GTR #13 (Phase 2)
FIRE TEST DEFINITION

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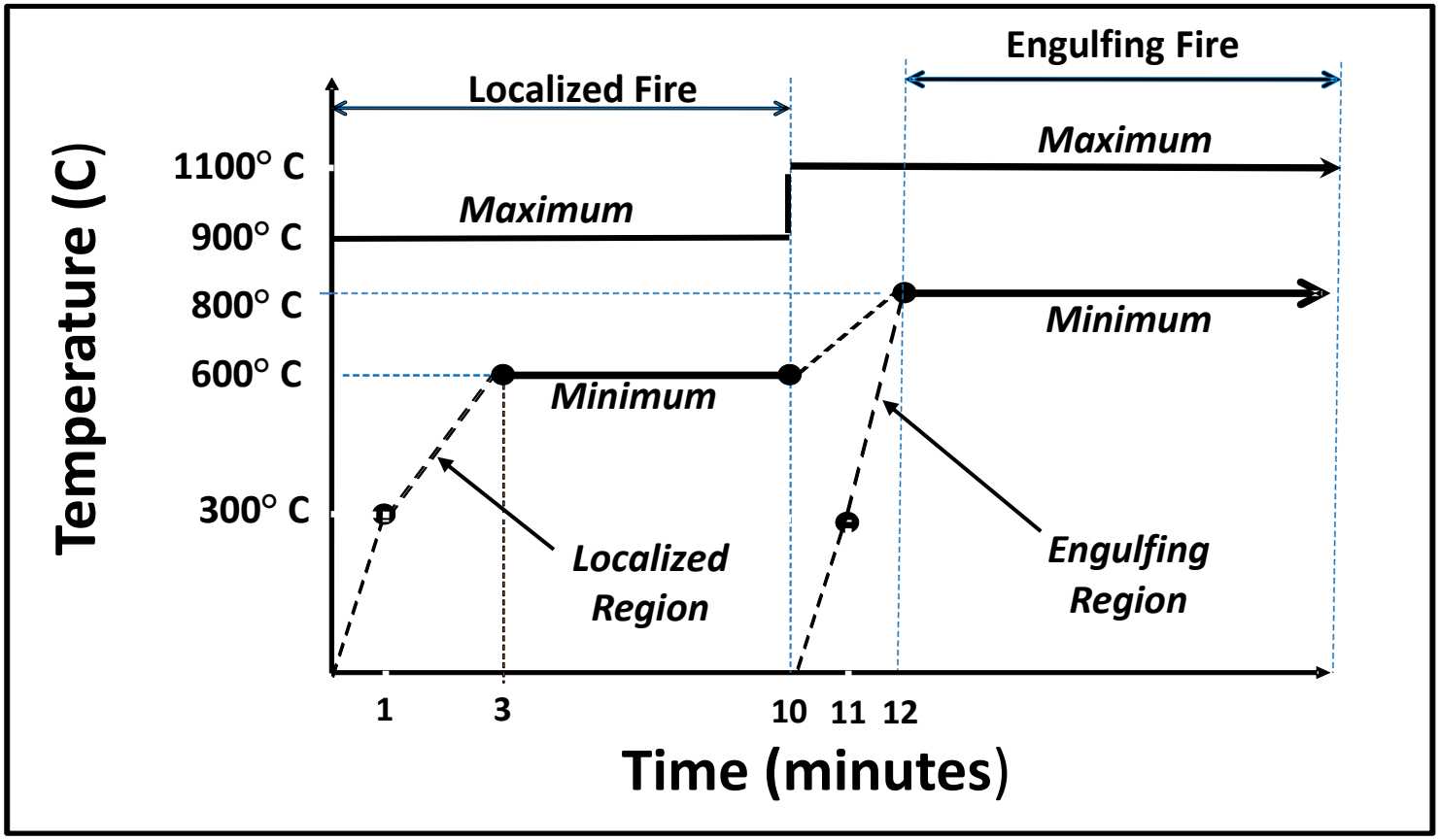
Background
FIRE EXPOSURE IN SAE J2579 AND GTR #13



GTR #13 PHASE 2 OBJECTIVES

- Address Variability in Fire Test Results
- Expand to Larger Vehicles
- Consider Other Situations and Alternatives

VARIABILITIY OF TEST RESULTS

The issue was pointed out at the SAE meeting in June 2017 based on back-to-back testing at four labs.

A Lab.	B Lab.	C Lab.	D Lab.
			
			

Surface temperature around the tank, internal pressure, flame scale, flame type differ.

ADDRESSING VARIABILITIY OF TEST RESULTS

- Sources of variability appear to be --

    1) Wind
    2) Width of fire (relative to tank diameter)
    3) Uniformity of fire within the test area
    4) Height of flame

- JARI is performing tests to investigate identified sources of variability.

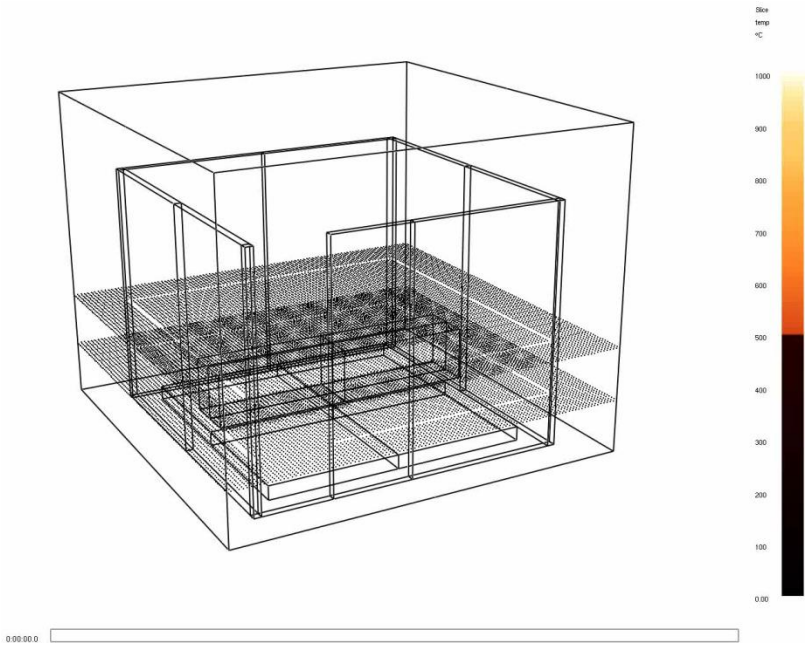
ADDRESSING VARIABILITIY OF TEST RESULTS

Wind

In GTR 13 Phase 1, the wind shields are applied to ensure uniform heating. However, installing an easy wind shields creates a fire whirl, and there is a problem with reproducibility.

Effect of wind shields(bonfire test)

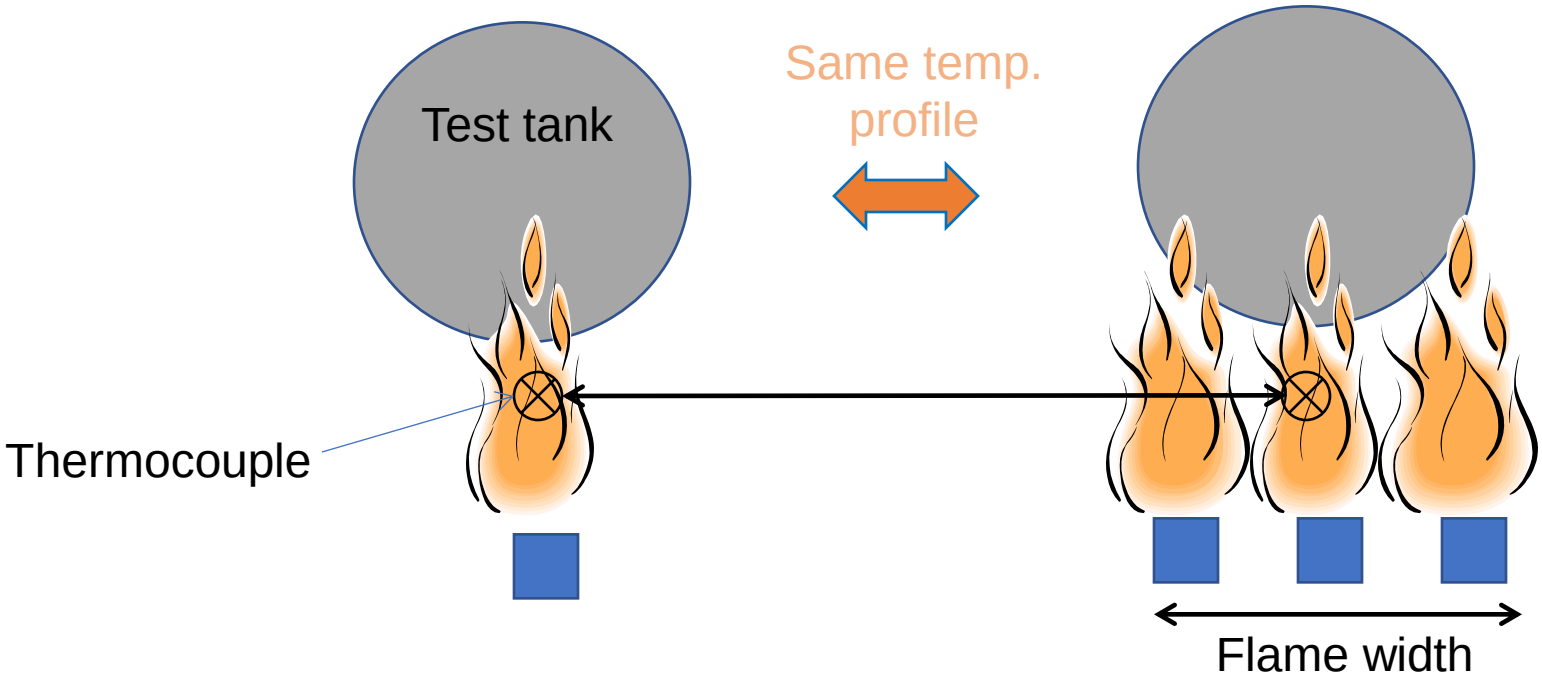
Numerical simulation
(wind vector)



ADDRESSING VARIABILITIY OF TEST RESULTS

Width of fire (relative to tank diameter)

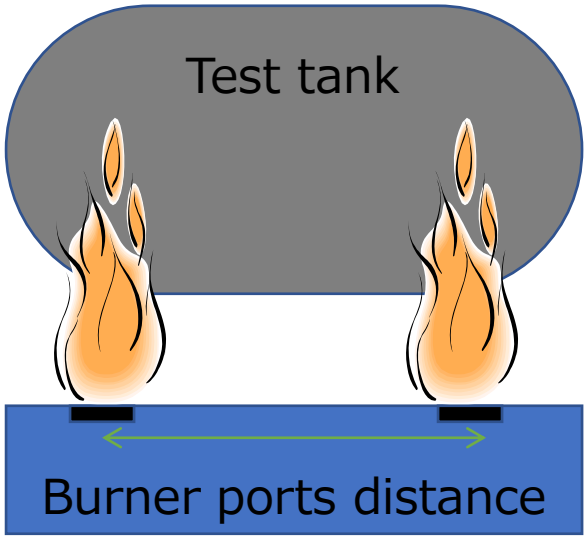
It is necessary to define the width of flame relative to the test tank.

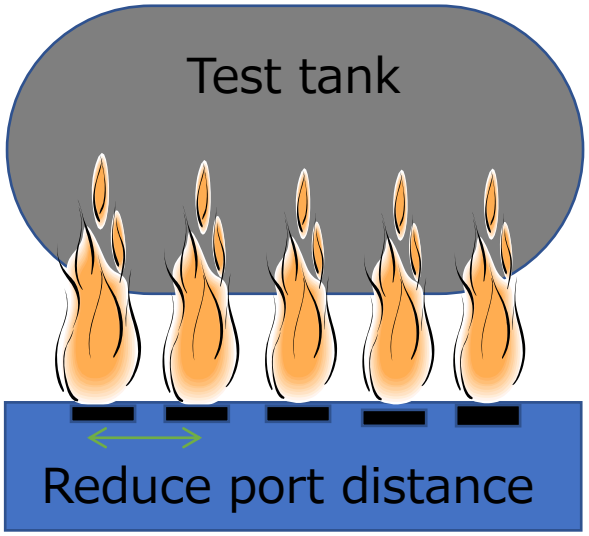


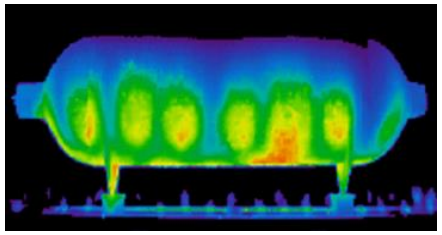
ADDRESSING VARIABILITIY OF TEST RESULTS

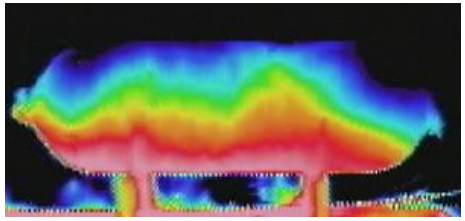
Uniformity of Fire

An example for making the flame uniform.







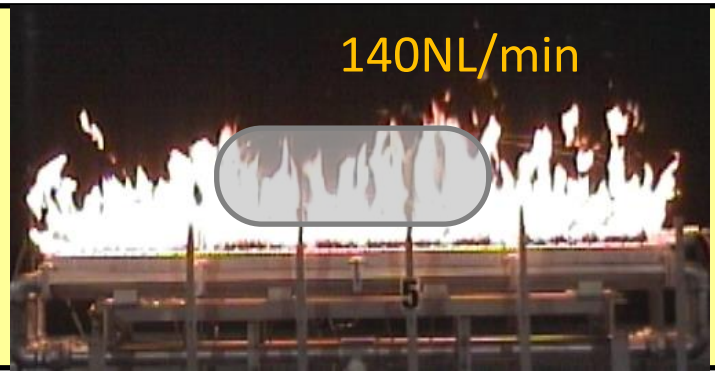
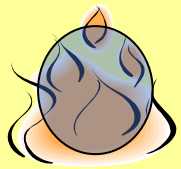
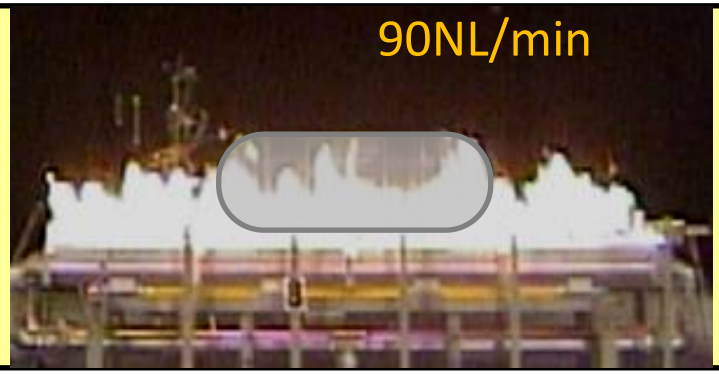


Nonuniform

Uniform flame

ADDRESSING VARIABILITIY OF TEST RESULTS

Height of Flame

Flame height		
Envelop flame		
2/3 cylinder diameter		
1/2 cylinder diameter		

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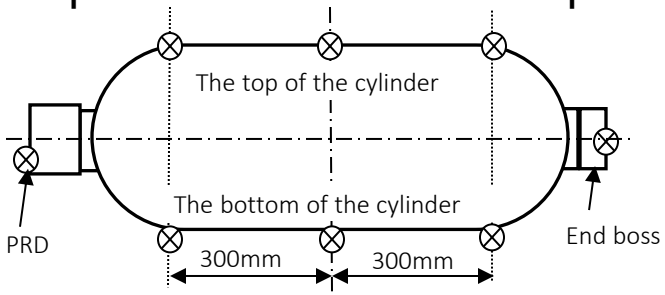
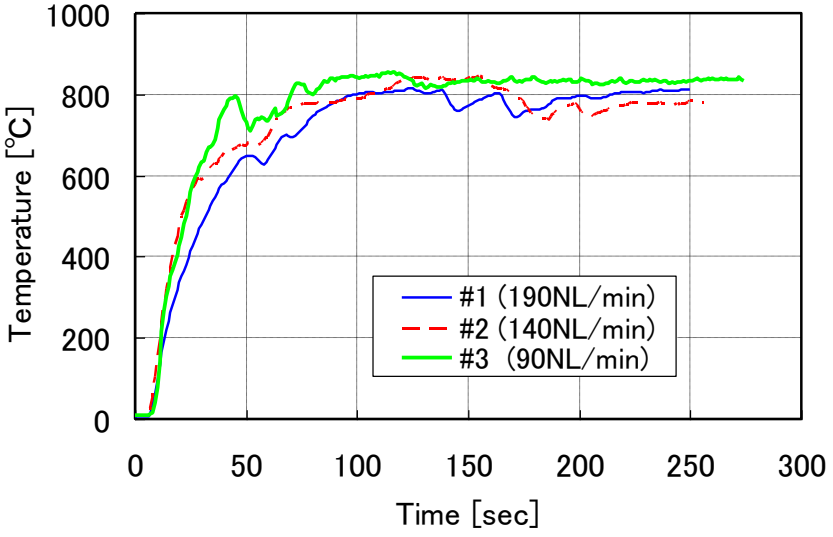
ADDRESSING VARIABILITIY OF TEST RESULTS

Height of Flame

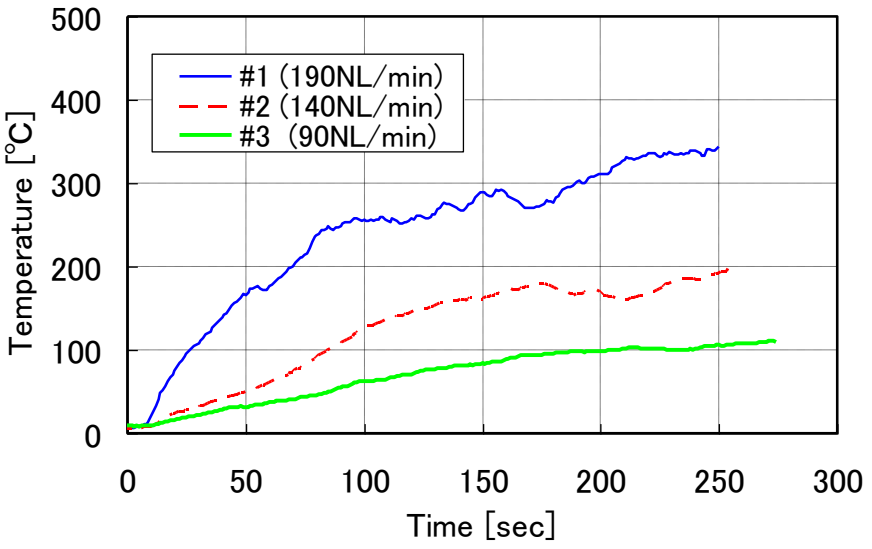
Temperature measurement points



Temp. of the cylinder bottom center



Temp. of the cylinder top center



The temperatures at the bottom are similar in these different flow rates.

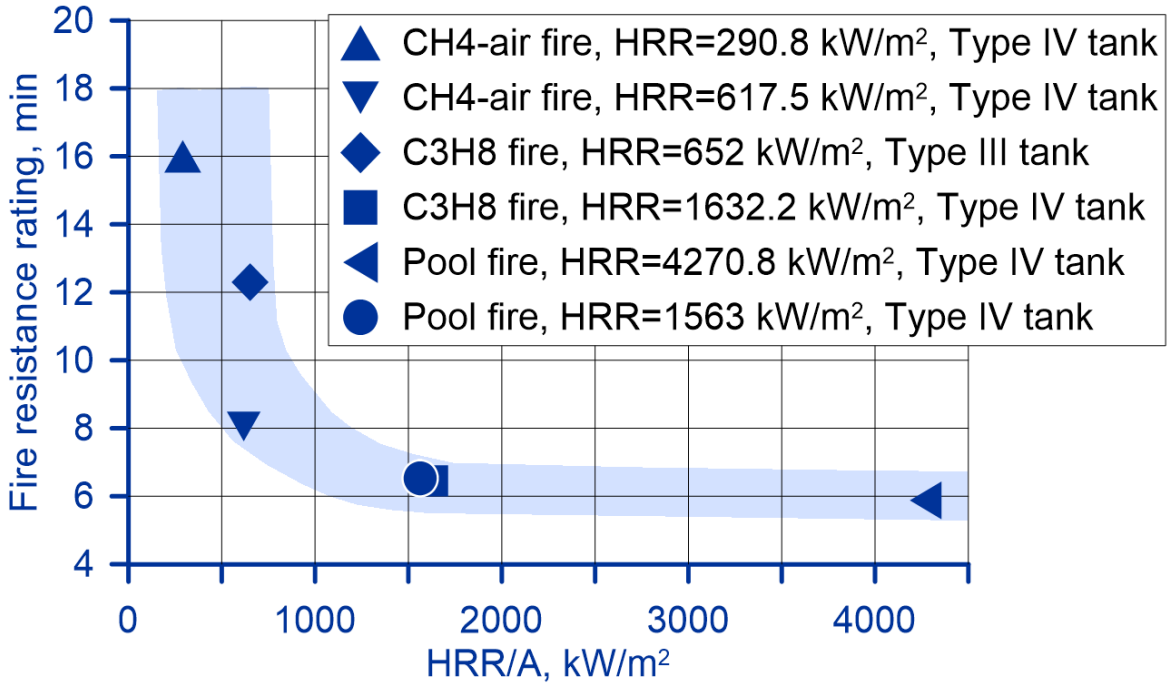
The temperatures at the top of the cylinder are significantly different and can effect TPRD response time.

ADDRESSING VARIABILITIY OF TEST RESULTS
STATUS

	GTR Phase 1	GTR Phase 2
Temperature of Container Bottom	✓	✓
Length of Flame	✓	✓
Wind	✓	Provide additional information to minimize effect of wind and possibly restrict testing if conditions not acceptable. More studyand discussion required.
Width of Fire		Require fire width to extend over full diameter and perhaps beyond. More study/testing required.
Uniformity of Fire		Define burner configuration such that fire spread uniformly over area of exposure without “hot spots”. More study/testing required.
Height of Fire		Additional study/testing required to define how to control flame height. Thermal imagining, temperature measurements, and HRR are possibilities.

ADDRESSING VARIABILITIY OF TEST RESULTS
Proposal from Ulster University

Relationship between the time until the rupture of a tank without PRD (FRR) and the heat release rate (HRR) of the fire.



Use of HRR is simple to control during the test <u>but</u> the proposed test is inconsistent with vehicle-level requirements.

- ✓ 1000kW/ m^2 is significantly greater than relevant heat flux on tank surface (100kW/m^2)
- ✓ Test without TPRD does not verify vehicle protection system

Extension of Fire Test to Larger Vehicles

- Current CNG vehicles are verified to an engulfing test similar to 6.2.5.2 of the GTR.

- Since the localized/engulfing fire test method in 6.2.5.1 of the GTR was based on adding a localized fire interval to the engulfing fire in 6.2.5.2, this localized/engulfing fire test method should also serve as a starting pointing for heavy-duty vehicles.

- From the standpoint of expanding the GTR to heavy-duty vehicles, the test methods in 6.2.5.1 and 6.2.5.2 are sufficient; however, the following precautions are being considered for inclusion:

  - The vehicle design shall ensure that no shielding, barriers, or structural supports prevent the fire to reach the TPRD.
  - The design shall prevent the possibility of long lasting localized fire on tanks or represent such additions as part of the localized fire test. See *other situations on next page*.

Considering Other Situations and Alternatives

- Cargo/load burning or hybrid battery fires or hot spots compromising the container may need to addressed by either --
  - adding a basic requirement for thermal isolation (by physical separation and/or barriers) *or*
  - address by discussing these issues in the non-normative or normative test description.

  *G*uidance with regard to approach will be appreciated!

- The possibility of exposure to hydrogen fires was also considered. Since 5.2.1.3.1 already prevents T-PRD vents from directly flows at containers, it was concluded that other hydrogen leak possibilities be deferred to TF#1.

- Introduction to Leak-No-Burst (LNB) technology
  - Supposed to allow safe venting of gas during fire without TPRD *but* verification of technology required.
  - Not yet adopted into container standards. Does a LNB liner meet other container requirements? For example, liner temperatures for “fast fills”.
  - Integration into vehicles and validation will also be required.
  - Is this approach ready for the GTR?