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**A REVIEW OF GM'S  
CORPORATE PRODUCT PERFORMANCE OBJECTIVE  
TESTING OF C/K PICKUPS**

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## REVIEW OF GM'S CPPO TESTING

**Introduction:** Beginning on July 24, 1981, GM conducted "fuel system integrity car-to-truck development corporate product performance objective (CPPO) tests" to "enhance the ability of the fuel storage system to manage significantly greater levels of energy." (GM's October 9, 1992, letter on page 15.)

GM initiated this test program in 1981 and continued the program through the early months of 1984. The CPPO test protocol involved impacts into the side of C and K pickups using a GM X Body car—e.g. Citation, Omega—as the striking vehicle. Based upon design and development work, supported specifically by the test program, GM released a new fuel system for its 1984 model year full-sized pickup trucks to enhance their fuel system crash performance. Among other things, the new design included a plastic shield, new lower mounting brackets with increased load-capacity, a "breakaway" filler neck, and revised welding of the tank seams.

Nineteen CPPO tests of the subject vehicles were conducted at 50 mph—seven on 2wd trucks and 12 on 4wd drive trucks. Three of the seven 2wd tests produced tank leaks and nine of the 12 4wd tests resulted in tank leaks. The tests involving a "lined" tank (C5434 and C5496) similar in construction to the fuel tank in the Chevrolet Corvette and the tests using a full coverage plastic shield (C5573 and C5692) resulted in no leakage from the fuel tank. GM also tested a modified version of the fuel tank cage used on its cab-chassis trucks (C5400). The test report states that there was fuel leakage when the "cage around rear section of tank cut the filler tube near the tank." Not mentioned in GM's report are other apparent failures of the sending unit and tank seam.

In addition to the 19 CPPO tests conducted at 50 mph, six additional tests were performed in accordance with the CPPO protocol—utilizing an GM X-body car (Citation, Omega, etc.) as the striking vehicle. Three of these tests were done at about 30 mph on vehicles with the experimental plastic shields, one test was conducted on a full-sized pickup with propane (LPG) fuel system at 50 mph, and two tests were done on full-sized Ford pickups at 50 mph.

The CPPO test program indicated, among other things, that the tank integrity performance appeared to differ greatly between the C-series, 2wd and K-series, 4wd trucks. To address the performance difference, GM altered the placement of various crossmembers in the 4wd trucks to encourage more frame deflection during side impacts and reduce tank "pinching." However, these performance differences are not reflected in FARS real-world accident data.

**Summary of C-series Truck (2wd) Tests:** Test C5308, on July 24, 1981, produced no tank leakage at 30 mph with plastic tank shields surrounding the tank. Test C5325 on August 25, 1981, produced no tank leakage at 30 mph with plastic shields surrounding the tank. Test C5366 on September 28, 1981, resulted in tank leakage at 50 mph with the same test setup used in tests C5308 and C5325.

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In test C5434, on February 16, 1982, GM used a C-series truck with a tank containing a Corvette-type inner liner. This configuration also leaked when struck at 50 mph; however, the leakage was minimal. According to GM's test report, 1.5 ounces of fuel was lost at impact from the fuel cap and .28 ounces was lost in the first 5 minutes following impact "due to an inadequate seal between the fuel filler neck and the fuel tank liner." No spillage occurred during the next 25 minutes.

GM's next CPPO test, C5496 (May 27, 1982), again utilized a tank liner, but with a filler neck shield to prevent the type of failure observed in test C5434. No tank leakage was observed at a 50-mph impact speed.

Test C5573, done on September 13, 1982, was the first test of what were to become the "enhancements" introduced with the 1984 model year, e.g., the full coverage plastic shield ("bathtub"), longer tank brackets, and a filler neck shield. There was leakage from the filler cap in this 50-mph test.

Prior to October 1982, GM had oriented the striking vehicle so that it struck the pickup truck at a 90-degree angle. This "T-bone" impact was centered on the midpoint of the truck's wheelbase, thereby ensuring that the entire fuel tank would be impacted. After the apparent success of test C5573, GM conducted side-impact crash tests using the same test conditions, except the impact angle was 60 degrees. Test C5618, conducted on November 1, 1982, was the first such test. This test configuration produced more penetration of the striking vehicle into the side of the truck. A leak was observed when the "tank seam separated at rear of tank and contents (18.7 gallons of fluid) emptied out in approximately 5 minutes" after a 60-degree 50-mph impact. Test C5661, on January 11, 1983, was essentially a re-test of test C5618, utilizing the same configuration and test protocol. The results were also similar to the those in test C5618. According to GM's test report, "fuel tank leakage for first 5 minutes after impact was 4-5 gallons; stopped measuring after 5 minutes as per Chevrolet test engineer. Leakage was from a two inch long opening in side of tank and small seam separation in rear of tank."

GM conducted the last C-series truck test on March 15, 1983. Test C5692 was another 50-mph, 60-degree side impact. According to GM documents, the truck test configuration was unchanged from tests C5618 and C5661. GM's report shows that 0.07 gallons of fluid loss from the filler cap seal was recorded, but there was no leakage from the tank.

GM did no further evaluation of the "enhancements" to assess their performance in other impact modes or to ascertain whether the results obtained in C5692 were repeatable.

**Summary of K-series Truck (4wd) Tests:** Because performance differences might occur as a result of certain design factors, GM also conducted CPPO testing on K-series trucks. The first K-series truck test (C5318) was conducted at 30 mph on August 8, 1981, using plastic shields surrounding the tank. The plastic shields were the same as tested on C-series trucks in tests C5308 and C5325. However, unlike those two tests, a tank leak was observed. Test C5367, on September 26, 1981, utilized the same plastic shields enclosing the fuel tank but the

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striking speed was increased to 50 mph. The impact angle remained at 90 degrees. Again a seam leak was observed.

In test C5400, conducted on November 16, 1981, the truck was equipped with a modified version of the fuel tank cage used on cab chassis vehicles. In this 50 mph test, there were tank failures at the seam, filler neck, and sending unit.

Test C5417, on January 19, 1982, utilized a "blow molded inner liner." Leaks were observed "due to a 180-degree rollover bend in the liner."

Test C5422, on January 28, 1982, tested a K-20 pickup with "two plastic half shells enclosing upper and lower halves of tank and cage around rear section of tank. Diagonal braces added to reduce fuel tank rotation, fuel hoses modified to increase stretch capability." This tank configuration also failed when "the fuel tank opened along the front seam and spillage occurred from this opening at a rate greater than 3.1 gallons for the first 5 minutes."

After the success noted with an "enhanced" C-series truck in test C5573, in September 1982, GM installed the same "enhancements" (bathtub shield, longer tank brackets, and filler neck shield) on a K-series truck to evaluate their performance on a 4wd truck. Test C5601, on October 14, 1982, indicated that the K-series truck performance differed dramatically from the C-series truck. According to GM's test report, the "fuel tank seam opened over a distance of approximately 300mm at front of tank. Contents (18.7 gallons of fluid) emptied in approximately 10 seconds."

Test C5619, on November 2, 1982, evaluated a configuration identical to test C5573 (i.e., with "enhancements"), except for the addition of "a steel deflector plate welded between the pickup box sills to divert the striking vehicle downward" (to prevent striking vehicle under-ride). Again, the K-series truck results were not consistent with the C-series truck. According to GM, the test was a failure when the "tank rotated approximately 110 degrees and a 6 [inch] tear at front seam weld (apparent hydraulic lock) and a 3 [inch] tear at rear seam. Metering unit (sending unit) locking ring pulled away from metering unit assembly causing leak. Solder joint at tank to fuel fill pipe distorted and leaks."

Test C5654, on December 22, 1982, used the "enhancements" again, but a tank anti-rotation bracket was installed in an effort to prevent both filler and vent line separation and tank exposure at impact. This 50-mph, 90-degree test resulted in a hydrostatic rupture of the tank at impact. Nearly all of the tank's contents were lost immediately, and both vehicles were enveloped in a vapor cloud as a result of the atomized fluid lost under pressure.

Test C5691 was conducted on March 14, 1983, utilizing the "enhancements" with the addition of a deflector shield (for anti-rotation) on a K-series truck at a 90-degree impact angle and 50 mph. The tank leaked in this test too. According to GM, the leak was "moderate" from a "tank rupture approximately .70 [inches] long at the front edge of the seam weld."

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Test C5729, on May 19, 1983, tested the "enhancements" with modifications to the rear fuel tank support assembly on a K-series truck. GM recorded tank leakage in this test, in that "the fuel tank had a .50 [inch] tear in the rear upper half tank corner radius. Fuel tank rotation was limited. The tear was in the upper rear tank section which differs from the normal seam weld or lower fuel tank tear."

Test C5753, on June 30, 1983, tested a K-series truck with the "latest production 1984 plastic shield and extension bracket design, an anti-rotation reinforcement bolted to frame rail flange behind rear support bracket, two reinforcements bolted from the frame rail flange to propshaft crossmember, and extended fuel tank bracket and support bracket along full lower flat surface." According to GM, the "fuel system leaked at impact" as follows:

- the filler neck hose was severed completely at lower filler neck;
- there was a slight leak under the metering unit seal due to fuel tank deformation in area of sending unit; and
- there was a tank rupture approximately 0.50 inches long in the rear upper corner of fuel tank.

In August 1983, the GM engineer in charge of the tests posed the question, "Why is the C and not the K passing the test?" and "Why does the tank crush differently front to rear on the K-truck?" To answer these questions, GM conducted additional testing that established that both the increased truck ride height and frame stiffness were subjecting the fuel tank in the K-series truck to different forces than those experienced in the C-series truck tests.

On December 8, 1983, after the model year 1984 trucks were released, GM conducted test C5831. This test included the "enhancements" described in test C5753, plus:

- a propshaft support crossmember to frame gusset; and
- a transmission crossmember with increased vertical stiffness.

GM reported the following tank failures in test C5831:

- "Leak on impact--sending unit area--locking plate and cam ring were deformed causing an opening between the "O" ring seal and cam ring. (One spot weld was pulled away from tank.)
- Fuel tank area--metal tear (1/2 inch) at seam (forward inboard corner) of tank due to excessive metal crimping."

According to GM's test engineer's notes, however, this test was a success, because with it GM achieved C-series truck frame crush characteristics on a K-truck. On February 11, 1984, (4 months after the 1984 trucks had been released), GM conducted what was to be the final CPPO test, C5873. A new frame crossmember was installed for this test. However, the

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K-series truck again leaked from "the filler tube which pulled from the tank at the tank-to-tube junction and the tank tore near seams at front and rear. No measure of spillage was taken, but spill rate estimated to be about 5 liters per minute."

No K-series trucks were tested at a 60-degree impact angle.

**Additional Information:** GM also conducted two 50-mph, side impact, CPPO-type tests (C5647 and C5826) on Ford full-sized pickup trucks. Test C5647 produced a tank leak when the spare tire hold down bolt punctured the tank. The test report does not mention whether GM removed the spare tire from the Ford truck before conducting the test. No fuel leakage is reported in test C5826.

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