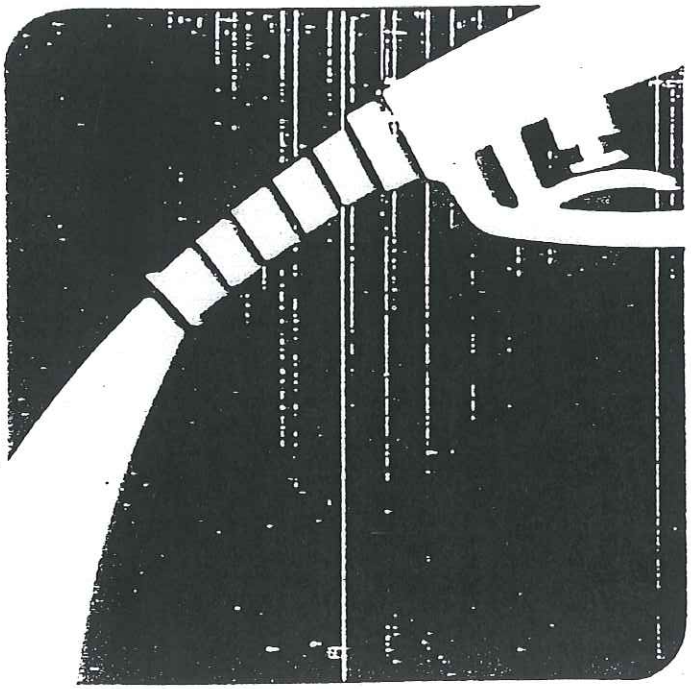
Fuel Supply Systems Design Guidelines

CHRYSLER CORPORATION



Fuel Supply System Design Guidelines

The following design guidelines for fuel supply system components will ensure that the resultant system wi

a. safely supply and store fuel.
b. be a weight and cost effective design.
c. have ease of manufacture.
d. provide for easy service.
e. comply with Federal impact regulations FMVSS 581 & 301.
f. comply with Federal and state emission standards.
g. give customer satisfaction.
h. reduce warranty.
i. be corrosion resistant.

These guidelines apply only to fuel supply systems designed in steel. As the use of lighter and more cost effi materials is developed, these guidelines will be updated accordingly.

The guidelines are considered under the following headings with safety being a primary concern in all cas

1. Fuel Tank
   - A. Basic configuration
   - B. Packaging clearances
   - C. Detail Design and Performance

2. Tank Attachments

3. Filler Tubes
   - A. Basic configuration
   - B. Packaging clearances
   - C. Detail Design and Performance

4. Filler Caps

5. Fuel and Vapor Tubes and Hoses
   - A. Basic configuration
   - B. Packaging clearances
   - C. Detail Design and Performance

6. Sending Unit

7. Fuel Gage

8. Venting and Temperatures

9. Government Safety Standards

For any items or considerations not covered in these guidelines, please consult with the Fuel Supply S Engineering Dept.

1. FUEL TANK

A. Basic Configuration

1. The capacity of the tank should give a driving range of 300 miles (483 kilometers), determined by the anticipated fuel economy of the base engine, as evaluated by Performance and Development Dept.

2. The tank should be located in a manner that avoids known impact areas and provides isolation from the passenger compartment. The Fuel Supply Dept. is to be consulted during advance fuel tank packaging studies.

3. The shape of the tank should tend to that of a cube, to minimize the weight of the tank and support system.

4. The tank should have parallel sides to simplify seam welding.

5. The plan view and cross sections of the tank should be symmetrical about its axes to minimize fuel gage inaccuracies.

6. Longitudinal and lateral restraints should be provided by underbody shape to eliminate the need for strainers (e.g. L Body).

7. An integral fuel/vapor separator and roll over valve should be located in the top center of the tank eliminating the need for fully domed tanks. It is desirable to have at least 1.5 inches between the liquid level and vent orifice for carryover reduction.

8. The sending unit should be located in the top stamping of the tank, with a sump effect provided for the float pickup in the bottom stamping to prove gage accuracy.

9. The sending unit should be capable being serviced without removal of tank.

10. The tank should be serviced with removal of adjacent components.

11. The design of the fuel tank and supply system should not be compromised for bumper or platform hitches. It is the responsibility of Hitch-Releasing Dept. to insure the performance of the fuel system defined in these guidelines, not be paired.

12. No offset flanges—see fig. 1.1.

13. Tank flanges, formations and reforcements should be configured as not to entrap corrosive agents

B. Packaging Clearances

1. Ground clearance—The minimum fuel tank clearance to ground is (76 mm) measured by design under dynamic full jounce metal to metal (includes tire deflections calculated for the dynamic tire load conditions of the particular vehicle).—see fig. 1.2.

2. Departure Line

   a. Tank Rear of Axle.

   0.25" (6.4 mm) clearance must be maintained between the tank and the departure line determined by a tangent constructed between the bottom

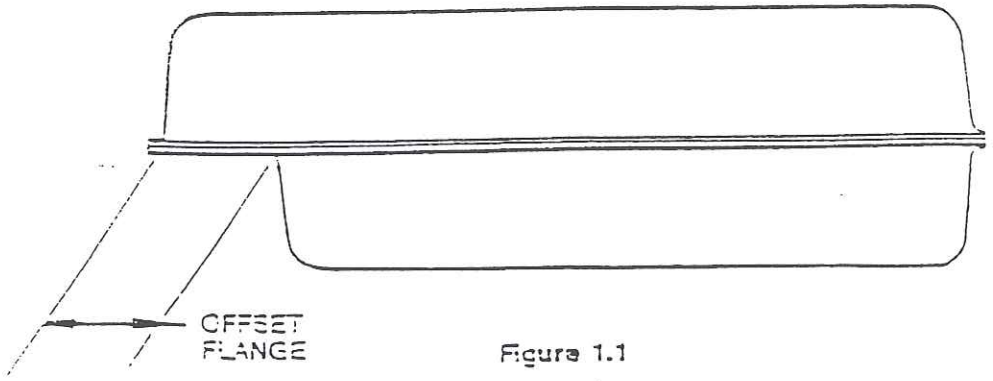


Figure 1.1

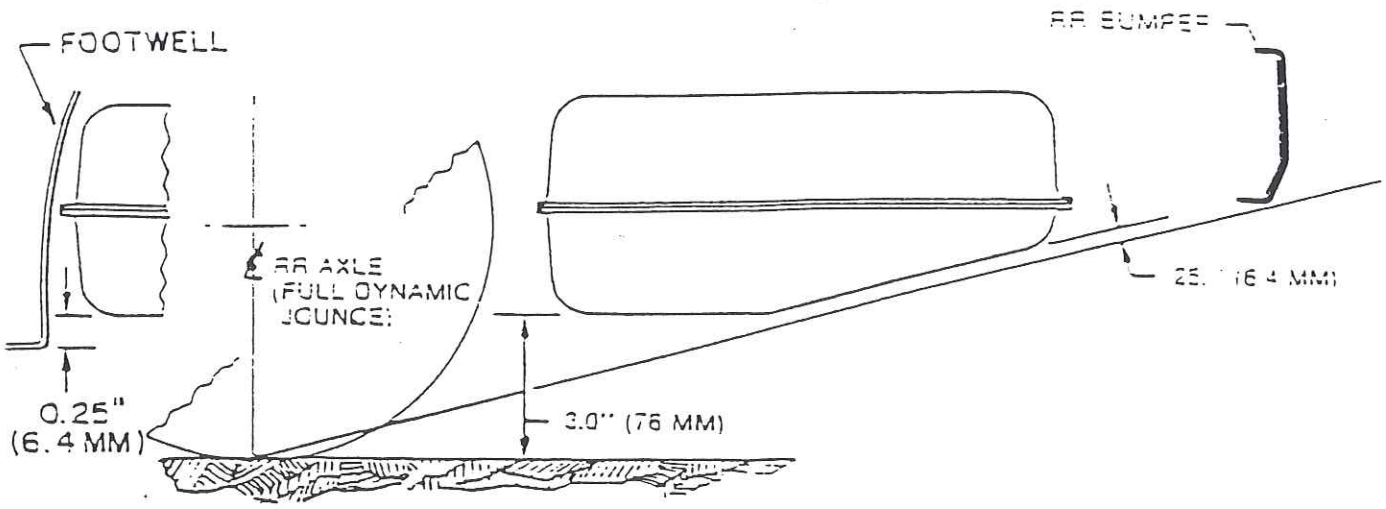


Figure 1.2

the tire centerline at full jounce and the bottom edge of the bumper, tie down skid plates or structurally sound license plate bracket.—see fig. 1.2.

b. Tank Ahead of Axle.

The tank should not fall below a horizontal line drawn 0.25" (6.4 mm) above the tangent to the rear seat foot well or other nearly leading structural member.—see fig. 1.2.

3. Spring Clearance—The minimum clearance to the tank flange is 2" (50.8 mm) static and 0.75" (19.1 mm) under dynamic sway deflection.—see fig. 1.3.

4. Rail Clearance—A minimum of 2.0" (50.8 mm) clearance between the fuel tank and underbody rail.—see fig. 1.3.

5. Exhaust Clearance—A minimum c 1.5" (38.1 mm) between exhaust com ponent and tank, and 1.0" (25.5 mm to tank flange.—see fig. 1.3.

6. Axle, Bumper and Shock Absorber— This clearance to be determined by combination of Advanced Body De sign crush analysis and actual mul vehicle FMVSS 301 rear impact. N contact should occur between thes components and the tank during th impact event. All components *mu* present a smooth and friendly surfac to the tank (axle vent, brake tee, shoc plate, bumper, etc.).

7. Shock and Spring Shackle Access Tank must permit service of shock a sorber and spring shackle withc folding tank flanges.

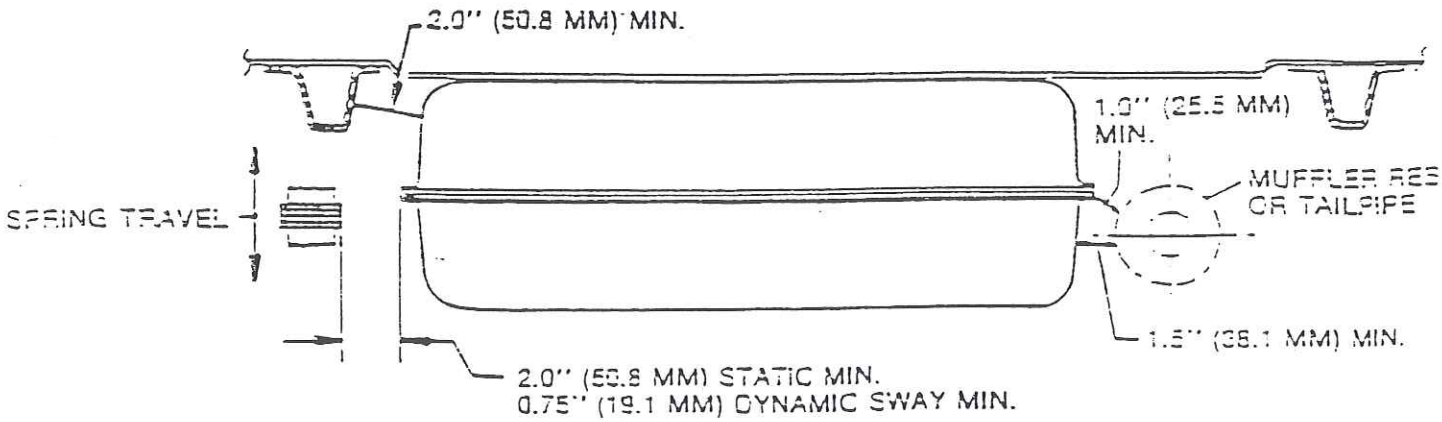


Figure 1.3

8. Shipping Tie Down Provision—A minimum of 0.5" (12.7 mm) clearance must be maintained between body tie down provisions and the tank (this includes removable shackles).

C. Detail Design and Performance

1. Tank Capacity—The usable capacity of the tank is determined as follows:

With tip angles of 16° fore and aft and 14° side to side the fuel level should not be higher than the venting point of the roll over valve. The volume below the limiting, tip angle surface represents: (unusable fuel ÷ usable fuel) × (1 ÷ thermal expansion) where:

unusable fuel = 0.3 gallons (1.26l)

thermal expansion = 0.027 (ΔT = 40°F)

Hence the usable fuel capacity of a given tank and roll over valve configuration can be determined.

2. Body Tolerances

a. ± 0.06" (1.5 mm) for locating any one floor pan strainer to the floor pan centerline.

b. ± 0.06" (1.5 mm) lateral tolerance between one floor pan strainer to the other.

c. ± 0.06" (1.5 mm) longitudinal tolerance between strainers.

3. Tank Location—Lateral and longitudinal location to be provided by body formations (such as seat formations in L Body). For tanks located by strainers:

Lateral—location provided by tank locating off one strainer permitting the other to float.

Longitudinal—locate off strainer at the front and strap at the rear.

4. Design line to line clearance between tank and floor pan or floor pan beads If insulator pad is used, allow for 0.05" (1.3 mm) pad thickness (No pad is to be used unless mandated by Sound Lab).

5. Flange bend radius to be 0.08" (2. mm) minimum. See fig. 1.4.

6. Flanges should not be folded, bu where required, the transition fror fold to normal will be 1.5" (38.1 mm In general, all folds are to be in dowr ward direction (see fig. 1.4). Folds

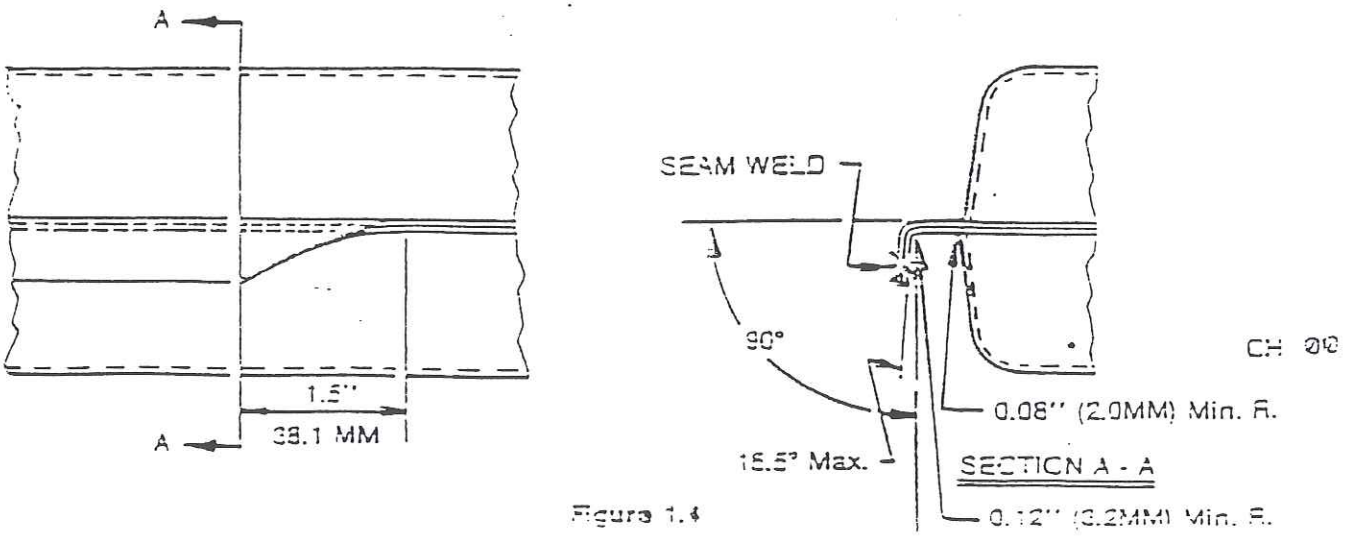


Figure 1.4

CH 20

the support strap locations may be upwards if this provides the most friendly bearing surface. Maximum bend to be 90° with 15° tolerance. Fold radius to be 0.12" (3.2 mm) minimum.

7. Location of seam welds.

   a. With fold—to be located outside of fold—see fig. 1.4.

   b. Without fold—to be located .025" (6.4 mm) from wall of tank (ref. P.S.-1759).

8. All manufacturing pre-seam weld spot welds must be located outside of seam weld path.

9. Ribs

   a. Ribs will be at least 0.25" (6.4 mm) deep.

   b. Rib neutral axis should be at half rib depth.

   c. Rib transition to normal surface should occur on vertical tank wall within 0.25" (6.4 mm) from flange. Round end rib face out must not be used. See fig. 1.5 for correct fade out. Rib character to be accurate in A-1 model.

   d. Rib configuration to be agreed to by Stamping Division.

10. Minimum & Maximum Material Thickness

    To be quoted on drawing with the minimum resulting from combined testing of:

    a. PV (Pressure Vacuum)

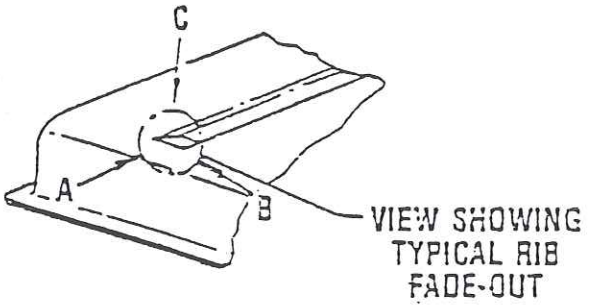
       500 cycles at pressure limits of cap followed by 2000 cycles at 60% of pressure limits. (P.S. 1764)

    b. Shake

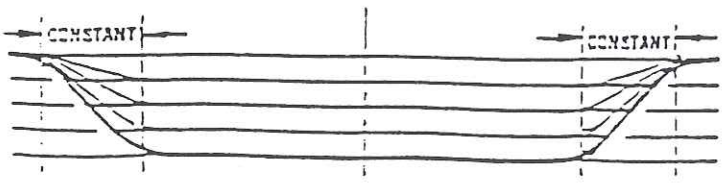
       Testing to PS1764.

    c. Impact

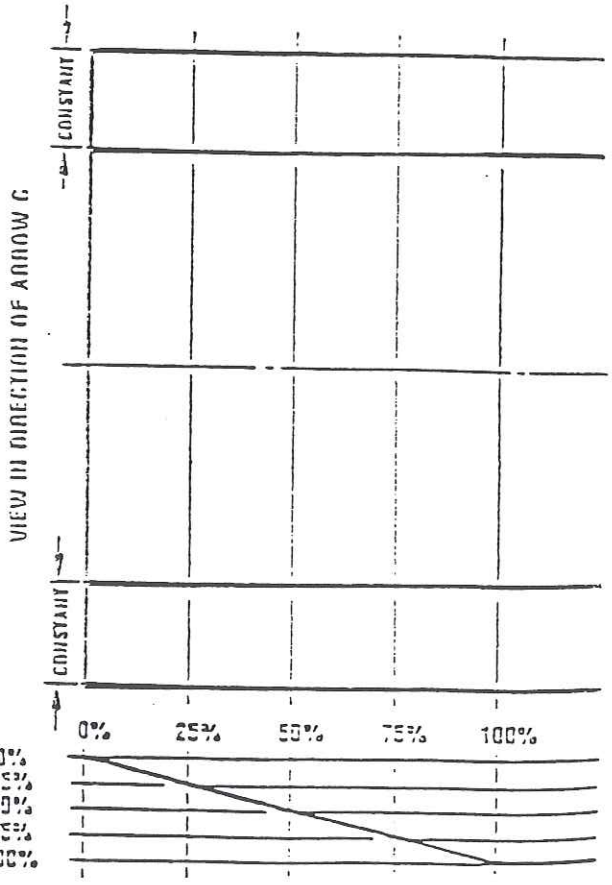
       FMVSS 301 impact testing.



SECTION OF FUEL TANK



VIEW IN DIRECTION OF ARROW A



VIEW IN DIRECTION OF ARROW B

Figure 1.5

d. P.G. (Proving Ground)

50.000 miles (80 000 km) of general endurance testing, or 25.000 miles (40 000 km) of accelerated endurance testing.

11. Manufactured tanks to be tested for leaks etc., to PS1764.

12. Date codes will be stamped in approprate size characters on bottom surface of stamping. Sharp corners are to be avoided.

13. Filler tube openings may require reinforcing if determined by impact testing.

2. TANK ATTACHMENTS

1. The straps are to be equispaced about the longitudinal centerline of the tank to equalize strap loads under operating and impact conditions.

2. Two identical straps are to be used.

3. The strap T-slot end is folded for double thickness.

4. The T-slot end will be the rear attachment unless otherwise agreed with SAD.

5. The strap bolted end is to be folded for double thickness.

6. Developed strap length will be determined by laboratory fitting on Program cars. Preliminary developed lengths will be determined by design.

7. Functional gaging to be called out detail drawing to check strap lengths.

8. If required, rolled edges should have cross section as shown in fig. 2.

9. With positive wire connection fc sending unit ground circuit, materia may be either terne or galvanized fc corrosion protection. Straps to c terne if no positive ground circu used.

10. Material thickness will be determine as for tanks in section 1.C.10.

11. Straps should shield openings at th front of strainers to minimize corro sion.

12. Between the tank and the underbod attachments, the strap should be pe pendicular to the weld flange of th tank.

3. FILLER TUBE

A. Basic Configuration

1. Preferred location is right side of ve cle with provisions to avoid separati of the tube from tank during impac

2. Design layout should assume 2" (5 mm) O.D. tube.

3. Filler tube should enter the center c side of the tank to minimize filling v iations.

4. Filler tube to determine fuel le without external vent.

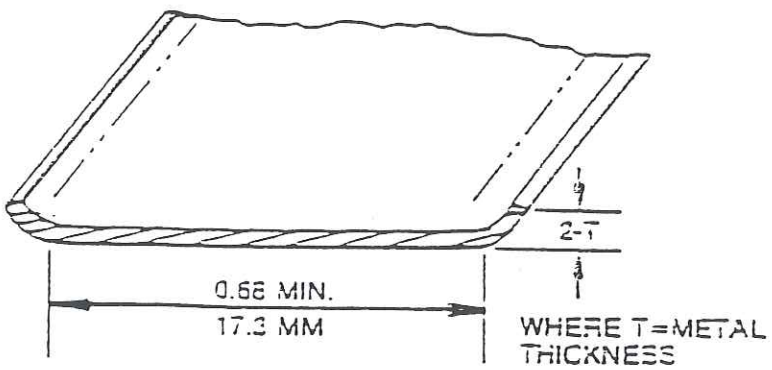


Figure 2

CH 0

5. Filler tube should be straight. If bends must be employed to facilitate packaging, all bends should be in one plane, if possible.

6. Must accommodate requirements of California vapor recovery for both leaded and unleaded filler tubes.

7. To be serviceable without removal of tank or other components.

8. Accept fill with 1 gallon (3.8 l) gas can. See layout 7730-36F-SK4557.

B. Packaging Clearances

1. Nominal clearance to fixed body components 0.5" (12.7 mm).

2. If tube passes through tire wheelhouse, minimum tire clearance should be 3.0" (76.2 mm) at full jounce.

3. If filler tube breakaway housing is used and it is located within wheelhouse, filler tube housing drain must be located away from radial wheel splash and hot exhaust components. Care should be taken in locating drain hole to assure that gasoline drainage does not attack sealing areas of lower wheelhouse.

4. Minimum clearance to spring 0.75" (19.1 mm) dynamic roll and 2.0" (50.8 mm) static full jounce.

5. Filler tube tank grommet must be 5.0" (127.00 mm) from exhaust.

6. For rear fills, fully stroked bumper components to be 0.25" (6.4 mm) from filler tube and present a smooth surface.

7. Fasteners are to be pointed away from filler tube. See design standard 31.17.

8. All surrounding components are to present a smooth friendly surface.

C. Detail Design and Performance

1. Minimum centerline bend radius should be 5.0" (127.0 mm) to permit less costly press rather than mandrii bends.

2. Minimum length of straight tube ween bend tangents to be equal to tube diameters.

3. Baffling or vent tube to permit fillir 15 g.p.m. (56.8 l) without spray b: spit back, or premature shut off is lined in Fuel Supply Dept. labora procedure.

4. Filler tube must accommodate sembly plant filling process.

5. For impact considerations, the tube must:—

a. Penetrate grommet by at least 2 (69.9 mm).

b. The filler tube grommet sealing of the filler tube is to be sized to w 0.015" of the nominal tube diar and be smooth without discont in an area of = 2.0" (50.8 mm) c designed seal location.

c. The surface of the filler tube v two inches of the grommet is to b of underbody sealer.

6. For corrosion purposes side fill must be lead dipped. Rear fill may be lead dipped or terne material.

7. Leaded fuel restrictor to compl the Federal requirement of preve insertion of leaded filler nozzl restricting the amount of leade that would be added, if attempt 700 cc.

8. Restrictor to pass life cycle of insertions of unleaded nozzle.

9. Maximum angularity of filler t grommet to be 10".

10. When the filler tube is articul the tank grommet, it must not c contact with any part of the s unit. To accommodate ass techniques it may be necessary foam tube stops. Beads as as aids are to be avoided.

11. Compliance with the Californi recovery standard is establis design. Guidelines for confo

7730-36F-SK4507
7730-36F-SK4508

Standard nozzle guidelines are shown on layout 7730-36F-SK4557.

12. The filler tube should enter the fuel tank at a downward angle under all loading conditions.

4. FILLER CAPS

1. Relative to the sealing face of the filler tube the minimum clearances required to accommodate all threaded caps (both standard and locking) are shown on 7730-36F-SK4510.

2. Pressure settings are to be common to all caps to decrease emission families:—

   Vacuum— —10" (254 mm) H_2O
   Pressure—Determined by the maximum static head of fuel that can be applied to the cap with the vehicle at any attitude plus a 3" (76.2 mm) water margin of safety. This represents minimum cap setting. The maximum is to be determined by the PV test described in 1. C. 10a.

3. Caps to comply with PF6017.

4. Caps to comply with FMVSS 581 & 301 impact testing.

5. Durability to be established by 50,000 miles (80 000 km) general endurance running.

6. If subject to impact, caps are to retain their sealing capabilities.

7. No cap to have English wording without French equivalent having equal prominence.

5. FUEL AND VAPOR TUBES AND HOSES

A. Basic Configuration

1. Lines shall be one piece from the fuel tank to engine compartment and routed in a manner that eliminates the need of molded hoses.

2. For simplification and to avoid mis-builds, lines and hoses should be identical for all engine combinations in a particular car line. Where this is not possible the combinations of lines and hoses should be foolproofed by design.

3. For a car line with more than one wheel base, the low volume W.B. lines are to be color coded.

4. The fuel, return and vapor lines and hoses must not interfere with the removal and installation of serviceable parts.

5. Fuel line clips and hose clamps should be serviceable without removal of other components.

6. Clamps, clips and screws are to be standardized.

7. Armor Usage.

   No armor is to used on lines unless:—

   a. Determined by the Corrosion Laboratory to be necessary to prevent premature corrosion failures.

   b. Established by general endurance testing to minimize stone damage in critical areas.

   c. Required for protection of lines during impacts.

B. Packaging Clearances

1. In the engine compartment a minimum of 1.0" clearance between the engine and the lines and hose must be maintained during body drop

2. All screws and clamps to have acceptable tool clearances. To be determined in cooperation with SAD chassis and underbody mock-ups.

3. For impact considerations, no sharp objects are to be pointed at the fuel supply and return lines within 2.0 (50.8 mm) (refer to drafting standard 31.17). Nor should they be located where they may be severed during impact.

4. Fuel hoses must clear exhaust components by 5" (127 mm).

5. Fuel hoses to be routed with 4" (102 mm) clearance to engine accessory drive belts.

C. Detail Design and Performance

1. For layout purposes provision should be made to bundle:—

Fuel supply ⅜" (9.5 mm) Dia.
Fuel return ⅜" (9.5 mm) Dia.
Vapor ¼" (6.4 mm) Dia.

Desired usage is:—

Fuel supply 5/16" (7.9 mm)
Fuel return ¼" (6.4 mm)
Vapor 3/16" (4.7 mm)

Larger sizes will only be used if dictated by applications such as EFM.

2. Tube material to be MS1806 steel (optional MS3235) with a wall thickness of 0.028" (0.71 mm), lead alloy coated to PS954B and inspected for cleanliness to PS3930.

3. Bead formation and hose stop to PS1797. To minimize possibility of hose cutting during impact, no burrs are permitted.

4. Hose material to be rubber and fabric MSEA212.

5. Bend Radii

a. Lines

Only two radii per line diameter permissible.

Dia.	Radii at Centerline	Bend
3/16" (4.7 mm)	0.5" (12.7 mm), 1.5" (38.1 mm)	90° Maximum
¼" (6.4 mm)	0.5" (12.7 mm), 1.5" (38.1 mm)	90° Maximum
5/16" (7.9 mm)	0.62" (15.9 mm), 1.5" (38.1 mm)	90° Maximum
⅜" (9.5 mm)	0.75" (19.1 mm), 1.5" (38.1 mm)	90° Maximum

b. Hoses

To avoid hoses kinking, the minimum [illegible] for hose routing is:—

Dia.	Minimum Radii at Centerline
3/16" (4.7 mm)	3" (76.2 mm)
¼" (6.4 mm)	3" (76.2 mm)
5/16" (7.9 mm)	4" (101.6 mm)
⅜" (9.5 mm)	5" (127.0 mm)

6. With the aid of SAO it must be determined if pre-bundled or single line installations are more economical Compatible clipping will then be designed.

7. Hoses must be located so that a broken exhaust component will not result in failure from exhaust gas impingment.

8. Lines and hoses are to be routed to protect them from being cut by collapsing leaf springs.

6. SENDING UNITS

1. The sending unit should be located in top stamping of the tank or on a surface that is not in line with the axle bowl or shock absorber or where it is likely to be damaged during impact.

2. For overall accuracy the sending unit must have positive bottom reference.

3. The float is to be located as close to the center of the tank as possible to minimize gauge fluctuations during various vehicle maneuvers and loading conditions.

4. The output of the sending unit is to be linear relative to fuel capacity.

5. Sending units will have positive wire connection for the ground circuit.

6. Servicing of the sending unit should be accomplished without removal the tank or other components.

7. The fuel filter must comply with MS3539 for standard units and PF5266 for EFM units. In both cases the filter must be capable of picking up all of the usable fuel, as defined in 1.C.1.

7. GAGE

1. Although every effort is made to make the combined output of the sending unit and gage linear, the graduations of the fuel gage are to truly reflect the actual fuel capacity.

2. The empty reserve is to be minimal so that its range is from zero to 10% of tank capacity.

3. The full reserve shall be that amount of fuel to always assure a full or beyond gage reading within the design limitation set forth in PF3865.

8. VENTING AND TEMPERATURES

1. A full tank must vent under the following conditions:—

   a. 16° fore and aft vehicle attitude

   b. 14° side to side vehicle attitude

   c. Δ T of 40°F combined with a. and b.

   d. The AMA cycle with zero carry over. (0.7 g acceleration and deceleration; 0.4 g cornering.)

2. Temperatures

   The following fuel supply system temperature goals exist for fuel levels in excess of a half tank. Fuel levels may raise the temperature goals of the tank surface and fuel another 20°F. Component relocation or shielding must be considered if these goals are exceeded.

INSTRUMENTATION DEFINITIONS FOR FUEL SYSTEM

Thermocouple Location	Long Term Goals		Short Term Goals	
	F	C	F	C
F/Tnk. Surface	150	65.6	160	71.1
F/Tnk Nrst Resonator	150	65.6	160	71.1
Fuel Temp. in F/Tnk.	130	54.4	140	60.0
Fuel Temp. at Axle Kickup	130	54.4	150	65.6
Fuel Temp. at F/Tnk. Outlet	130	54.4	150	65.6
Fuel Temp. TB/HS Int. U/Fnt. Ftw1	130	54.4	150	65.6
Fuel Line-rubber hose connections (all locations)	180	82.2	250	121
RR W/Well F/Line Clip Nrst. Exh.	150	65.6	150	65.6
F/Vapor Temp. at F/Tnk. Int.	120	48.9	120	48.9
R/O Val. Extl. Surf.	250	121	300	149

9. GOVERNMENT SAFETY STANDARDS

1. FMVSS 581—Bumper Impact Standard

   All changes to the fuel supply components will be reviewed for compliance with the subject standard and confirming tests run where judged necessary.

2. FMVSS 301—Fuel Integrity Standard

   The Fuel Supply Department has the overall responsibility for meeting the subject standard. A 301 steering committee, chaired by the Fuel Supply Department, meets bi-weekly to review compliance status. This forum is used to evaluate changes to the vehicle for their possible effect on the standard and to arrange for any necessary testing, and/or changes.

   Note:
   IT IS INCUMBENT ON THE DEPTS. MAKING CHANGES TO ADVISE THE 301 STEERING COMMITTEE IF THEY FEEL THAT THE CHANGES MAY AFFECT COMPLIANCE WITH FMVSS 301