

AEROSPACE RECOMMENDED PRACTICE

SAE ARP5818

Issued 2003-10
Reaffirmed 2011-11

Design and Operation of Aircraft Refueling Tanker Vehicles

1. SCOPE:

This document is a guideline for the design of an Aviation Aircraft Refueling and Defueling Tanker Vehicle and for the materials and components used thereon. The criteria set forth herein are the minimum recommendations and are limited to aircraft refueling vehicles for airport operations with operating fuel pressures and flow rates as specified within this document.

2. REFERENCES:

The latest bulletins, publications, documents, and regulations listed in this paragraph are applicable documents that form a part of this document to the extent specified herein.

2.1 API Publications:

Available from American Petroleum Institute, 1220 L Street, Northwest, Washington, DC 20005.

API STD 1529 Aviation Fueling Hose

API/IP STD 1542 Identification Markings For Dedicated Aviation Fuel Manufacturing And Distribution Facilities, Airport Storage And Mobile Fueling Equipment

API/IP SPEC 1581 Specifications And Qualification Procedures For Aviation Jet Fuel Filter/Separators

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2011 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
http://www.sae.org

SAE WEB ADDRESS:

**SAE values your input. To provide feedback
on this Technical Report, please visit
<http://www.sae.org/technical/standards/ARP5818>**

SAE ARP5818

2.1 (Continued):

API/IP SPEC 1582 Similarity For API/IP 1581 Aviation Jet Fuel Filter/Separators

API/IP SPEC 1583 Specification And Qualification Procedures For Aviation Fuel Filter Monitors With Absorbent Type Elements

API/IP SPEC 1584: Four-Inch Hydrant System Components And Arrangements

2.2 ASTM Standards:

Available from American Society For Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

ASTM D 910 Standard Specification for Aviation Gasolines

ASTM D 1655 Standard Specification for Aviation Turbine Fuels

ASTM D 4865 Standard Guide for Generation and Dissipation of Static Electricity in Petroleum Fuel Systems

ASTM D 6615 Standard Specification for Jet B Wide-Cut Aviation Turbine Fuels

2.3 ATA Publications:

Available from Air Transport Association, Engineering, and Maintenance Division, 1709 New York Avenue, Northwest, Washington, DC 20006-5206.

ATA Specification 103 Standards for Jet Fuel Quality Control at Airports

2.4 IP Publications:

Available from The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR, England.

API/IP Specification 1582 Specification for Similarity for API/IP 1581 Aviation Jet Fuel Filter/Separators

API/IP Specification 1583 Specifications and Qualification Procedures - Aviation Fuel Filter Monitors with Absorbent Type Elements

SAE ARP5818

2.5 Joint Inspection Group Publications:

To be supplied with Purchase Specifications if compliance with this Publication is required.

JIG 1 Guidelines for Aviation Fuel Quality and Operating Procedures for Joint into Plane Fueling Services

2.6 NFPA Publications:

Available from the National Fire Protection Association, 1 Batterymarch Park, Quincy MA 02269-9101.

NFPA 10 Standard for Portable Fire Extinguishers

NFPA 70 National Electrical Code

NFPA 385 Tank Vehicles for Flammable and Combustible Liquids

NFPA 407 Standards for Aircraft Fuel Servicing

2.7 SAE Publications:

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AIR1375 General Requirements for Aerospace Special Purpose Airline Ground Support Equipment

AIR4782 Hydrant Valve and Coupler Historical Background

AIR4783 Glossary of Terms - Aircraft Refueling

AIR4929 Aircraft Refueling Pressure Surge Creation and Limitation

AIR4974 Guidelines for Aircraft Hydrant Servicers

ARP1247 General Requirements for Aerospace Ground Support Equipment, Motorized and Non-motorized

ARP1328 Aircraft Ground Support Equipment Vehicle Stability Analysis

ARP1330 Welding of Structures for Ground Support Equipment

SAE ARP5818

2.7 (Continued):

ARP5918 Standardized Test Criteria For Aircraft Refueling

AS5877 Detailed Specification for Aircraft Pressure Refueling Nozzle

SAE Handbook

2.8 TTMA Recommended Practices/Requirements:

Available from Truck Trailer Manufacturers Association, 1020 Princess Street, Alexandria, VA 22314.

TTMA Recommended Practice RP #98-99 Cargo Tank To Truck Chassis Attachment

TTMA Recommended Practice RP #59-99 Tank Trailer Ladders and Walkways

2.9 United States - Code of Federal Regulations (CFR):

Available from the United States Government Printing Office, Washington, DC 20402.

Transportation (DOT) 49 CFR 173, 177, 178, 180, 383, 390, 393, 571

Labor (OSHA) 29 CFR 1910

2.10 Local Requirements:

Available from the local State, Municipality, Governmental Unit, Local Agency, or Airport Owner or Operator's office as required by the Vehicle Purchase Specifications.

3. DEFINITIONS:

3.1 Definitions for terms used in this document are defined in AIR4783. Other terms as used in this document shall be defined as follows.

3.2 Cab-Chassis OEM:

The original equipment manufacturer of the cab-chassis.

SAE ARP5818

3.3 Tanker Vehicle OEM:

The original equipment manufacturer of the tanker vehicle and identified as the final-stage vehicle manufacturer.

3.4 Vehicle Purchase Specifications:

The vehicle specifications as stipulated by the purchaser outlining the minimum equipment, capabilities, and operating requirements for the tanker vehicle.

4. DESIGN CRITERIA:

4.1 General:

- 4.1.1 Every effort is to be taken by the Tanker Vehicle OEM to assure that the principles of engineering and ergonomics are designed into the functional controls of the vehicles. Systems on the vehicle shall incorporate the use of fail safe design.
- 4.1.2 The vehicle shall be designed and manufactured so that it operates with no undue stresses or abnormal wear on any components or structure of the vehicle. The Tanker Vehicle OEM shall be responsible to design and manufacture these vehicles so that they meet these requirements and all others as mandated or required by 49CFR, NFPA 407, API/IP, ATA, EN, and all other requirements that apply to construction, operation, and maintenance of aircraft refueling tanker vehicles. The Tanker Vehicle OEM shall be responsible to provide the vehicles with all components, equipment, and items required to place the vehicles in service and to perform the aircraft refueling and/or defueling function(s). These specifications establish the minimum requirements for the vehicle. Additional specification requirements for the vehicle shall be specified by the Vehicle Purchase Specifications. The Tanker Vehicle OEM shall be responsible to design, manufacture, and certify that the vehicle is in compliance with these specifications, and that all other component(s), function(s), and/or system(s), including those specifically specified by the Vehicle Purchase Specifications, provide safety, reliability, and a fail-safe operation.

4.2 Vehicle Driveability and Maneuverability:

- 4.2.1 The vehicle shall be able to traverse all roadways and areas at the airport, as specified by the Vehicle Purchase Specifications, necessary to service aircraft in a normal manner, without disruption of other vehicular or aircraft operational traffic.

4.3 Vehicle Operational Capabilities:

- 4.3.1 Capability requirements shall be as specified by the Vehicle Purchase Specifications.

SAE ARP5818

4.4 Welding:

- 4.4.1 All welding of pressure containing components of the tanker, except those listed in the next paragraph, shall be performed using procedures, processes and welders (operators) certified in accordance with the ASME Boiler and Pressure Vessel Code, Section IX or other comparable national code for the country of origin. All materials shall meet the requirements of Section II, Part A (for ferrous materials), Part B (for non-ferrous), and Part C (for welding materials).
- 4.4.2 Any filter vessels, accumulators, surge tanks, fuel recovery vessels, or fuel containers that operate above 15 psig shall be manufactured per the ASME Section IIIV - Division 1, Rules for Construction of Pressure Vessels.
- 4.4.3 All welding of piping systems shall be in accordance with ANSI B31 code.
- 4.4.4 All structural welding on the vehicle not addressed by the DOT 406 tank assembly code or ANSI B31 code for piping assembly shall be performed in accordance with applicable AISC, ANSI, and AWS codes, or other comparable national codes for the country of origin.

4.5 Materials of Construction:

- 4.5.1 All materials in contact with the fuel and not specified elsewhere in this document shall be corrosion resistant and shall not be adversely affected by or affect the fuel. All components and piping downstream of the filtration system shall be of aluminum or stainless steel. All material in contact with the fuel shall also be free of cadmium, copper, lead, or zinc. Brass components shall be minimized but accepted in hose couplings/hose reducers and drain valves. Copper components will be minimized but accepted in drain lines that render the product as sump fuel. Non-metallic materials shall not affect or be adversely affected by the fuel under any operating conditions specified for the equipment.

4.6 Design/Operating Pressure and Flow Rating:

- 4.6.1 The aircraft tanker vehicle may be any size tanker that operates on a self-contained pumping system that has a maximum operating pumping pressure of 125 psig and a maximum fueling flow capacity as designated by the Tanker Vehicle OEM. The vehicle shall have the operating pressure and flow ratings as established by the Tanker Vehicle OEM. These ratings shall be the maximum allowable operating pressure and flow rate that the vehicle system is to operate in during any aircraft refueling operation.

NOTE: This document does NOT address tanker systems with operating pressure above 125 psi although many of the paragraphs can be used as a guideline.

SAE ARP5818

4.7 Delivery Flow Rate And Pressures:

- 4.7.1 The aircraft tanker vehicle shall perform the aircraft refueling operation by delivering fuel at the maximum delivery flow rate and pressure(s) required by the Vehicle Purchase Specifications.

4.8 Design Features:

- 4.8.1 The construction of the complete vehicle and all of its systems shall be of new current production materials and components.
- 4.8.2 All systems shall be designed to allow quick and efficient operation of the vehicle. Pneumatic, electrical, hydraulic, and other systems shall be operational within an ambient temperature range between -20 °F and 120 °F, unless a wider range is specified by the Vehicle Purchase Specifications.
- 4.8.3 All fueling system piping, components, and hoses shall be designed to assure that the maximum fuel flow velocity does not exceed the following limits. The maximum fuel flow velocity through components shall be based on the component's nominal size.
 - a. When the aircraft tanker vehicle dispenses Jet Fuel Without SDA (Static Dissipating Additive), the piping and components shall be selected and designed to assure the maximum fuel flow velocity does not exceed 23 feet per second.
 - b. When the aircraft tanker vehicle dispenses Jet Fuel With SDA (Static Dissipating Additive), the piping shall be selected and designed to assure the maximum fuel flow velocity does not exceed 31 feet per second.
- 4.8.4 All fueling hoses shall be designed to assure the maximum fuel flow velocity does not exceed 31 feet per second.
- 4.8.5 The system shall be designed to provide a minimum of 3 seconds relaxation time from the outlet of the last filter vessel to any dispensing nozzles, when SDA is not used.
- 4.8.6 The fueling system shall be designed with a provision that automatically prevents any air from being drawn into any part of the fueling system between the product tank's internal valve(s) and/or any other point that is upstream of the fueling hose(s). This provision shall specifically address any of the following operations:
 - a. Dispensing fuel to a point where the complete product tank is emptied and the fueling system continues to be operated.
 - b. During defueling if air is either drawn in, or pumped in (via the aircraft pumps), through the defueling hoses.
 - c. Any other possible operation that may introduce any air into the fueling system.

SAE ARP5818

4.8.7 All parts of the vehicle and auxiliary equipment shall be easily accessible for inspection, operation, and maintenance.

4.8.8 Any components which may require maintenance or repair shall be readily removable and replaceable without requiring cutting or welding.

4.9 Factor of Safety:

4.9.1 All structural members including attachment of major components shall be designed in accordance with safety factors of four (4) unless otherwise specified.

5. ACCEPTANCE CRITERIA:

5.1 Product Tank Hydrostatic Test:

5.1.1 The product tank shall be hydrostatically tested in accordance with 49 CFR 178.345 and 178.346.

5.2 Fueling System Hydrostatic Test:

5.2.1 The complete fueling system including all piping, components, welded assemblies, etc. handling the product shall be hydrostatically tested. The test shall be performed at a hydrostatic pressure of $1\frac{1}{2}$ times the maximum design working pressure experienced by any portion of the system. Pressure loss during a fifteen (15) minute period shall not exceed 5 psig, and no additional pressure loss shall be permitted in constant pressure, temperature, and volume conditions. No visible leakage shall be permitted.

NOTE: When equipment is designed to permit "In Place Hose Testing," the hose isolation valve and all components down stream must be rated to withstand the design working pressure of the hose.

6. EQUIPMENT INSPECTION AND QUALITY CONTROL:

6.1 Conformance To Specification:

6.1.1 The Tanker Vehicle OEM shall be responsible to demonstrate that the vehicle is designed and manufactured in accordance with all applicable requirements and the Vehicle Purchase Specifications.

6.2 Workmanship Standards:

6.2.1 The workmanship shall be in accordance with ARP1247.

SAE ARP5818

6.3 Quality Control:

- 6.3.1 The Tanker Vehicle OEM shall be responsible for assuring Quality Control of his suppliers and shall arrange for the required tests, certifications, and for the test location and all equipment required for testing.
- 6.3.2 The Tanker Vehicle OEM shall be responsible to demonstrate compliance with these requirements, all others referenced by these requirements, and all requirements specified by the Purchase Vehicle Specifications.
- 6.3.3 The Tanker Vehicle OEM shall have a test plan covering all tests required by these requirements, all others referenced by these requirements, and all requirements specified by the Purchase Vehicle Specifications. All such tests shall be performed and documented in a vehicle test and certificates booklet.
- 6.3.4 The vehicle shall be fully tested to check its operation and performance, and include the following tests as further detailed in ARP5918:
 - a. Vehicle laden and unladen total weight and weight distribution checked on a certified scale.
 - b. Vehicle driveability and maneuverability to include service braking, parking brakes, top speed, and turning diameter.
 - c. Power Take-Off system operation.
 - d. Product pumping, fueling, and defueling system operation and performance.
 - e. Interlock system operation.
 - f. Bottom-loading system.
 - g. Other tests as required by these specifications, tests required by the referenced documents, and all tests as specified by the Vehicle Purchase Specifications.

6.4 Sample Visual Inspection Report:

- 6.4.1 See ARP5918 for a sample of a typical New Vehicle Inspection Report.

SAE ARP5818

6.5 Performance Testing:

6.5.1 The Tanker Vehicle OEM must have a test facility capable of conducting the required testing to demonstrate the proper performance, safe operation of the equipment and to allow adjustment of all controls prior to delivery. As a minimum, the following capabilities must be on-hand at the Tanker Vehicle OEM's production facility.

- a. Dynamic flow test equipment capable of flows and pressures at least 125% of the equipment's specifications with appropriate tank bottom loading equipment, nozzle connections, pressure and flow controls and instrumentation, filling the tank, dispensing from nozzles, and to perform defueling operations. The fluid used for all system tests shall be ASTM certified Jet A, kerosene or other petroleum fluid as required by Vehicle Purchase Specifications. Filtration and water removal must be provided as part of the test loop to prevent gross contamination of the tanker's equipment.
- b. Test gauges and flow meters shall be calibrated in accordance with NIST and US Weights and Measures requirements and/or other national or local standard.
- c. Timers, electronic transducers and readouts/recorders calibrated as above for measuring surge pressures during quick valve closures.
- d. Quick closing valve system capable of being controlled to a measureable 2 seconds or faster closure at the maximum rate of flow specified for the equipment to prove specified surge control compliance.

6.5.2 Critical components and the complete vehicle must demonstrate compliance to the Vehicle Purchase Specifications and the testing criteria. (See ARP5918 for a sample of a typical New Tanker Functional Test Report.)

6.6 Minimum Performance Test Criteria:

- a. Vehicle performance with fixed or lift platform in accordance with ARP1247.
- b. Weight distribution per 6.4.
- c. Under-body clearance in accordance with NFPA 407.
- d. Interlock system operation per Section 44.
- e. Emergency Shutoff control operation per Section 46.
- f. Deadman control operation per Section 45.
- g. Filter-Separator water defense system in accordance with ATA 103.

SAE ARP5818

6.6 (Continued):

- h. Pressure regulation, flow control, and shutdown surge control per Section 35.
- i. Primary and secondary pressure control per Section 34.
- j. Verify operation of all dial type gauges to operate within $\pm 2\%$ of scale psi unless otherwise indicated.
- k. Verify meter operations and calibration in accordance with Section 38.

6.7 Equipment Reliability:

- 6.7.1 The vehicle shall meet the reliability requirement in accordance with the latest edition of ARP1247.

6.8 Maintainability:

6.8.1 Standard Components:

- 6.8.1.1 Wherever possible, commercially available standard parts complying with commercial standards shall be used.

6.8.2 Interchangeability:

- 6.8.2.1 All components, assemblies, and sub-assemblies used in the construction of the tanker shall be designed and manufactured to dimensional tolerances which permit interchangeability and will facilitate replacement of parts.

6.8.3 Availability Of Spare Parts:

- 6.8.3.1 The Tanker Vehicle OEM shall manufacture the vehicle with components for which spare parts required to support the vehicle are readily available for a minimum period of ten (10) years from the date of manufacture.

6.8.4 Accessibility:

- 6.8.4.1 Components and/or systems requiring routine or frequent inspections or maintenance shall be readily accessible.
- 6.8.4.2 The vehicle shall be of open construction, and no excessive non-structural paneling shall be used.
- 6.8.4.3 Major assemblies shall be easily disconnected and removed from the vehicle without the necessity for extensive disassembly of other components. Flange and/or grooved type pipe connections shall be permitted.

SAE ARP5818

6.8.5 Warranty:

- 6.8.5.1 The Tanker Vehicle OEM shall guarantee the complete vehicle against any defect in design, workmanship, material, and against any failure to operate satisfactorily for a minimum period of one (1) year, and shall provide the same guarantee for the product tank for a minimum period of five (5) years. The guarantees shall begin on the date the vehicle is placed in service. Should the service date be more than 60 days from the delivery date and the delay is of no fault of the Tanker Vehicle OEM, the operator will be required to request, in writing, an extension. The warranty period extension will be granted at the Tanker Vehicle OEM's option.

7. VEHICLE DESIGN:

- 7.1 The tanker vehicle shall be designed and manufactured to meet all requirements specified in the 49 CFR, NFPA 407, ATA 103, and ARP1247 latest revision, and all the requirements specified in this ARP (except part 565 of 49 CFR (Vehicle Identification Number Requirements) for off-highway utility-type vehicles). Any requirement not specified in this ARP shall be required as specified in the referenced documents. In the event of conflicts between this ARP and any of the referenced documents, this ARP shall be the governing requirement, unless otherwise stated herein.
- 7.2 The tanker vehicle shall have a cab-chassis with the proper Gross Vehicle Weight Rating (GVWR), Gross Combination Weight Rating (GCWR), Front Gross Axle Weight Rating (Front GAWR), and Rear Gross Axle Weight Rating (Rear GAWR), as rated for the application at the maximum governed speed. The vehicle's laden weight shall not exceed the GVWR, GCWR, or the front and rear GAWRs. The cab-chassis shall meet all other requirements set forth within this document.
- 7.3 The cab-chassis shall be selected with the proper wheelbase and chassis rated components. The rating of all components or systems shall be taken as the rating certified by the Cab-Chassis OEM. The wheelbase and chassis components shall be selected so that the cab-chassis is operated within the GVWR and GCWR ratings and the GAWR for each axle, as established by the Cab-Chassis OEM, while operating in the most severe conditions. The severe conditions shall be established by the Vehicle Purchase Specifications.

SAE ARP5818

7.4 The vehicle shall have the weight distribution and its Center Of Gravity (CG) as follows:

- a. Straight Type Vehicles: the vehicle's laden or unladen weight shall be distributed 25% to 50% on the front axle(s) and 75% to 50% on the rear drive axle(s).
- b. Tractor/Semi-Trailer and Combination Type Vehicles: the vehicle's laden or unladen combination weight shall be distributed 50% to 70% on the tractor and 50% to 30% on the trailer, and the tractor's laden or unladen weight shall be distributed 25% to 40% on the front axle(s) and 75% to 60% on the rear drive axle(s).
- c. The location of the center of gravity (CG) of the laden or unladen vehicle shall be a minimum of 24 inches forward from the centerline of the vehicle's rear drive axle(s) under all conditions of loadings.
- d. Combination vehicles that operate as a tank truck pulling a full trailer shall be designed so that the gross vehicle weight (GVW) of the laden trailer does not exceed 50% of the gross combination weight (GCW) in any operating condition.

8. CAB-CHASSIS:

- 8.1 The tanker vehicle shall have either a commercially available standard production cab-chassis, or a cab-chassis specifically designed for low-speed, high volume, aircraft refueling operation. Specialty vehicles must be manufactured by a reputable Cab-Chassis OEM, having both sufficient engineering qualifications and production capabilities. The former shall meet all latest applicable federal regulations, including the applicable Federal Motor Vehicle Safety Standards (FMVSS) and all Motor Carrier Safety Regulations (MC-DOT); the latter also shall meet the above criteria, except those not applicable do to vehicles with GVWR ratings far higher than those that may be legally operated on public highways even with special permits.
- 8.2 The cab-chassis shall have the appropriate axle configuration for its design and all other components required for the vehicle to comply with all applicable federal and local regulations. The cab-chassis shall have the minimum capacity that satisfies the vehicle's laden operating requirements. The vehicle's operating requirements shall be established by the Vehicle Purchase Specifications, that shall specify the minimum equipment capabilities, and operating requirements for the tanker vehicle as required for the operation. The refueling capability specified shall be based on the Vehicle Purchase Specifications and type of aircraft that are to be refueled, and shall be within the scope of this document. The cab-chassis shall be selected so that all operating parameters shall be considered to provide optimum vehicle operation and maximum vehicle reliability.

SAE ARP5818

9. ENGINE:

- 9.1 The vehicle engine shall be of the 4-cycle internal combustion gasoline or diesel type engine, or powered by other type of alternatively fueled engine that meets the latest EPA Regulations for the production model year and NFPA requirements for aircraft refueling vehicle application. The engine shall be properly sized with the transmission, providing a properly rated power train system with all other necessary components. The vehicle's power train and components shall be selected so that the vehicle is capable of maintaining a minimum speed of 5 mph on a 10% grade at the laden GVWR and GCWR. The Tanker Vehicle OEM shall certify that the power train is rated to meet all the performance requirements of the vehicle.
- 9.2 The vehicle top speed shall be limited to a maximum speed of 20 mph unless a higher top speed is specified by the Vehicle Purchase Specifications. When the vehicle top speed cannot be limited by selection of the proper rear axle ratio and tire size, the engine governor and/or throttle system shall be properly modified to limit the vehicle's top speed. The modification shall not limit or restrict the operation of the vehicle in any manner other than to limit the vehicle's top speed.
- 9.3 The vehicle engine shall be installed in an engine compartment that provides considerable protection from weather and possible product spills. Any part of the engine that is exposed to possible product spills shall be covered with a removable aluminum or stainless steel cover. The cover shall be designed and configured so that the engine will have proper ventilation and to divert any product fuel that leaks or spills away from the engine, transmission, and any of its components.
- 9.4 The engine governor, throttle, ignition, and starting system shall be equipped with all Cab-Chassis OEM required components. Any modifications to the system shall be engineered, performed, and certified by the Tanker Vehicle OEM. All modifications shall not adversely alter or affect the operation of the vehicle.
- 9.5 The engine shall be equipped with all components, shields, accessories, and systems required to provide reliable vehicle operation in severe conditions as established by the Vehicle Purchase Specifications. All engine system controls, monitors, and indicators shall be installed in the cab on the dash, and ready for operation or observation by the driver.

SAE ARP5818

9.6 The engine shall be equipped with the following minimum features:

- a. Engine manufacturer's recommended lubrication and cooling system.
- b. Engine oil filters: full flow, spin on type.
- c. The engine shall be serviced with a 50/50 mix of permanent type (ethylene glycol) antifreeze and water.
- d. EPDM or Silicone coolant hoses (for radiator and heater). A coolant spin-on filter is/are recommended for extended service.
- e. Fuel System:
 - Fuel filter system: Spin-On type
 - Diesel Engine shall be equipped with a filter/water separator with drain valve. A heated unit is recommended for cold temperature climates.
- f. Engine Starter:
 - The engine shall be equipped with a heavy duty electric starter as required by the Cab-Chassis OEM. The engine may be equipped with an air starter when required by the Vehicle Purchase Specifications and available from either the Cab-Chassis OEM or the Tanker Vehicle OEM.
- g. Cold Starting Aid:
 - Cab-Chassis OEM standard production recommended cold starting aid(s) for the vehicle to properly operate in ambient temperature and weather conditions as specified by the Vehicle Purchase Specifications.

SAE ARP5818

9.6 (Continued):

- h. Controls, Monitors, And Indicators: The engine shall be equipped with the following minimum controls, monitors, and indicators:
1. On/Off/Start ignition switch
 2. Engine temperature gauge or indicator light
 3. Engine oil pressure gauge or indicator light
 4. Engine hour-meter
 5. Engine tachometer
 6. Air filter restriction indicator for engines larger than 165 HP
 7. Engine speed governor
 8. Diesel engines or when required by the Vehicle Purchase Specifications, engine shutdown system with override, and visual and audible alarm for low oil pressure and high coolant temperature. The engine shutdown system with an automatic override is recommended.
 9. Controls, monitors, and indicators shall be installed for ease of operation, and they shall be properly labeled and ready observation by the driver.

10. ENGINE EXHAUST:

- 10.1 The engine exhaust system shall be configured so that it is not exposed to leaks of grease, oil, vehicle fuel, or product. The engine exhaust system shall be equipped with a muffler and a spark arrestor or a spark arresting type muffler.
- 10.2 The complete exhaust system shall be properly sized for the engine as required by the Cab-Chassis OEM and engine manufacturer. The exhaust shall discharge down and opposite of the driver's side of the vehicle.

11. ENGINE NOISE:

- 11.1 The vehicle engine shall conform to applicable federal, state, and local noise level codes. The sound level of the engine in the cab shall not exceed 85 dB(A).

SAE ARP5818

12. TRANSMISSION AND DRIVESHAFT:

12.1 The transmission shall be a multi-speed transmission properly rated for the maximum net input horsepower and torque. Sized with the engine, providing a power-train system with all other necessary components that meet the requirements specified in Section 8. The Transmission shall be rated to meet the performance requirements for the GVWR and GCWR of the laden vehicle.

12.2 The transmission and driveshaft shall be equipped with the following minimum features:

- a. Neutral safety switch for starter
- b. All driveshaft bolts shall have locking tabs, safety wire, or other bolt securing system
- c. If the vehicle is equipped with an automatic transmission, it shall be equipped with the following minimum features:
 1. Transmission oil cooler for continuous operation of the vehicle
 2. Transmission fluid filter: transmission manufacturer's standard production
 3. Illumination for gear selector segment
 4. Transmission shall be equipped with the proper lock-up as required for the pumping system

12.3 Any part of the transmission that is exposed to possible product leaks shall be covered with a removable aluminum or stainless steel cover. If the transmission is equipped with open electrical connections, the connections shall be either vapor proof or the electrical connections shall be sealed and covered with the above cover. The cover shall be designed and configured to divert any product fuel that leaks or spills away from the engine, transmission, and any of their components.

12.4 The vehicle shall be provided with neutral safety switch. The safety switch shall prevent the engine from being started, unless the transmission selector is either in neutral or park.

12.5 It is strongly recommended that the Vehicle Purchase Specification require that the transmission have a shift inhibitor provided which prevents the transmission from being shifted from neutral to any drive gear unless the vehicle is fully stopped and the service brakes applied.

12.6 A backup alarm shall be installed at the rear of the vehicle. The backup alarm shall be activated whenever the transmission is placed in reverse. The backup alarm shall be an SAE J994, Type B vehicle backup alarm.

SAE ARP5818

13. POWER TAKE-OFF (PTO):

13.1 Transmission and Engine PTO:

- 13.1.1 The PTO and pumping system shall be properly designed and rated so that the system operates in accordance with the PTO and Pump manufacturer's recommendations. All driveshafts shall have at least two universal joints and one slip-type joint. All driveshafts and joints shall be designed and installed to operate within the respective manufacturer's recommendations. All hydrostatic and hydraulic systems shall be designed and operate in accordance with the requirements specified in Section 49.
- 13.1.2 The Tanker Vehicle OEM shall be responsible for selecting properly rated components to power the product pump and operate the system within the performance criteria for the service requirements. The PTO system shall be capable of handling ample power required to pump at the design flow and pressure out of the product pump at an ambient temperature of -20 °F. The PTO system shall be connected into the vehicle's brake interlock system. The PTO engagement system shall be designed as a fail-safe system, and operate so that the PTO does not shift unless the vehicle is stopped and the transmission gear selector is in the park or neutral position. The system shall be equipped with indicator lights to show when the PTO system is engaged. When a split-shaft PTO/Pump is utilized, two indicator lights shall be provided to show when the PTO system is engaged (Pump Mode) or disengaged (Road Mode).

14. STEERING:

- 14.1 The vehicle shall be equipped with an integral hydraulic power assisted or hydrostatic steering system. Vehicle that will be operated above 25 mph will be equipped with a system that shall revert to manual mode in the event of the power assist failure. The power assist system shall be the Cab-Chassis OEM installed system only. Add-on or after market kits are not acceptable.
- 14.2 The power assist steering system shall be easily operated by being capable of turning the steering wheel lock to lock with one hand with the vehicle stopped on hard surface pavement, and engine idling with laden vehicle.

15. BRAKES:

- 15.1 The vehicle shall be equipped with full service and parking brake systems that meet the performance requirements of current federal and local requirements. The service brakes shall be air spring set or hydraulic dual system with power assist.
- 15.2 The vehicles shall be equipped with a brake interlock system as described in Section 44. The brake interlock system shall operate in a manner so that it applies the vehicle's brakes and prevents the vehicle from movement when it is activated.

SAE ARP5818

- 15.3 In case of emergency, the brake interlock system shall have a provision to override the interlock system and allow the brakes to be released. The interlock override control shall be located on the front left side of the vehicle above the bumper or in another specific location as specified by the Vehicle Purchase Specifications. When the brake interlock override system is activated it shall allow the driver to release the vehicle brakes from inside the cab, operating the same cab-chassis brake release control as provided by the Cab-Chassis OEM.
- 15.4 The braking system shall be equipped with all Cab-Chassis OEM required components and systems. Any modifications to the brake system to install the interlock system shall only be engineered, performed, and certified by the Tanker Vehicle OEM. All brake system controls, monitors, and indicators shall be installed in the cab on the dash, and ready for operation and observation by the driver.
- 15.5 The braking system shall have the following minimum components, and with the air system components only utilized on air brake system vehicles:
- Disc, Wedge or S-Cam brakes
 - Non-asbestos brake pads or linings
 - Automatic slack adjusters for drum brakes
 - Air compressor: Shall have a minimum capacity that meets the following minimum requirement, whichever is greater:
 - Nominal capacity of 12 CFM
 - Sufficient capacity to provide a maximum recovery time, in seconds, determined by the results of the following formula: $(\text{Actual Reservoir Capacity} \times 25) / (\text{Required Reservoir Capacity})$, to increase the cab-chassis air system (no auxiliary air system) from 85 psi to 100 psi, when the engine is operating at the Cab-Chassis OEM maximum recommended RPM.
 - Alcohol evaporator is recommended if vehicle is to operate in cold climate conditions where ambient temperatures reach 20 °F or lower for any period of time.
 - Air tank drain valves on each air tank: cable operated type
 - Automatic moisture ejector drain valve for the wet air tank in addition to the drain valve required in paragraph 14.5F.
 - Adjustable governor and system-relief valve

SAE ARP5818

15.5 (Continued):

- i. Air dryer: Equipped with heater for vehicles operating in cold climate conditions
- j. Air pressure gauge with visual and audible alarm
- k. Low air pressure warning
- l. Mechanical release provision for spring parking brakes

15.6 The compressor air intake shall be connected to a properly sized air intake with an air cleaner. The compressor shall be properly cooled and lubricated by the engine lubrication system. A governor shall be provided that unloads the compressor when the air pressure reaches 120 psi and cuts-in the compressor when the pressure reaches 100 psi. The required quantity of air reservoirs to provide a minimum capacity of 12 times the total brake chamber volume at maximum stroke shall be provided. The air tanks shall be furnished with all required air brake system components. All air tanks shall be equipped with manual cable operated drain valve that are easily activated for draining moisture from the tanks.

15.7 An auxiliary compressed air system shall be provided for operating the fueling equipment on the vehicle. The system shall include the minimum components as described in Section 47. The auxiliary air system shall be connected to the cab-chassis' air brake system reservoir through a regulating valve that will assure that the cab-chassis brake system has 65 psi before the auxiliary air system is charged. The air line that supplies air to the auxiliary air system shall be a minimum size of 1/2-inch ID and it shall be of SAE rated air brake hose.

15.8 When the engine is equipped with an air starter, the air supply shall be provided from the auxiliary system. The air system starter circuit shall be equipped with all components required by the starter manufacturer to assure reliable operation in all ambient conditions.

16. FRONT AXLE AND SUSPENSION:

16.1 The vehicle shall be equipped with front axle(s) and suspension system properly rated to provide a satisfactory Vehicle Front GAWR. The GAWR shall be determined and set by the lowest rated capacity of the tires, brakes, wheels, suspension, and axle. The vehicle's Front GAWR shall not be less than the vehicle's front laden weight.

16.2 The vehicle shall be provided with the proper capacity wheel and tire assemblies. Split side 2-piece ring type wheels are not permitted. The vehicle's front tires shall be of highway tread design tires. The tires shall provide positive traction in driving and turning while operating in the most severe conditions, as established by the Vehicle Purchase Specifications.

SAE ARP5818

17. REAR AXLE AND SUSPENSION:

- 17.1 The vehicle shall be equipped with rear axle(s) and suspension system properly rated to provide a satisfactory vehicle Rear GAWR. The GAWR shall be determined and set by the lowest rated capacity of the tires, brakes, wheels, suspension, and axle. The vehicle's Rear GAWR shall not be less than the vehicle's rear laden weight.
- 17.2 The vehicle's rear axle ratio and tires size shall be properly selected to provide the vehicle's top speed. When the vehicle top speed cannot be limited by selection of the proper rear axle ratio and tire size, the engine governor and/or throttle system shall be properly modified to limit the top speed as specified in 8.2.
- 17.3 The vehicle shall be provided with the proper capacity wheel and tire assemblies. Split side 2-piece ring type wheels are not permitted. The vehicle's rear tires shall be of highway or snow/mud tread design tires. The tires shall provide positive traction in driving and turning while operating in the most severe conditions, as established by the Vehicle Purchase Specifications.

18. FRAME:

- 18.1 The vehicle shall be equipped with a chassis frame of suitable strength and rigidity to allow the vehicle to operate properly at the rated GVWR.
- 18.2 The frame shall be properly selected to have the proper Yield Strength (YS), Section Modulus (SM), and Resistance Bending Moment (RBM) for the tanker vehicle application. The frame shall be selected through an engineered process developing a shear and bending moment diagram and using a minimum safety factor of four (4), calculated in static conditions and based on frame yield strength and at maximum loading conditions.
- 18.3 The frame shall be a continuous formed steel channel, or a continuous miscellaneous (Ship and Car) type channel with minimum physical properties of ASTM A 36. Where frame extensions are required, they shall be connected to the frame at a minimum distance of 12 inches behind the rear spring hanger bracket and have an overlapping inner frame reinforcement of the proper length, engineered to support all loading conditions with the required safety factor. The required section modulus shall not be obtained by the use of fish plating; however, the use of inverted "L", inner, or outer channels to obtain the required section modulus shall be permitted.

SAE ARP5818

18.4 The tank and all fueling equipment shall be equipped with their own framework. The tank's and fueling equipment framework assembly shall be installed directly to the chassis' and secured with assembly brackets engineered for the tanker vehicle application by the Tanker Vehicle OEM. The tank shall have a wood, rubber, other high density plastic sill installed between the tank and chassis'. The sill shall be secured to the tank with proper retaining and securing devices designed for the installation. When the fueling equipment framework is an integral part of the tank, it shall be equipped with all brackets, reinforcements, and gussets to provide a structurally sound design and be in compliance with DOT 406 requirements. All bolts, nuts, and washers where used to assemble all components to the chassis frame or tank shall be a minimum of SAE grade 5.

18.5 The wheelbase of the cab-chassis shall only be altered if permitted by the cab-chassis OEM and performed as per the cab-chassis OEM requirements. If the wheelbase of the cab-chassis is altered, the alteration shall include all cab-chassis OEM components. The cab-chassis' frame shall not be altered between the front and rear axles. Any alterations performed to any part of the cab-chassis shall be made in accordance with the cab-chassis OEM with the recommended crossmembers and grade of fasteners.

19. CAB:

19.1 The vehicle shall be equipped with a fully enclosed cab conforming to current applicable federal and state requirements.

19.2 The cab-chassis shall be equipped with all exterior lights, indicators, and reflectors conforming to the latest federal and local requirements.

19.3 The cab shall be equipped with all components, controls, monitors, and indicators as required by the Cab-Chassis and Tanker Vehicle OEM's.

19.4 The cab entrance floor or step shall not exceed a height of 16 inches from the ground. All steps shall have a non-skid surface. When the vehicle is equipped with a step for access into the cab, a cab entrance assist handle shall be provided.

19.5 All cab windows shall be safety glass type windows that meet FMVSS requirements.

19.6 Side view mirrors shall be provided on each side of the vehicle to provide a full view of the full tank width from the driver's position. Additional convex mirrors shall be provided so that the driver has a complete view of each side of the vehicle.

20. CAB-CHASSIS ELECTRICAL SYSTEM:

20.1 The vehicle shall be equipped with an integral electrical system consisting of battery, alternator, starter, wiring harness, and all other necessary electrical components, devices, and systems.

20.2 The vehicle's electrical system shall have a negative ground and a nominal system of 12 VDC or greater.

SAE ARP5818

- 20.3 Vehicle electric starter motor cables shall be sized in accordance to SAE No. J541, Voltage Drop for Starting Motor Circuits.
- 20.4 The vehicle shall be equipped with an engine driven alternator which shall provide all required electrical power demands to maintain battery charge. The alternator shall be selected for high output at engine idle speed. The alternator output shall be rated in accordance to SAE No. J56.
- 20.5 All cab-chassis electrical circuits shall have properly rated fusible links, fuses, or circuit breaker protection, except for starting and ignition.
- 20.6 All cab-chassis wiring shall be in accordance to SAE No. J1292 Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring.
- 20.7 All wiring installed by the Tanker Vehicle OEM shall be performed in accordance to the requirements specified in Section 48.

21. BATTERY:

- 21.1 The vehicle shall be equipped with the required capacity of battery power. The battery capacity and number of batteries required shall be selected by the tanker vehicle OEM and capable of delivering ample electrical power required when operating the vehicle and refueling aircraft in a 24 hour continuous operation. The battery shall have the minimum capacity as required by the Cab-Chassis OEM.
- 21.2 The battery(ies) shall have a nominal voltage of 12 VDC or greater, and be rated in Cold Cranking Amps (CCA) in accordance to SAE No. J537 at 0 °F (-18 °C), Storage Batteries.
- 21.3 The batteries shall be installed in a suitable location readily accessible for checking and replacement. The batteries shall be protected from external splashing by a suitably vented cover and be in accordance with NFPA 407.
- 21.4 The batteries shall be properly installed in accordance to SAE No. J538, Grounding of Storage Batteries and SAE No. J541, Voltage Drop for Starting Motor Circuits.
- 21.5 A battery disconnect switch, properly rated, shall be installed at a location as close as possible to the battery enclosure. The battery disconnect switch shall be readily accessible on the driver side on the exterior of the vehicle, and be properly labeled.

22. VEHICLE FUEL TANK:

- 22.1 The vehicle shall be equipped with a properly sized fuel tank available from the Cab-Chassis OEM, and selected to satisfy the Vehicle Purchase Specification. The tank fill and cap shall be easily accessible for filling. When required, the tank may be equipped with a strainer. The filler neck and tubing routing shall accept fuel at a minimum flow rate of 10 GPM without back splash.

SAE ARP5818

22.2 When the engine is a diesel engine, the tank filler neck if exposed shall have a minimum 4-inch by 4-inch square around the fill area painted green. A permanent green label with white lettering approximately one and one-half (1½) inches high stating "DIESEL FUEL ONLY" shall be installed as close as practical to the fuel tank fill.

22.3 When the engine is a gasoline engine, the tank filler neck if exposed shall have a minimum 4-inch by 4-inch square around the fill area painted red. A permanent red label with white lettering approximately one and one-half (1½) inches high stating "GASOLINE FUEL ONLY" shall be installed as close as practical to the fuel tank fill.

22.4 The fuel filler cap shall have a retainer or safety chain to prevent loss. The safety chain shall not be welded, riveted, or bolted to the tank.

23. ACCESSORIES:

23.1 Front and Rear Bumpers:

23.1.1 The vehicle shall be equipped with a front and rear bumper directly installed and reinforced to the chassis frame. The front bumper shall be the full width of the cab and the rear bumper shall be the full width of the body. The bumpers shall meet all DOT 406, Federal, and local requirements.

23.2 Driveshaft Guards:

23.2.1 All driveshafts shall be equipped with driveshaft guards positioned to capture the driveshaft in all directions in the event of any driveshaft failure. The spacing between the U-bolt or bracket and the driveshaft at the bottom, top, and sides shall be approximately 2 inches.

23.3 Fenders:

23.3.1 All wheels shall be equipped with fenders to retain road splash. The rear fenders shall be capable of supporting all applied loads.

23.4 Mud Flaps:

23.4.1 The vehicle shall be equipped with mud flaps on each fender as required to comply with all DOT, Federal and local requirements.

23.5 Tow Hooks: Optional

23.5.1 As an option, the vehicle may be equipped with one (1) or two (2) tow hooks at the front and/or the rear of the vehicle. The tow hooks shall be bolted directly to the frame rails.

SAE ARP5818

24. PRODUCT TANK:

- 24.1 The tank shall have a nominal capacity and material as specified in the Vehicle Purchase Specifications. The actual capacity of the tank shall be determined by the Tanker Vehicle OEM. The tank shall have a capacity so that the vehicle is capable of dispensing a minimum of 98% of the nominal capacity of the tank with a full tank while having the additional capacity required for fuel expansion and for tank sump area allowances. The tank shall be constructed throughout of ASTM Aluminum or 300-Series Stainless Steel material as specified by the Vehicle Purchase Specifications. The product tank shall be designed and manufactured by an FHWA Registered Cargo Tank Manufacturer and have a DOT 406 specification plate affixed to the tank in the prescribed location. The tank shall also be tested to the DOT 406 requirements and a certificate of compliance shall be provided certifying that the tank meets all the latest DOT 406 construction and test requirements. Documents of all tests and certificates of compliance shall be documented in the vehicle test and certificates booklet. The tank shall have a warranty to operate satisfactorily without any leaks for a minimum period of five (5) years, from the time the vehicle is placed in-service.
- 24.2 The product tank bottom shall have a trough(s) or other design configuration to provide the required sump area to collect water and have a low point draw off to allow cleaning of the low point of the trough. Each trough shall have a minimum size of 4 inches wide and be of proper length practical for the size and configuration tank. The tank bottom with the troughs shall provide a minimum transverse slope of one-in-ten at the bottom of all compartment(s). The bottom of each trough shall be provided with an internal type drain valve that will fully drain each compartment. The tank bottom with the trough shall be designed and constructed so that it meets all DOT 406 requirements.
- 24.3 A strapping chart measured in 1/4-inch increments shall be furnished and provided in the manuals.
- 24.4 If the tank is installed on a chassis, the tank shall be properly installed on the chassis frame according to the TTMA RP # 98-99.
- 24.5 The tank interiors shall be clean and free of scale, rust, weld spatter, welding debris, and water, and shall be flushed with the proper ASTM clean fuel.

SAE ARP5818

25. PRODUCT TANK MANHOLES:

25.1 The tank shall be equipped with the following minimum number of hinged manhole openings located at the longitudinal center of the tank:

- a. Tanks with a nominal capacity of 1,500 gallons or less shall have a minimum of one (1) manhole opening. The manhole opening shall be located at the longitudinal center of the tank.
- b. Tanks with a nominal capacity between 1,501 and 5,000 gallons shall have a minimum of two (2) manhole openings. The manhole openings shall be located at the longitudinal center of the tank and in alternate cavities.
- c. Tanks with a nominal capacity of 5,001 gallons or greater shall have a minimum of three (3) manhole openings. The manhole openings shall be located the longitudinal center of the tank, one at each end of the tank and one at the center of the tank. The tank shall also have a minimum of one manhole opening in every other cavity.

25.2 A manhole opening with a hinged cover shall also be located approximately above the internal valve. In addition, the tank shall be equipped with a minimum of one (1) manhole opening per every two (2) tank sections, equipped with blank covers. All manhole openings shall be located at the top center of the tank section and be not less than 20 inches in diameter. Hinged manhole covers shall be of the same material as the product tank. Blank manhole covers shall be stainless steel.

25.3 The hinged manhole covers shall meet the latest 49CFR178.346 and NFPA 407 requirements. The cover shall be installed so that the hinges are located at the forward end of the vehicle, so that the covers close when the vehicle moves forward. The manhole assembly shall be 300-series stainless steel, not less than 20 inches in diameter, with 10 inch diameter hinged fill covers of the self latching type. The manhole cover(s) and vents shall not be obstructed and they shall conform to the latest DOT 406 tank requirements.

25.4 All manhole cover gaskets shall be of a material approved for use with aviation fuels. All vents shall be equipped with fire screens.

26. PRODUCT TANK ROLLOVER PROTECTION:

26.1 The top of the tank shall have structural rollover protection rails of proper height and configuration. The top of the rollover structure shall have a minimum clearance of 1 inch above the highest point of any component installed on the top of the tank. The rollover protection structure shall be designed to fully protect the tank, manhole covers, vents, and all other components installed on the top of the tank from damage in the event the vehicle overturns. The rollover rails shall be fabricated so that the vehicle is in full compliance with DOT 406 requirements.

SAE ARP5818

- 26.2 A 1½ inch minimum size transparent (clear) drain line shall be provided on the bottom corners on each side of the rollover protection, at the front and rear sections, to drain liquids from the center of the rollover sections. Each line shall run from the top to approximately 6-inches below the frame rails and direct run-off away from all vehicle components. All drain lines shall be properly secured.
- 26.3 All walkways shall meet the requirements of TTMA RP #59. All walkway areas between the manhole covers shall have anti-skid material. Any area on the walkway shall be capable of supporting a 450 pound load without experiencing any permanent deformation. All open edges shall be ground smooth and there shall be minimum projections.
27. PRODUCT TANK TOP ACCESS LADDER:
- 27.1 A permanent ladder that is in full compliance with OSHA TTMA RP #59 requirements shall be provided for access to the top of the tank, in an accessible location. The ladder shall have flexible type joints if installed on the chassis to relieve flexing stress between the chassis and the tank.
- 27.2 The ladder shall be of a heavy duty construction with the required supports. If required, a stirrup step shall be bolted so that the first step is not more than 16 inches above the ground.
- 27.3 Grab-handles shall be provided on the top of the tank and a handrail on each side of the ladder. The grab-handles on the top of the tank shall be continuous with the handrails on the ladder to provide safety of ascent and descent.
28. PRODUCT TANK INTERNAL VALVES AND VENT VALVES:
- 28.1 Internal Valves:
- 28.1.1 The tank shall be equipped with internal valve(s) that meet all 49CFR178.346 and NFPA 407 requirements. Valves shall be sized to adequately provide the product supply to the pump. All internal valves and their components, including brackets, supports, hardware, etc., shall be stainless steel or aluminum. The internal valve(s) shall be properly sized and have the flow characteristics required for the proper performance of the pumping system during all conditions of fueling and defueling operations, as recommended by the pump manufacturer.
- 28.1.2 The internal valve shall be equipped with a bolt-on vortex breaker located inside the tank that properly handles all flow conditions. The vortex breaker shall be easily removable.
- 28.1.3 The tank shall have properly sized bottom product loading and discharge pipe(s) to properly load and off load the product through the internal valve(s). It is recommended that the Purchased Specification require the product discharge pipe have a low point sump installed at its lowest point with a drain valve. The bottom loading system shall meet the requirements specified in Section 29.

SAE ARP5818

28.1.4 The tank product loading and discharge pipe(s) shall be equipped with a maintenance shutoff valve to isolate the tank from the fueling system. A readily accessible maintenance valve shall be installed in the discharge pipe to isolate the tank from the fueling system.

28.1.5 The operating handle or operating circuit of all internal valves shall be equipped with a fusible link or plug that closes the valves in the event of a fire.

28.1.6 All internal valves and their components shall be properly protected and arranged so that they can be serviced and easily removed.

28.2 Vent Valves:

28.2.1 To provide adequate venting of the product tank, the tank shall be equipped with normal vent valve(s), independent of the vents on manhole covers, and shall meet all 49CFR178.346 and NFPA 407 requirements. All vent valves and their components, including brackets, supports, hardware, etc., shall be stainless steel or aluminum. The vent valve(s) shall be properly sized and have the flow characteristics required for the proper operation of the tank during all fueling, defueling, and filling operations, as recommended by the tank manufacturer. All normal vents shall be designed so that they are protected from the weather and vent to the rear of the vehicle. The exits of the vent(s) shall be equipped with a fitting to install a pressure/vacuum gauge to periodically test the vent(s) for proper operation and/or blockages. The exits of all vents shall be equipped with a screen.

28.2.2 All vents shall be equipped with a fire screen to control flame propagation.

28.2.3 The operating circuit of all vent valves shall be equipped with a fusible link or plug that closes the valves in the event of a fire. When the vent valve is mechanically operated with the internal valve, only the internal valve may be equipped with the fusible link or plug.

28.2.4 All vent valves shall be equipped with a sealed cover that protects the valve and prevents water from rain or snow to collect on the top of the valve.

28.2.5 All vent valves and their components shall be properly protected and arranged so that they can be serviced and easily removed.

28.3 Operation Of Internal Valves And Vent Valves:

28.4 The vent valve(s) shall be operationally interlocked so that the internal valve(s) do not open until all vent valves are first opened. This sequencing operation shall occur when the vehicle is set to perform the fueling, defueling, or bottom loading operation.

SAE ARP5818

- 28.5 The internal valve(s) shall have a minimum capability of pumping the product out or filling the tank during the bottom loading operation at a minimum rate that is 10% higher than the rated flow rate of the vehicle, with the liquid level in all sections of the tank remaining at an equal height.
- 28.6 The internal valves shall be located in the tank so that their seat opening is raised above the bottom of the tank to provide the tank sump area required to trap water. The tank sump area shall be a minimum of 0.5% of the tank's nominal capacity.

29. PRODUCT TANK SUMP DRAIN SYSTEM:

- 29.1 All tank and piping sumps shall be fitted with an internal water drain system consisting of a 1 inch remotely operated drain valve. The valve shall be equipped with a coarse stainless steel screen on the inside of the sump. The valves shall be designed with a spring loaded positive shut-off system, so that the valve will self-close. The valve(s) shall automatically close when the actuating device is released. The tank drainage system shall be designed, assembled, and operate so that it meets all requirements specified in 49CFR178.346. All drain lines shall be a minimum of 14 inches above the ground.
- 29.2 The sump drain valve(s) shall be connected to $\frac{3}{4}$ inch discharge ball valves with metallic tubing. The discharge valve handles shall not be less than three inches long. Each discharge shall be fitted with a brass street elbow facing down with a one inch diameter by three inch long brass pipe nipple, and equipped with a one inch male quick-connecting end and a chained cap. The discharge ball valves shall be grouped together in an accessible location, protected against accidental operation or damage by external objects, and properly labeled. Each compartment and valve assembly shall be arranged so that no water pockets can form.

30. BOTTOM LOADING SYSTEM:

- 30.1 The vehicle shall be equipped with a bottom loading system with adapter(s) as specified in the Vehicle Purchase Specification. A properly sized isolation valve shall be installed in the product loading pipe just ahead of each adapter. Each bottom loading adapter shall be equipped with a protective cap. The bottom loading system shall be capable of loading the product tank at the rate as specified in the Vehicle Purchase Specifications.
- 30.2 The bottom loading adapter(s) shall be located in an accessible area and be protected. Both the mounting height and the downward angle of the connection should permit ease of connection by the operator without undue back strain to the operator.
- 30.3 The bottom loading system shall be equipped with a high level shut-off system that senses the level in the center of the tank. The high level shut-off system shall be connected to shut-off the internal valve. If required by the Vehicle Purchase Specifications, it shall also shut-off the vehicle loading rack. All sense lines shall be neatly run and securely clamped to the bulkheads or baffles.

SAE ARP5818

- 30.4 Where a fuel operated high-level system is used, a drain line from the high-level sensor collector can(s) shall be plumbed to the bottom of the tank to reduce a possible hazard due to static electric discharge.
- 30.5 Unless a continuous self checking system is used, the high level shutdown system shall be equipped with a pre-check system to check that the system properly operates. If the pre-check system is operated by fuel, the pre-check system shall be equipped with a filter or strainer, fuel pressure gauge, and manually operated control located near the bottom loading connection(s).
- 30.6 The bottom loading system shall be equipped with an interlock system that automatically applies the parking brakes when any loading hose is connected to the vehicle. If a fueling rack shutdown system is used, the rack shall shutdown before the on-board system. The interlock system shall also remain activated unless the fueling rack system is disconnected from the vehicle.
- 30.7 It is recommended that the Purchase Specification require a secondary redundant overfill control system be incorporated in the bottom load equipment.

31. EQUIPMENT CABINETS:

- 31.1 Equipment cabinet(s) or modular framework assemblies shall be provided on the vehicle to support all components. Construction shall be of a heavy duty structural design, capable of supporting all required components, with all necessary cross members, diagonals, gussets, brackets, and mounting plates. All enclosures or splash plates or shields shall be provided to protect the components.
- 31.2 All cabinets or modules shall be properly installed and located so that they provide the best maintenance accessibility to all components. The location of all equipment cabinets or modules shall also be selected to achieve the proper vehicle weight distribution. A minimum of 12 inches ground clearance at all points shall be maintained with a laden vehicle. All lighting necessary for night time fueling operation will be provided

32. TRAILER PRODUCT TANKS:

- 32.1 Tanker vehicles with a design configuration that utilizes a semi-trailer, full-trailer, or any combination tanker vehicles with multiple trailers shall comply with the minimum requirements as stipulated within this ARP, and shall also be designed, manufactured, and tested to operate in accordance with 49CFR, DOT 406 requirements, and also be in compliance with ARP1247 latest revisions.
- 32.2 Trailer Frame:
- 32.2.1 The trailer shall be equipped with the required framework to provide the proper structural support to withstand both vertical and side loads in all operating conditions.

SAE ARP5818

32.3 Trailer Axle(s) And Suspension:

32.3.1 The trailer shall be equipped with axle(s) and suspension system properly rated to provide a satisfactory GAWR. The GAWR shall be determined and set by the lowest rated capacity of the tires, brakes, wheels, suspension, and axle. All trailer axle and suspension systems shall have a rating as established by the axle and suspension manufacturer(s), and installed as per manufacturer's recommendations. Modifications or retrofits to upgrade the axles or suspensions are not permitted. The trailer axle(s) GAWR shall be established by the axle and suspension manufacturer. The trailer axle's GAWR shall not be less than the axle weight with laden vehicle. Each trailer axle shall be properly located so that the vehicle will have a satisfactory weight distribution in all conditions of payload loading.

32.3.2 The trailer shall be provided with the proper capacity wheel and tire assemblies. Split side 2-piece ring type wheels are not permitted.

32.4 Fifth Wheel(s) And Multiple Trailer Combinations:

32.4.1 The tractor shall be equipped with a heavy duty fifth wheel that is properly rated for the required service, and properly installed as per manufacturer's recommendations. All friction areas shall be equipped with grease fittings and automatic greasing systems. The fifth wheel shall be properly located to satisfy the laden and unladen vehicle weight distribution. The fifth wheel release lever shall be designed so that it can be locked in the latched position with bolt(s) and nut(s).

32.4.2 The trailer shall be equipped with an upper steel fifth wheel plate that has a minimum thickness of 5/8 inch, and equipped with the proper king pin. The plate shall be fastened with bolts to a heavy duty frame that evenly distributes all loads to the trailer framework.

32.4.3 Where the vehicle is equipped with a liquid fifth wheel coupler, it shall have a suitable roller bearing assembly and meet all requirements of 32.4.1 and 32.4.2.

32.5 Trailer Landing Gear:

32.5.1 The semi-trailer shall be provided with either an attached or a readily attachable two-speed hand cranked heavy duty jack stand landing gear capable of supporting the tank when empty. The jack stand shall be equipped with skid feet, each having a minimum of 150 square inches. The jack stand shall be properly braced with heavy duty steel cross brace supports.

32.5.2 As an alternative to 32.5.1, the semi-trailer may be provided with a trailer stand device that is easily used and capable of supporting the tank when it is fully loaded, and provided by Tanker Vehicle OEM.

SAE ARP5818

32.6 Tractor-Trailer Air Supply System:

32.6.1 The tractor-trailer shall be equipped with a complete air system as required by the latest applicable federal regulations, including the Federal Motor Vehicle Safety Standards and Motor Carrier Safety Regulations.

33. FUEL DELIVERY SYSTEM:

33.1 Pumping System Design:

33.1.1 The Tanker Vehicle OEM shall design a fail-safe operating pumping system that is driven by an enclosed engine or transmission mounted PTO assembly, a driveline mounted split-shaft PTO/product pumping assembly, or a hydraulically driven product pump capable of meeting the flow rate and required pressure, as specified in the Vehicle Purchase Specification. Systems requiring belts or open gear assemblies shall not be utilized. The system design and operation shall be in compliance with ARP1247 (latest revision). The fueling system shall be designed so that when the vehicle is dispensing fuel (refueling) all fuel is pumped through the filter-separator and/or filter-monitor vessel(s) and then through the meter. When the vehicle is defueling, all fuel shall be pumped through the meter. If the fuel flows through the filter-separator and/or filter-monitor vessel(s) when defueling, the fuel flow shall be in the same direction as when fueling and shall not be reversed at any time.

33.2 Engine Or Transmission PTO Pumping Systems:

33.2.1 The engine or transmission PTO pumping systems design shall utilize a properly rated PTO with a direct coupled or driveline driven product pump for the required design application.

33.3 Split-shaft PTO/Product Pumping System:

33.3.1 The split-shaft PTO/Product pumping system design shall utilize a split shaft driven, self priming centrifugal product pump with a heavy duty gear box for the required design application.

33.4 Hydraulically Driven Pumping Systems:

33.4.1 The hydraulically driven product pumping system design shall utilize a properly rated hydraulic system that drives the product pump for the required design application.

SAE ARP5818

- 33.4.2 All components to activate and transmit power from the truck chassis powertrain to the PTO that drives the product pump shall be installed per the component manufacturer's recommendations. The pumping system shall be installed to operate as per PTO, hydraulic system, and pump manufacturer's recommendations. Vehicles equipped with automatic transmission shall have the pumping system operate through the neutral safety switch, to assure that the pump is engaged only when the transmission is in neutral or park. The system shall be designed to operate the power take-off, drive shaft, or hydraulic system with activating and deactivating components that use an interlock system to assure that the system operates in a fail-safe manner and within the rating of all components.
- 33.4.3 The PTO shall power the product pump through a proper sequencing actuating system. The PTO system actuation shall operate to insure that the vehicle is completely stopped before the system shifts into the pump mode or road mode, and that the interlock system is activated. The system shall also be properly interlocked to function smooth and as described in Section 44. The actuating system shall be fully designed to function in a fail-safe manner under all conditions. The control to activate the pumping system shall be installed in the cab in a location convenient for the driver's control. An optional indicator light may be installed in the cab near the control and a second indicator light shall be installed on the control panel.
- 33.5 Product Pump Piping:
- 33.5.1 The piping system assembled to the pump shall be designed and installed so that it complies with all of the pump manufacturer's recommended requirements. All connections to the pump or through bulkheads shall be made using machined grooved or flange type couplings.
- 33.5.2 The piping system shall be designed with pipes and swivel joint assemblies to provide maximum flexibility and necessary movement between the cab-chassis, the tank, and the equipment. The piping shall incorporate all requirements of 49CFR178.346 and NFPA 407.
- 33.5.3 The pump installation and piping design shall take into consideration component stress; vertical, horizontal, and torsional loads; flotation; lubrication; maintainability; appropriate bracketing to secure the piping and components properly; and facilitate the easy removal and installation of pipe sections and other components.
- 33.6 Miscellaneous Product Tanks:
- 33.6.1 Any accumulators, surge tanks, fuel recovery vessels, or fuel containers that operate above 15 psig shall be in compliance and manufactured per the ASME or DOT 406 code as applicable.

SAE ARP5818

33.7 Alternate Fuel Delivery Pumping System:

33.7.1 If the Tanker Vehicle OEM designs and manufactures an alternate fuel delivery system, it shall comply with all requirements of this ARP that are applicable to system design, manufacture, operation, performance, and maintainability.

33.8 Fueling And Defueling System Piping And Fittings:

33.8.1 All piping and fittings shall be aluminum or stainless steel, and have a minimum working pressure rating of 125 psi.

33.9 Product Piping:

33.9.1 All product piping shall be either aluminum or stainless steel.

33.9.2 Aluminum alloy seamless piping shall be a minimum of schedule 10 and be in accordance with ASTM B 241 and B 210 or other Nations applicable codes.

33.9.3 Stainless Steel piping shall be 300-series, be a minimum of schedule 5, and be full finished, annealed, and pickled in accordance with ASTM A 312.

33.10 Product Fittings:

33.10.1 All product fittings shall be either aluminum or stainless steel.

33.10.2 Aluminum fittings shall be a minimum of schedule 10, and be seamless wrought aluminum belled-end or butt-welded end fittings manufactured in accordance with ASTM B 361, dimensional tolerances in accordance with ANSI B16.9.

33.10.3 Stainless steel fittings shall be 300-series, be a minimum of schedule 5, and be full finished, annealed, and pickled stainless steel belled-end fittings or butt-welded manufactured in accordance with ASTM A 403. Dimensional tolerances shall be in accordance with ANSI B16.9.

33.11 Swivels (Swing Joints):

33.11.1 All swivels, except for hose end swivels and nozzle swivels, shall be completely fabricated from aluminum or stainless steel and have roller or double row ball bearings. The swivels shall have a minimum concentric rotational tolerance of ± 0.050 inches between the ends of the mating parts unless a smaller tolerance is required to assure proper rotation of the joints, so that they operate without leakage or undue wear through their normal service cycle. The swivels shall be greaseless, have sealed permanent lubed bearings, or have a sealed bearing chamber with a grease a port to install a grease fitting, be rated for aviation fuels, and be rated for the working pressure of the tanker fueling system. All swivels shall have the grease fittings removed and plugged before the vehicle is placed in-service.

SAE ARP5818

33.12 Fuel Filtration System:

- 33.12.1 The fueling system shall be equipped with a filter-separator and/or a filter-monitor vessel(s) as specified in the Vehicle Purchase Specifications. The filter-separator vessel shall be designed, manufactured, and qualified in accordance with the latest requirements of the American Petroleum Institute/Institute of Petroleum (API/IP) SPEC 1581. The filter-monitor vessel shall be designed, manufactured, and qualified in accordance with the latest requirements of API/IP SPEC 1583. Each filtration system shall be rated by the filter manufacturer for the maximum flow rate and working pressure of the tanker fueling system. The filter vessel shall be designed and labeled in accordance with the ASME code for unfired pressure vessels (Section VIII) or other codes applicable in the country of use. Filter separator and monitor vessels rated at 100 GPM or less do not need to meet the ASME code.
- 33.12.2 The filter vessel shall be equipped with a manual water/sump drain valve with a spring return handle that renders the valve normally closed. This valve must be stainless steel, aluminum, or brass and a minimum of ½ inch nominal size on vessels rated at 50 gpm or less and ¾ inch nominal size on vessels rated greater than 50 gpm.
- 33.12.3 Each filter vessel shall be equipped with an automatic air eliminator and relief valve sized in accordance with the filter manufacturers' recommendations. The air eliminator shall be piped to the tank and fitted with a maximum of 1 psi check valve. All lines and components that handle the product shall comply with the requirements of 33.9.
- 33.12.4 The filter vessel may, if required by the Vehicle Purchase Specifications or regulatory authority, be equipped with an interlock system to prevent operation of the filter assembly without a complete set of elements installed.
- 33.12.5 The filter vessel shall be installed on the tanker and the system designed to operate so that reverse flow through the filter cannot occur.
- 33.12.6 The filter-separator vessel shall be fitted with an Automatic Water Defense System in accordance with ATA 103.
- 33.12.7 All filter vessels shall be equipped with a vacuum breaker or similar device installed at the top to facilitate draining and servicing.

34. PRESSURE REGULATION AND FLOW CONTROL:

- 34.1 The fueling system shall be equipped with a dual pressure control system, designated as a primary and secondary pressure regulation and flow limiting control system. Avgas tanker vehicles may have a single pressure control system.
- 34.2 The Flow Limiting Control system shall ensure that the fueling system does not exceed the fueling system's design capacity.

SAE ARP5818

- 34.3 The dual pressure control system shall insure that the aircraft fuel loading manifold is limited to a maximum fueling pressure as specified in the Vehicle Purchase Specifications, but not exceed 50 psi. Under all operating conditions, peak surge pressure shall be limited to not exceed 120 psi. Two independent pressure regulating/control systems must be installed between the pump and the aircraft fueling adapter. When one venturi is used to provide sense pressure to two control valves, it shall have dual porting and twin sensing. For the purposes of this paragraph, fueling pressures shall be measured at a point directly downstream of the fueling nozzle(s).
- 34.4 The primary pressure control shall be set to independently control the fueling pressure and shall insure that the aircraft fuel loading manifold is limited to a maximum fueling pressure as specified in the Vehicle Purchase Specifications, but not exceed 40 psig. The secondary pressure control shall be set to control the fueling pressure, if the primary control fails, and limit it to 50 psig. The primary and secondary fueling pressures may be set at other pressure limits if specified by the Vehicle Purchase Specifications. The pressure control system shall also limit the fueling pressure at the nozzle to a maximum peak surge pressure of 120 psig during a complete aircraft fueling valve(s) closure made in a maximum timeframe of 2 seconds. The fueling pressure shall be the actual pressure measured at the nozzle's pressure gauge connection.
- 34.5 The primary and secondary pressure control systems shall be provided and independently operate. These pressure control system shall consist of consist of a pump by-pass control valve, in-line control valve, and/or hose end pressure control valve. These valves may be alternately set to operate as primary and secondary controls.
- 34.6 Other than hose end pressure control valves, all other equipment listed shall have the fueling pressure sensed from a venturi or other form of a pressure compensator that consistently and repeatedly simulates the fueling pressure, and calibrated to indicate the actual pressure to within ± 2 psi when fueling at a manifold pressure of 30 psi and higher. The system shall meet the above requirements at all fueling pressure settings, and all flow conditions, ranging from 50 gpm to the maximum rated flow setting, both operating with either the primary or secondary system. Avgas tanker vehicles may only utilize a pump by-pass control system. The pressure and flow control systems shall operate in accordance with the pressures and flow setting as stipulated in ARP5918.

35. DEFUELING SYSTEM:

- 35.1 When required by the Vehicle Purchase Specifications, the vehicle shall be equipped with an aircraft defueling capability designed to allow the system to defuel an aircraft from any fueling hose connection(s).
- 35.2 The defueling system shall be equipped with a fuel/defuel valve(s), or an alternate system, and all other components as required so that the system is capable of defueling at a minimum rate as specified by the Vehicle Purchase Specifications. The fuel/defuel valve(s) shall have an external indicator showing that the system is in the fueling or defueling mode.

SAE ARP5818

36. PRODUCT LEVEL AND AIR INGESTING PREVENTION SHUTDOWN SYSTEM:

36.1 The vehicle shall be equipped with the following minimum product tank low level and high level shutdown systems, and a shutdown system that prevents air from being ingested into the fueling system.

36.1.1 The low level shutdown system shall shutdown the fueling system when the product reaches a level in the tank that can ingest air into the fueling system with the vehicle positioned at $\pm 5\%$ grade.

36.1.2 The high level shutdown system shall shutdown the tank's internal valve(s) as required by Section 30 when the product reaches the full level as required by Section 24 when the product tank is filled by bottom loading. If required by the Vehicle Purchase Specifications, the high level shutdown system may also be activated to shutdown the internal valve(s) when defueling.

36.1.3 The fueling system shall have a provision to shutdown the fueling system when air is sensed during defueling, and prevent any air from being ingested into any component located upstream of the defueling hose(s). The system shall assure that no air is introduced into the meter, filter-separator, or filter-monitor.

37. TANKER VEHICLE SYSTEM COMPONENTS AND SYSTEMS SELECTION AND UTILIZATION:

37.1 The Tanker Vehicle OEM shall be responsible for the selection of the available types of valves and design the complete system so that all components are utilized in accordance with each of the component manufacturer's recommendations and ratings, and provide the performance requirements as called for herein. The Tanker Vehicle OEM designer must be aware of the interactions between the various types of valves that will affect total system performance as well as the capabilities and limitations of each valve type.

38. PRODUCT FLOW METERS:

38.1 Unless a smaller accuracy and repeatability are required by the Vehicle Purchase Specifications, the meter shall be calibrated to operate with the following minimum accuracy and repeatability requirements.

38.1.1 The meter shall be calibrated to an accuracy of $\pm 0.1\%$ when operating throughout the flow range from 10% to 100% of rated flow and $\pm 0.2\%$ when operating throughout the flow range from 5% to 10% of rated flow. The meter shall also have a repeatability of $\pm 0.05\%$ when operating throughout the flow range from 5% to 100% of rated flow.

38.1.2 If an electronic meter with multi-point calibrations is required by the Vehicle Purchase Specifications, the meter shall be calibrated to an accuracy of $\pm 0.05\%$ when operating throughout the flow range from 5% to 100% of rated flow. The meter shall also have a repeatability of $\pm 0.05\%$ when operating throughout the flow range from 5% to 100% of rated flow.

SAE ARP5818

38.1.3 A greater accuracy and repeatability may be provided if required by the Vehicle Purchase Specifications.

38.2 Product flow meters shall be located downstream of the filtration system.

38.3 Product flow meters may be equipped with the following optional accessories:

- Printers with date, zero-start, accumulative, I.D. number, ticket type
- Mass Readout
- Rate of Flow Indicators
- Temperature Compensation
- Large Numeral Registers showing whole U.S. gallons, dekaliters, or liters
- Pulsers for a remote readout
- Electronic read-out

39. HOSE REELS:

39.1 Construction:

39.1.1 Drums, discs and frames should be designed and constructed to handle the required amount of hose filled with fuel through the full range of design/working pressures. Drums should be roll-formed with full-length welds. Discs should have rolled edges and a concentric strengthening rib. Reinforced tie rods should be used to join the discs and drum. The discs should be of sufficient size (diameter) so that all of the hose of a given diameter and length is below the outer edge of the disc when rewound. Single or double wrap (Catherine) reels are acceptable.

39.2 Rewind Drives:

39.2.1 Manual Rewind Drives: A manual gear-driven crank rewind may be used on small reels.

SAE ARP5818

39.2.2 Powered Rewind Drives: A powered gear-driven crank rewind is recommended when the hose exceeds 2 inch ID diameter or 50 feet in length. It is highly recommended that powered rewind hose reels have an auxiliary manual rewind mechanism.

- a. Electric Rewind Drives: A chain and sprocket drive powered by a 12/24 volt DC explosion proof electric motor (NEC, Article 500, Class 1, Div. 1). Motors should have overload protection (in case of hose jamming). The motor shall be equipped with an explosion proof drain.
- b. Hydraulic/Pneumatic Rewind Drives: A chain and sprocket drive powered by a hydraulic motor. Hydraulic motors shall have a hydraulic relief valve (in case of hose jamming).
- c. Other Rewind Drives: All other type of powered rewind reels shall be rated for the application and equipped with all other components required to properly operate in all conditions of use.

39.3 Pipes And Fittings:

39.3.1 All pipes and fittings shall be made of either aluminum or stainless steel. The swivels shall not have any provisions to allow the installation of a grease fitting.

39.3.2 Inlet: The inlet shall have a ball and/or roller bearing swivel joint.

39.3.3 Outlet: The hub assembly, swivel, and outlet riser shall be easily accessible for disassembly. There shall be a minimum of 1 inch clearance between the outlet riser and the drum, and the outlet shall match the curve of the drum.

39.3.4 Minimum Reeling Diameter: The hose reel drum diameter shall comply with the minimum bend diameter of the hose as required by API Bulletin 1529.

39.3.5 Controls and Switches: All controls and switches for powered drive reels shall be of the vapor-proof sealed momentary (spring-loaded) type.

39.4 Other Features:

39.4.1 The reel should be automatically free-riding when the hose is being powered in/out.

39.4.2 The reel mechanism should incorporate a stop to prevent the last half turn of hose from being unwound.

39.4.3 Guards should be installed to enclose open chain, sprocket, and gear mechanisms.

SAE ARP5818

39.5 Options:

39.5.1 Hose guide rollers are recommended for easier hose handling and rewinding, and to protect the hose from chaffing. Non-metallic rollers and bearings must be constructed of static-dissipating material.

39.5.2 Chain clutch reduction units are recommended (when increased torque or reduced rewind speed are required) for large (greater than 39 inch disc diameter) reels are required.

40. INSTRUMENTATION AND OPERATOR CONTROLS:

40.1 Control Panel:

40.1.1 The control panel shall be on the fueling side of the vehicle, ~~at~~ of the truck cab, and installed next to the flow meter readout. It shall be well illuminated and shock mounted to isolate it from vehicle vibrations.

40.1.2 The control panel shall have the following gauges, instruments, controls, and indicators with the specified minimum requirements.

- a. Gauges: Gauges shall be liquid filled and have a minimum accuracy of 2% of full scale. Dial graduations shall be provided at least every 2% of full scale.
- b. Air Reference Pressure Gauge: 0 to 160 psi, 2 inch minimum diameter. One gauge shall be provided for each air set control valve.
- c. Fueling Pressure Gauge: 0 to 160 psi, 4 inch minimum diameter.
- d. Differential Pressure Gauge(s): Direct reading piston type with a range of 0 to 30 PSID. The gauge(s) shall have a spring loaded purge valve located in an accessible location and routed to the product tank or recovery tank. Gauges of this type shall be provided as follows:
 - Filter/Separator Vessel: The gauge shall be connected to read the differential pressure across the filter-separator.
 - Monitor Vessel: The gauge shall be connected to read the differential pressure across the inlet and outlet of the elements.
 - 3-Stage Filter-Separator-Monitor Vessel: Two separate differential pressure gauges shall be used. The first shall be connected to read the differential pressure across the coalescer elements and the second shall be connected to read the differential pressure across the inlet and outlet of the monitor elements.

SAE ARP5818

40.1.2 (Continued):

- e. Air System Pressure Gauge: 0 to 160 psi, 2 inch minimum diameter.
- f. Pump Output Pressure Gauge: 0 to 160 psi, 2 inch minimum diameter.
- g. Thermometer: As specified by the Vehicle Purchase Specifications.
- h. The Filter-Separator vessel water detection system shall be equipped with an amber water detection warning light, normally "On" when fueling, and "Off" when the water detection system is activated.
- i. Pump/PTO Light: Red, normally "On" when activated

40.2 Optional Digital Readout:

- 40.2.1 A digital readout system may be substituted for any of the above items. The readout shall be LED or other suitable high visibility digits designed to operate within the temperature parameters of the specification. Digital readout characters shall be a minimum of one inch high and day light visible. Night visibility can be accomplished by using either external or back lighting.

40.3 Control Panel Options:

- 40.3.1 Air System Pressure Regulators: Tamper-proof

41. IDENTIFICATIONS AND MARKINGS:

41.1 Operator's Controls:

- 41.1.1 All gauges and controls shall be properly labeled with either engraved plastic or anodized aluminum plates with a minimum of 3/8 inch letters and must be permanently attached. Printed labels shall not be used.

41.1.2 Product Flow Diagram and Operating Instructions

41.2 Equipment Labeling:

- 41.2.1 The fuel system main service points.
- 41.2.2 The filtration system, product tank sump, and all other draining points shall be labeled accordingly.
- 41.2.3 The indicator lights which show the interlock system status, including the interlock override, shall be labeled with instructions indicating what the light means, such as "Interlock System in Override".

SAE ARP5818

41.2.4 The "Sample Points" as outlined in Section 51 shall be individually labeled.

41.2.5 The "Emergency Shut-Off" shall be labeled in accordance with 46.5.

41.2.6 A line flow diagram, with the maximum flow rate of the vehicle shall be provided on or adjacent to the Operator's Panel.

41.3 Electrical System Equipment:

41.3.1 The master battery shut-off switch shall be located as close as possible to the batteries and labeled "Battery Shut-Off."

41.4 Labeling

41.4.1 The vehicle shall be equipped with all required labels in accordance with 49CFR, ATA 103 and NFPA 407, and include the following minimum labels.

41.4.2 The name of the service company operating the vehicle and the name of the owner of the vehicle. The name of the service company shall be in a minimum of 6 inch high lettering marked on each side of the vehicle. The owner of the vehicle shall be in a minimum of 3 inch high lettering marked on the driver side of the vehicle.

41.4.3 The "Product" being dispensed, such as "JET-A", shall be prominently labeled on both sides, front, and rear of the vehicle. The letters shall be a minimum of 3 inches high and with the proper designation for the product handled. All labeling shall be in accordance with API 1542.

41.4.4 The air tank drain actuator(s) shall be labeled "Air Tank Drain(s)" and "Drain Daily."

41.4.5 "NO SMOKING" labels shall be installed on the dash inside of the cab.

41.4.6 "FLAMMABLE" shall be prominently labeled on both sides and at the rear of the product tank or vehicle. The letters shall be a minimum of 6 inches high and of a color that contrasts with the color of the product tank/vehicle.

41.4.7 "Hazmat Symbols" shall be prominently displayed as required by 49CFR.

42. MANLIFT PLATFORMS, LADDERS AND HANDRAILS:

42.1 Fueling Platforms:

42.1.1 The fueling platform shall meet the requirements of 29 CFR 2910.67 and the requirements set forth by the regulatory agency having jurisdiction. The platform shall meet all requirements of ARP1247 latest revision and all other requirements listed in this paragraph.

SAE ARP5818

42.1.2 The fueling platform shall be equipped with an entrance/exit gate that is spring loaded shut and swings opens only toward the inside of the platform area.

42.1.3 Minimum Size and maximum height shall be defined by the Vehicle Purchase Specifications. The platform shall be stable up to its maximum height. (Note: The fueling panel of the highest wide body aircraft is currently 20 feet high measured from the ground to the aircraft's fueling panel).

42.1.4 Variable height lift platforms shall be capable of lowering completely while the fueling nozzles remain connected to the aircraft fueling adapters that are located within an area vertically above the inside perimeter of the handrails, without placing stress on the aircraft adapter(s) or fueling hose(s).

42.2 Handrails:

42.2.1 Handrails shall be provided on any fixed-height platform in accordance with OSHA requirements. Variable height lift platforms shall always have handrails.

42.3 Escape Access:

42.3.1 Dual manual override lowering devices shall be provided on all variable height platforms. This lowering device will override the main control and provide a smooth, controlled lowering of the platform. One device shall be located on the platform and the other shall be located so that it can be operated from the ground. Fixed height platforms shall have a ladder.

42.4 Toe Board:

42.4.1 The platform shall have a toe board around its perimeter, except for any access points. The toe board shall be a nominal 4 inches above the deck floor.

42.5 Fueling Hoses:

42.5.1 Variable height lift platforms shall move freely with or without the hoses connected to the aircraft. The hoses shall be configured so that they do not bind or are susceptible to catching on any part of the platform when the platform is lowered with the hoses connected to the aircraft. This criteria shall be met when the aircraft fueling adapter connections are at any location that is within the area delineated by a boundary that is perimeter of the platform floor and vertically above the platform floor.

42.6 Wing Stop:

42.6.1 Variable height lift platforms shall have two (2) stop controls located in the areas most effective to stop the platform from lifting if the highest portion of the lift comes in contact with the aircraft.

SAE ARP5818

42.7 Platform Descend Speed Control:

42.7.1 Variable height lift platform shall have some method to control the descent speed in the event of a hydraulic failure. The valve shall be located at the end of the hydraulic cylinder(s).

42.7.2 A pilot operated safety valve shall be installed in the hydraulic line located at the end of the hydraulic cylinder(s) to prevent the lift cylinder(s) from lowering in the event of a mechanical malfunction or jam. This valve shall be adjusted to allow the lift basket to lower at a safe speed when operating empty or at maximum rated capacity.

42.7.3 Platform Audible Alarm is recommended when the platform is moving.

42.8 Ladders:

42.8.1 The ladder shall be designed to be in full compliance with OSHA requirements and be designed for a minimum of a 450 pound vertical load per TTMA RP #59-99. The ladder shall have the following minimum requirements:

- a. Step Width: 18 inches.
- b. Step Distance: 11 inches.
- c. Step Depth: 4 inches.
- d. Step Surface: Non-slip under all weather conditions.
- e. Toe Clearance: Minimum 6 inches from inner edge of ladder step.
- f. Handrails: Minimum 1 inch in diameter.

43. INTERLOCK SYSTEM:

43.1 The tanker vehicle shall be equipped with a safety interlock system to assure the safe operation of the vehicle. The safety interlock system shall operate as follows.

SAE ARP5818

43.2 The vehicle's brakes shall be set in accordance with 14.2 when any of the following conditions exist:

- a. The vehicle air pressure drops below 60 psi, if the vehicle is equipped with an air brake system.
- b. The PTO or Pump is selected
- c. Any hose nozzle is removed from its receptacle
- d. The bottom loading system is activated
- e. Any internal valve is open
- f. The lift platform is raised from the full down position.
- g. Folding handrails are raised from full down position.

43.3 The vehicle brakes shall be allowed to be released when all of the following conditions exist:

- a. The vehicle air pressure is above 60 psi
- b. The PTO or Pump is deactivated
- c. All hose nozzles are properly installed in their receptacles.
- d. The bottom loading system is deactivated
- e. All internal valves are closed
- f. The lift platform is in the full down position.
- g. Folding handrails are lower in the full down position.

43.4 The vehicle interlock system shall be designed in such a way as to prevent moving the vehicle any time an interlock is activated, except when the interlock system is overridden in accordance with Section 44.

43.5 When a vehicle brake system is air operated the interlock system shall be designed to prevent the vehicle from moving when the air system pressure drops below a safe level.