing structure to the survival cell, a static side load test must be carried out . Details of the test procedure may be found in Article 18.5.

ARTICLE 16 : IMPACT TESTING

16.1 Conditions applicable to all impact tests :

16.1.1 All tests must be carried out in accordance with FIA Test Procedure 01/00, in the presence of an FIA technical delegate and by using measuring equipment which has been calibrated to the satisfaction of the FIA technical delegate.

16.1.2 Any significant modification introduced into any of the structures tested shall require that part to pass a further test.

16.2 Frontal test :

All parts which could materially affect the outcome of the test must be fitted to the test structure which must be solidly fixed to the trolley through its engine mounting points but not in such a way as to increase its impact resistance.

The fuel tank must be fitted and must be full of water.

A dummy weighing at least 75kg must be fitted with safety belts described in Article 14.4 fastened. However, with the safety belts unfastened, the dummy must be able to move forwards freely in the cockpit.

The extinguishers, as described in Article 14.1 must also be fitted.

For the purposes of this test, the total weight of the trolley and test structure shall be 780kg and the velocity of impact 14.0 metres/sec.

The resistance of the test structure must be such that during the impact :

- the average deceleration over the first 150mm of deformation does not exceed 5g ;
- the average deceleration of the trolley does not exceed 40g ;
- the peak deceleration in the chest of the dummy does not exceed 60g for more than a cumulative 3ms, this being the resultant of data from three axes.

Furthermore, there must be no damage to the survival cell or to the mountings of the safety belts or fire extinguishers.

This test must be carried out on the survival cell subjected to the higher loads in the tests described in Articles 18.2-4, and on a frontal impact absorbing structure identical to the one which was subjected to the test described in Article 18.5.

16.3 Side test :

All parts which could materially affect the outcome of the test must be fitted to the test structure which must be solidly fixed to the ground and a solid object, having a mass of 780kg and travelling at a velocity of 10m/s, will be projected into it.

The object used for this test must :

- incorporate an impactor assembly specified by the FIA which is fitted in accordance with their instructions ;
- be positioned in order that its centre of area strikes the structure 300mm **(+/-5mm)** above the reference plane and at a point 500mm forward of the rear edge of the cockpit opening template.

During the test the striking object may not pivot in any axis and the survival cell may be supported in any way provided this does not increase the impact resistance of the parts being tested. The impact axis must be perpendicular to the car centre line and parallel to the ground.

The resistance of the test structure must be such that during the impact :

- the average deceleration of the object, measured in the direction of impact, does not exceed 20g ;
- the force applied to any one of the four impactor segments does not exceed 80kN for more than a cumulative 3ms ;
- the energy absorbed by each of the four impactor segments must be between 15% and 35% of the total energy absorption.

Furthermore, all structural damage must be contained within the impact absorbing structure.

This test must be carried out on the survival cell subjected to the higher loads in the tests described in Articles 18.2-4.

16.4 Rear test :

All parts which will be fitted behind the rear face of the engine and which could materially affect the outcome of the test must be fitted to the test structure. If suspension members are to be mounted on the structure they must be fitted for the test. The structure and the gearbox must be solidly fixed to the ground and a solid object, having a mass of 780kg and travelling at a velocity of 12m/s, will be projected into it.

The object used for this test must be flat, measure 450mm wide by 550mm high and may have a 10mm radius on all edges. Its lower edge must be at the same level as the car reference plane and must be so arranged to strike the structure vertically and at 90° to the car centre line.

During the test, the striking object may not pivot in any axis and the crash structure may be supported in any way provided this does not increase the impact resistance of the parts being tested.

The resistance of the test structure must be such that during the impact :

- the average deceleration of the object does not exceed 35g ;
- the maximum deceleration does not exceed 60g for more than a cumulative 3ms, this being measured only in the direction of impact

Furthermore, all structural damage must be contained within the area behind the rear wheel centre line.

16.5 Steering column test :

The parts referred to in Article 10.4.4 must be fitted to a representative test structure, any other parts which could materially affect the outcome of the test must also be fitted. The test structure must be solidly fixed to the ground and a solid object, having a mass of 8kg and travelling at a velocity of 7m/s, will be projected into it.

The object used for this test must be hemispherical with a diameter of 165mm.

For the test, the centre of the hemisphere must strike the structure at the centre of the steering wheel along the same axis as the main part of the steering column.

During the test the striking object may not pivot in any axis and the test structure may be supported in any way provided this does not increase the impact resistance of the parts being tested.

The resistance of the test structure must be such that during the impact the peak deceleration of the object does not exceed 80g for more than a cumulative 3ms, this being measured only in the direction of impact.

After the test, all substantial deformation must be within the steering column and the steering wheel quick release mechanism must still function normally.

ARTICLE 17 : ROLL STRUCTURE TESTING

17.1 Conditions applicable to both roll structure tests :

17.1.1 Rubber 3mm thick may be used between the load pads and the roll structure.

17.1.2 Under the load, deformation must be less than 50mm, measured along the loading axis and any structural failure limited to 100mm below the top of the rollover structure when measured vertically.

17.1.3 Any significant modification introduced into any of the structures tested shall require that part to pass a further test.

17.2 Principal roll structure :

A load equivalent to 50kN laterally, 60kN longitudinally in a rearward direction and 90kN vertically, must be applied to the top of the structure through a rigid flat pad which is 200mm in diameter and perpendicular to the loading axis.

During the test, the roll structure must be attached to the survival cell which is supported on its underside on a flat plate, fixed to it through its engine mounting points and wedged laterally by any of the static load test pads described in Article 18.2.

17.3 Second roll structure :

A vertical load of 75kN must be applied to the top of the structure through a rigid flat pad which is 100mm in diameter and perpendicular to the loading axis.

During the test, the rollover structure must be attached to the survival cell which is fixed to a flat horizontal plate.

ARTICLE 18 : STATIC LOAD TESTING

18.1 Conditions applicable to the tests in 18.2-18.5 :

18.1.1 All the following tests must be carried out on the survival cell subjected to the impact tests described in Article 16.

18.1.2 Every subsequent survival cell must also be subjected to all the following tests with peak loads reduced by 20%. During these subsequent tests (on deflections greater than 3.0mm), the deflection across the inner surfaces must not exceed 120% of the deflection obtained at 80% of the peak load during the first test.

18.1.3 Deflections and deformations will be measured at the centre of area of circular load pads and at the top of rectangular pads.

18.1.4 All peak loads must be applied in less than three minutes, through a ball jointed junction at the centre of area of the pad, and maintained for 30 seconds.

18.1.5 In the tests described in 18.2, 18.3 and 18.4, permanent deformation must be less than 1.0mm (0.5mm in 18.3) after the load has been released for 1 minute.

18.1.6 All tests must be carried out by using measuring equipment which has been calibrated to the satisfaction of the FIA technical delegate.

18.1.7 A radius of 3mm is permissible on the edges of all load pads and rubber 3mm thick may be placed between them and the test structure.

18.1.8 For the tests described in 18.2, 18.3 and 18.4, the survival cells must always be produced in an identical condition in order that their weights may be compared. If the weight differs by more than 5% from the one subjected to the impact tests described in Articles 16.2 and 16.3 further frontal and side impact tests and roll structure tests must be carried out.

18.1.9 Any significant modification introduced into any of the structures tested shall require that part to pass a further test.

18.2 Survival cell side tests :

18.2.1 For test 1, referred to in Article 15.5.4, pads 100mm long and 300mm high, which conform to the shape of the survival cell, must be placed against the outermost sides of the survival cell with the lower edge of the pad at the lowest part of the survival cell at that section.

A constant transverse horizontal load of 25.0kN will be applied and, under the load, there must be no structural failure of the inner or outer surfaces of the survival.

On every survival cell tested after that one, the same tests must be carried out but with a load of only 20.0kN. During the tests, on deflections greater than 3.0mm only, the deflection across the inner surfaces must not exceed 120% of the deflection obtained at 20.0kN load during the first test.

18.2.2 For test 2), referred to in Article 15.5.4, pads 200mm in diameter which conform to the shape of the survival cell, must be placed against the outermost sides of the survival cell.

The centre of the pads must pass through the plane mentioned above and the mid point of the height of the structure at that section.

A constant transverse horizontal load of 30.0kN will be applied to the pads and, under the load, there must be no structural failure of the inner or outer surfaces of the survival cell and the total deflection must not exceed 15mm.

18.2.3 For test 3), referred to in Article 15.5.4, pads 200mm in diameter which conform to the shape of the survival cell, must be placed against the outermost sides of the survival cell.

The centre of the pads must be located 350mm above the reference plane and on the vertical plane mentioned in Article 15.5.4.

A constant transverse horizontal load of 30.0kN will be applied to the pads and, under the load, there must be no structural failure of the inner or outer surfaces of the survival cell and the total deflection must not exceed 15mm.

18.3 Fuel tank floor test :

A pad of 200mm diameter must be placed in the centre of area of the fuel tank floor and a vertical upwards load of 12.5kN applied.

Under the load, there must be no structural failure of the inner or outer surfaces of the survival cell.

18.4 Cockpit rim test :

Two pads, each of which is 100mm in diameter, must be placed on both sides of the cockpit rim with their upper edges at the same height as the top of the cockpit side with their centres at a point 200mm forward of the rear edge of the cockpit opening template longitudinally.

A constant transverse horizontal load of 10.0kN will then be applied at 90° to the car centre line and, under the load, there must be no structural failure of the inner or outer surfaces of the survival cell and the total deflection must not exceed 20mm.

18.5 Nose push off test :

During the test the survival cell must be resting on a flat plate and secured to it solidly but not in a way that could increase the strength of the attachments being tested.

A constant transversal horizontal load of 40.0kN must then be applied to one side of the impact absorbing structure, using a pad identical to the ones used in the lateral tests in Article 18.2.1, at a point 550mm from the front wheel axis.

The centre of area of the pad must pass through the plane mentioned above and the mid point of the height of the structure at the relevant section. After 30 seconds of application, there must be no failure of the structure or of any attachment between the structure and the survival cell.

18.6 Side intrusion test

18.6.1 The test must be carried out in accordance with FIA Test Procedure 02/00, in the presence of an FIA technical delegate and by using measuring equipment which has been calibrated to the satisfaction of the FIA technical delegate.

18.6.2 The test panel must be 500mm x 500mm and will be tested by forcing a rigid truncated cone through the centre of the panel at a rate of 2mm (+/-1mm) per second until the displacement exceeds 150mm.

During the first 100mm of displacement the load must exceed 150kN and the energy absorption must exceed 6000J. There must be no damage to the fixture or border before these requirements have been met.

ARTICLE 19 : FUEL

19.1 Purpose of Article 19 :

19.1.1 The purpose of this Article is to ensure that the fuel used in Formula One is petrol as this term is generally understood.

19.1.2 The detailed requirements of this Article are intended to ensure the use of fuels which are predominantly composed of compounds normally found in commercial fuels and to prohibit the use of specific power-boosting chemical compounds.

19.1.3 Additionally, and in order to encourage the development of future commercial fuels, those formulated to achieve one or more of the following objectives will be permitted :

a) fuels needed to meet advanced passenger car engine designs ;

b) fuels formulated to minimise overall emissions ;

c) fuels suitable to be offered to the commercial market with some special feature permitting greater efficiency, better driveability or economy to the user ;

d) fuels developed through advances in refinery techniques and suitable for trial by the general public.

19.1.4 Any petrol which appears to have been formulated in order to subvert the purpose of this regulation will be deemed to be outside it.

19.2 Definitions :

Paraffins - straight chain and branched alkanes.

Olefins - straight chain and branched mono-olefins.

- Monocyclic mono-olefins (with five or more carbon atoms in the ring) and saturated aliphatic side chains.

Naphthenes - monocyclic paraffins (with five or more carbon atoms in the ring) and saturated aliphatic side chains.

Aromatics - monocyclic and bicyclic aromatic rings with and without saturated aliphatic side chains and/or fused naphthenic rings.

Oxygenates - specified organic compounds containing oxygen.

19.3 Properties :

The only fuel permitted is petrol having the following characteristics:

Property	Units	Min	Max	Test Method
RON		95.0	102.0	ASTM D 2699-86
MON		85.0		ASTM D 2700-86
Oxygen	%m/m		2.7	Elemental Analysis
Nitrogen	%m/m		0.2	ASTM D 3228
Benzene	%v/v		1.0	EN 238
RVP	hPa	450	600	ASTM D 323
Lead	g/l		0.005	ASTM D 3237
Density at 15°C	kg/m^3	720.0	775.0	ASTM D 4052
Oxidation stability	minutes	360		ASTM D 525
Existent gum	mg/100ml		5.0	EN 26246
Sulphur	mg/kg		50	EN-ISO/DIS 14596
Copper corrosion	rating		C1	ISO 2160
Electrical conductivity	pS/m	200		ASTM D 2624

Distillation characteristics :

At E70°C	%v/v	20.0	48.0	ISO 3405
At E100°C	%v/v	46.0	71.0	ISO 3405
At E150°C	%v/v	75.0		ISO 3405
Final Boiling Point	°C		210	ISO 3405
Residue	%v/v		2.0	ISO 3405

The fuel will be accepted or rejected according to ASTM D 3244 with a confidence limit of 95%

19.4 Composition of the fuel :

19.4.1 The petrol must consist solely of substances defined in 19.2 and 19.4.4, and whose proportions of aromatics, olefins and di-olefins, within the total petrol sample, comply with those detailed below:

	Units	Min	Max	Test Method
Aromatics	%v/v	0*	35*	ASTM D 1319
Olefins	%v/v	0	18*	ASTM D 1319
Total di-olefins	%m/m	0	1	GCMS

*Values when corrected for fuel oxygenate content.

In addition, the fuel must contain no substance which is capable of exothermic reaction in the absence of external oxygen.

19.4.2 The total of individual hydrocarbon components present at concentrations of less than 5%m/m must be at least 30% m/m of the fuel.

19.4.3 The total concentration of each hydrocarbon group in the total fuel sample (defined by carbon number and hydrocarbon type), must not exceed the limits given in the table below:

% m/m	C4	C5	C6	C7	C8	C9+	Unallocated
Paraffins	10	30	25	25	55	20	-
Naphthenes	-	5	10	10	10	10	-
Olefins	5	20	20	15	10	10	-
Aromatics	-	-	1.2	35	35	30	-
Maximum	15	40	45	50	60	45	10

For the purposes of this table, a gas chromatographic technique should be employed which can classify hydrocarbons in the total fuel sample such that all those identified are allocated to the appropriate cell of the table. Hydrocarbons present at concentrations below 0.5% by mass which cannot be allocated to a particular cell may be ignored. However, the sum of the unallocated hydrocarbons must not exceed 10.0% by mass of the total fuel sample.

19.4.4 The only oxygenates permitted are :

Methanol (MeOH)

Ethanol (EtOH)

Iso-propyl alcohol (IPA)

Iso-butyl alcohol (IBA)

Methyl Tertiary Butyl Ether (MTBE)

Ethyl Tertiary Butyl Ether (ETBE)

Tertiary Amyl Methyl Ether (TAME)

Di-Isopropyl Ether (DIPE)

n-Propyl alcohol (NPA)

Tertiary Butyl Alcohol (TBA)

n-Butyl Alcohol (NBA)

Secondary Butyl Alcohol (SBA)

Compounds normally found as impurities in any of the above oxygenates are permitted at concentrations below 0.8% m/m of the total petrol sample.

19.5 Air :

Only ambient air may be mixed with the fuel as an oxidant.

19.6 Safety :

19.6.1 Manganese based additives are not permitted.

19.6.2 All competitors must be in possession of a Material Safety Data Sheet for each type of petrol used. This sheet must be made out in accordance with EC Directive 93/112/EEC and all information contained therein strictly adhered to.

19.7 Fuel approval :

19.7.1 Before any fuel may be used in an Event, two separate five litre samples, in suitable containers, must be submitted to the FIA for analysis and approval.

19.7.2 No fuel may be used in an Event without prior written approval of the FIA.

19.8 Sampling and testing :

19.8.1 All samples will be taken in accordance with FIA Formula One fuel sampling procedures.

19.8.2 Fuel samples taken during an Event will be checked for conformity by using densitometry and a gas chromatographic technique which will compare the sample taken with an approved fuel.

19.9 Amendments to Article 19 :

19.9.1 The physical and compositional properties of the fuel described in 19.3 and 19.4 incorporate the currently known limits for 2000, as laid out in European Fuels Directive 98/70/EC (13 October 1998).

19.9.2 When the Final Directive, as defined by the FIA, is adopted for 2005 (or such other date as the Directive may specify), the new values will replace those being used in 19.3 and 19.4 no later than one year after the figures are known.

ARTICLE 20 : TELEVISION CAMERAS

20.1 Presence of cameras and camera housings :

All cars must be fitted with either two cameras, two camera housings or one of each at all times throughout the Event.

20.2 Location of camera housings :

Camera housings, when used, must be fitted in the same location as cameras.

20.3 Location of camera equipment :

All cars must be equipped with five positions in which cameras or camera housings can be fitted. Referring to Drawing 6, all cars must carry a camera or camera housing in position 4, the position of the remaining camera or camera housing will be determined by the FIA after consultation with the relevant Competitor.

Once positions are determined in the above manner, any decision as to whether a camera or camera housing is fitted in those positions will rest solely with the relevant Competitor.

20.4 Timing transponders

All cars must be fitted with a timing transponder supplied by the officially appointed timekeepers. This transponder must be fitted in strict accordance with the instructions of the FIA.

ARTICLE 21 : FINAL TEXT

The final text for these regulations shall be the English version should any dispute arise over their interpretation.

ARTICLE 22 : CHANGES FOR 2002

22.1 Amendments to Article 10.4.2 :

10.4.2 Power assisted steering systems are permitted but may not **be electronically controlled nor may they** carry out any function other than reduce the physical effort required to steer the car.

~~If an electronically controlled power steering system is used the only permissible inputs are steering torque, steering angle and car speed. If these inputs are filtered the cut-off frequencies must be approved and published by the FIA. Additionally, the settings may not be changed whilst the car is in motion.~~

~~If faults or errors are detected by the driver or by on-board software, back-up sensors may be used and different settings may be manually or automatically selected. However, any back-up sensor or new setting chosen in this way must not enhance the performance of the car and the original setting may only be restored when the car is stationary in the pits.~~

22.2 Amendments to Article 15.5.5 :

15.5.5 To test the attachments of the frontal **and rear** impact absorbing structure**s** static side load test**s** must be carried out. Details of the**se** test procedure**s** may be found in Article**s** 18.5 **and 18.7**.

22.3 Amendments to Article 18.6 :

18.6 Side intrusion test

18.6.1 The test must be carried out in accordance with FIA Test Procedure 02/00, in the presence of an FIA technical delegate and by using measuring equipment which has been calibrated to the satisfaction of the FIA technical delegate.

18.6.2 The test panel must be 500mm x 500mm and will be tested by forcing a rigid truncated cone through the centre of the panel at a rate of 2mm (+/-1mm) per second until the displacement exceeds 150mm.

During the first 100mm of displacement the load must exceed **200kN** and the energy absorption must exceed **8000J**. There must be no damage to the fixture or border before these requirements have been met.

22.4 Addition of an Article 18.7

18.7 Rear impact structure push off test :

During the test the gearbox and the structure must be solidly fixed to the ground but not in a way that could increase the strength of the attachments being tested.

A constant transversal horizontal load of 40kN must then be applied to one side of the impact absorbing structure, using a pad identical to the ones used in the lateral tests in Article 18.2.1, at a point 300mm from the rear wheel axis.

The centre of area of the pad must pass through the plane mentioned above and the mid point of the height of the structure at the relevant section. After 30 seconds of application, there must be no failure of the structure or of any attachment between the structure and the gearbox.

APPENDIX E : JAPANESE AUTOMOBILE STANDARDS ORGANIZATION (JASO)

- JASO M 316-80 – Fuel Hoses for Automobiles
- JASO B 301-89 Test Procedure on Safety of Fuel Systems for Passenger Cars

Fuel Hoses for Automobiles

1. Scope

This standard covers straight rubber hoses and rubber tubing (hereinafter called hoses) for passage of liquid and gas fuels employed in gasoline or diesel automobiles.

Remark Units and numerical values enclosed with{ } herein conform to System of International Units (SI) and have been appended for reference.

2. Purpose

The purpose of this standard is to ensure proper quality by standardizing the hoses.

3. Definition of Terms

Terms used herein are defined as follows:

(1) Rubber hose

Tube of rubber compound and employing fiber or wire reinforcement which has been made by vulcanizing for transportation of liquids or pressure.

(2) Rubber tubing

Tube of flexible rubber without fiber, wire, or other reinforcement.

4. Types

Hoses shall be of three types, classified by pressure resistance as indicated in **Table 1**.

Table 1

Type	Pressure resistance	Remarks
Type 1	Hydraulic test pressure 0.5 kgf/cm^2 {0.049 MPa}	w/o reinforcement (rubber tube)
Type 2	Hydraulic test pressure 2 kgf/cm^2 {0.196 MPa}	w/reinforcement (rubber hose)
Type 3	Hydraulic test pressure 5 kgf/cm^2 {0.490 MPa}	

Reference standard:	**JASO M 319-80**	Standard Method of Testing Hose for Automobile
Related Standards:	**JIS K 6200**	Glossary of Terms Used in Rubber Industry
	JIS K 6301	Physical Testing Methods for Vulcanized Rubber
	JASO M 318-78	Blow-Bye Gas Rubber Hose for Automobile
	JASO M 322-77	High Temperature and Low Temperature Test Methods for Rubber Parts
	SAE J 30d	Fuel and Oil Hoses
Old Standard No. :	**JASO 7212**	

5. Performance

Hose shall be tested for performance in accordance with **8.2** Performance Tests and shall conform to the requirements in **Table 2**.

Table 2

Item		Performance			Test conditions	Test method item No.
Pressure resistance	Hydraulic press. test (1)	Type 1	Shall be free from water leakage, local swelling or other defects		0.5 kgf/cm² {0.049 MPa}	**8.2.1 (1)**
		Type 2			2 kgf/cm² {0.196 MPa}	
		Type 3			5 kgf/cm² {0.490 MPa}	
	Bursting test	Type 1	Above 3 kgf/cm² {0.294 MPa}		—	**8.2.1 (2)**
		Type 2	Above 10 kgf/cm² {0.980 MPa}			
		Type 3	Above 30 kgf/cm² {2.94 MPa}			
	Vacuum test	Shall be free from peeling and other defects. Outer diameter distortion rate — within 20 %			−250 mmHg {−33.3 kPa}, 30s	**8.2.1 (3)**
Adhesion (2)	Friction test	Above 1.1 kgf/cm {10.8N/cm}			25.0±1.5 mm/min	**8.2.2**
Low temp. resist.	Low temp. test	Shall be free from cracks			$-30 \pm 2^{\circ}C$, $5\ ^{+0.5}_{0}$ hr	**8.2.3**
Ozone resistance	Ozone aging test	Shall be free from cracks			50 pphm, $40 \pm 2^{\circ}C$, $70\ ^{+2}_{0}$ hr	**8.2.4**
Heat aging resist.	Cyl. bending test	Shall be free from cracks			$120 \pm 1^{\circ}C$ $70\ ^{+2}_{0}$ hr	**8.2.5**
Oil resist. (3)	Immersion test	Ins. rubber	Volumetric change	Fuel oil C below +35 %	$40 \pm 1^{\circ}C$, $48\ ^{+1}_{0}$ hr	**8.2.6 (1)**
		Out. rubber		No. 3 oil 0 ~ 100 %	$100 \pm 1^{\circ}C$, $70\ ^{+2}_{0}$ hr	**8.2.6 (2)**

Notes (1) In case of necessity to specify outside diameter distortion rate in hydraulic test, values shall be determined upon agreement with the parties concerned.
(2) This item shall be applicable only to the reinforced hose between type 2 and type 3.
(3) Shall be applicable to the inner surface rubber when there is no difference between inner and outer surface rubber.

6.1 Inside diameter and tolerance

Hose inside diameters and tolerances shall be as specified in **Table 3.**

Table 3

Unit: mm

Inside diameter	Tolerance	Applicable hose nominal dia. (4) ((Reference)
3.5	±0.3	4.0
4.0		4.5
4.5		4.76*
5.5		6
6.0	±0.4	6.35*
7.0		7.5
7.5		8.0*
8.0		8.5
9.0		9.5
9.5		10.0*
11.5	±0.5	12.0*

Note (4) Applicable hose is that provided with bulge or spool.
(*) Indicates that specified in **JASO M 101-75** (Metal Tubes and Tubing for Automobiles)

6.2 Wall thicknesses and tolerances

Hose wall thicknesses and tolerances shall be as specified in **Table 4.**

Table 4

Unit: mm

Wall thickness	Tolerance
2.5	±0.3
3.0	±0.4
3.5	
4.0	±0.5

6.3 Length tolerances

Hose length tolerances shall be as specified in **Table 5,** except when hose length is 500 mm or over, in which case the tolerance shall be $^{+2}_{0}$ % of the length.

Table 5

Unit: mm

Length	Tolerance
Under 100	$^{+4}_{0}$
100 and over to under 200	$^{+6}_{0}$
200 and over to under 300	$^{+8}_{0}$
300 and over to under 500	$^{+10}_{0}$

7. Appearance

Hose appearance shall be tested visually and shall satisfy the following requirements.

(1) Hose shall have uniform inner diameter and wall thickness and smooth inner surface.

(2) Hose shall be flexible and free from bubbles or other defects detrimental to usage.

8. Measurement and Test Methods

8.1 Dimensional measurements

8.1.1 Inner diameter measurement

Hose inner diameter measurement shall be performed in accordance with **5.2. (1)** of **JASO M 319-80** (Standard Method of Testing Hose for Automobile).

8.1.2 Wall thickness measurement

Hose wall thickness measurement shall be performed in accordance with **5.4** of **JASO M 319-80.**

8.1.3 Length measurement

Hose length measurement shall be performed in accordance with **5.5** of **JASO M 319-80.**

8.2 Performance test

8.2.1 Pressure resistance

Pressure tests in regard to hydraulic pressure, bursting, and vacuum shall be made. The sample length shall, as a rule, be 300 mm.

(1) Hydraulic pressure test

Shall be performed in accordance with **6.1.2 (1)** of **JASO M 319-80.**
Test pressure shall be 0.5 kgf/cm^2 {0.049 MPa} for type 1, 2 kgf/cm^2 {0.196 MPa} for type 2, and 5 kgf/cm^2 {0.490 MPa} for type 3.

(2) Bursting test

Shall be performed in accordance with **6.1.2 (2)** of **JASO M 319-80.**

(3) Vacuum test

Shall be performed in accordance with **6.1.2 (4)** of **JASO M 319-80.** Suction shall be made from atmospheric pressure down to 250 mmHg {33.3 kPa} (gauge pressure), and after standing 30 seconds, outer diameter distortion rate shall be investigated.

Remark Pressure application and reduction speeds for pressure resistance shall be determined by agreement between the parties concerned.

8.2.2 Adhesion

Friction test shall be performed in accordance with **6.4.2 (1)** of **JASO M 319-80.** Sample shall be of ring shape, 25.0 ±0.5 mm in length. Pulling speed shall be 25.0 ±1.5 mm/min.

8.2.3 Low temperature resistance

Low temperature test shall be performed in accordance with **6.2.2 (1)** of **JASO M 319-80,** with test conditions as indicated in **Table 6.**

Table 6

Item			Test Condition
Sample length and cylinder			**Table 7**
Low temp. oven	Temperature	°C	−30 ±2
	Standing time	h	$5\,^{+0.5}_{0}$
	Bending time	s	Within 4

Table 7

Unit: mm

Hose inside diameter	Cylinder outside dia.	Sample length
3.5 ~ 6.0	76.2	400 app.
7.0 ~ 9.5	89	450 app.
11.5	101.6	500 app.

8.2.4 Ozone resistance

Ozone aging test shall be performed in accordance with **6.3.2 (1)** of **JASO M 319-80.** Test conditions shall be as indicated in **Table 8.**
In case inside diameter enlargement test is to be performed, it shall be made in accordance with **6.3.2 (3)** of **JASO M 319-80.** Test condition details shall be determined by agreement between the parties concerned.

Table 8

Item			Test conditions
Cylinder outside diameter			5 times hose outside diameter
Room temp. standing time		h	20 ~ 24
Ozone tank	Concentration	pphm	50 ±5
	Temperature	°C	40 ±2
	Time	h	$70\,^{+2}_{0}$

Remark Hose outside diameter is defined as the sum of the standard dimension of inside diameter and double the standard dimension of wall thickness.

8.2.5 Heat aging resistance

Heat aging test shall be performed in accordance with **6.7.2 (1)** of **JASO M 319-80** with the test conditions as prescribed in **Table 9**.

Table 9

Item		Test condition
Sample length and cylinder		**Table 7**
Constant temp. oven	Temp. °C	120 ±1
	Time h	$70\ ^{+2}_{0}$

8.2.6 Oil resistance

Immersion test shall be performed on the following items in accordance with **7.4** of **JASO M 319-80.**

(1) Fuel oil C

Inner surface rubber shall be immersed in fuel oil C at temperature of 40 ±1°C for $48\ ^{+1}_{0}$ hours and investigation made in the change of volume to that prior to immersion.

(2) Lubrication oil No. 3

Outer surface rubber shall be immersed in lubricating oil at temperature of 100 ±1°C for 70^{+2}_{0} hours and investigation made in the change of volume to that prior to immersion.

Remark Test shall, as a rule, be made on the sample taken from the hose but in case of difficulty in sampling from the hose such as outer surface rubber of double pipe, test may be made on sample that can be substituted on agreement between the parties concerned.

9. Records

Test conditions utilized shall be recorded in with the test results.

10. Inspection

10.1 Inspection items

Hose inspection items shall be as follows, but may be abbreviated on agreement between the parties concerned.

(1) Performance

(2) Dimensions

(3) Appearance

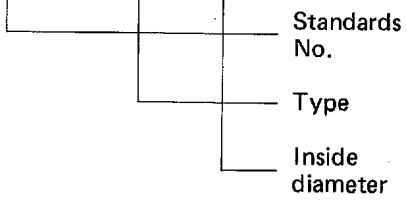
10.2 Criteria

Sampling inspection method and criteria shall be by agreement between the parties concerned.

11. Designation

Designation shall be by standards No., type, and inside diameter.

Example: **JASO M 316 Type 1 3.5**



12. Marking

Hose shall be marked with the following particulars, except in the case of difficulty in marking the hose, marking may be made in package units.

(1) Product or its abbreviation (FUEL)

(2) Manufacturer's name or abbreviation

(3) Manufactured date or abbreviation

In the event of any doubt, the original
standards in Japanese should be referred.

Established by the Standard Council of JSAE

Date of Establishment: 1972-4-24

Date of Revision: 1980-5-16

Subcommittee in which the draft was made: SC of Fuel Hoses

Technical Committee under which the draft was discussed: TC of Material

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Test Procedure on Safety of Fuel Systems for Passenger Cars

1. Scope

This standard specifies the test procedure for evaluation of safety of fuel systems for passenger cars (hereinafter referred to as "automobiles") that use fuels having boiling points of 0°C or higher.

Remark: In this standard, units and numerical values are based on **SI** (International System of Units), while units and numerical values given in { } are of customary systems of units indicated for reference.

2. Purpose

This standard aims to standardize the test procedure on safety of the fuel system, in order to minimize the risk of fire that may be caused by fuel leakage from the fuel system in the event of turning, panic braking or collision.

3. Definitions

Definitions of major terms to be used in this standard are as follows.

(1) Fueld systems
The system consisting of all parts in which fuel is present, such as the fuel tank, filler hose, filler cap, piping, etc. (Refer to the following **Figure**)

(2) Test Fuel
The fuel used in the test vehicle, or a substitute fuel to be used, in terms of the safety and the handling ease in the test.

(3) Fixed Barrier
A fixed barrier to be used in the automobile collision test.

(4) Moving Barrier
A movable barrier to be used in the automobile collision test.

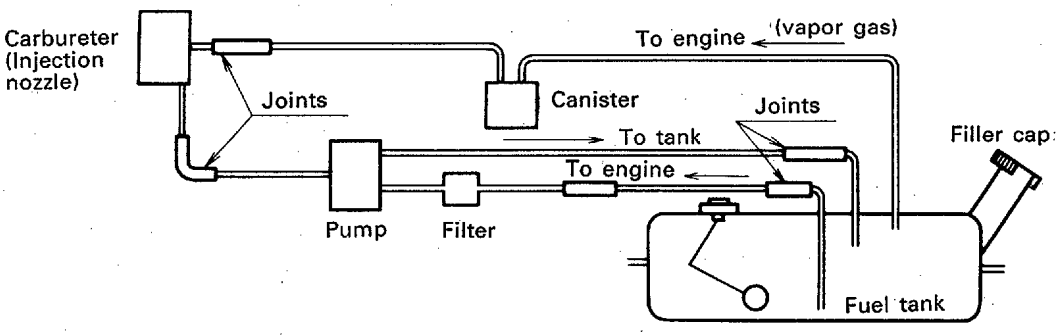
(5) Longitudinal Median Plane (of Automobile)
The vertical plane passing through the center point of the right and left wheels of the automobile in the straight forward running posture. The OY plane specified under **JIS D 0030** (Three-dimensional Reference System for Automobiles).

(6) Fuel Tank Capacity
Nominal capacity of fuel system.

(7) During the Collision
Time required for the test vehicle to stop from the moment of collision.

(8) After the Collision
Period after the test vehicle has stopped.

Fig. An Example of Fuel System



Applicable Standards: Refer to 8
Reference Standards: Refer to 8

4. Test Items

Test items shall be as given below. However, either one of test items **4.1** and **4.2**, and either one of **4.3** and **4.4** may be selected.

4.1 Turning Test

A test to turn the automobile to determine the fuel leakage from the fuel system.

4.2 Side Tilting Test

A test to tilt the automobile sideward to determine the fuel leakage from the fuel system.

4.3 Braking Test

A test to brake the automobile to determine the fuel leakage from the fuel system.

4.4 Vertical Tilting Test

A test to tilt the automobile vertically to determine the fuel leakage from the fuel system.

4.5 Frontal Collision Test

A test to have the automobile collide against the fixed barrier head on, in order to determine the fuel leakage from the fuel system.

4.6 Rear Collision Test

A test to have a moving barrier collide against the back of the automobile, in order to determine the fuel leakage from the fuel system.

5. Test Methods

5.1 Turning Test

5.1.1 Measuring Items

(1) The centripetal acceleration during the turning.
(2) Fuel leakage from the fule system and its conditions, if any.

5.1.2 Proving Ground and Test Equipment

(1) Proving ground
The proving ground shall have a flat and even concrete or asphalt paved road surface, and an adequate space to cope with unexpected running of the test vehicle during the turning. It is recommended that a turning radius for the test is drawn on the proving ground.

(2) Measuring Instrument for centripetal Acceleration
An instrument capable of accurate measurement of the centripetal acceleration.

(3) Tracing Device
A device to record the running locus of the automobile, which shall be used only when it is particularly required.

5.1.3 Test Conditions

(1) Conditions of Test Vehicle
(a) Standard parts and equipment shall be installed on portions of the vehicle, that may affect substantially on test results.
(b) The tire pneumatic pressure shall be as specified.
(c) The test fuel shall be filled to 90% or more of the fuel tank capacity.

(2) Proving Ground Road Surface and Meteorological Conditions
Proving ground road surface and meteorological conditions shall be as specified under **4.2** of **JIS D 0210** (General Rules of Brakes of Automobiles and Motor Cycles).

(3) Turning Conditions
(a) The test vehicle shall be driven at constant speed and circularly at a centripetal acceleration of 4.9 m/s^2 {0.5G} or greater, along the given circle. The duration of the centripetal acceleration shall be 10 seconds or longer. The centripetal acceleration shall be calculated by the following equation.

$$\alpha = 4.02 \frac{R}{T^2}$$

Where,
α: centripetal acceleration (m/s^2) {G} (gravitational acceleration)
R: turning radius (m)
T: time (s) required for a constant circular turning

(b) The test shall be carried out for right and left turnings.

5.1.4 Test Procedure

(1) Carry out the inspection and maintenance of the test vehicle and the test equipment.

(2) Check the road surface conditions.
(3) Accelerate the test vehicle until the specified centripetal acceleration is obtained, and turn the vehicle constantly and circularly.
(4) Check to see if the fuel leaks out of the fuel system, and conditions of the leakage, if any.
(5) Record test data as follows.
  (a) Date of test
  (b) Place of test
  (c) Specifications of test vehicle
    Name and model of test vehicle
    Chassis number
    Type of engine installed on the test vehicle
    Kind of fuel
  (d) Centripetal acceleration
  (e) Fuel leakage from the fuel system and its conditions, if any.
  (f) Quantity of test fuel filled.

5.2 Sideward Tilting Test

5.2.1 Measuring Items

(1) Tilting angle of the tilting board
(2) Fuel leakage from the fuel system and its conditions, if any.

5.2.2 Test Equipment

(1) Tilting Test Equipment
It shall be capable of tilting the board to 30° or more from the horizontal plane, with the test vehicle installed on the board.

(2) Tilting Angle Measuring Instrument
It shall be capable of accurate measurement of the tilting angle of the tilting board.

5.2.3 Test Conditions

(1) Conditions of Test vehicle
  (a) Standard parts and equipment shall be installed on portions of the test vehicle, that may affect substantially on test results.
  (b) The test fuel shall be filled to 90% or more of the fuel tank capacity.

(2) Tilting Conditions
  (a) Set the test vehicle on the tilting board in such a manner that the test vehicle median plane becomes parallel to the rotation axis of the tilting board.
  (b) Tilt the tilting board at a given velocity, until the tilting board inclines to 30° or more against the horizontal plane, and hold the tilting angle for 10 seconds or longer unless otherwise specified. However, some other optional angle and the duration may be selected, according to the particular purpose of the test.
  (c) Carry out right and left tilting tests.

5.2.4 Test Procedure

(1) Carry out the inspection and the maintenance of the test vehicle and test equipment.
(2) Tilt the tilting board to the specified angle.
(3) Check to see if the fuel leaks out of the fuel system, and conditions of the leakage, if any.
(4) Record test data as follows.
  (a) Data of test
  (b) Place of test
  (c) Specifications of test vehicle
    Name and model of test vehicle
    Chassis number
    Type of engine installed on the test vehicle
    Kind of fuel
  (d) Tilting angle of tilting board
  (e) Fuel leakage from the fuel system and its conditions, if any.
  (f) Quantity of test fuel filled

5.3 Braking Test

5.3.1 Measuring Items

(1) Initial speed
(2) Deceleration during the braking
(3) Fuel leakage from the fuel system and its conditions, if any.

5.3.2 Proving Ground and Test Equipment

(1) Proving Ground
The proving ground shall have a flat and even concrete or asphalt paved road surface and an adequate course to accelerate and brake the test vehicle. The width of the test course shall be adequate to cope with unexpected

running of the test vehicle on sudden braking.

(2) Deceleration Measuring Instrument
An instrument capable of accurate measurement of the deceleration during braking.

5.3.3 Test Conditions

(1) Conditions of Test Vehicle
(a) Standard parts and equipment shall be installed on portions of the test vehicle, that may affect substantially on test results.
(b) The test vehicle shall have normal braking performance.
(c) The test fuel shall be filled to 90% or more of the fuel tank capacity.

(2) Proving Ground and Meteorological Conditions
As specified under **4.2** of **JIS D 0210.**

(3) Initial Speed
The initial speed shall be 100 km/h or higher. For light passenger cars, it shall be 80 km/h or higher.

(4) Braking Deceleration
5.9 m/s^2 {0.6G} or more

5.3.4 Test Procedure

(1) Carry out the inspection and maintenance of the test vehicle and the test equipment.
(2) Check the road surface conditions.
(3) After accelerating the test vehicle to the specified initial speed, brake the vehicle at the specified deceleration.
(4) Check to see if the fuel leaks out of the fuel systems, and the conditions of leakage, if any.
(5) Record test data as follows.
(a) Date of test
(b) Place of test
(c) Specifications of test vehicle
Name and model of test vehicle
Chassis number
Type of engine installed on the test vehicle
Kind of fuel
(d) Initial speed
(e) Deceleration during braking
(f) Fuel leakage from the fuel system and its conditions, if any.
(g) Quantity of test fuel filled

5.4 Vertical Tilting Test

5.4.1 Measuring Items

(1) Tilting angle of the tilting board
(2) Fuel leakage from the fuel system and its conditions, if any.

5.4.2 Test Equipment

(1) Tilting Test Equipment
It shall be capable of tilting the board to 37° or more from the horizontal plane, with the test vehicle installed on the board.

(2) Tilting Angle Measuring Instrument
It shall be capable of accurate measurement of the tilting angle of the tilting board.

5.4.3 Test Conditions

(1) Conditions of Test Vehicle
(a) Standard parts and equipment shall be installed on portions of the test vehicle, that may substantially affect on test results.
(b) The test fuel shall be filled to 90% or more of the fuel tank capacity.

(2) Tilting Conditions
(a) Set the test vehicle on the tilting board in such a manner that the median plane becomes vertical to the rotation axis and the vehicle faces the rotation axis.
(b) Tilt the tilting board at a given velocity, until the tilting board inclines to 37° or more against the horizontal plane and hold the tilting angle for 10 seconds or longer, unless otherwise specified. However, some other optional tilting angle and its duration time may be selected according to the particularly purpose of the test.

5.4.4 Test Procedure

(1) Carry out the inspection and maintenance of the test vehicle and test equipment.
(2) Tilt the tilting board to the specified angle.
(3) Check to see if the fuel leaks out of fuel system, and conditions of the leakage, if any.

(4) Record test data as follows.
- (a) Date of test
- (b) Place of test
- (c) Specifications of test vehicle
  - Name and model of test vehicle
  - Chassis number
  - Type of engine installed on the test vehicle
  - Kind of fuel
- (d) Tilting angle of tilting board
- (e) Fuel leakage from the fuel system and its conditions, if any.
- (f) Quantity of test fuel filled

5.5 Frontal Collision Test

5.5.1 Measuring Items

(1) Collision Speed

The measurement of the speed shall be done as follows.
- (a) The distance between the location of the measurement and the collision spot shall not be more than 3 m.
- (b) Measure the time required for the test vehicle to travel over a given distance, or the distance travelled over for a given period of time.

(2) Fuel leakage from the fuel system and the measurement of the quantity of fuel leakage, if any.
- (a) Check to see immediately after the collision, whether any fuel leaked out of the fuel system during the collision, by means of visual inspection.
- (b) If any fuel leakage is found after the collision, collect the fuel flowing or dripping out of the fuel system, using a pan, etc. Determine the quantity (mass) of the fuel leaked out during the five minute period.

(3) Mass of test vehicle

5.5.2 Proving Ground and Test Equipment

(1) Test Course

The proving ground shall be as follows.
- (a) Running course : it shall have an adequate space to accommodate the fixed barrier and other equipment necessary for the test.
- (b) The road surface of the zone of 15 m in front of the collision spot shall be firm and horizontal. The gradient of any 1 m portion of the zone shall be 3% or less.

(2) Fixed Barrier

The fixed barrier shall be as follows.
- (a) The portions above the ground shall consist of reinforced concrete blocks of a width 3 m or wider, a height of 1.5 m or higher, and the thickness 0.6 m or more. The mass shall be 70 ton or more.
- (b) The front of the barrier shall be flat and vertical, and covered by plywoods with the thickness of 20±2 mm. Metal sheets or structures having high rigidity may be inserted between the plywoods and the fixed barrier.

(3) Traction Equipment

It shall be as follows.
- (a) It shall be capable of accelerating the test vehicle to the specified speed according to the purpose of the test, and holding the speed nearly constant.
- (b) It shall be so constructed that the traction force and the guide system are released from the test vehicle immediately before the collision.

Remark: The installation of a jig or a guide system on the test vehicle to be tracted shall not have adverse effects on the performance of the test vehicle.

(4) Pit

It is recommended to equip with a pot on the running course near the collision spot, which should not impede the posture and behavior of the test vehicle.

(5) Speed Measuring Instrument

The instrument shall have the accuracy of less than ±1%, and the resolution of 0.5 km/h.

5.5.3 Test Conditions

(1) Conditions of Test Vehicle
- (a) **Test vehicle mass:** it shall be the mass under standard equipment conditions. However, if any other specification is given according to the particular purpose of the test, it shall be followed.
  The removal or addition of parts or auxiliary weights may be done in order to adjust the mass, when such parts or weights do not affect on test results.

(b) Vehicle accessories and optional parts shall be installed as called for.
(c) Coolant, lubricating oil, battery fluid, etc. may be drained out of the vehicle, when the draining does not affect on test results.
(d) Test fuel shall be filled to 90% or more of the fuel tank capacity.
(e) Test fuel shall be filled into the fule pipe similarly to the normal condition.
(f) The tire pneumatic pressure shall be as specified.
(g) The transmission gear shall be at the neutral position.
(h) The door lock shall be released.
(i) For a test vehicle equipped with an electric fuel pump, the pump shall operate at the time of collision, if the pump is such that it operates whenever the electric system is working.

(2) Conditions of Collision

The conditions shall be as follows.

(a) The test vehicle shall be collided against the barrier in such a manner that the deviation of the longitudinal median plane from the intended collision angle is less than 2°.
(b) The lateral deviation between the vertical median plane, that crosses normally to the fixed barrier, and the test vehicle longitudinal median plane shall be within 300 mm.

(3) Collision Speed

It shall be within the range specified according to the test purpose.
The collision speed of the test vehicle against the fixed barrier shall be, however, within 48 to 52 km/h, and the speed for a light passenger car shall be 38 to 42 km/h unless otherwise specified.

5.5.4 Test Procedure

(1) Carry out the inspection and maintenance of the test vehicle and test equipment.
(2) Set the test vehicle in such a manner that the vehicle will collide against the fixed barrier at the specified location and the direction.
(3) Collide the test vehicle against the fixed barrier at the specified speed.
(4) Check to see if the fuel leaks out of the fuel system, and determine the quantity of leakage, if any.
(5) Record test data as follows.
(a) Data of test
(b) Place of test
(c) Specifications of test vehicle
Name and model of test vehicle
Chassis number
Type of engine installed on the test vehicle
Kind of fuel
(d) Collision speed
(e) Whether fuel leaked out of the fuel system or not. If any leakage is found, draw the schematic of the fuel system and the location of the leakage.
(f) Quantity (mass) of the leakage during the five minutes after the collision.
(g) Test vehicle mass
(h) Name of test fuel used
(i) Quantity of test fuel filled

5.6 Rear Collision Test

5.6.1 Measuring Items

(1) **Moving barrier collision speed:** the measurement of the speed shall be done as follows.
(a) The distance between the location of the measurement and the collision spot shall not be more than 3 m.
(b) Measure the time required for the moving barrier to travel over a given distance or the distance travelled in for a given period of time.

(2) Fuel leakage from the fuel system and the measurement of the quantity of the leakage, if any.

(a) Check to see immediately after the collision whether any fuel leaked out of the fuel system during the collision, by means of visual inspection.
(b) If any fuel leakage is found after the collision, collect the fuel flowing or dripping out of the fuel system, using a pan, etc. Determine the quantity (mass) of the fuel leaked out during the five minute period.

(3) Mass of test vehicle

5.6.2 Proving Ground and Test Equipment

(1) Test Course

The proving ground shall be as follows.

(a) It shall have an adequate space to accommodate a running course and other equipment necessary for the test.

(b) The road surface of the zone of 15m in front of the collision spot shall be firm and horizontal, and the gradient of any 1 m portion on the zone shall be 3%.

(2) Moving Barrier

The barrier shall be as follows.

(a) The collision surface shall be flat vertical and firm plane that will not be deformed by the collision, and its dimensions shall be as given on **Table** below. However, these dimensions shall not be applied when the dimensions are specified otherwise according to the test purpose.

Table Dimensions of Collision Surface

Unit: mm

Width	Height	Ground clearance of lower end
2,500 or more	800 or more	175±25

(b) The collision surface shall be covered by plywoods with the thickness of 20±2 mm.

(c) The collision surface shall be normal to the longitudinal axis of the moving barrier.

(d) The main structure of the moving barrier shall not absorb the collision energy by deformation, etc. upon collision.

(e) It shall be so constructed that the second collision with the test vehicle can be avoided.

(f) The gross mass shall be 1,100±20 kg. This may not be applied when a different specification is given according to the particular purpose of the test.

(3) Traction Equipment

It shall be as follows.

(a) It shall be capable of accelerating the moving barrier to the specified speed according to the purpose of the test, and holding the speed nearly constant.

(b) It shall be so constructed that the traction force and the guide system are released from the test vehicle immediately before the collision.

Remark: The installation of a jig or a guide system on the test vehicle to be tracted shall not have adverse effects on the performance of the test vehicle.

(4) Pit

It is recommended to equip with a pit on the running course near the collision spot, which should not impede the posture and behavior of the test vehicle.

(5) Speed Measuring Instrument

The instrument shall have the accuracy of within the range of ±1%, and the resolution of 0.5 km/h.

5.6.3 Test Conditions

(1) Conditions of Test Vehicle

(a) **Test vehicle mass:** it shall be the mass under standard equipment conditions. However, if any other specification is given according to the particular purpose of the test, it shall be followed.
The removal or addition of parts or auxiliary weights may be done in order to adjust the mass, when such parts or weights do not affect on test results.

(b) Vehicle accessories and optional parts shall be installed as called for.

(c) Coolant, lubricating oil, battery fluid, etc. may be drained out of the vehicle, when the draining does not affect on test results.

(d) Test fuel shall be filled to 90% or more of the fuel tank capacity.

(e) Test fuel shall be filled into the fuel pipe similarly to the normal condition.

(f) The tire pneumatic pressure shall be as specified.

(g) The transmission gear shall be at the neutral position.

(h) The parking brake shall be released, unless otherwise specified.

(i) The door lock shall be released.

(j) For a test vehicle equipped with an electric fuel pump, the pump shall

operate at the time of collision, if the pump is such that it operates whenever the electric system is working.

(2) Condition of Collision

The condition shall be as follows.

(a) The moving barrier shall be collided against the barrier in such a manner that the deviation of the longitudinal median plane from the intended collision angle is less than 2°.

(b) The lateral deviation between the vertical median plane, that crosses normally to the moving barrier, and the test vehicle longitudinal median plane shall be within 300 mm.

(3) Collision speed

It shall be within the range specified according to the test purpose.

The collision speed of the moving barrier against the test vehicle shall be, however, within 35 to 38 km/h unless otherwise specified.

5.6.4 Test Procedure

(1) Carry out the inspection and maintenance of the test vehicle and test equipment.

(2) Set the test vehicle and the moving barrier in such a manner that the moving barrier will collide against the test vehicle at the specified location and the direction.

(3) Collide the moving barrier against the test vehicle at the specified speed.

(4) Check to see if the fuel leaks out of the fuel system, and determine the quantity of leakage, if any.

(5) Record test data as follows.

(a) Date of test
(b) Place of test
(c) Specifications of test vehicle
  Name and model of test vehicle
  Chassis number
  Type of engine installed on the test vehicle
  Kind of fuel
(d) Collision speed
(e) Whether fuel leaked out of the fuel system or not. If any leakage is found, draw the schematic of the fuel system and the location of the leakage.
(f) Quantity (mass) of the leakage during five minutes after the collision.
(g) Test vehicle mass
(h) Moving barrier mass
(i) Name of test fuel used
(j) Quantity of test fuel filled

Applicable Standards:	**JIS D 0030**	Three-dimensional Reference System for Automobiles.
	JIS D 0210	General Rules of Brakes Test Method of Automobile Motor Cycle
Reference Standards:	**JIS D 1042**	Determination of Fuel Leakage in the Event of a Collision for Passenger Cars
	JIS D 1060	Frontal and Rear Vehicle Collision Test Procedure
	JASO C 402	Service Brake Road Test Procedure – Passenger Car
	JASO C 403	Service Brake Road Test Performance Requirements – Passenger Car
	JASO Z 103	Front Barrier Collision Test Procedure for Passenger Cars
	JASO Z 105	Moving Barrier Collision Test Procedure for Passenger Cars
	ISO 3437	Road Vehicles – Determination of Fuel Leakage in the Event of a Collision
	ISO 3560	Road Vehicles – Frontal Fixed Barrier Collision Test Method
	ISO 3784	Road Vehicles – Measurement of Impact Velocity in Collision Tests.
	ISO 3984	Road Vehicles – Passenger Cars – Moving Barrier Rear Collision Test Method

Explanatory Note
on
JASO B 301-89 The Procedure on Safety of Fuel Systems for Passenger Cars

3. Definitions

(1) Fuel system

The range of fuel leakage during the test is not limited to the fuel tank and its connecting unit, but as defined in the **Text.**

(2) Test Fuel

While it is most practical to use the fuel usually used on the vehicle, a substitute fluid, i. e., "a fluid with an equivalent viscosity and a specific gravity equivalent to, or greater than that of the fuel" may be used in the test, to prevent the risk of fire that may occur during the test.

The substitute fuel refers to a distilled fluid of petroleum which is not easily burned and use in dry cleaning, which is same as the Type 1 fluid specified under **7.1.1** of **FMVSS No. 301-75.** The type 1 fluid is specified under **ASTM D 484-71** "Standard Specification for Hydrocarbon Dry Cleaning Solvents". the properties of the said substitute fluid are given below.

Color:
Water white (not darker than #21)
Corrosion at 100°C:
ASTM Reference fraction or smaller
Doctor test: Negative
Content of sulfide: 5% or less
Flash point: 100° F (37.8°C) or higher
Fractional distillation at 370°F (176°C):
50% or more
Distillation end point temperature:
407°F (208.3°C) or lower
Residue: 1.5% or less
Acidity: Neutral

(6) Fuel Tank Capacity

A value corresponding to the nominal value of the specification, catalogue, etc. is given here.

4. Test Items

Six items of turning, braking, frontal collision, rear collision and sideward tilting and longitudinal tilting as the substitutes for the turning and braking tests are specified as in the **Text.**

As a result, regular test items were specified here because of the difficulties in the reproduction of turning and braking tests, which are once considered to be carried out as a test in a period of transition, or with limitation. Since turning and braking tests can be simulated by static tests, it is specified that may be substituted by tilting bench tests.

5. Test Methods

5.1 Turning Test

The turning test is related with a performance that should be basically ensured for the automobile fuel system. The provision is given based on the constant circular turning test method which is already established for the evaluation of kinematic performance of automobiles.

5.1.1 Measuring Items

(1) Centripetal Acceleration During Turning

The centripetal acceleration is usually calculated by the turning radius and the time required for the vehicle to turn circularwise, as specified in the **Text.** Therefore, it is necessary to measure the turning radius and the time required for turning.

Since the constant circular turning is generally done by running the vehicle with the inside front wheel going along a reference circle drawn in advance, the turning radius should be the value obtained by adding 1/2 value of the tread to the radius of the reference circle. A turning locus tracing instrument should be used in order to ensure a strict accuracy of the measurement (see (3) of **Explanatory Note 5.1.2).**

(2) **Fuel leakage**
As this standard is aimed mainly at the establishment of test procedure, no criteria value is given, and the provision is limited to the confirmation of the presence or absence of fuel leakage and its condition.
As for the quantitative measurement of fuel leakage, the method to install a plastic bag to the unit that may cause the fuel leakage is generally employed.

5.1.2 Proving Ground and Test Equipment

(2) **Measuring Instrument for Centripetal Acceleration**
The centripetal acceleration is measured by either the method to use accelerometers or the method to measure the turning time. For the measurement of the turning time, a stop watch is usually used.

(3) **Tracing Device**
The tracing device is a device to draw a tracing line of the turning locus of the test vehicle, which is generally installed on the front or rear bumper. As shown in **Explanatory Fig. 1**, ink fed by some pressure such as a high pressure air, gear pump, etc, is jetted against the road surface from a thin jet outlet.
There is also a device to jet the ink sideward once in a second or once in 1/2 second by means of electric watch or electromagnet, in order to provide time pulses on the turning locus at the same time.

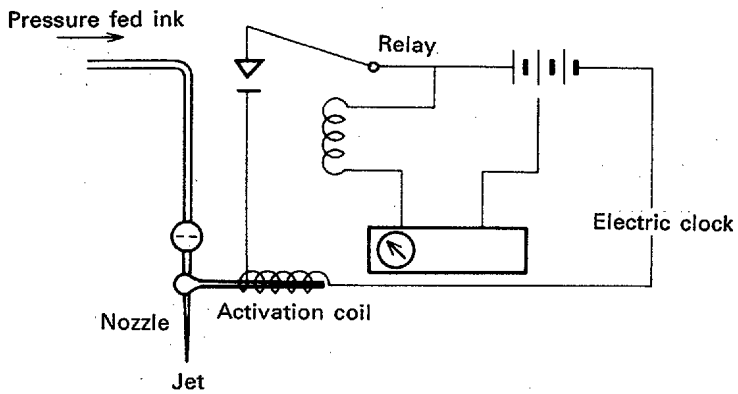
5.1.3 Test Conditions

(1) **Conditions of test vehicle**
As the confirmation of the presence or absence of the fuel leakage is the main objective of the provision, conditions approximate to those under actual use of vehicle are specified in the **Text.**
The provision that the fuel be filled to 90% or more of the fuel tank capacity given in the **Text** is based on the assumption that the test will be done with the fuel filled to approximately 90%, but not less than 90%.

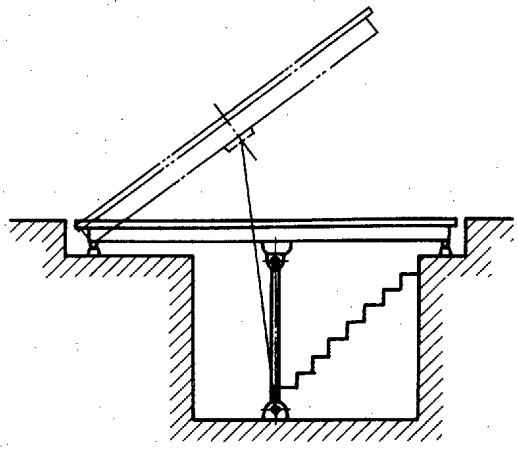
(2) **Proving ground road surface and meteorological conditions**
Such conditions are specified according to **5.2** of **JIS D 0210** (General Rules of Brake Test Methods of Automobiles Motor cycles).

(3) **Turning conditions**
During investigation there were some opinions that the turning or centripetal acceleration should be 5.9 m/s² {0.6G}

Explanatory Fig. 1



Explanatory Fig. 2



or more as the turning condition. But in consideration of practical condition, it was decided as in the **Text.**
Conditions specified in the **Text** are equivalent to the conditions of turning the vehicle by 60° along a road of radius 160 m at the vehicle speed of 100 km/h.

5.1.4 Test Procedure

The standard recording procedure of test data is specified in the **Text** based on **JIS D 1060** (Frontal and Rear Vehicle Collision Test Procedure).

5.2 Sideward Tilting Test

Although the primal objective of the sideward tilting test is to determine the rolling angle of the automobile, the sideward tilting test is employed in place of a turning test.

5.2.1 Measuring Items

(1) Tilting angle of the tilting board
(2) Same as **Explanatory Note** (2) in **5.1.1.**

5.2.2 Test Equipment

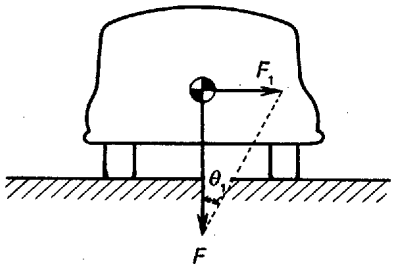
(1) Tilting test equipment
The equipment should be able to tilt the test vehicle continuously to 30° or more, and stop the tilting at a given tilting angle, with an instrument to measure the tilting angle. The tilting test equipment shown in **Explanatory Fig. 2** is usually used in practice.

5.2.3 Test Conditions

(1) Conditions of test vehicle
The same as given in (1) of **Explanatory Note 5.1.3.**

(2) Tilting conditions
Since this is a substitute of the turning test, efforts were made to make the conditions as similar as possible to the conditions of the turning test. However, only the centripetal acceleration and the duration time in the turning test are considered in the **Text.**
The basis for the determination of the conditions is given below.

(a) Side acceleration on turning test:

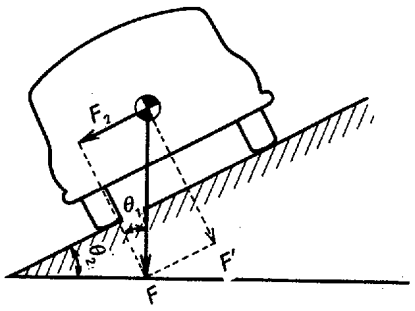


$$F_1 = F \tan\theta_1$$

Assuming that $F_1 = 4.9$ m/s² {0.5G}
$\theta_1 = 26.6$ deg

F_1 F_2 : centripetal acceleration
F : gravitation acceleration

(b) Side acceleration on sideward tilting test:



$$F_2 = F \sin\theta_2$$

In order to obtain $F' = F \cos\theta_2$

$F_2 = 4.9$ m/s² {0.5G}

$\theta_2 = 30$ deg

where, $F' = 8.5$ m/s² {0.87G}

In order to make the magnitude of the side acceleration equal to that of turning test by the tilting test equipment, $\theta_2 = 30$ deg. is equivalent to actual turning test conditions, assuming that $F_1 = F_2 = 4.9$ m/s² {0.5G}.

5.3 Braking Test

The same concept as that in **5.1** is followed here. Some provisions given under **JASO C 402** (Service Brake Road Test Procedure – Passenger Car) and **JASO C 403** (Service Brake Road Test Performance Requirements – Passenger Cars) are referred to in this standard.

5.3.1 Measuring Items

(3) Fuel leakage
The same as **5.1.1** (2) of the **Explanatory Note.**

5.3.3 Test Conditions

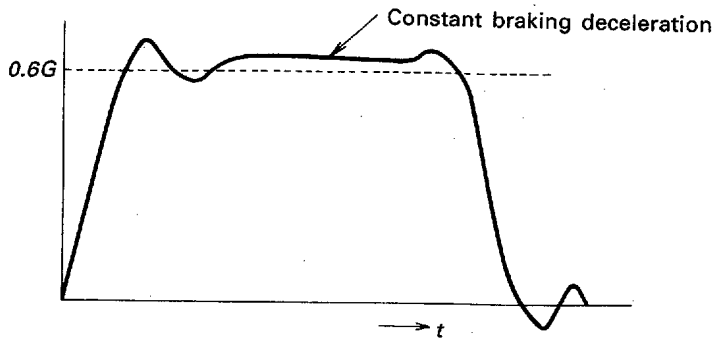
(1) Conditions of test vehicle
The same as **5.1.3** (1) of the **Explanatory Note.**

(2) Proving ground and meteorological conditions
The same as **5.1.3** (2) of the **Explanatory Note.**

(3) Initial speed
5.2 of **JASO C 402** was referred to in this standard, but the provision is divided respectively for general passenger cars and light passenger cars.

(4) Braking deceleration
The repeatability was taken into account for the braking deceleration, and the provision is given in the **Text**, making reference to **JASO C 402** and **JASO C 403**, which provide the conditions as critical as possible.
The specification of "5.9 m/s² {0.6G} or more" means that the constant braking deceleration should be 5.9 m/s² {0.6G} or more, and that the majority of decelerations is 5.9 m/s² {0.6G} or more at the time of braking as shown in **Explanatory Fig.3.** The reason for specifying "the constant deceleration" is to eliminate the possibility of effects on test results by the maximum or mini-

Explanatory Fig. 3



mum value, if the method to take the mean value is employed, which would not meet the objective of the provision.

5.4 Vertical Tilting Test

The objective of the provision is the same as **5.2** of the **Explanatory Note**, but this test is specified in place of the braking test.

5.4.1 Measuring Items

(1) Tilting angle of the tilting board
The same as **5.2.1 (1)** of the **Explanatory Note.**

(2) Fuel leakage
The same as **5.1.1 (2)** of the **Explanatory Note.**

5.4.2 Test Equipment

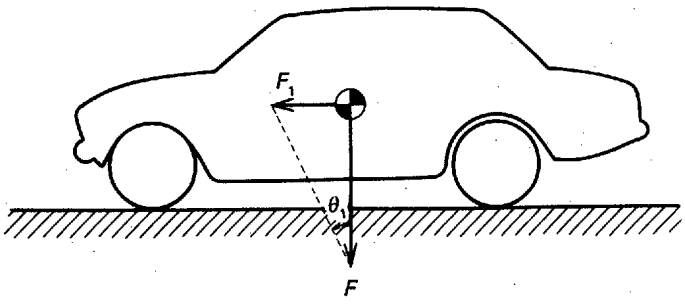
The same as **5.2.2 (1)** of the **Explanatory Note.** The maximun tilting angle is, however, specified as 37°C or more.

5.4.3 Test Conditions

(1) Conditions of test vehicle
The same as **5.1.3 (1)** of the **Explanatory Note.**

(2) Tilting conditions
Since the test is the substitute for the braking test, efforts were made to make the conditions as similar as possible to the conditions of the braking test. However only the braking deceleration and the duration time in the braking test are considered in the **Text.**

(a) Deceleration in braking

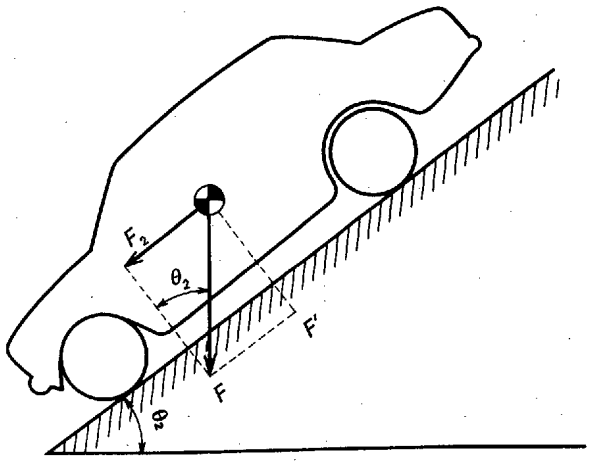


$F_1 = F \tan\theta_1$

Assuming that $F_1 = 5.9$ m/s² {0.6G}

$\theta_1 = 31$ deg

(b) Acceleration in longitudinal tilting test



$F_2 = F \sin\theta_2$

In order to obtain $F_2 = 5.9$ m/s² {0.6G}

$\theta_2 = 36.9$ deg

F_1 F_2 : braking acceleration 5.9 m/s² {0.6G}

F : gravitation acceleration 9.8 m/s² {1.0G}

As shown in **Fig.** above, it is necessary to tilt the vehicle with $F_1 = F_2 = 5.9$ m/s² {0.6G}, in order to attain the deceleration of 5.9 m/s² {0.6G} by the longitudinal tilting. Thus, $\theta_2 = 37$ deg is equivalent to the actual braking deceleration conditions.

5.5 Frontal Collision Test

The frontal collision test procedure is specified generally identical to the provision given under **JIS D 1060.**

5.5.1 Measuring Items

(1) **Collision speed**
It is specified according to **JIS D 1060.**
(2) **Fuel leakage**
It is specified according to **JIS D 1042** (Measuring Method of Fuel Leakage in the Event of a Collision of a Passenger Car).

5.5.2 Proving Ground and Test Equipment

According to **JIS D 1060.**

5.5.3 Test Conditions

(1) **Conditions of test vehicle**
According to **JIS D 1060.**
No particular value of the test vehicle mass is given, which should be decided according to the purpose of each test. The quantity of the fuel filled is the same **5.1.3.**
(2) **Conditions of collision**
According to **JIS D 1060.**
(3) **Collision speed**
It is specified that the speed should be within the range specified according to the purpose of each test, but it is recommended that the speed specified under technical requirements of 2 of Article 15, Safety Regulations for Road Vehicles should be used unless otherwise specified.
Collision speeds specified by regulations/standards in countries concerned are as shown on **Explanatory Table 1.**

5.5.4 Test Procedure

The recording is specified according to **JIS D 1060** and **JIS D 1042.**

5.6 Rear Collision Test

According to **JIS D 1060.**

5.6.1 Measuring Items

(1) **Collision speed**
According to **JIS D 1060.**
(2) **Fuel leakage**
According to **JIS D 1042.**

5.6.2 Proving Ground and Test Equipment

According to **JIS D 1060.**

5.6.3 Test Conditions

(1) **Conditions of test vehicle**
According to **JIS D 1060.**
No particular value of the test vehicle mass is given, which should be decided according to the purpose of each test. The quantity of the test fuel filled is the same as **5.1.3.** While it is specified that the parking brake should be released, it is given in the **Text** that the brake may be applied for the prevention of possible danger.
(2) **Conditions of collision**
According to **JIS D 1060.**

Explanatory Table 1

Regulation		Frontal collision
Technical requirements	Fuel leakage prevention	50±2 km/h (for light passenger cars, 40±2 km/h)
FMVSS 301	Fuel leakage prevention	Up to 30 mph
ECE 34	Prevention of fire	48.3 to 53.1 km/h

(3) Collision speed

It has been specified that the moving barrier collision speed should be within the range specified according to the test purpose, but it is recommended that the speed specified under technical requirement be employed unless otherwise specified. For light passenger cars, it has been specified that the speed should be 80% of ordinary passenger cars, unless otherwise specified. But th is special condition was deleted according to the revision of technical requirement.

Collision speeds specified by regulations of other countries are as shown on **Explanatory Table 2.**

5.6.4 Test Procedure

The recording of test data was specified according to **JIS D 1060** and **JIS D 1042.**

Explanatory Table 2

Regulation		Rear collision
Technical requirements	Fuel leakage prevention	35 to 38 km/h
FMVSS 301	Fuel leakage prevention	Up to 30 mph
ECE 34	Fire prevention	35 to 38 km/h

Reference Standards and Reference Data:

FMWSS No.301	Fuel System Integrity
SAE J 850	Barrier Collision Test
SAE J 972	Moving Barrier Collision Tests

In the event of any doubt, the original
standards in Japanese should be referred.

(SI) : SECOND PHASED STANDARD
(The standard where customary units and converted values are given in brackets after values of SI units.)

Established by the Standard Council of JSAE

Date of Establishment: 1970-10-9
Date of Revision: 1982-3-10
Date of Revision: 1989-3-31
Sub Committee in which the draft was made: SC of Fuel tank
Technical Committee under which the draft was discussed: TC of Body
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APPENDIX F : UNITED NATIONS ECONOMIC COMMISION FOR EUROPE (UN/ECE)

- UN/ECE Regulation No. 34 – Prevention of Fire Risks

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World Forum for Harmonization of Vehicle Regulations (WP.29)

Working Party on General Safety Provisions (GRSG)
(Eightieth session, 2-6 April 2001,
agenda item 11.1.)

PROPOSAL FOR DRAFT AMENDMENTS TO REGULATION No. 34
(Prevention of fire risk)

Transmitted by the Expert from France

Note: The text reproduced below was prepared by the expert from France in order to improve the fire safety of vehicles. The current text of the Regulation has been divided into 2 parts. The first part will be mandatory and aligned to the text of the European Community Directive 70/221/EEC as last amended by the European Community Directive 2000/8/EC. The second part, to be applied on the request of the manufacturer, includes the requirements of the existing Regulation, that are not included in the European Community Directive 2000/8/EC and introduces the frontal impact test procedure according to Regulation No. 94.

The vehicle can be approved pursuant to:
Part I of this Regulation,
Part I and Part II - frontal impact fire protection pursuant this Regulation,
Part I and Part II - rear impact fire protection pursuant this Regulation,
Part I and Part II - frontal and rear impact fire protection pursuant this Regulation,

Given the text extent of modifications, the text has been prepared as a draft Revision of Regulation No. 34.

Note: This document is distributed to the Experts on General Safety Provisions only.

Regulation No. 34, amend to read:

"UNIFORM PROVISIONS CONCERNING THE APPROVAL OF VEHICLES WITH REGARD TO THE PREVENTION OF FIRE RISKS

1. SCOPE

This Regulation applies to:

1.1. PART I: the approval of vehicles of categories M, N and O 1/ with regard to the tank(s) for liquid fuel.

1.2. PART II: the approval of vehicles of categories M1 fitted with tank(s) for liquid fuel which have been approved to Part I of this Regulation with regard to the prevention of fire risks in the event of a frontal and/or rear collision. Part II shall be applied at the request of the manufacturer.

1.3. At the request of the manufacturer, vehicles other than those above mentioned in paragraph 1.2. may be approved under this Regulation.

2. DEFINITIONS

For the purposes of this Regulation:

2.1. "approval of a vehicle" means the approval of a vehicle type with regard to the prevention of fire risks;

2.2. "vehicle type" means vehicles which do not differ in such essential respects as:

2.2.1. the structure, shape, dimensions and materials (metal/plastic) of the tank(s);

2.2.2. in vehicles of category M1 (1) the position of the tank(s) in the vehicle in so far as it has a negative effect on the requirements of paragraph 5.10.;

2.2.3. the characteristics and siting of the fuel feed system (pump, filters, etc.); and

2.2.4. the characteristics and siting of the electrical installation in so far as they have an effect on the results of the impact tests prescribed in this Regulation;

2.3. "transverse plane" means the vertical transverse plane perpendicular to the median longitudinal plane of the vehicle;

2.4. "passenger compartment" means the space for occupant accommodation bounded by the roof, floor, side walls, doors, outside glazing, front bulkhead, and the plane of the rear compartment bulkhead or the plane of the rear seat back support;

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1/ As defined in annex 7 of the Consolidated Resolution of the Construction of Vehicles (R.E.3) (TRANS/WP.29/78/Rev.1/Amend.2)

2.5. "unladen mass" means the mass of the vehicle in running order, unoccupied and unladen but complete with fuel, coolant, lubricants, tools and a spare wheel (if provided as standard equipment by the vehicle manufacturer);

2.6. "tank" means the tank(s) designed to contain the liquid fuel, as defined in paragraph 2.8., used primarily for the propulsion of the vehicle excluding its accessories [filler pipe (if it is a separate element), filler hole, cap, gauge, connections to the engine or to compensate interior excess pressure, etc.];

2.7. "capacity of the fuel tank" means the fuel-tank capacity as specified by the manufacturer; and

2.8. "liquid fuel" means a fuel which is liquid in normal conditions of temperature and pressure.

3. APPLICATION FOR APPROVAL

3.1. The application for approval of a vehicle type to a part of this Regulation shall be submitted by the vehicle manufacturer or by his duly accredited representative.

3.2. It shall be accompanied by the under mentioned documents in triplicate and by the following particulars:

3.2.1. a detailed description of the vehicle type with respect to the items specified in paragraph 2.2. above. The numbers and/or symbols identifying the engine type and the vehicle type must be specified;

3.2.2. drawing(s) showing the characteristics of the fuel tank and specifying the material from which it is made;

3.2.3. a diagram of the entire fuel feed systems, showing the site of each component on the vehicle; and

3.2.4. for application pursuant to Part II of this Regulation, a diagram of the electrical installation showing its siting and its mode of attachment to the vehicle.

3.3. The following must be submitted to the technical service responsible for conducting the type-approval tests:

3.3.1. A vehicle representative of the vehicle type to be approved or the parts of the vehicle which the technical service deems necessary for approval tests;

3.3.2. In the case of a vehicle equipped with a tank made of a plastic material: seven additional tanks, with their accessories;

3.3.3. In the case of a vehicle equipped with a tank made of another material: two additional tanks, with their accessories.

4. APPROVAL

4.1. If the vehicle submitted for approval pursuant to this Regulation meets the requirements of Part I and/or Part II below, approval of that vehicle type shall be granted.

4.2. Each type approved shall be assigned an approval number whose first two digits shall constitute the number of the most recent series of amendments incorporated in the Regulation on the date of issue of the approval. A Contracting Party may however assign the same approval number to several vehicle types as defined in paragraph 2.2. if the types are variants of the same basic model and provided that each type is separately tested and found to comply with the conditions of this Regulation.

4.3. Notice of approval or of refusal of approval of a vehicle type pursuant to this Regulation shall be communicated to the Parties to the Agreement which apply this Regulation by means of a form conforming to the model in annex 1 to this Regulation and of drawings, giving the particulars referred to in paragraphs 3.2.2., 3.2.3. and 3.2.4. above (supplied by the applicant for approval) in a format not exceeding A 4 (210 x 297 mm) or folded to that format and on an appropriate scale.

4.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle conforming to a vehicle type approved under this Regulation, an international approval mark consisting of:

4.4.1. a circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval;2/

4.4.2. the number of this Regulation, followed by the letter "R", a dash and the approval number to the right of the circle prescribed in paragraph 4.4.1.

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2/ 1 for Germany, 2 for France, 3 for Italy, 4 for Netherlands, 5 for Sweden, 6 for Belgium, 7 for Hungary, 8 for the Czech Republic, 9 for Spain, 10 for Yugoslavia, 11 for the United Kingdom, 12 Austria, 13 for Luxembourg, 14 for Switzerland, 15 (vacant), 16 for Norway, 17 for Finland, 18 for Denmark, 19 for Romania, 20 for Poland, 21 for Portugal, 22 for the Russian Federation, 23 for Greece, 24 for Ireland, 25 for Croatia, 26 for Slovenia, 27 for Slovakia, 28 for Belarus, 29 for Estonia, 30 (vacant), 31 for Bosnia and Herzegovina, 32 for Latvia, 33 (vacant), 34 for Bulgaria, 35-36 (vacant), 37 for Turkey, 38-39 (vacant), 40 for The former Yugoslav Republic of Macedonia, 41 (vacant), 42 for the European Community (Approvals are granted by its member States using their respective ECE symbol), 43 for Japan, 44 (vacant), 45 for Australia, and 46 for Ukraine. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify or accede to the Agreement Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approval Granted on the Basis of these Prescriptions, and the numbers thus assigned shall be communicated

by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

4.5. If the vehicle conforms to a vehicle type approved, under one or more other Regulations annexed to the Agreement, in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 4.4.1. need not be repeated; in such a case the additional numbers, approval numbers and symbols of all the Regulations under which approval has been granted in the country which has granted approval under this Regulation shall be placed in vertical columns to the right of the symbol prescribed in paragraph 4.4.1.

4.6. The approval mark shall be clearly legible and indelible.

4.7. The approval mark shall be placed close to or on the vehicle data plate affixed by the manufacturer.

4.8. Annex 2 to this Regulation gives examples of arrangements of the approval mark.

PART I APPROVAL OF VEHICLE WITH REGARDS TO ITS FUEL TANKS

5. REQUIREMENTS FOR LIQUID FUEL TANKS

5.1. Tanks must be made so as to be corrosion-resistant.

5.2. Tanks must satisfy, when equipped with all accessories, which are normally attached to them, the leakage tests carried out according to paragraph 6.1. at a relative internal pressure equal to double the working excess pressure, but in any event not less than an excess pressure of 0,3 bar.

Tanks for vehicles made of a plastic material are considered as meeting this requirement if they have passed the test described in annex 5, paragraph 2.

5.3. Any excess pressure or any pressure exceeding the working pressure must be compensated automatically by suitable devices (vents, safety valves, etc.).

5.4. The vents must be designed in such a way as to prevent any fire risk. In particular, any fuel, which may leak when the tank(s) is (are) being filled must not be able to fall on the exhaust system. It shall be channelled to the ground.

5.5. The tank(s) must not be situated in, or form, a surface (floor, wall, bulkhead) of the occupant compartment or other compartment integral with it.

5.6. A partition must be provided to separate the occupant compartment from the tank(s). The partition may contain apertures (e.g. to accommodate cables) provided they are so arranged that fuel cannot flow freely from the tank(s) into the occupant compartment or other compartment integral with it during normal conditions of use.

5.7. Every tank must be securely fixed and so placed as to ensure that any fuel leaking from the tank or its accessories will escape to the

ground and not into the occupant compartment during normal conditions of use.

5.8. The filler hole must not be situated in the occupant compartment, in the luggage compartment or in the engine compartment.

5.9. The fuel must not escape through the tank cap or through the devices provided to compensate excess pressure during the foreseeable course of operation of the vehicle. In the case of overturning of the vehicle, a drip may be tolerated provided that it does not exceed 30 g/min; this requirement must be verified during the test prescribed in paragraph 6.2.

5.9.1. The tank cap must be fixed to the filler pipe: the seal must be retained securely in place, the cap must latch securely in place against the seal and filler pipe when closed.

5.9.1.1. The requirements of paragraph 5.9.1. will be deemed to be satisfied if the vehicle meets the requirements of paragraph 5.1.3. of Regulation No. 83, 05 series of amendments subject to the provision that the examples listed in the third indent of that section do not apply to vehicles in categories other than M1 or N1.

5.10. Tanks must be installed in such a way as to be protected from the consequences of an impact to the front or the rear of the vehicle; there shall be no protruding parts, sharp edges, etc. near the tank.

5.11. The fuel tank and the filler neck shall be designed and installed in the vehicles in such a way as to avoid any accumulation of static electricity charges on their entire surface. If necessary, they shall be discharged into the metallic structure of the chassis or any major metallic mass by means of a good conductor.

5.12. The fuel tank(s) shall be made of a fire-resistant metallic material. It (they) may be made of a plastics material provided the requirements of annex 5 are complied with.

6. TESTS OF LIQUID FUEL TANKS

6.1. Hydraulic test

The tank must be subjected to a hydraulic internal pressure test which must be carried out on an isolated unit complete with all its accessories. The tank must be completely filled with a non-flammable liquid (water, for example). After all communication with the outside has been cut off, the pressure must be gradually increased, through the pipe connection through which fuel is fed to the engine, to a relative internal pressure equal to double the working pressure used and in any case to not less than an excess pressure of 0,3 bar, which must be maintained for one minute. During this time the tank shell must not crack or leak; however, it may be permanently deformed.

6.2. Overturn test

6.2.1. The tank and all its accessories must be mounted on to a test fixture in a manner corresponding to the mode of installation on the vehicle for which the tank is intended: this also applies to systerris for the compensation of the interior excess pressure.

6.2.2. The test fixture shall rotate about an axis lying parallel to the longitudinal vehicle axis.

6.2.3. The test will be carried out with the tank filled to 90 per cent of its capacity and also 30 per cent of its capacity with a non-flammable liquid having a density and a viscosity close to those of the fuel normally used (water may be accepted).

6.2.4. The tank must be turned from its installed position 90° to the right. The tank must remain in this position for at least five minutes. The tank must then be turned 90° further in the same direction. The tank must be held in this position, in which it is completely inverted, for at least another five minutes. The tank must be rotated back to its normal position. Testing liquid that has not flowed back from the venting system into the tank must be drained and replenished if necessary. The tank must be rotated 90° in the opposite direction and left for at least five minutes in this position.

The tank must be rotated 90° further in the same direction. This completely inverted position must be maintained for at least five minutes. Afterwards the tank must be rotated back to its normal position.

PART II APPROVAL OF VEHICLE WITH REGARD TO THE PREVENTION OF FIRE RISKS IN THE EVENT OF COLLISION

7. REQUIREMENTS FOR INSTALLATION OF AN APPROVED LIQUID FUEL TANK

7.1. Fuel installation

7.1.1. the tanks for liquid fuel shall be approved according to Part I of this Regulation.

7.1.2. The components of the fuel installation shall be adequately protected by parts of the frame or bodywork against contact with possible obstacles on the ground. Such protection shall not be required if the components beneath the vehicle are further from the ground than the part of the frame or bodywork in front of them.

7.1.3. The pipes and all other parts of the fuel installation shall be accommodated on the vehicle at sites protected to the fullest possible extent. Twisting and bending movements, and vibrations of the vehicle's structure or drive unit, shall not subject the components of the fuel installation to friction, compression or any other abnormal stress.

7.1.4. The connections of pliable or flexible pipes with rigid parts of components of the fuel installation shall be so designed and constructed as to remain leak-proof under the various conditions of

use of the vehicle, despite twisting and bending movements and despite vibrations of the vehicle's structure or drive unit.

7.1.5. If the filler hole is situated on the side of the vehicle, the filler cap shall not, when closed, project beyond the adjacent surfaces of the bodywork.

7.2. Electrical installation

7.2.1. Electric wires other than wires accommodated in hollow components shall be attached to the vehicle's structure or walls or partitions near which they lead. The points at which they pass through walls or partitions shall be satisfactorily protected to prevent cutting of the insulation.

7.2.2. The electrical installation shall be so designed, constructed and fitted that its components are able to resist the corrosion phenomena to which they are exposed.

8. TESTS ON THE VEHICLE

In the frontal-impact test against a barrier carried out by the procedure specified in annex 3 to this Regulation, and in the rear-end impact test carried out by the procedure specified in annex 4 hereto,

8.1. no more than a slight leakage of liquid in the fuel installation shall occur on collision;

8.2. if there is continuous leakage in the fuel installation after the collision, the rate-of leakage must not exceed 30 g/min; if the liquid from the fuel installation mixes with liquids from the other systems, and if the several liquids cannot be easily separated and identified, the continuous leakage shall be evaluated from all the fluids collected;

8.3. no fire maintained by the fuel shall occur.

8.4. During and after the impacts described in paragraph 8. above, the battery must be kept in position by its securing device.

8.5. At the request of the manufacturer, the frontal impact test set out in annex 3 of this Regulation can be replaced by the test procedure described in annex 3 of Regulation No. 94, 01 series of amendments.

9. MODIFICATIONS OF THE VEHICLE TYPE

9.1. Every modification of the vehicle type shall be notified to the administrative department which approved the vehicle type. The department may then either:

9.1.1. consider that the modifications made are unlikely to have appreciable adverse efforts, and that in any case the vehicle still meets the requirements; or

9.1.2. require a further test report from the technical service responsible for conducting the tests.

9.2. Without prejudice to the provisions of paragraph 9.1. above, a variant of the vehicle whose unladen mass does not differ by more than ± 20 per cent from that of the approval-tested vehicle shall not be regarded as a modification of the vehicle type.

9.3. Notice of confirmation of approval or of refusal of approval, specifying the modifications shall be communicated by the procedure specified in paragraph 4.3. above to the Parties to the Agreement which apply this Regulation.

10. CONFORMITY OF PRODUCTION

10.1. Every vehicle bearing an approval mark as prescribed under this Regulation shall conform to the vehicle type approved and satisfy the requirements of Part I and/or Part II above.

10.2. In order to verify conformity as prescribed in paragraph 10.1. above, a sufficient number of serially-produced vehicles bearing the approval mark required by this Regulation shall be subjected to random checks.

10.3. As a general rule, the conformity of the vehicle with the approved type shall be checked on the basis of the description given in the approval form and its annexes. However, the vehicle shall if necessary be subjected to the checks prescribed in paragraph 6. above.

11. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

11.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirement laid down in paragraph 10.1. above is not complied with or if the vehicle has failed to pass the checks prescribe in paragraph 8. above.

11.2. If a Party to the Agreement which applies this Regulation withdraws an approval it has previously granted, it shall forthwith notify the other Parties to the Agreement which apply this Regulation thereof by means of a copy of the approval form bearing at the end, in large letters, the signed and dated annotation "APPROVAL WITHDRAWN".

12. NAMES AND ADDRESSES OF TECHNICAL SERVICES CONDUCTING APPROVAL TESTS, AND OF ADMINISTRATIVE DEPARTMENTS

The Parties to the Agreement which apply this Regulation shall communicate to the Secretariat of the United Nations the names and addresses of the technical services conducting approval tests and of the administrative departments which grant approval and to which forms certifying approval or refusal or withdrawal of approval, issued in other countries, are to be sent.

Annex 1

COMMUNICATION

(Maximum format: A 4 (210 x 297 mm))

issued by: Name of administration:
.....
.....

Concerning: 2/ APPROVAL GRNATED
APPROVAL EXTENDED
APPROVAL REFUSED
APPROVAL WITHDRAWN
PRODUCTION DEFINITELY DISCONTINUED

of a vehicle type with regard 2/ to the tank for liquid fuel
to the prevention of fire risks in the event of frontal collision
to the prevention of fire risks in the event of rear collision,

pursuant to Regulation No. 34.

Approval No..... Extension No.: .....

1. Trade name or mark of the power-driven vehicle: .....

2. Vehicle type: .....

3. Manufacturer's name and address: .....

4. If applicable, name and address of manufacturer's representative: .....
.....

5. Kind of engine: positive-ignition diesel 2/: .....

6. Site of engine: front/rear/centre 2/: .....

7. Brief description of fuel tank and fuel .....

7.1. Characteristics and site of fuel tank: .....

7.2. For fuel tanks made of a plastics material, state material and trade name or mark: .....

7.3. Characteristics of fuel installation (site, connections, etc.): .....
.....

8. Description of electrical installation (site attachment, protection, etc.): .....

9. Vehicle submitted for approval on: .....

10. Technical service responsible for conducting approval tests: .....

11. Date of report issued by that service: .....

12. Number of report issued that service: .....

13. Approval granted/refused 2/ .....

14. Position of approval mark on the vehicle: .....

15. Place: .....

16. Date:.....

17. Signature: .....

18. The following documents, bearing the approval number shown above, are annexed to this communication: .....
.....

drawings and layout diagrams of the fuel tank, the fuel installation, the electrical installation, and other components of importance for the purposes of this Regulation.

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1/ Distinguishing number of the country which has granted/extended/refused/withdrawn/ the approval (see approval provisions in the Regulation).

2/ Strike out what does not apply

Annex 2

ARRANGEMENTS OF THE APPROVAL MARK

(To be elaborated)

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Annex 3

FRONTAL-IMPACT TEST AGAINST A BARRIER

1. PURPOSE AND SCOPE

The purpose of this test is to simulate the conditions of frontal impact against a fixed obstacle or by another vehicle approaching from the opposite direction.

2. INSTALLATIONS, PROCEDURES AND MEASURING INSTRUMENTS

2.1. Testing ground

The test area shall be large enough to accommodate the run-up track, barrier and technical installations necessary for the test. The last part of the track, for at least 5 m before the barrier, must be horizontal, flat and smooth.

2.2. Barrier

The barrier consists of a block of reinforced concrete not less than 3 m wide in front and not less than 1.5 m high. The barrier must be of such thickness that it weighs at least 70 tons. The front face must be vertical, perpendicular to the axis of the run-up track, and covered with plywood boards 2 cm thick in good condition. The barrier shall be either anchored in the ground or placed on the ground with, if necessary, additional arresting devices to limit its displacement. A barrier with different characteristics, but giving results at least equally conclusive, may likewise be used.

2.3. Propulsion of vehicle

At the moment of impact, the vehicle must no longer be subject to the action of any additional steering or propelling device. It must reach the obstacle on a course perpendicular to the collision wall; the maximum lateral misalignment tolerated between the vertical median line of the front of the vehicle and the vertical median line of the collision wall is $\pm$ 30 cm.

2.4. State of vehicle

2.4.1. The vehicle under test shall either be fitted with all the normal components and equipment included in its unladen kerb weight or be in such condition as to fulfil this requirement so far as the components and equipment affecting fire risks are concerned.

2.4.2. If the vehicle is driven by external means, the fuel installation must be filled to at least 90 per cent of its capacity either with fuel or with a non-inflammable liquid having a density and a viscosity close to those of the fuel normally used. All other systems (brake-fluid header tanks, radiator, etc.) may be empty.

2.4.3. If the vehicle is driven by its own engine, the fuel tank must be at least 90 per cent full. All other liquid-holding tanks may be filled to capacity.

2.4.4. If the manufacturer so requests, the technical service responsible for conducting the tests may allow the same vehicle as is used for tests prescribed by other Regulations (including tests capable of affecting its structure) to be used also for the tests prescribed by this Regulation.

2.5. Velocity on impact

The velocity on impact must be between 48.3 km/h and 53.1 km/h. However, if the test has been carried out at a higher impact velocity and the vehicle has satisfied the conditions prescribed, the test shall be considered satisfactory.

2.6. Measuring instruments

The instrument used to record the speed referred to in paragraph 2.5. above shall be accurate to within one per cent.

3. EQUIVALENT TEST METHODS

3.1. Equivalent test methods are permitted provided that the conditions referred to in this Regulation can be observed either entirely by means of the substitute test or by calculation from the results of the substitute test.

3.2. If a method other than that described in paragraph 2. above is used its equivalence must be demonstrated.

Annex 4

PROCEDURE FOR REAR-END IMPACT TEST

1. PURPOSE AND SCOPE

1.1. The purpose of the test is to simulate the conditions of rear-end impact by another vehicle in motion.

2. INSTALLATIONS, PROCEDURES AND MEASURES INSTRUMENTS

2.1. Testing ground

The test area shall be large enough to accommodate the impactor (striker) propulsion system and to permit after-impact displacement of the vehicle struck and installation of the test equipment. The part in which vehicle impact and displacement occur shall be horizontal, flat and smooth and have a coefficient of friction of not less than 0.5.

2.2. Impactor (striker)

2.2.1. The impactor shall be of steel and of rigid construction.

2.2.2. The impacting surface shall be flat, not less than 2,500 mm wide, and 800 mm high, and its edges shall be rounded to a radius of curvature of between 40 and 50 mm. It shall be clad with a layer of plywood 20 mm thick.

2.2.3. At the moment of impact the following requirements shall be met:

2.2.3.1. the impacting surface shall be vertical and perpendicular to the median longitudinal plane of the vehicle struck;

2.2.3.2. the direction of movement of the impactor shall be substantially horizontal and parallel to the median longitudinal plane of the vehicle struck;

2.2.3.3. the maximum lateral deviation tolerated between the median vertical line of the surface of the impactor and the median longitudinal plane of the vehicle struck shall be 300 mm. In addition, the impacting surface shall extend over the entire width of the vehicle struck;

2.2.3.4. the ground clearance of the lower edge of the impacting surface shall be 175 $\pm$ 25 mm.

2.3. Propulsion of the impactor

The impactor may either be secured to a carriage (moving barrier) or form part of a pendulum.

2.4. Special provisions applicable where a moving barrier is used

2.4.1. If the impactor is secured to a carriage (moving barrier) by a restraining element, the latter must be rigid and be incapable of

being deformed by the impact; the carriage shall at the moment of impact be capable of moving freely and no longer be subject to the action of the propelling device.

2.4.2. The velocity of impact shall be between 35 and 38 km/h.

2.4.3. The aggregate weight (mass) of carriage and impactor shall be 1,100 ± 20 kg

2.5. Special provisions applicable where a pendulum is used

2.5.1. The distance between the centre of the impacting face and the axis of rotation of the pendulum shall be not less than 5 m.

2.5.2. The impactor shall be freely suspended by rigid arms rigidly secured to it. The pendulum so constituted shall be substantially incapable of being deformed by the impact.

2.5.3. Arresting gear shall be incorporated in the pendulum to prevent any secondary impact by the impactor on the test vehicle.

2.5.4. At the moment of impact the velocity of the centre of percussion of the pendulum should be between 35 and 38 km/h.

2.5.5. The reduced mass "m_r" at the centre of percussion of the pendulum is defined as a function of the total mass "m", of the distance “a” 1/ between the centre of percussion and the axis of rotation, and of the distance "l" between the centre of gravity and the axis of rotation, by the following equation:

$$m_r = m\ (l/a).$$

2.5.6. The reduced mass m_r shall be 1,100 ± 20 kg.

2.6. General provisions relating to the mass and velocity of the impactor

If the test has been conducted at an impact velocity higher than those prescribed in paragraphs 2.4.2. and 2.5.4. and/or with a mass greater than those prescribed in paragraphs 2.4.3. and 2.5.6., and the vehicle has met the requirements prescribed, the test shall be considered satisfactory.

2.7. State of vehicle under test

2.7.1. The vehicle under test shall either be fitted with all the normal components and equipment included in its unladen kerb weight or be in such condition as to fulfil this requirement so far as the components and equipment affecting fire risks are concerned.

2.7.2. The fuel tank must be filled to at least 90 per cent of its capacity either with fuel or with a non-inflammable liquid having a density and a viscosity close to those of the fuel normally used. All other systems (break-fluid header tanks, radiator, etc.) may be empty.

2.7.3. A gear may be engaged and the brakes may be applied.

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1/ It is recalled that the distance “a” is equal to the length of the synchronous pendulum under consideration

2.7.4. If the manufacturer so requests, the following derogation shall be permitted:

2.7.4.1. the technical service responsible for conducting the tests may allow the same vehicle as is used for tests prescribed by other Regulations (including tests capable of affecting its structure) to be used also for the tests prescribed by this Regulation; and

2.7.4.2. the vehicle may be weighted to an extent not exceeding 10 per cent of its unladen kerb weight with additional weights rigidly secured to the structure in such a way as not to affect the behaviour of the structure of the passenger compartment during the test.

2.8. Measuring instruments

The instruments used to record the speed referred to in paragraphs 2.4.2. and 2.5.4. above shall be accurate to within one per cent.

3. EQUIVALENT TEST METHODS

3.1. Equivalent test methods are permitted provided that the conditions referred to in this Regulation can be observed either entirely by means of the substitute test or by calculation from the results of the substitute test.

3.2. If a method other than that described in paragraph 2. above is used, its equivalence must be demonstrated.

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Annex 5

TESTING OF FUEL TANKS MADE OF A PLASTICS MATERIAL

1. Impact resistance

1.1. The tank must be filled to its capacity with a water-glycol mixture or with another liquid having a low freezing point, which does not change the properties of the tank material, and must then be subjected to a perforation test.

1.2. During this test the tank temperature must be 233K ± 2K (- 40 °C ± 2 °C).

1.3. A pendulum impact testing fixture must be used for the test. The impact body must be of steel and have the shape of a pyramid with equilateral-triangle faces and a square base, the summit and the edges being rounded to a radius of 3 mm. The centre of percussion of the pendulum must coincide with the centre of gravity of the pyramid; its distance from the axis of rotation of the pendulum must be 1 m. The total mass of the pendulum must be 15 kg. The energy of the pendulum at the moment of impact must be not less than 30 Nm and as close to that value as possible.

1.4. The tests must be made on the points of the tank which are regarded as vulnerable to frontal or rear collisions. The points regarded as vulnerable are those which are most exposed or weakest having regard to the shape of the tank or the way in which it is installed on the vehicle. The points selected by the laboratories must be indicated in the test report.

1.5. During the test, the tank must be held in position by the fittings on the side or sides opposite the side of impact. No leak must result from the test.

1.6. At the choice of the manufacturer, all the impact tests may be carried out on one tank or each may be carried out on a different tank.

2. Mechanical strength

The tank must be tested under the conditions prescribed in paragraph 6.1. of this Regulation for leaks and for rigidity of shape. The tank and all its accessories must be mounted onto a test fixture in a manner corresponding to the mode of installation on the vehicle for which the tank is intended. Water at 326 K (53 °C) must be used as the testing fluid and must fill the tank to its capacity. The tank must be subjected to a relative internal pressure equal to double the working pressure and in any case to not less than 0,3 bar at a temperature of 326 K ± 2 K (53 °C ± 2 °C) for a period of five hours. During the test, the tank and its accessories must not crack or leak; however, it may be permanently deformed.

3. Fuel permeability

3.1. The fuel used for the permeability test must be either the reference fuel specified in Regulation No. 83, annex 9 or a commercial premium-grade fuel. If the tank is only designed for installation on vehicles with a compression-ignition engine, the tank shall be filled with diesel fuel.

3.2. Prior to the test, the tank must be filled to 50 per cent of its capacity with testing fuel and stored, without being sealed, at an ambient temperature of 313 K ± 2 K (40 °C ± 2 °C) until the weight loss per unit time becomes constant.

3.3. The tank must then be emptied and refilled to 50 per cent of its capacity with test fuel, after which it must be hermetically sealed and be stored at a temperature of 313 K ± 2 K (40 °C ± 2 °C). The pressure must be adjusted when the contents of the tank have reached the testing temperature. During the ensuing test period of eight weeks, the loss of weight due to diffusion during the test period shall be determined. The maximum permissible average loss of fuel is 20 g per 24 hours of testing time.

3.4. If the loss due to diffusion exceeds the value indicated in paragraph 3.3., the test described there must be carried out again, on the same tank, to determine the loss by diffusion at 296 K ± 2 K (23 °C ± 2 °C) but under the same conditions otherwise. The loss so measured shall not exceed 10 g per 24 hours.

4. Resistance to fuel

After the test referred to in paragraph 3., the tank must still meet the requirements set out in paragraphs 1. and 2.

5. Resistance to fire

The tank must be subjected to the following tests.

5.1. For two minutes, the tank, fixed as on the vehicle, must be exposed to flame. There must be no leakage of liquid fuel from the tank.

5.2. Three tests must be made on different tanks filled with fuel as follows:

5.2.1. If the tank is designed for installation on vehicles equipped with either a positive ignition engine or a compression ignition engine, three tests must be carried out with tanks filled with premium-grade gasoline;

5.2.2. If the tank is only designed for installation on vehicles equipped with a compression-ignition engine, three tests must be carried out with tanks filled with diesel fuel;

5.2.3. For each test the tank and its accessories must be installed in a testing fixture simulating actual installation conditions as far as possible. The method whereby the tank is fixed in the fixture must correspond to the relevant specifications for the vehicle. Vehicle

parts which protect the tank and its accessories against exposure to flame or which affect the course of the fire in any way, as well as specified components installed on the tank and plugs must be taken into consideration. All openings must be closed during the test, but venting systems must remain operative. Immediately prior to the test the tank must be filled with the specified fuel to 50 per cent of its capacity.

5.3. The flame to which the tank is exposed must be obtained by burning commercial fuel for positive-ignition engines (hereafter called "fuel") in a pan. The quantity of fuel poured into the pan shall be sufficient to permit the flame, under free-burning conditions, to burn for the whole test procedure.

5.4. The pan dimensions must be chosen so as to ensure that the sides of the fuel tank are exposed to the flame. The pan must therefore exceed the horizontal projection of the tank by at least 20 cm, but not more then 50 cm. The sidewalls of the pan must not project more than 8 cm above the level of the fuel at the start of the test.

5.5. The pan filled with fuel must be placed under the tank in such a way that the distance between the level of the fuel in the pan and the tank bottom corresponds to the design height of the tank above the road surface at the unladen mass (see paragraph 2.5.). Either the pan, or the testing fixture, or both, must be freely movable.

5.6. During phase C of the test, the pan must be covered by a screen placed 2 cm ± 1 cm above the fuel level.

The screen must be made of a refractory material, as prescribed in appendix 2. There must be no gap between the bricks and they must be supported over the fuel pan in such a manner that the holes in the bricks are not obstructed. The length and width of the frame must be 2 cm to 4 cm smaller than the interior dimensions of the pan so that a gap of 1 cm to 2 cm exists between the frame and the wall of the pan to allow ventilation.

5.7. When the tests are carried out in the open air, sufficient wind protection must be provided and the wind velocity at fuel-pan level must not exceed 2,5 km/h. Before the test the screen must be heated to 308 K ± 5 K (35 °C ± 5°C). The firebricks may be wetted in order to guarantee the same test conditions for each successive test.

5.8. The test must comprise four phases (see appendix 1).

5.8.1. Phase A: Pre-heating (figure 1)

The fuel in the pan must be ignited at a distance of at least 3 m from the tank being tested. After 60 seconds pre-heating, the pan must be placed under the tank.

5.8.2. Phase B: Direct exposure to flame (figure 2)

For 60 seconds the tank must be exposed to the flame from the freely burning fuel.

5.8.3. Phase C: Indirect exposure to flame (figure 3)

As soon as phase B has been completed, the screen must be placed between the burning pan and the tank. The tank must be exposed to this reduced flame for a further 60 seconds.

5.8.4. Phase D: End of test (figure 4)

The burning pan covered with the screen must be moved back to its original position (phase A). If, at the end of the test, the tank is burning, the fire must be extinguished forthwith.

5.9. The results of the test shall be considered satisfactory if no liquid fuel is leaking from the tank.

6. Resistance to high temperature

6.1. The fixture used for the test must match the manner of installation of the tank on the vehicle, including the way in which the tank vent works.

6.2. The tank filled to 50 per cent of its capacity with water at 293 K (20 °C) must be subjected for one hour to an ambient temperature of 368 K ± 2 K (95 °C ± 2 °C).

6.3. The results of the test shall be considered satisfactory if, after the test, the tank is not leaking or seriously deformed.

7. Markings on the fuel tank

The trade name or mark must be affixed to the tank; it must be indelible and clearly legible on the tank when the latter is installed on the vehicle.

_____

Annex 5 - Appendix 1

TEST OF RESISTANCE TO FIRE

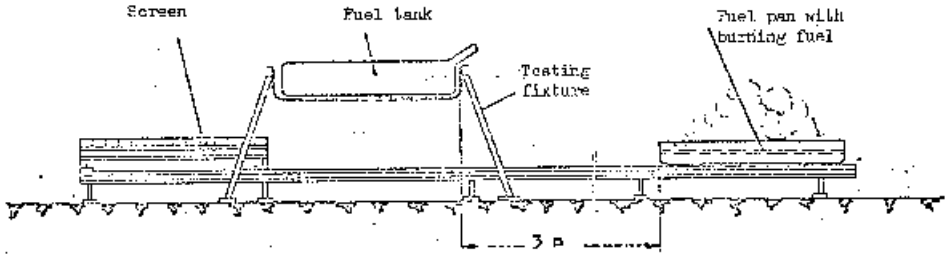


Figure 1
Phase A: Pre-heating

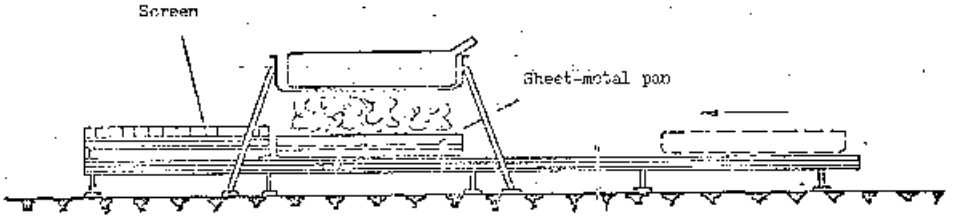


Figure 2
Phase B: Direct exposure to flame

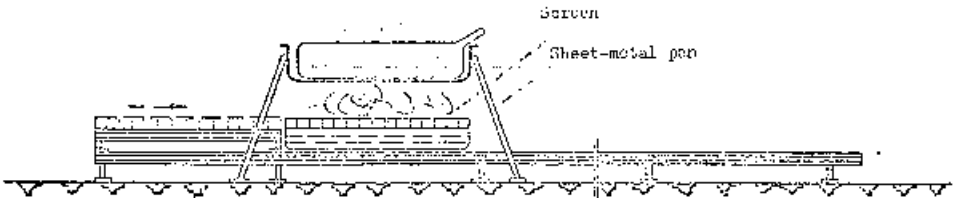


Figure 3
Phase C: Indirect exposure to the flame

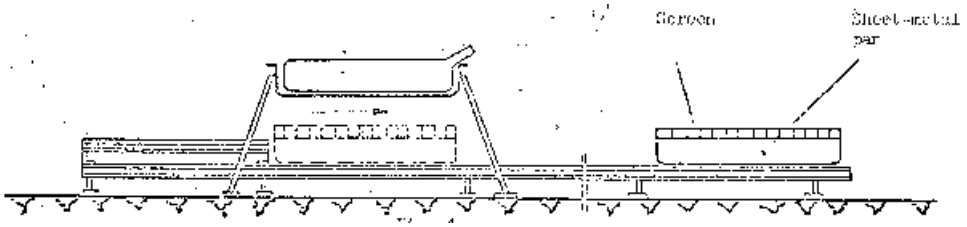
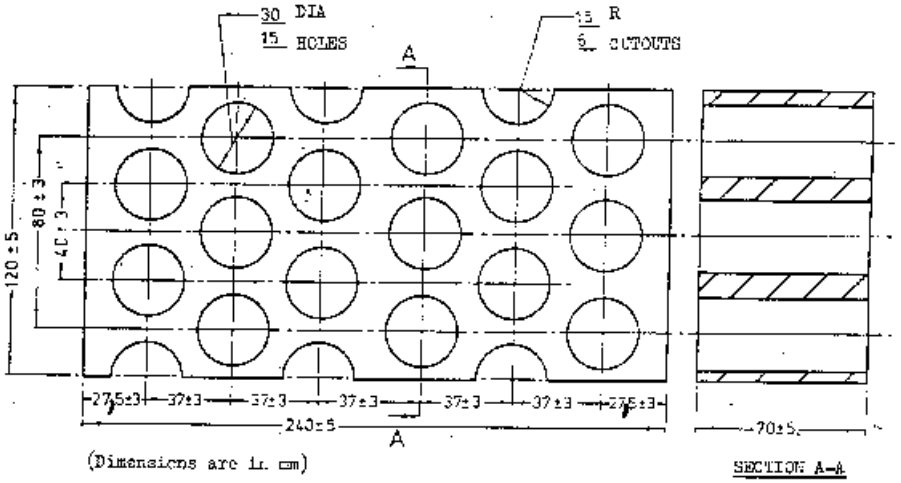


Figure 4
Phase D: End of test

_____

Annex 5 - Appendix 2

DIMENSIONS AND TECHNICAL DATA OF FIREBRICKS



Fire resistance	(Seger-Kegel) SK 30
Al_2O_3 content	30-33 per cent
Open porosity (P_o)	20-22 per cent vol.
Density	1,900-2,000 kg/m^3
Effective holed area	44.18 per cent

_____ "

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Last Printed On: 16/01/01 17.20
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Number of Pages: 28
Number of Words: 6,161 (approx.)
Number of Characters: 35,119 (approx.)

APPENDIX G : SUGGESTED LIS T OF VEHICLES TO BE INSPECTED

Base Price Range	Car coupes / hatchback / sedans / wagons	SUV (note 2) full-size	 compact	Pickup Truck full-size	 compact	Van minivan	 full-size
Under $15,000	Chevrolet Cavalier, Pontiac Sunfire (1) Daewoo Lanos (1) Ford Focus Honda Civic Hyundai Tiburon (1) Saturn S series Nissan Sentra (1) Toyota Corolla, Chevrolet Prizm VW Golf GTI Dodge Neon (1)				Ford Ranger GMC sonoma Nissan Frontier Toyota Tacoma		
$15,000 to $19,999	Chevrolet Malibu (1) Toyota Camary Honda Accord Nissan Altima Ford Taurus Pontiac Grand AM Ford Mustang (1) VW Jetta (1)		Kia Sportage Jeep Liberty Chevrolet Blazer Toyota Rav 4 Honda CRV	Toyota Tundra Ford F-series GMC Sierra Dodge Ram	Dodge Dakota	Dodge Caravan	
$20,000 to $24,999	Mazda Miata (1) Acura RSX		Subaru Forester Ford Explorer			Toyota Sienna (1) Ford Windstar (1) Nissan Quest (1) Chevrolet Venture Mazda MPV KIA sedona Honda Odyssey	GMC Savana Ford E350 (1) Dodge Ram Wagon
$25,000 to $29,999	Toyota Avalon (1) Nissan Maxima BMW 3 series Volvo S60 Chrysler 300M Audi A4 Acura TL Pontiac Bonneville		Nissan Pathfinder Toyota 4runner Dodge Durango Jeep Grand Cherokee (1)				
$30,000 to $49,999	Chevrolet Corvette (1) Cadilac Eldorado BMW M coupe Volvo C70	Ford Expidition Chevrolet Suburban	Acura MDX BMW X5				
Over $50,000	Audi A8						

Notes:
1- Shaded cells are the initial selection of vehicles based on the scope definition and vehicle selection criteria.
2- The SUV's will likely all employ some form of a tank shield.

APPENDIX H : HONDA ODYSSE Y REVIEW CHECKLIST/REPORT

VEHICLE FUEL SYSTEM REVIEW
CHECKLIST/REPORT

VEHICLE: Honda Odyssey
COMPLETED BY: J. Kotz, E. Fournier
DATE (YY/MM/DD) : 02/03/22

Prepared for:	Dr. Ken Digges Motor Vehicle Fire Research Institute
Author:	Ed Fournier Matthew Keown
Date:	March 2002
Report No. :	R02-06

TABLE OF CONTENTS

1. GENERAL VEHICLE INFORMATION

Make:	Honda			
Model:	Odyssey			
Trim level:	EX-L			
Type:	☐ Coupe	☐ Sedan	☐ Hatchback	☐ Wagon
	☑ Mini-van	☐ SUV	☐ Pickup	☐ Van
Class:	☐ Compact		☑ Full-sized	
Number of doors:	☐ 2	☐ 3	☐ 4	☑ 5
V.I.N.:	2HKRL18962H 008181			
Date of Manufacture (YY/mm)	02/03			
GVW:	2570 kg			
Number of Tanks:	☑ 1	☐ 2	☐ 3	☐ 4
Tank Options				

2. FUEL TANK SYSTEM 1: INFORMATION

Tank No.: 1 of 1	Capacity (Litres): 20	
Location		
Tank location relative to rear axle:	☐ Behind axle ☐ Over axle ☑ Ahead of axle ☐ Other _____	
Tank location relative to vehicle centreline:	☐ Left side ☑ Mid-ship ☐ Right side ☐ Other _____	
Tank location measurements (cm):	Front bumper to rear axle:	≈ 384
	Front of tank to front bumper:	274
	Rear of tank to rear bumper:	96
	Left side of tank to vehicle left side:	48
	Right side of tank to vehicle right side:	80
Height of tank bottom to ground (cm)	24	
Lowest point of fuel line relative to ground (cm)	29	
Identify possible intrusive components	rear axle sway bar mount - left side	
Filler		
Filler location:	☑ Left side ☐ Rear ☐ Right side ☐ Other _____	
Filler location measurements (cm):	Height of filler opening from ground:	82
	Distance forward of rear axle:	30
Filler door type:	☐ Lockable ☐ Non-lockable ☐ Automatic Release	
Other		
Tank shield:	Coverage:	☐ Full ☐ Partial ☑ None
	Material:	☐ Steel ☐ Plastic ☑ Other N/A
Fuel lines:	Shielded:	☐ Full ☑ Partial ☐ None
	Material:	☑ Rubber ☑ Steel ☐ Braided
Fuel line routing notes	lines run along inner side of uni-body frame rail - left side	

Canister:	1 of 1	
Location		
Canister location relative to rear axle:	☐ Behind axle ☐ Over axle ☑ Ahead of axle ☐ Other _____	
Canister location relative to vehicle centreline:	☐ Left side ☑ Mid-ship ☐ Right side ☐ Other _____	
Canister location measurements (cm):	Front of canister to front bumper:	167
	Rear of canister to rear bumper:	325
	Left side of canister to vehicle left side:	63
	Right side of canister to vehicle right side:	97
Identify possible intrusive components	front end shielded - rear exposed	

3. FUEL TANK SYSTEM 2: INFORMATION

Tank No.: 1 of_____	Capacity (Litres):		
Location			
Tank location relative to rear axle:	☐ Behind axle ☐ Over axle ☐ Ahead of axle ☐ Other _____		
Tank location relative to vehicle centreline:	☐ Left side ☐ Mid-ship ☐ Right side ☐ Other _____		
Tank location measurements **(cm)**:	Front bumper to rear axle:		
	Front of tank to front bumper:		
	Rear of tank to rear bumper:		
	Left side of tank to vehicle left side:		
	Right side of tank to vehicle right side:		
Height of tank bottom to ground **(cm)**			
Lowest point of fuel line relative to ground **(cm)**			
Identify possible intrusive components			
Filler			
Filler location:	☐ Left side ☐ Rear ☐ Right side ☐ Other _____		
Filler location measurements **(cm)**:	Height of filler opening from ground:		
	Distance forward of rear axle:		
Filler door type:	☐ Lockable ☐ Non-lockable ☐ Automatic Release		
Other			
Tank shield:	Coverage:	☐ Full ☐ Partial ☐ None	
	Material:	☐ Steel ☐ Plastic ☐ Other _____	
Fuel lines:	Shielded:	☐ Full ☐ Partial ☐ None	
	Material:	☐ Rubber ☐ Steel ☐ Braided	
Fuel line routing notes			

Canister:	1 of_____	
Location		
Canister location relative to rear axle:	☐ Behind axle ☐ Over axle ☐ Ahead of axle ☐ Other _____	
Canister location relative to vehicle centreline:	☐ Left side ☐ Mid-ship ☐ Right side ☐ Other _____	
Canister location measurements (cm):	Front of canister to front bumper:	
	Rear of canister to rear bumper:	
	Left side of canister to vehicle left side:	
	Right side of canister to vehicle right side:	
Identify possible intrusive components		

4. FIRE SAFETY RELATED FUEL SYSTEM FEATURES

Select all that apply and photograph where applicable.

YES	NO	
☑	☐	Filler check valve.
☐	☐	Fuel shut off valves (ie 7g valve).
☐	☑	Shielding of tank.
☑	☐	Shielding of other fuel system components. (cannister)
☑	☐	Multiple layered tanks.
☐	☑	Tank bladders.
☐	☑	Tear away fuel line connections with cut-off valves.
☐	☐	Fire shields/blankets in the engine compartment.
☐	☐	Anti-siphoning.
☐	☑	Spark arrestors.
☑	☐	Electrical isolation.
☐	☑	Tank additives (such as Explosafe or foams).
☐	☑	Slip-in-tube drive shaft.
☐	☐	EFI Fuel Pump shut off.
☐	☑	Active fire suppression system.
☐	☐	Other: _____
☐	☐	Other: _____
☐	☐	Other: _____
☐	☐	Other: _____

5. PHOTOGRAPH CHECKLIST

Important: If a detail is not visible DO NOT skip the photograph, instead take a photograph of the notice page contained in Appendix A. A skipped photograph may lead to confusion when the digital files are renamed.

Check	Photograph	Filename (XXX – vehicle number)
	General Vehicle Photographs	
☑	1- Front.	XXX-01-front-general.jpg
☑	2- Left Side.	XXX-02-left-general.jpg
☑	3- Rear.	XXX-03-rear-general.jpg
☑	4- Right side.	XXX-04-right-general.jpg
☑	5- Underside of hood.	XXX-05-under-hood.jpg
	Engine Compartment	
☑	6- From left side.	XXX-06-engine-left.jpg
☑	7- From front.	XXX-07-engine-front.jpg
☑	8- From Right.	XXX-08-engine-right.jpg
☑	9- Connection to fuel injection unit.	XXX-09-fuel-line-injector-1.jpg
☑	10- Connection to fuel injection unit.	XXX-10-fuel-line-injector-2.jpg
	Fuel Filler Door and Cap	
☑	11- Filler door closed.	XXX-11-filler-closed.jpg
☑	12- Filler door opened.	XXX-12-filler-open.jpg
☑	13- Filler cap outside.	XXX-13-cap-open.jpg
☑	14- Filler cap inside.	XXX-14-cap-underside.jpg
	Vehicle Underside	
☑	15- Full from front.	XXX-15-full-under-front.jpg
☑	16- Full from front left side.	XXX-16-full-under-front-left.jpg

Check	Photograph	Filename (XXX – vehicle number)
☑	17- Full from rear left.	XXX-17-full-under-rear-left.jpg
☑	18- Full from rear.	XXX-18-full-under-rear.jpg
☑	19- Full from rear right.	XXX-19-full-under-rear-right.jpg
☑	20- Full from right side.	XXX-20-full-under-right.jpg
☑	21- Front from directly underneath.	XXX-21-front_under.jpg
☑	22- Mid front, directly underneath.	XXX-22-front-mid-under.jpg
☑	23- Mid rear, directly underneath.	XXX-23-rear-mid-under.jpg
☑	24- Rear from directly underneath.	XXX-24-rear-under.jpg
	Fuel Tank and Surroundings	
☑	25- Front of tank.	XXX-25-tank-front.jpg
☑	26- Left side.	XXX-26-tank-left.jpg
☑	27- Rear of tank	XXX-27-tank-rear.jpg
☑	28- Right side.	XXX-28-tank-right.jpg
☑	29- Full tank and surroundings from directly underneath.	XXX-29-tank-under.jpg
	Fuel Line Routing	
☑	30- Fuel line at tank.	XXX-30-fuel-line-tank.jpg
☑	31- Routing photo 1.	XXX-31-fuel-line-routing-1.jpg
☑	32- Routing photo 2.	XXX-32-fuel-line-routing-2.jpg
☑	33- Routing Photo 3.	XXX-33-fuel-line-routing-3.jpg
☑	34- Fuel line at engine.	XXX-34-fuel-line-engine.jpg
☑	35- Connection to filter.	XXX-35-fuel-line-filter.jpg
☑	36- Filler tube from underside.	XXX-36-filler-tube-underside.jpg
☑	37-Filler tube from side.	XXX-37-filler-tube-side.jpg

6. FUEL TANK COMPONENTS

No.	Description	OEM Part Number
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
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19		
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21		
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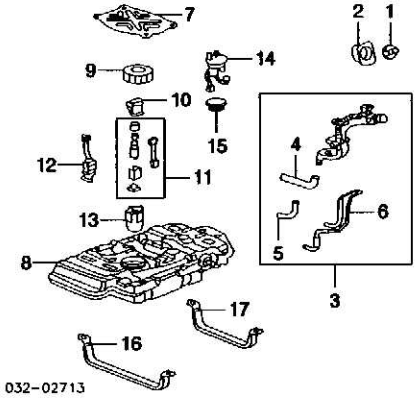
23		
24		
25		
26		
27		
28		
29		

See attached

APPENDIX A

DETAIL
IS NOT
VISIBLE

FUEL TANK



R&I Fuel Tank			1.0	
NOTE: R&I/R&R Does Not include drain fuel.				
1 Cap, Fuel			17670-SV1-A01	$14.71
2 Gskt, Fuel Filler	99		17662-S50-003	$13.62
	00-02		17662-S50-013	$14.19
3 Pipe Assy, Fuel Filler	99		17650-S0X-A01	$375.90
	00		17650-S0X-A02	$424.72
	01		17650-S0X-A52	$384.26
	02		17650-S0X-A52	$384.26
4 Hose, Filler¶			17651-S0X-A02	$179.94
5 Tube, Breather¶			17658-S0X-A01	$24.57
6 Tube, Vent¶	99		17657-S0X-A01	$15.52
	00		17657-S0X-A02	$29.39
	01-02		17657-S0X-A51	$100.07
¶Included w/Fuel Filler Pipe Assy				
7 Cover, Maintenance			74660-S0X-A00	$7.25
8 Tank, Fuel	99-0(#1.3		17500-S0X-A01	$932.36
	01-02 #1.3		17500-S0X-A51	$536.55
#Includes R&R Fuel Pump & Sender				
9 Cap, Fuel Pump			17719-S1A-E01	$6.62
10 Filter, Fuel	99-00		16010-S0X-A00	$61.65
	01		16010-S0X-A01	$36.60
	02		16010-S0X-A02	$36.60
11 Pump, Fuel	99-01	1.3	17040-S0X-A00	$644.16
	02	1.3	17040-S0X-A30	$654.55
12 Sender, Fuel	99-01	1.3	17630-S0X-A02	$101.50
	02	1.3	17630-S0X-A03	$101.50
13 Reservoir			17706-S0X-A01	$58.39
14 Flange	99-00		17709-S0X-A01	$129.50
	01-02		17709-S0X-A02	$159.58
15 Gasket, Base			17574-S1A-E01	$12.78
16 Band, Mounting Front (2)			17521-S0X-A01	$43.36
17 Band, Mounting Rear			17522-S0X-A01	$43.36

2002 Honda Odyssey EX Navi Passenger Van