
Simulation approach for fuel system integrity according to MDB impact tests

Submitted by the expert from Republic of Korea

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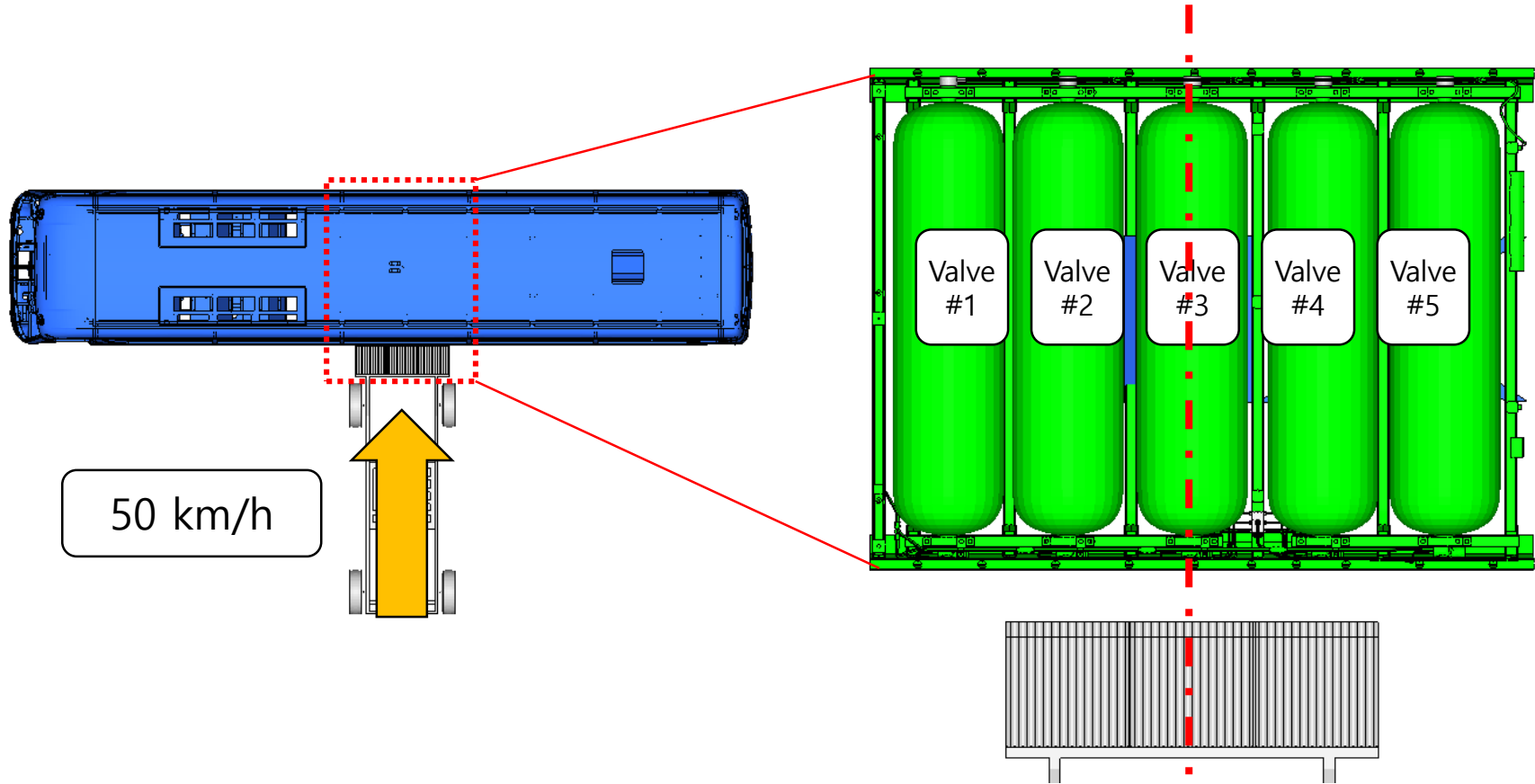
1. Overview

- **[Background]** To investigate the fuel system severity of Hydrogen bus model through the simulation methods according to MDB impact test procedure of UN R 94.
- **[Research Plan]** This study is to evaluate the factors for finding fuel system risk mechanisms according to the MDB impact test.
 - Acceleration of fuel system
 - Impact load
 - Deformation of impacted structure
 - Deflection of fuel tank system

2. Side impact simulation

Bus to MDB Side Impact Simulation - Model setup

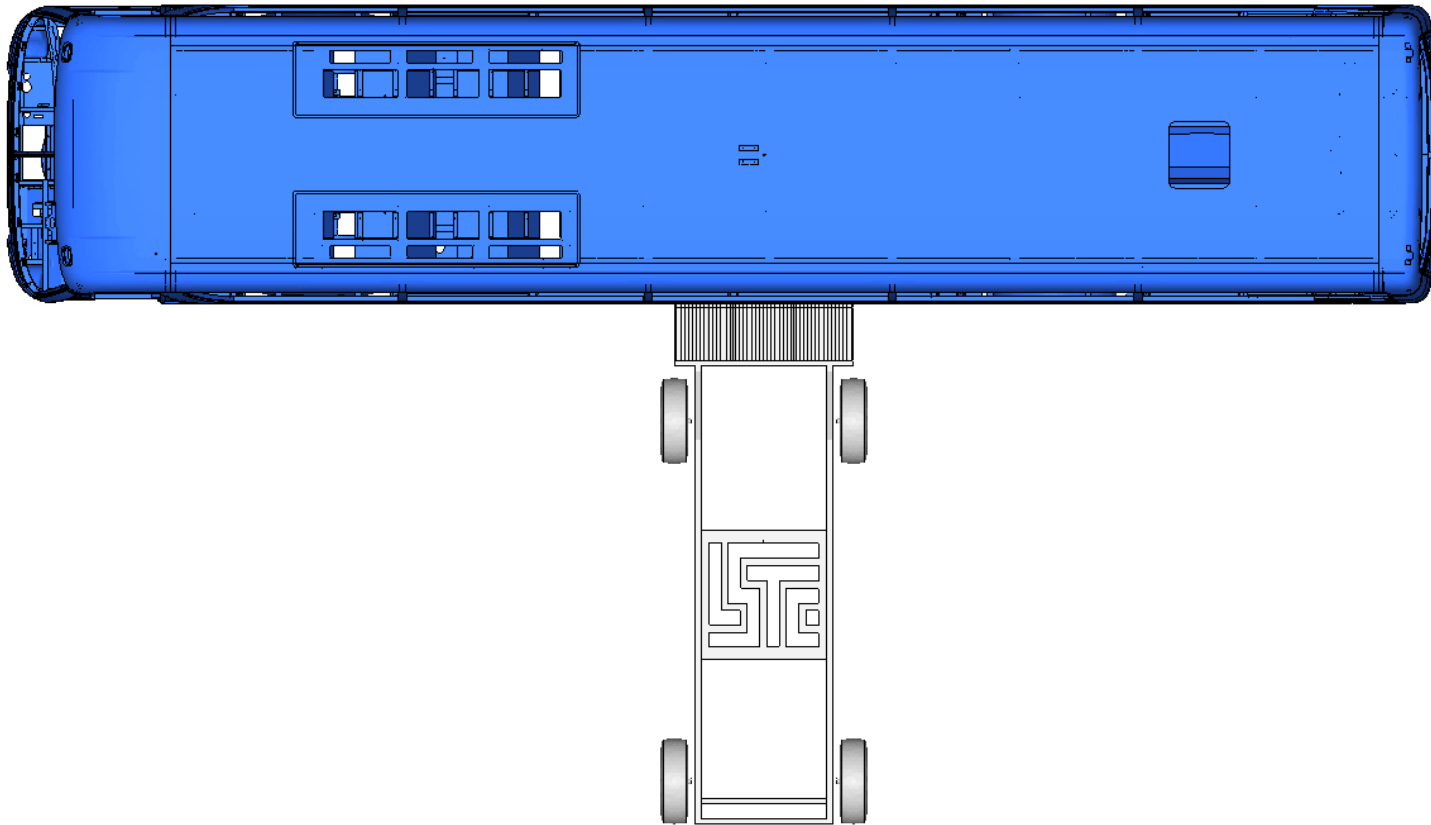
- Hydrogen bus to MDB (950 kg) side impact simulation setup
- Impact location at the center of hydrogen tank system (five tanks)



Bus to MDB Side Impact Simulation

- Deformed shapes

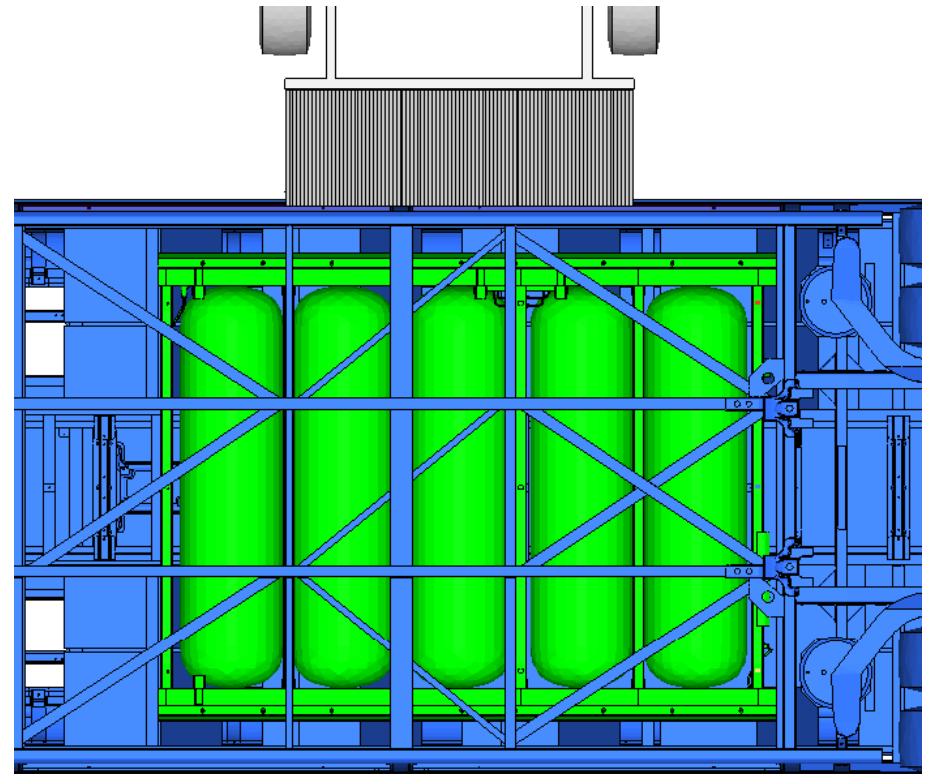
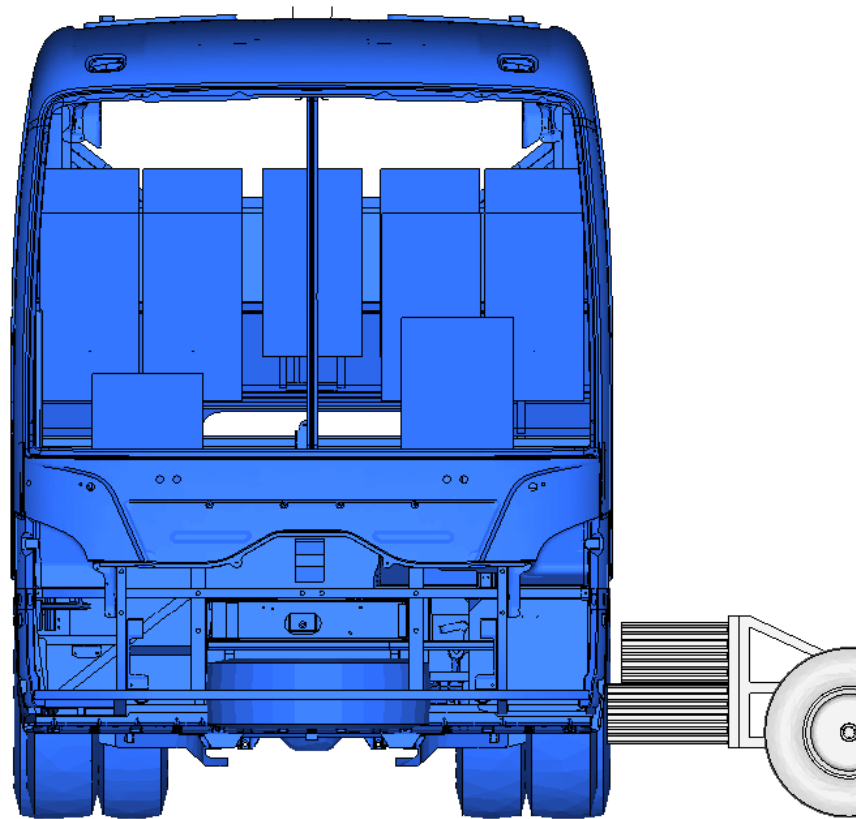
- Top view



Bus to MDB Side Impact Simulation

- Deformed shapes

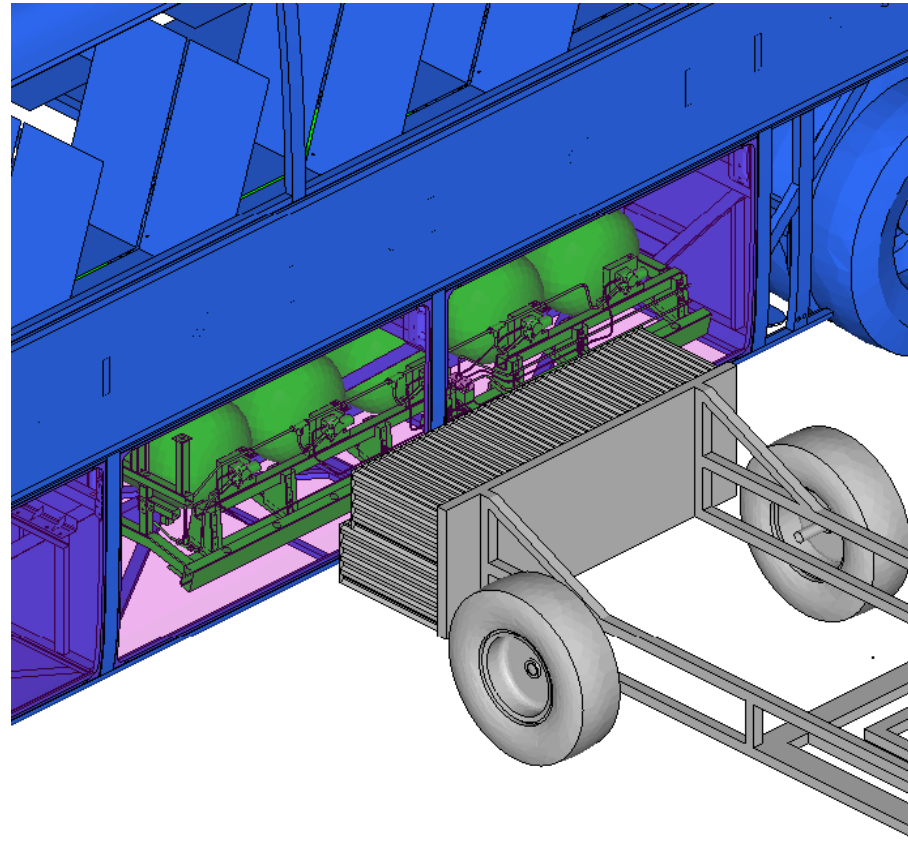
- Side and bottom views



Bus to MDB Side Impact Simulation

- Deformed shapes

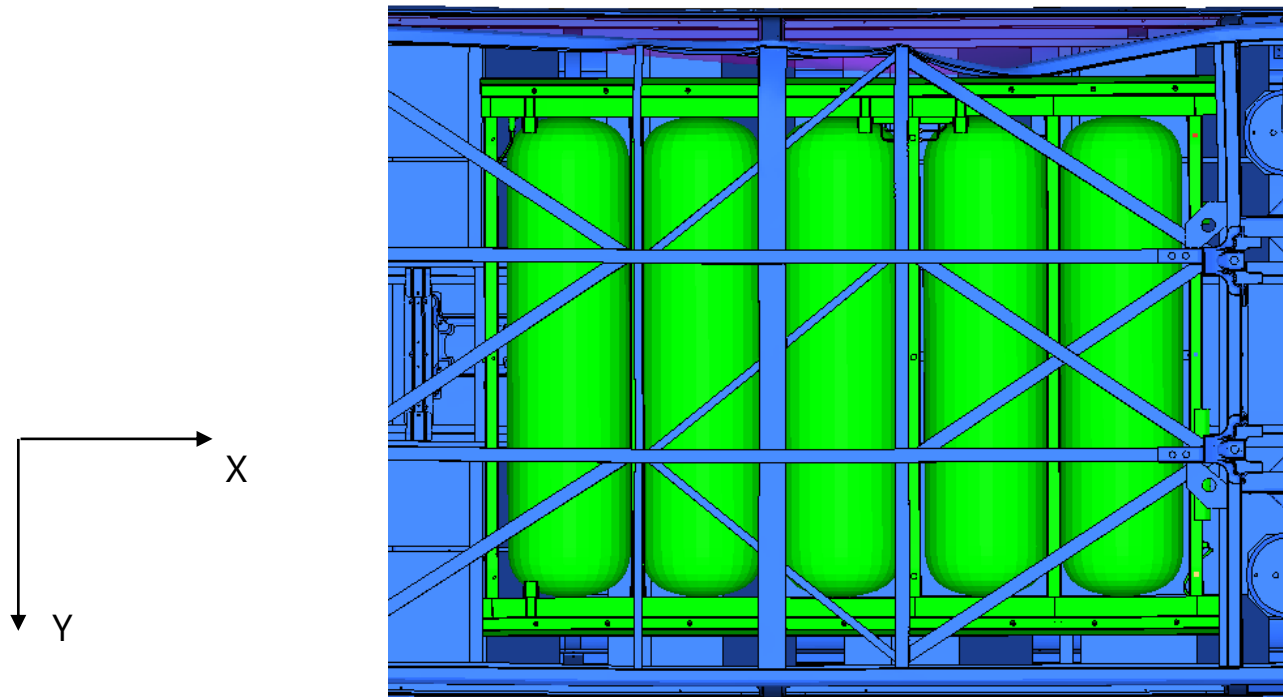
- Isometric view



Bus to MDB Side Impact Simulation

- Deformed shapes

- Maximum deformation of hydrogen tank system and bus underbody was observed at 65 msec.

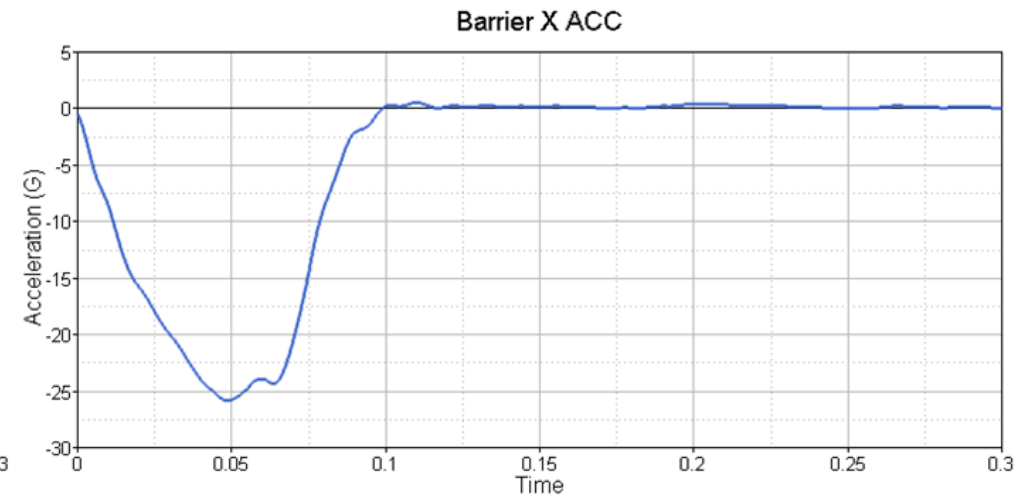
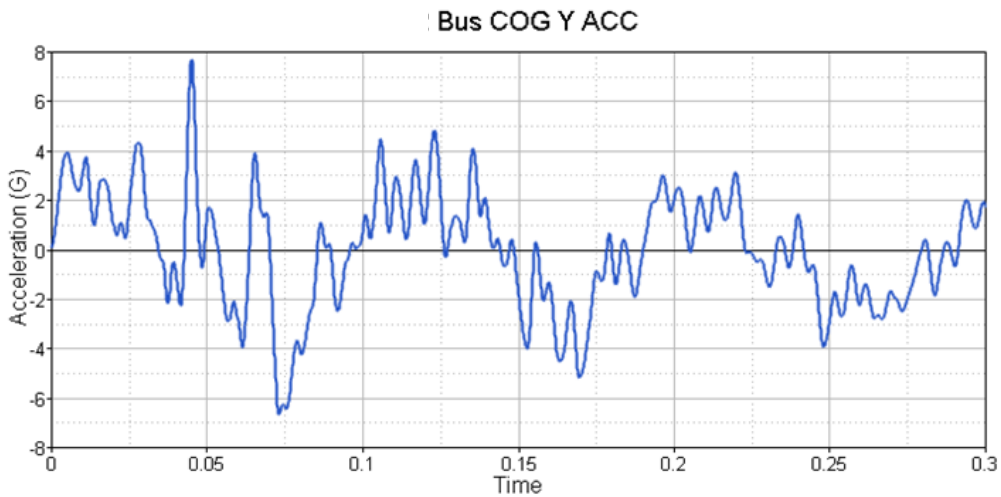


at 65 msec

Bus to MDB Side Impact Simulation

- Time history data

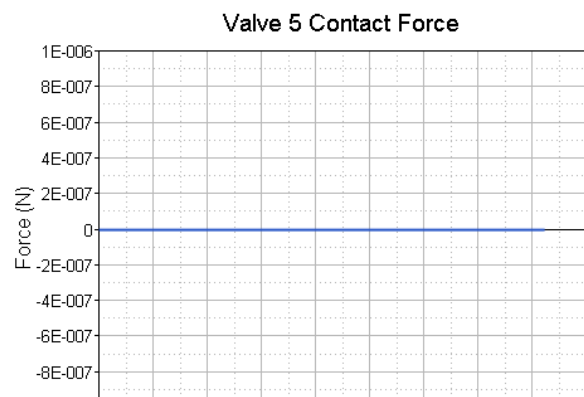
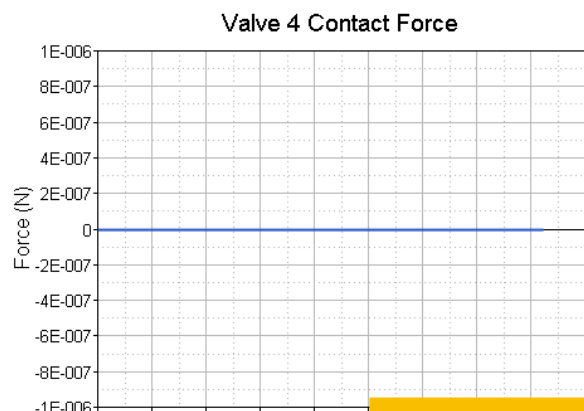
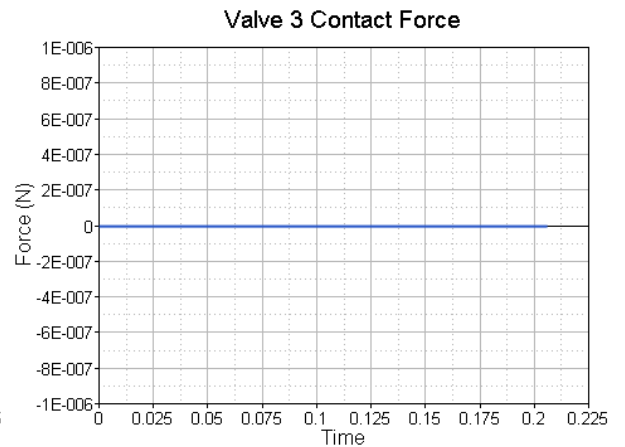
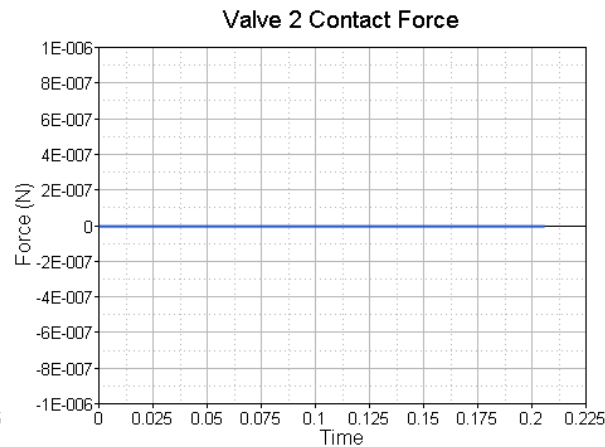
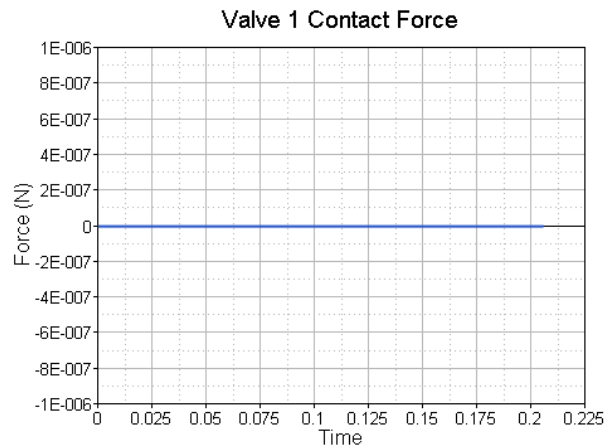
- Acceleration time histories at CGs of bus and MDB



Bus to MDB Side Impact Simulation

- Valve Contact Forces

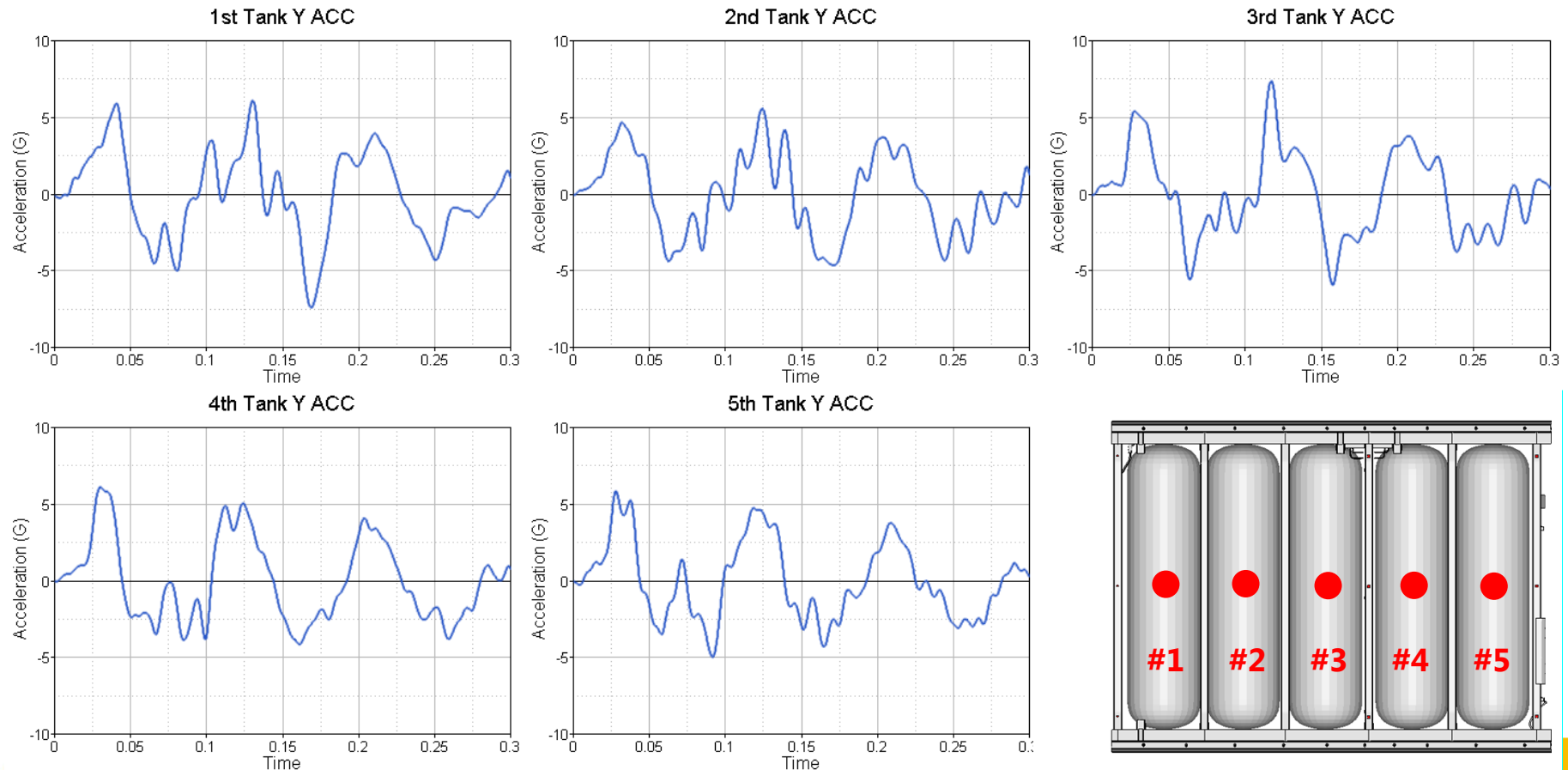
- No contact forces at five tank valves were calculated during simulation.



Bus to MDB Side Impact Simulation

- Acceleration time histories

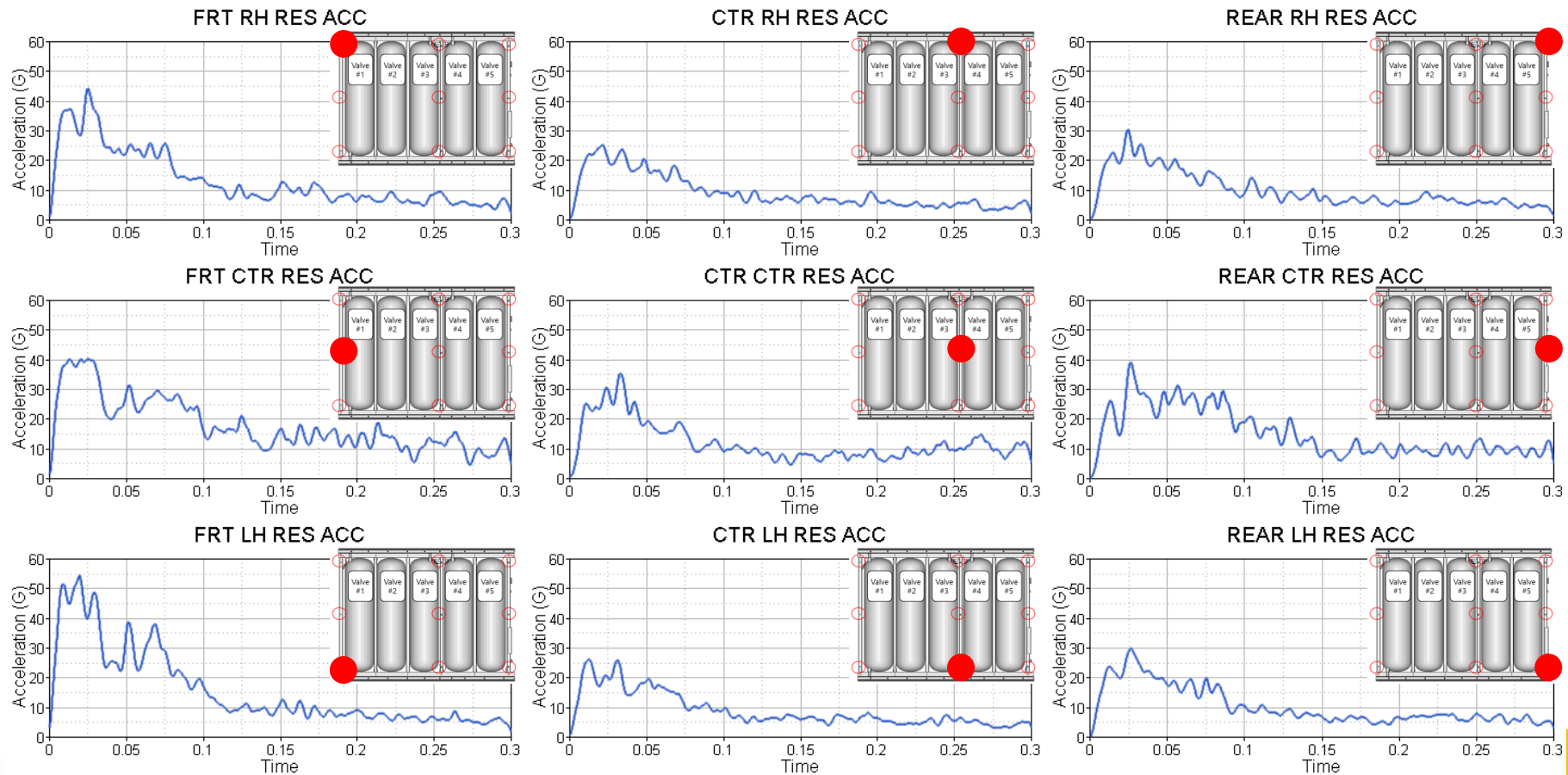
- Acceleration time histories at five centers of hydrogen tanks



Bus to MDB Side Impact Simulation

- Acceleration time histories

- Acceleration time histories at nine locations of hydrogen tank mounting frame

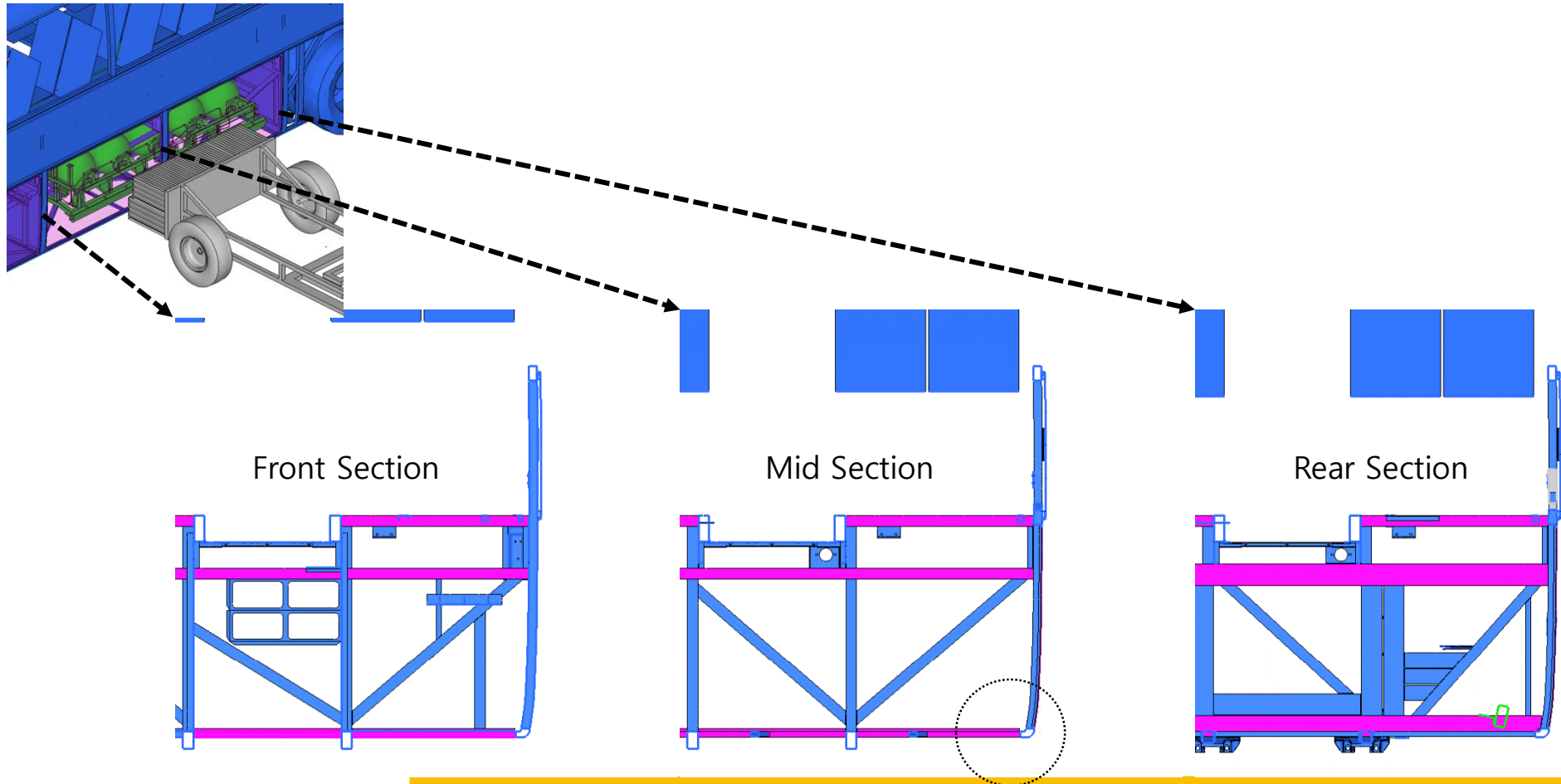


Bus front

Bus to MDB Side Impact Simulation

- Displacements

- Deformed shapes of cross sections at hydrogen tank system.



Max. displacement:
57 mm

3. Summary

- **No direct contacts of fuel tanks in this simulation.**
 - No direct contact of fuel tanks is observed and 57 mm (max. deformation) is calculated in mid section of bus underbody.
- **The inertial acceleration(circa 8g) is calculated due to no direct contact.**
 - Similar as acceleration values of sled test proposed to EU
 - ※ Side impact simulation of a typical bus model was performed.
So, computational results may be related on layout of fuel tank system and vehicle structure & specification.

(Tentative opinion)

- ➔ 1) The MDB impact test is possible to evaluate both the inertial and impact mechanism(risk) at the same time.
- ➔ 2) In case that the fuel tank system is designed in side of protection structure of a HDV, a sled test of fuel tank system is able to evaluate crashworthiness instead of full vehicle side impact.

4. Next plans

- **Additional side impact simulations are planned.**

- Bus side impact simulation with a different type of MDB model
- Bus to bus side impact simulations under various impact speeds

- **Subsystem test evaluation of fuel tank system**

- Investigation for the subsystem test method of fuel tank system to setup the equivalent crash severity of full vehicle impact test