

# CNG Vehicle Tank Burst During Filling

by

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# Event

On 26 May 2007 an airport shuttle van driver was killed when his CNG tank burst during filling.

The sheriff and coroner initially investigated the accident.

The vehicle was turned over to the pressure vessel experts in California Dept. of Occupational Safety and Health.

# Information - Vehicle

2001 Ford van – E350 Super Club  
Wagon XL

OEM manufactured with 3 CNG tanks

Two additional tanks were added in the  
aftermarket to extend range

- ⌘ One tank longitudinal on passenger side
- ⌘ One white tank behind rear axle – right in front of rear bumper
- ⌘ White tank manufactured by Comdyne

3600 psi nominal pressure tanks

- ⌘ Longitudinal aftermarket tank rated at 3000 psi and expired

Rear-most seats removed for luggage  
storage



# Information – Filling Station

Station owned and located on the property of the LA County Sanitation District

Station operated by Clean Energy  
Station quite new – November 2006

Surveillance camera at station but was not recording

Fill data and measured OEM tanks pressure indicates that the station did not over-pressurize the tank



# Rear End Accident

**6 May 2007 the van was involved in a rear impact accident.**

- Van was hit from behind by a Honda Accord
- Damage to van minor
  - ≡ Rear bumper bent a few inches
  - ≡ Minor body work
- Extensive damage to Honda
  - ≡ Under-rode the Van – both vehicles braking
  - ≡ Van's rear wheels off the ground when at rest
  - ≡ Extensive frontal damage
  - ≡ Hood crumpled
  - ≡ Battery acid spilled on rear of Van



# Close-up of Battery Area



# Vehicle “Inspection”

Driver had tanks “looked at” by an alternative fuel conversion company

- ≡ Recommended driver replace tank and not fill tank (based on accident description – not inspection)
- ≡ Cursory inspection
  - Vehicle not put on lift
  - Tank not removed
- ≡ Tank may have been isolated by closing mechanical valve

# Van Repair

Repair estimate was made

- ⌘ Cleaning battery acid off rear doors was part of the estimate

Body work was completed and the van was returned to the driver the evening before the incident

- ⌘ Rear bumper replaced
- ⌘ No work on fuel system
- ⌘ Did not see any battery acid on tank
- ⌘ Only ca \$1200 damage



# The Burst Incident

Vehicle was refueled shortly after the rear-end accident

Second fueling was taking place after repair of rear end crash damage

Driver was behind the vehicle

- ⌘ Might have been kneeling

Tank Burst - Driver was thrown about 30 feet and had massive trauma

- ⌘ He died instantly

# Vehicle Damage

- Two rear and one side window broken
- Bumper blown off and twisted up
- Tank has “fish mouth” shaped rupture
- Al liner torn open in several pieces



# Possible Causes

Mechanical damage to tank from rear impact

Battery acid damage to tank

- ⌘ From Honda battery in engine compartment
- ⌘ Cleaning of acid mentioned in repair estimate

Over-pressurization of tank by station

- ⌘ Evidence for no-over-pressurization

# Comdyne Tanks

- Type 3 – aluminum liner
- E-glass fiber
- Manufactured under DOT exemption
  - ≡ Most manufactured in 1990s
- Early tanks were white
- Later tanks were black due to a protective coating
- Many purchased by GM and Chrysler

# Comdyne Tanks (continued)

- GM had two tank bursts on pick-up trucks
  - ≡ Investigation showed susceptibility to corrosive fluids
    - One due to battery acid
    - Other due to corrosive wheel cleaner (Fluoride)
  - ≡ Problem studied by SwRI and Failure Analysis Associates
  - ≡ GM recalled ca 2200 vehicles and destroyed tanks
  
- Comdyne no longer in business

# Inspection

## Disassembled Vehicle Fuel System – 17 July 2007

- Visual inspection of tanks and plumbing
- Frame rails had been torched to provide room for tank end domes
- OEM tanks were still pressurized – 2650 psi
- Burst tank and shut-off valve removed
- Aftermarket tank that did not burst was rated at 3000 psi and had exceeded its lifetime (2006)



# Rear View of Van



# Inspection (Continued)

## Detailed inspection of burst tank and valve 14 -15 August 2007

- Performed at SEAL Laboratories, Torrance, CA
  - ≡ Visual inspection and photographs
  - ≡ Tank end-of-life 2009
  - ≡ Wall samples cut out
  - ≡ Inspection by microscopy, SEM, EDX, FTIR, TGA, & DSC
- Some mechanical damage – not in area of burst
- Light brown stain on tank
- Extensive cracking of surface fibers



# Tank after Removal



# Light Brown Stain on Tank



# Conclusions from SEAL Inspection

Tank lost strength due to Stress Corrosion Cracking (SCC)

- ⌘ Caused by battery acid spilled on tank
- ⌘ Brown stain was replicated – with heat to dry it

SCC takes both stress and time to occur

- ⌘ Tank was pressurized once without bursting
- ⌘ Burst on second fill ca 2 weeks later
- ⌘ Similar to burst of fire fighter SCBA cylinder (1996)

Shut-off valve in open position

- ⌘ Driver may have been opening valve

# Lessons Learned – Aftermarket Converters

Required to provide “continued conformity” to Federal safety standards

Consider a training and certification process for aftermarket converters

Consider independent third party inspection of conversions

## Bad Practices

- ⌘ 3000 psi tanks should not be installed in a 3600 psi system
- ⌘ Expired tank was not removed
- ⌘ Tanks should not be right behind rear bumper
- ⌘ Rear frame rails should not be torched to accommodate tank



# Lessons Learned – Inspection after an Accident

Should be thorough

FMVSS 304 requires a label saying inspection should be done after a fire or crash and every 36 months

- ⌘ Probably requires that the tank be removed
- ⌘ All damage may not be detectable visually

Inspection results should be written – not verbal

- ⌘ Copy to owner and driver

# Lessons Learned – Get Expired Tanks out of Service

Comdyne and other tanks made in the 90s are reaching the end of their 15-year life

Need process to get tanks out of service or recertified

- ⌘ Consider using state vehicle registration process to prevent re-registration when the tanks have expired
  - Similar to required smog equipment checks

May be pre-1998 tanks still on the road which are susceptible to SCC.

- ⌘ CVEF has issued warning

Questions?

Comments?