Necessity of Bus Rollover Test

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1. Backgrounds

- Number of CNG buses in Korea: about 31,000 (urban: 29,000, inter city: 2,000)
- Most of CNG and hydrogen buses are equipped with fuel storages mounted in the roof

Hyundai hydrogen bus

Toyota hydrogen bus

- A preliminary study shows that roll-over possibility increased by 18% due to upward movement of center of gravity
- In the event of roll-over, the possibility of gas leakage is high due to breakage of valves (based on the test result in Korea)
- During the Phase1 meeting (SGS-5-13), this was issued, but large bus was excluded from the scope of UN GTR 13, expecting the discussion in the next step

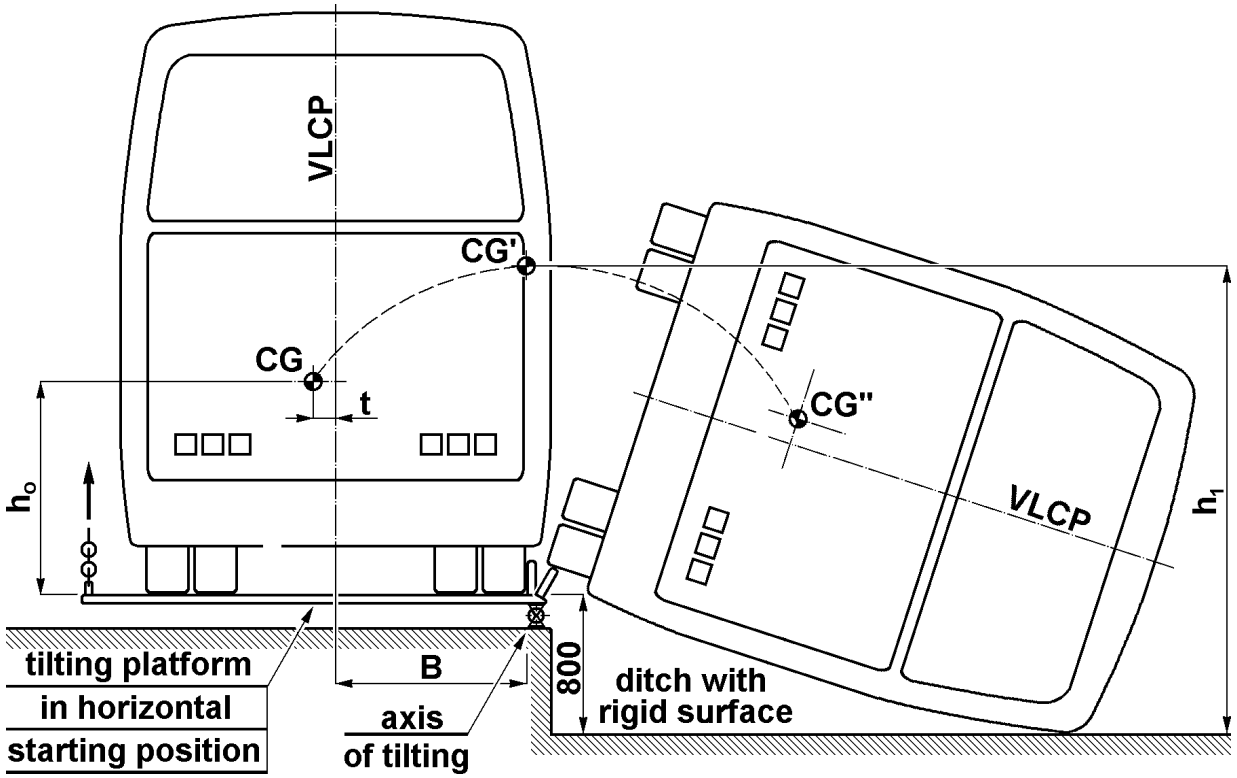
2. Related regulation

❑ Applied regulations

- UN R66 and KMVSS 102-2
  - Requirement: The superstructure of the vehicle shall have the sufficient strength to ensure that the residual space during and after the rollover test on complete vehicle is unharmed

- FMVSS 303 and KMVSS 91
  - Requirement: The pressure drop in the high pressure portion of the fuel system, expressed in kilopascal (kPa), in any fixed or moving barrier crash from vehicle impact through the 60 minute period following cessation of motion shall not exceed: (1) 1062 kPa (154 psi), or (2) 895 (T/VFS); whichever is higher

3. Bus rollover test (1/4)



- 6 CNG storages (924 liter): pressure 210kPa, filled with nitrogen 60% and helium 40%
- Place a test vehicle on the platform above 800 mm from the ground tilting less than 0.087rad/sec

3. Bus rollover test (2/4)

Before

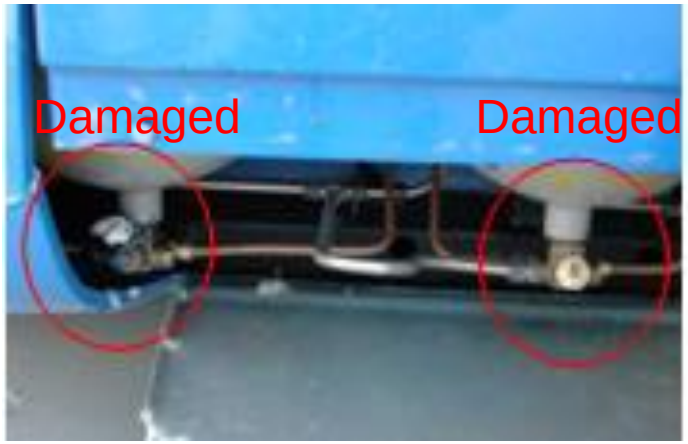
After

3. Bus rollover test (3/4)

Before

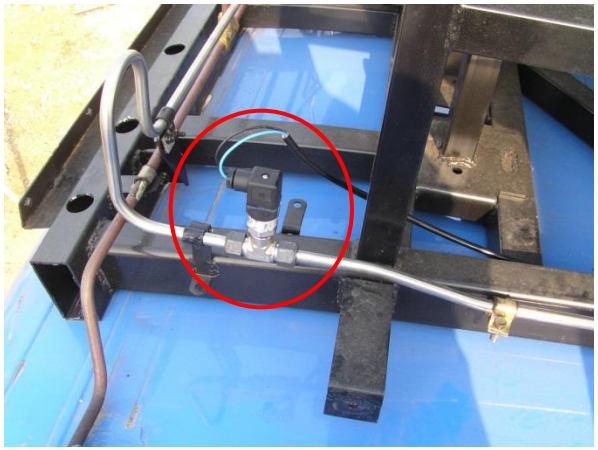
After

Closed view of valves

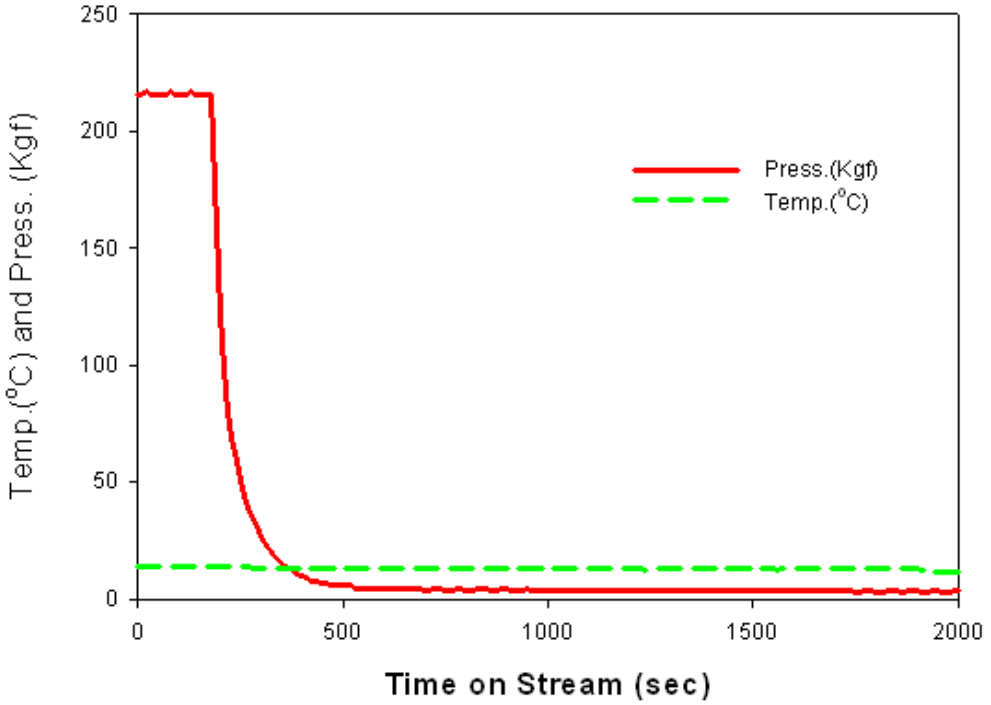


3. Bus rollover test (4/4)

- Strength of superstructure: Satisfied (Rollover at 40 degree)
- Analysis of fuel system integrity
  - Gas leakage from broken valves due to the impact
  - Leakage amount by pressure drop in the high pressure portion exceeded the fuel leakage limit of UN GTR 13 (118NL per minute)

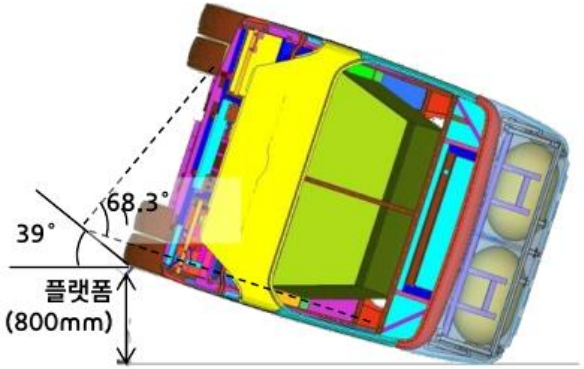


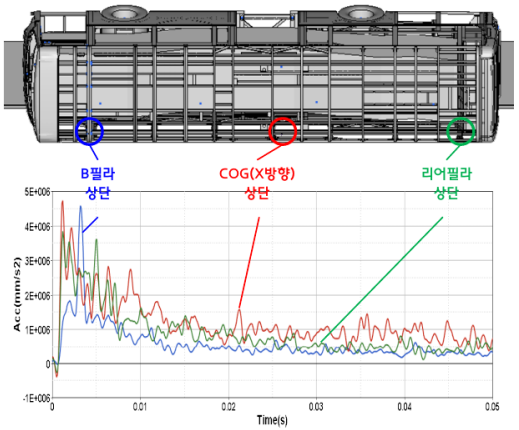
Pressure sensor



4. Conclusion

- Bus rollover test result
  - Mass gas leakage was occurred through the broken valves due to the impact
- Buses with fuel storages in the roof have possibility of gas leakage after rollover
- Need to consider bus rollover test in GTR No.13 Ph.2
- Considerations with test method
  - Body acceleration is very high (more than 40g based on simulation result)
  - Korea is planning to further research on this issue





Thank for your attention

Q&A

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