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Test method of Heavy Duty Vehicle's Fuel Consumption in Japan

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Out line

- **Issues and solutions of measuring emissions and fuel consumption of heavy-duty vehicles**
- **Test method in Japan**
- **Evaluated elements**
- **Next issues**
- **Summary**

Issues and Solutions
(Emissions of heavy-duty vehicles)

- **Issues**
  - ✓**Emissions from engine unit are demanded**
  - ✓**Measurement of real world emissions**

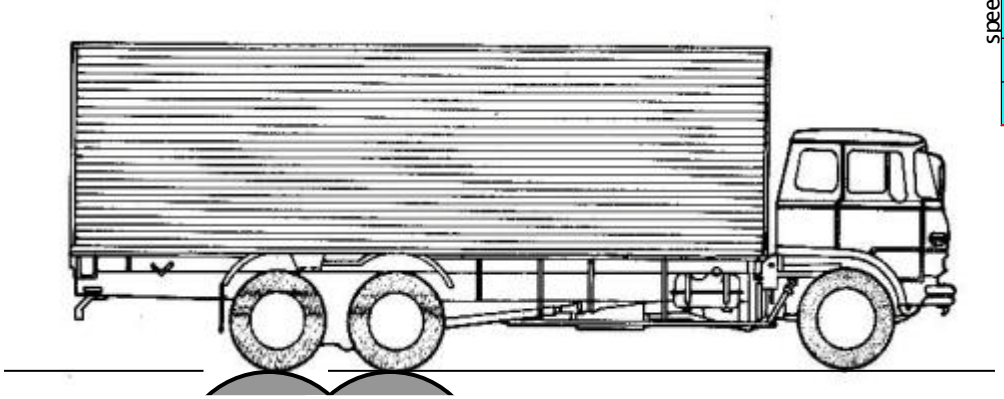
- **Solution**
  - ✓**Engine dynamometer test method**
  - ✓**Transient engine speed and torque for real world emissions**
    - **WHTC, JE05, FTP, ETC test procedure, etc.**
  - ✓**WHTC will be the standard test method all over the world**

Issues and Solutions
(Fuel consumption of heavy-duty vehicles)

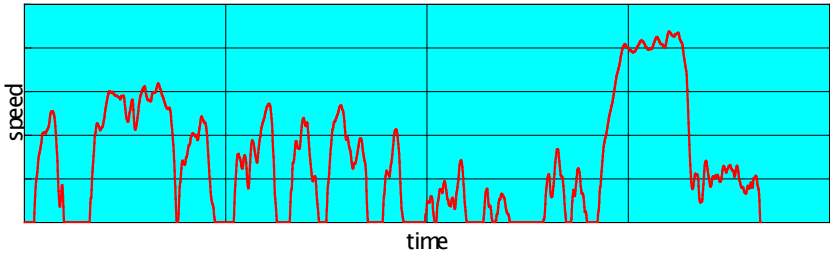
- **Issues**
  - ✓Fuel consumption from vehicle is demanded
  - ✓Many kind of engines and chassis
  - ✓Cost to constitute test facilities (test truck, chassis dynamometer)

- **Solutions**
  - ✓ Chassis dynamometer method
  - ✓ Engine dynamometer method
  - ✓ Simulation based on fuel consumption rate map

Chassis dynamometer method



Real world driving cycle (JE05)



Problems

- **Necessary to constitute the test facilities**
- **Huge time is necessary to measure**
- **Necessary to secure the vehicle**

Unrealistic

Many kind of engines and chassis (1)

- **Body shapes of heavy duty vehicles**

Flat carrier

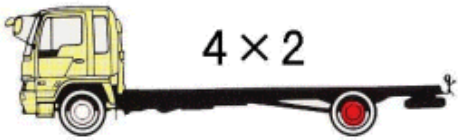
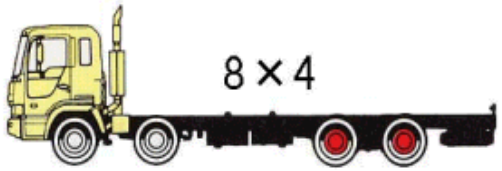
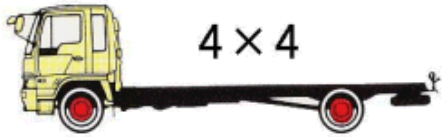
Van

Dump truck

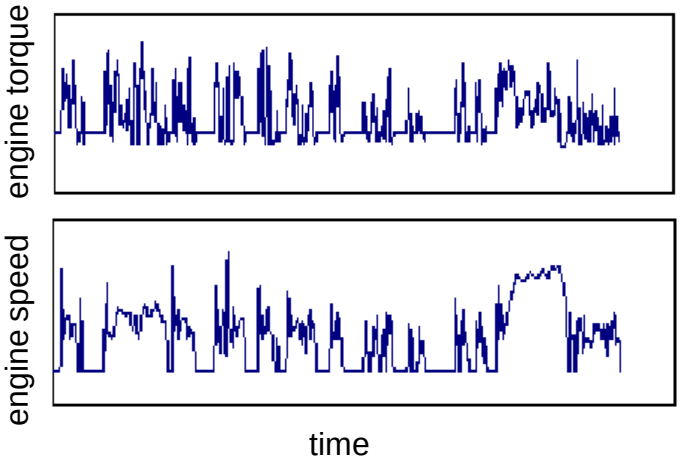
Tractor

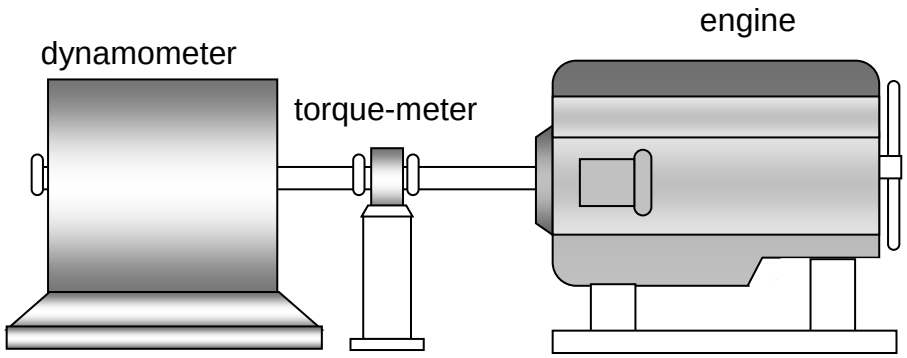
Many kind of engines and chassis (2)

- **Drive Systems of heavy duty vehicles**

2-axle vehicle	3-axle vehicle	4-axle vehicle
		
		
		
		

Engine dynamometer method





Problems

- **Use the representative vehicle specification of emission test** → **Inappropriate for accuracy**
- **Use the actual vehicle specification** →
  - **many engine dynamometer tests are needed**
  - **High cost**

Out line

- Issues and solutions of measuring emissions and fuel consumption of heavy-duty vehicles
- Test method in Japan (simulation method)
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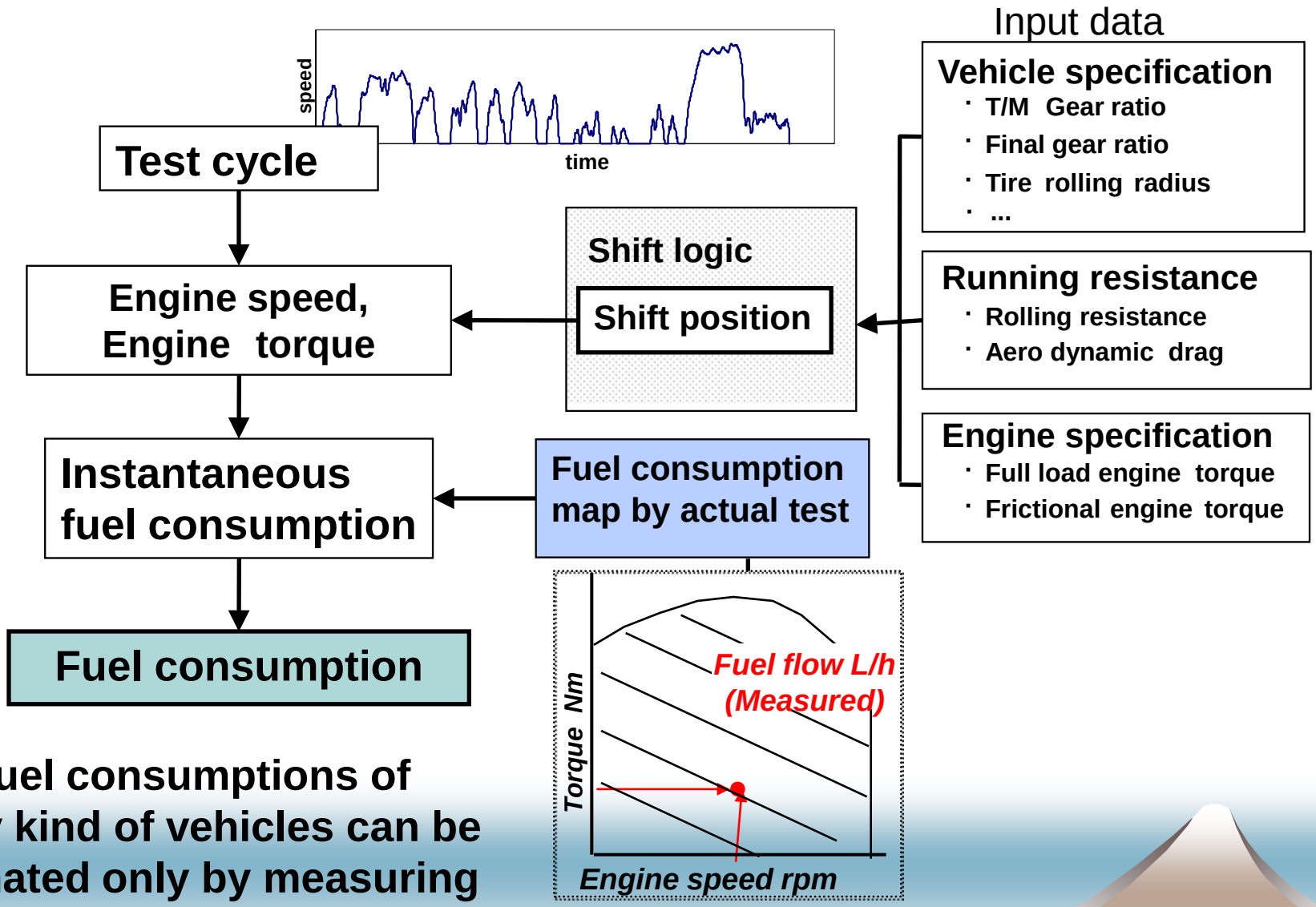
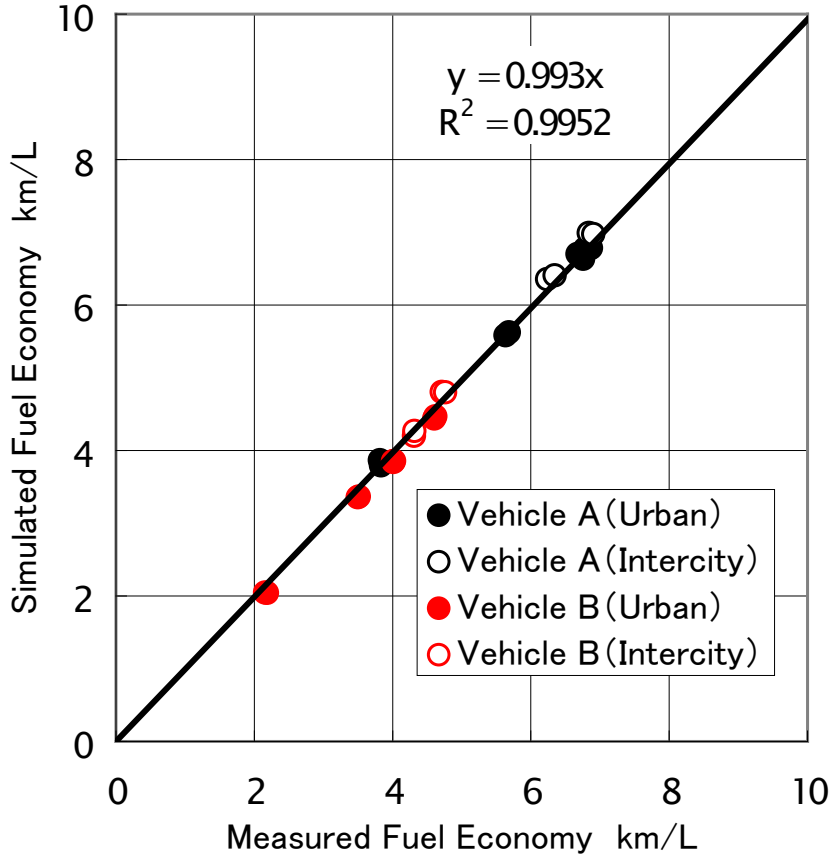
Simulation method



The fuel consumptions of many kind of vehicles can be estimated only by measuring a fuel consumption map.

Accuracy of simulated fuel consumption

The estimated accuracy of the fuel consumptions is very high.



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Element considering on simulation

- **Driving pattern**
  - ✓Real-world transient speed cycle
  - ✓Grade (in free way cycle)

- **Input data of vehicle specification**

item		spec.	
engine	full load engine torque	every engine	actual spec.
	engine friction torque		
	idling engine speed		
	rated engine speed		
	governed engine speed		
transmission	No. of transmission gear	every transmission	actual spec.
	transmission gear ratio		
	final reduction gear ratio	every engine & transmission	actual spec. (final reduction gear & tire closest to average V1000* @top gear)
	tire rolling radius		
running resistanse	rolling resistanse	same value @ each category	standard spec.
	aerodynamic drag		
body	vehicle weight	same value @ each category	standard spec.
	maximum payload		
	persons		
	overall hight		
	overall width		

* speed(km/h) @1000rpm engine speed

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Next issues (2)

- **Input data of vehicle specification**
  - ✓**Reflection of actual running resistance**
    - **Aerodynamic drag coefficient**
    - **Rolling resistance**
  - ✓**Measurement / Estimation of running resistance**
    - **Aerodynamic drag coefficient: Estimation by CFD ?**
    - **Rolling resistance: Reflection of ISO tire test method ?**
- **Objective vehicle shapes**
  - ✓**Standard vehicle type (flat carrier) in Japanese method**
  - ✓**Actual vehicle shapes are needed to evaluate aerodynamic improvement**
  - ✓**Adjustment with manufacturing "chassis and cabin"**

Standard production process of HDV

Chassis with cabin
（vehicle manufacturer）

Finished
（body manufacturer）

Standard vehicle type in Japanese method

- **Simplified vehicle variation and standard vehicle spec**
  - ✓**Flat carrier vehicle (truck)**
  - ✓**Standard aerodynamic drag coefficient**
  - ✓**Standard rolling resistance coefficient**

type	No.	category		standard vehicle specification				
		GVW (t)	payload (t)	vehicle weight (kg)	maximum payload (kg)	capacity (persons)	overall height (m)	overall weidth (m)
except tractor	1	3.5＜＆≦7.5	≦1.5	1,957	1,490	3	1.982	1.695
	2		1.5＜＆≦2	2,356	2,000	3	2.099	1.751
	3		2＜＆≦3	2,652	2,995	3	2.041	1.729
	4		3＜	2,979	3,749	3	2.363	2.161
	5	7.5＜＆≦8	–	3,543	4,275	2	2.454	2.235
	6	8＜＆≦10	–	3,659	5,789	2	2.625	2.239
	7	10＜＆≦12	–	4,048	7,483	2	2.541	2.350
	8	12＜＆≦14	–	4,516	7,992	2	2.572	2.379
	9	14＜＆≦16	–	5,533	8,900	2	2.745	2.480
	10	16＜＆≦20	–	8,688	11,089	2	3.049	2.490
	11	20＜＆≦25	–	8,765	15,530	2	2.934	2.490
tractor	1	tractor-head GVW ≦20		10,525	24,000	2	2.927	2.490
	2	tractor-head GVW 20＜		19,028	40,000	2	2.890	2.490

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Summary

- **Engine dynamometer method for exhaust emissions test**
  - ✓ **WHTC will be the standard**
- **Simulation method for fuel consumption test**
  - ✓**High accuracy and low cost**
  - ✓**Most of affecting elements of fuel consumption are evaluated**
    - **Real world diving cycle**
    - **Engine performance of fuel consumption**
    - **Vehicle specification**

      Mass, Transmission gear ratio, Aerodynamic drag, Rolling resistance, etc.
- **Element which should be improved**
  - ✓**Actual vehicles' aerodynamic coefficient**
  - ✓**Actual vehicles' rolling resistance coefficient**

Thank you for your attention.