WLTP-12-XYZ-rev1e

Study on Evaluation Criteria of Road Load Tolerance in Korea

29 Sep. ~ 1 Oct. 2015

KATRI, The Republic of KOREA
(Korea Automobile Testing & Research Institute)

Contents

1. Korea Regulation related to RL Tolerance

❖ KOREA regulation related to Fuel economy & Running resistance test

⇒ "Regulation for Test procedures for Energy efficiency, Greenhouse gas emission and Fuel economy for Motor Vehicles"

- Article 12 (Running resistance test)

(1) The running resistance test shall, upon compliance test, be performed in accordance with Article 6, in the providing ground defined by the Minister of MOLIT.

(2) If the tolerance of running resistance value between measured by testing agency pursuant to Clause 1 and specified by the manufacturers is within 15%, the value specified by manufacturers shall be accepted. Herein, the tolerance means the discrepancy of energy considering fuel economy mode. If exceeding the tolerance, the value measured by testing agency shall be applied.

2. Status for Road-Load Evaluation Criteria in Korea

MOLIT
Ministry of Land, Infrastructure and Transport

KATRI
Korea Automobile testing & research Institute

- Evaluation criteria for the Road-Load tolerance

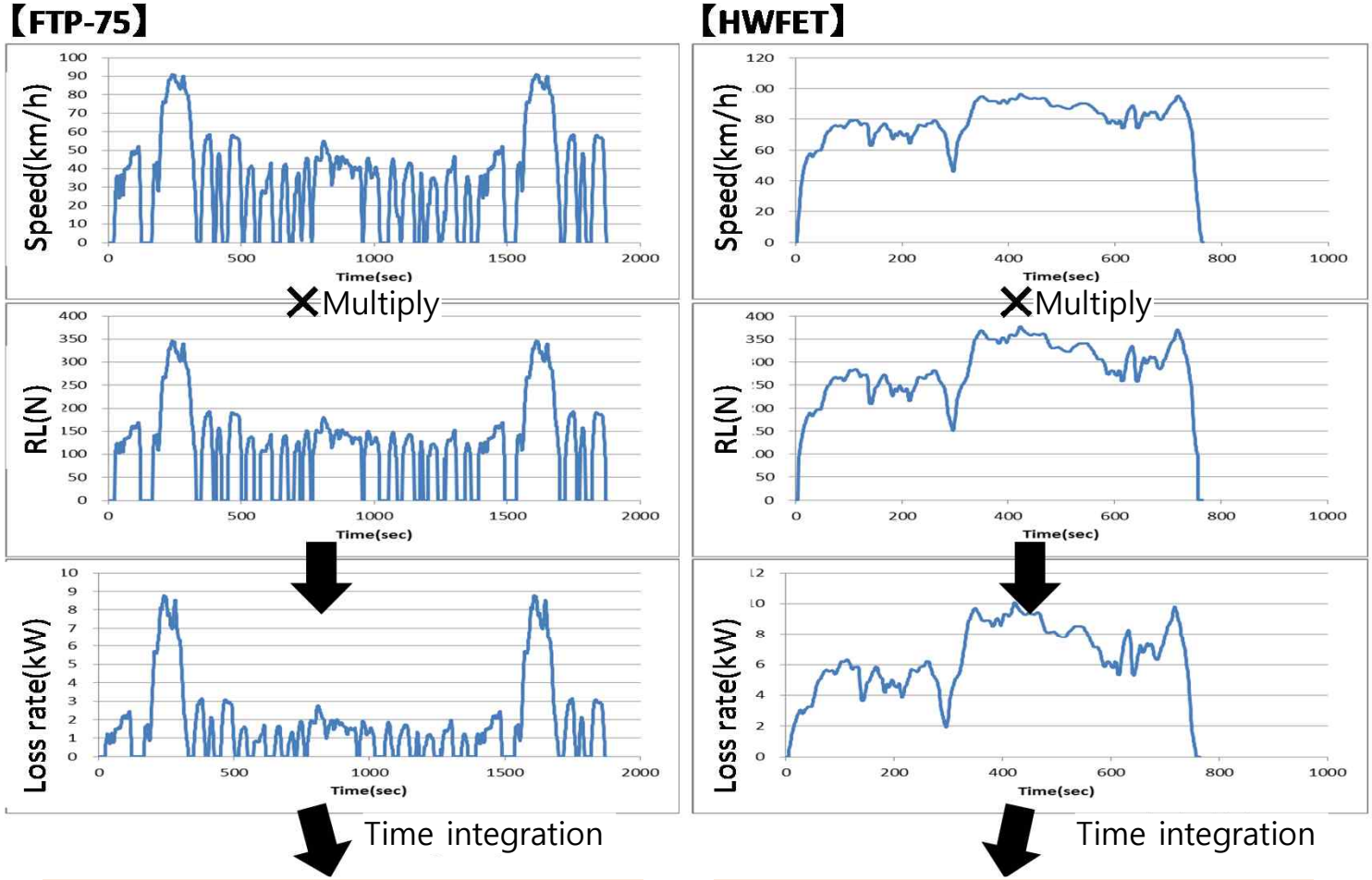
  ➢ Status of RL study in Korea

Under the study for evaluation criteria in KOREA

	brief description	Remarks
1. Energy loss diff. considering each FC test cycle	▪ Each energy loss comparison of FTP-75 and HWFET test cycle by using audit values (measured by Gov.) and target values (submitted by manufactures)	☺
2. Energy loss diff. considering FC test cycles(weighted)	▪ First, each weighted energy loss calculation of FTP-75 and HWFET test cycle by using audit values and target values *weighted energy loss = 0.55*FTP-75 energy loss + 0.45*HWFET energy loss ▪ Finally, weighted energy loss comparison based on the two results	☺
3. RL force diff. considering coastdown velocity range (KOREA compliance test)	▪ First, calculate each RL force based on coastdown speed range by using audit values and target values ▪ At this time, each RL force is calculated based on 5kph intervals within the coastdown speed range ▪ Finally, averaged RL force comparison for 21 points	-
4. RLHP diff. at 50mph (EPA)	▪ RLHP is calculated at 50mph by using audit values and target values ▪ Finally, RLHP comparison for 1 point at 50 mph	-
5. Each RL coefficient diff. (Brazil compliance test)	▪ RL coefficients(f0, f2) comparison by using audit values and target values	Need to be checked

2. Status for Road-Load Evaluation Criteria in Korea

- Energy loss(kJ) considering FC test cycle (each or combined)



$$\text{Energy loss}_{Combined}(kJ) : 0.55 \times \text{Energy loss}_{FTP-75}(kJ) + 0.45 \times \text{Energy loss}_{HWFET}(kJ)$$

3. Derivation of Constant of RL Coefficients using each FC cycle energy

● Derivation method for RL Tolerance Coefficient considering Energy loss(kJ) of each FC test cycle(FTP-75 & HWFET)

▪ **Energy loss$_{FTP-75}$(kJ) :** $\int_0^{2477}(f_0+f_1v_F+f_2v_F^2)\times v\,dt = \int_0^{2477}(f_0v_F+f_1v_F^2+f_2v_F^3)dt$

$= f_0\times\underbrace{\int_0^{2477}v_F dt}_{A(F)_{f0}} + f_1\times\underbrace{\int_0^{2477}v_F^2 dt}_{B(F)_{f1}} + f_2\times\underbrace{\int_0^{2477}v_F^3 dt}_{C(F)_{f2}}$

$= f_0\times A(F)_{f0} + f_1\times B(F)_{f1} + f_2\times C(F)_{f2}$

$\Rightarrow \boldsymbol{f_0\times 17.4 + f_1\times 994.0 + f_2\times 58865.6}$

▪ **Energy loss$_{HWFET}$(kJ) :** $\int_0^{765}(f_0+f_1v_H+f_2v_H^2)\times v\,dt = \int_0^{765}(f_0v_H+f_1v_H^2+f_2v_H^3)dt$

$= f_0\times\underbrace{\int_0^{765}v_H dt}_{A(H)_{f0}} + f_1\times\underbrace{\int_0^{765}v_H^2 dt}_{B(H)_{f1}} + f_2\times\underbrace{\int_0^{765}v_H^3 dt}_{C(H)_{f2}}$

$= f_0\times A(H)_{f0} + f_1\times B(H)_{f1} + f_2\times C(H)_{f2}$

$\Rightarrow \boldsymbol{f_0\times 16.5 + f_1\times 1337.9 + f_2\times 110664.5}$

	A_{f0} (km)	B_{f1} (km²/h)	C_{f2} (km³/h²)
FTP-75	17.4	944.0	58,865.6
HWFET	16.5	1,337.9	110,664.5

※ Available vehicle speed : $v \geq$ 10mph (≒16kph)
(Veh. speed is treated as zero at less than 10mph)

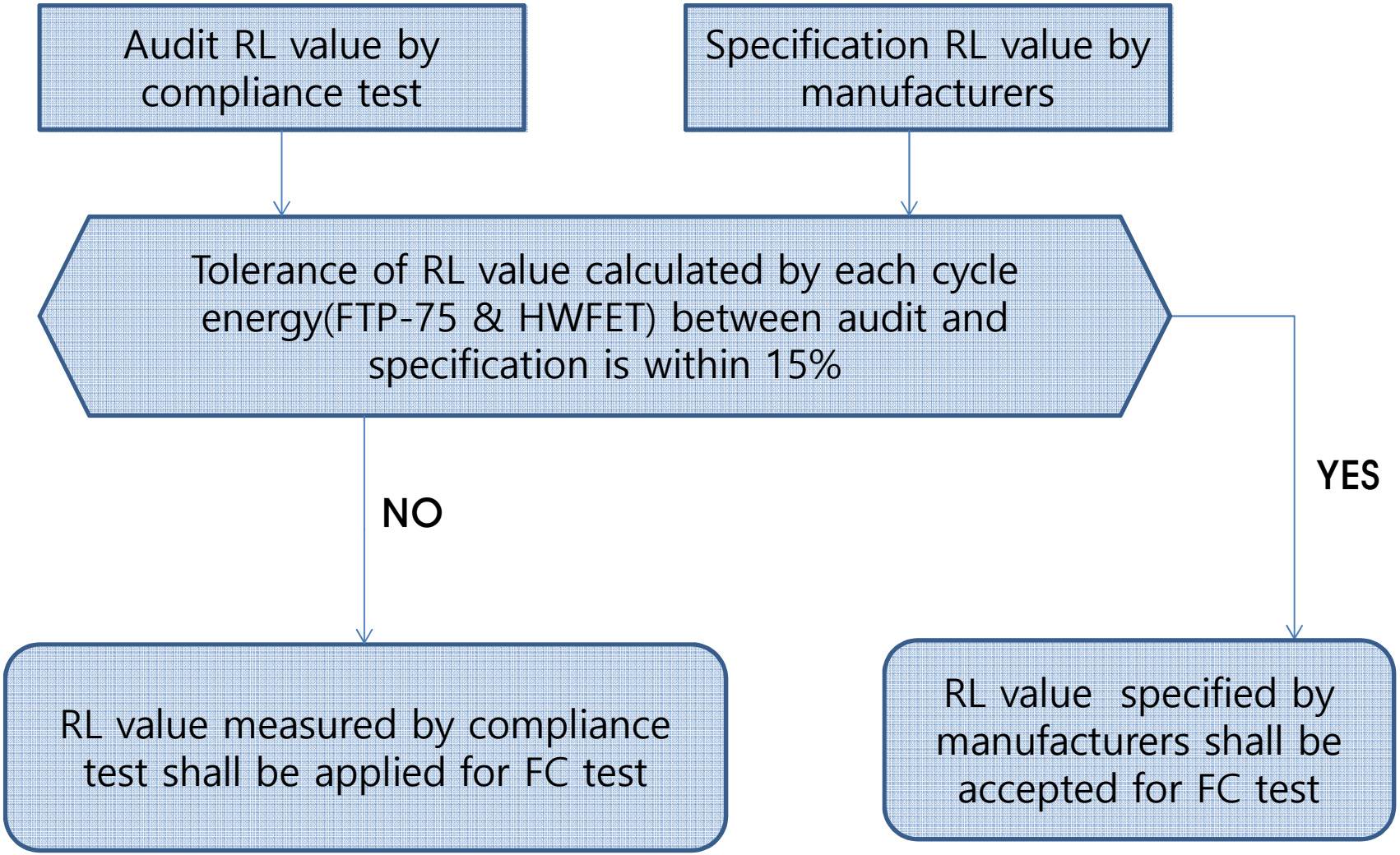
4. Evaluation of RL Tolerance using Constants of each RL Coefficient

● Calculation of Road-Load Tolerance using constants of each RL coefficient

		Description		C.E based on M.Spec. (kJ)	C.E based on A.value (kJ)	RL difference (%)	Remarks
		Manufacture's specification	Audit value	-	-	-	-
Coeffi-cients	f0(N)	120.1	155.7	-	-		
	f1(N/KPH)	0.636	0.691	-	-		
	f2(N/KPH^2)	0.0309	0.0309	-	-		
1. Energy loss diff. considering each FC test cycle		FTP-75 test cycle (17.4*f0+944*f1+58865.6*f2)		4059.1	5180.4	14.9	$v \geq$ 10MPH (≒16KPH)
		HWFET test cycle (16.5*f0+1337.9*f1+110664.5*f2)		5180.4	6913.1	10.6	
2. Energy loss diff. considering FC test cycles(weighted)		0.55*FTP-75 energy loss + 0.45*HWFET energy loss		5293.4	5960.1	12.6	

5. Approving process of RL tolerance regarding RL compliance test

- Flowchart of evaluating RL tolerance



6. Conclusions

- KOREA derived constants of RL tolerance Coefficients(A_{f0}, B_{f1}, C_{f2}) using each FC cycle energy (FTP-75 & HWFET).

  ⇒ Energy loss(kJ) = $f_0 \times A_{f0} + f_1 \times B_{f1} + f_2 \times C_{f2}$

  – $A_{f0} = \int_0^{t_{cycle}} v_F dt$, $B_{f1} = \int_0^{t_{cycle}} v_F^2 dt$, $C_{f2} = \int_0^{t_{cycle}} v_F^3 dt$,

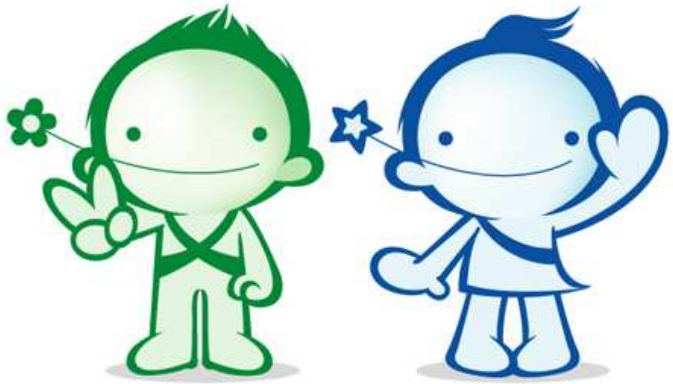
  - FTP-75: A_{f0} = 17.4 km, B_{f1} = 944.0 km²/h, C_{f2} = 58,865.6 km³/h²

  - HWFET: A_{f0} = 16.5 km, B_{f1} = 1,337.9 km²/h, C_{f2} = 110,664.5 km³/h²

- If this study item is contained in WLTP phase2, KOREA will support based on our on-going RL study results.

  ⇒ need to calculate constants of RL tolerance Coefficients(A_{f0}, B_{f1}, C_{f2}) using WLTC cycle Energy

Thank you very much ! !



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