



NCAT – National Center for Advanced Technology

National Vehicle and Fuel Emissions Laboratory

Office of Transportation and Air Quality

U.S. Environmental Protection Agency

The following presentation material was prepared by FEV Engine Technology under EPA Contract EP-C-12-014 and describes the test procedures performed by FEV on the 845RE transmission. Use of any NCAT material provided below, included as part of the complete test data package, should reference the suggested citation provided.

SUGGESTED CITATION: *2014 FCA HFE 845RE Transmission Mapping –Test Data Package*. Version 2019-04. Ann Arbor, MI: US EPA, National Vehicle and Fuel Emissions Laboratory, National Center for Advanced Technology, 2019.

EP-C-12-014 WA 3-11

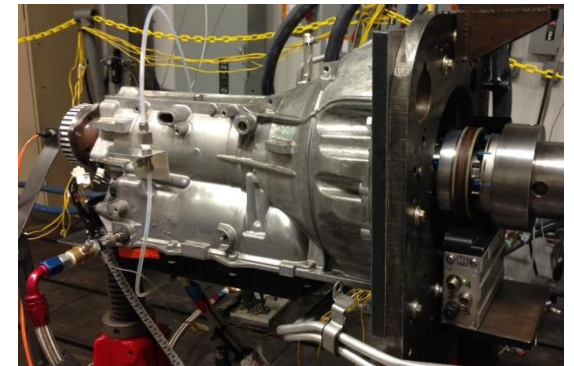
FEV Benchmarking

2014 Ram HFE, 3.6L V6

845RE Transmission Benchmark

May 4th, 2015

EPA did not request a final report for this task; this presentation serves as documentation of completion for this work assignment. Further information on this project is contained in the SAE paper 2016-01-1142 "Investigating the Effect of Advanced Automatic Transmissions."



Ram HFE 8-Speed – Benchmark Agenda

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



- 1. Project Objectives**
- 2. Transmission Specifications**
- 3. Vehicle Investigations**
- 4. Test Bench Setup**
- 5. Bench Testing**

Ram HFE 8-Speed – Benchmark

Project Overview

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



1. Evaluation of transmission control strategy in vehicle

- Analysis of solenoid control signals during driving maneuvers on road
- Evaluation of solenoid shift logic for driving in gear and coasting in neutral
- Determination of main line pressures as basis for bench testing

2. Transmission spin loss evaluation under defined conditions on test bench

- Analysis of parasitic losses by applying the control strategy developed for loaded efficiency testing

3. Transmission efficiency evaluation under defined conditions on test bench

- Implement transmission controls observed in vehicle to control transmission on test bench
 - TCM not included in controls in order to not be limited to hard-coded range of operation
- Assess transmission efficiency at various loads, speeds, and temperatures

4. Transmission neutral coast down evaluation under conditions observed in the vehicle

- Simulation of vehicle coast down event in N on test bench
 - Using the solenoid logic published for the 845RE
 - Using the solenoid observed in-vehicle

5. Transmission inertia evaluation under defined conditions on test bench

- Evaluation of inertia of each gear, including neutral, through multiple acceleration rates

6. Transmission oil pump efficiency evaluation under defined conditions on test bench

- Evaluation of oil pump characteristic in modified test bench setup
- Evaluation of pump chain drive losses with de-vaned oil pump

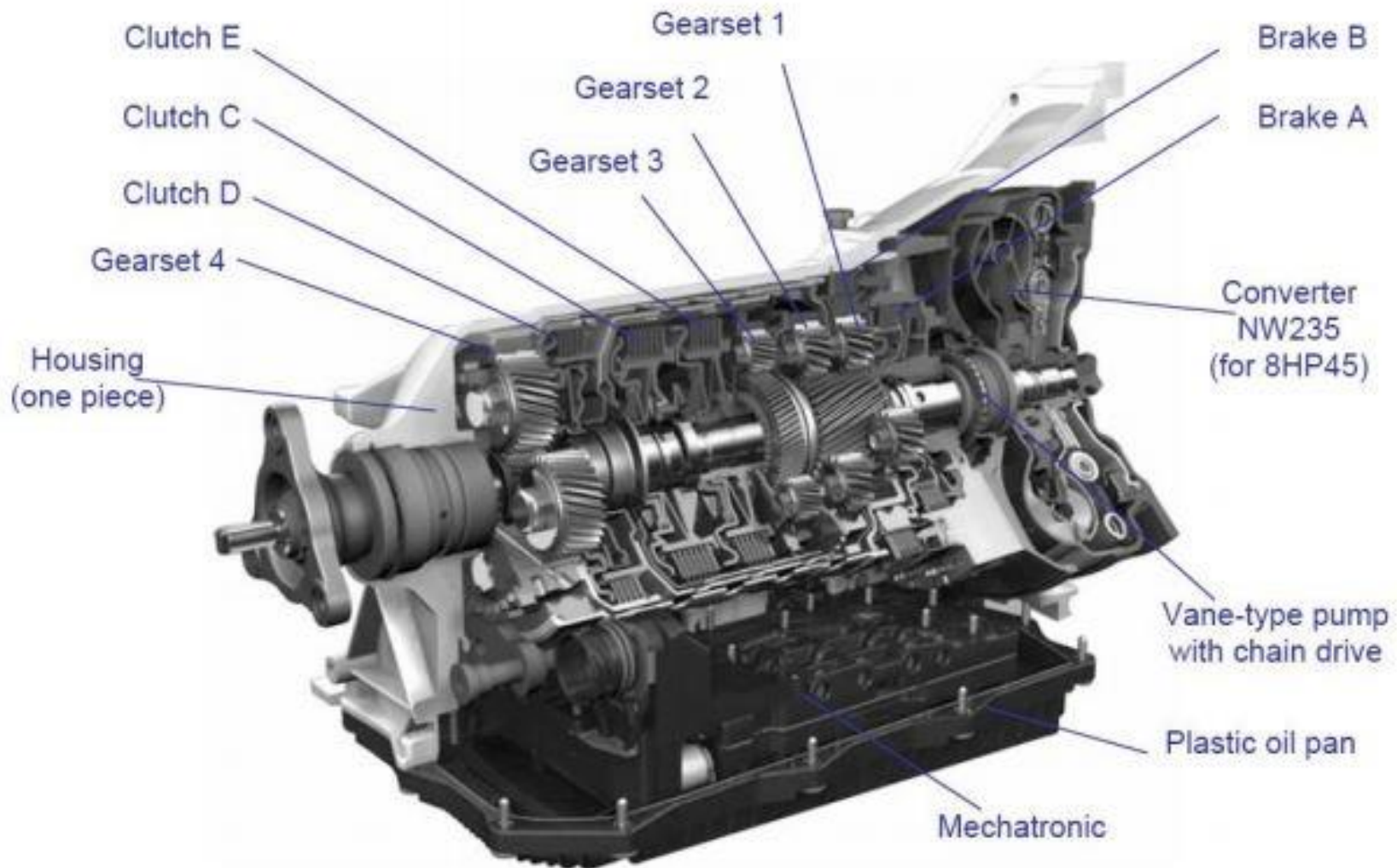
Ram HFE 8-Speed – Benchmark Transmission Specifications

Contract No. EP-C-12-014, Work Assignment 3-11
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<input type="checkbox"/> Transmission Model:	845RE (8HP45)
<input type="checkbox"/> Maximum Engine Power/Torque:	250kW/450Nm
<input type="checkbox"/> Max Speed:	7200rpm
<input type="checkbox"/> Min Idle Speed:	550rpm
<input type="checkbox"/> Max Speed in 8 th Gear:	5700rpm
<input type="checkbox"/> Transmission Weight:	80kg (wet)
<input type="checkbox"/> Fluid Capacity:	9 L
<input type="checkbox"/> Gear Ratios:	4.717, 3.143, 2.106, 1.667, 1.285, 1.000, 0.893, 0.667, -3.295
<input type="checkbox"/> Ratio Spread:	7.071
<input type="checkbox"/> Vehicle Application:	Chrysler 300, Dodge Charger, Ram 1500

Ram HFE 8-Speed – Benchmark Transmission Specifications

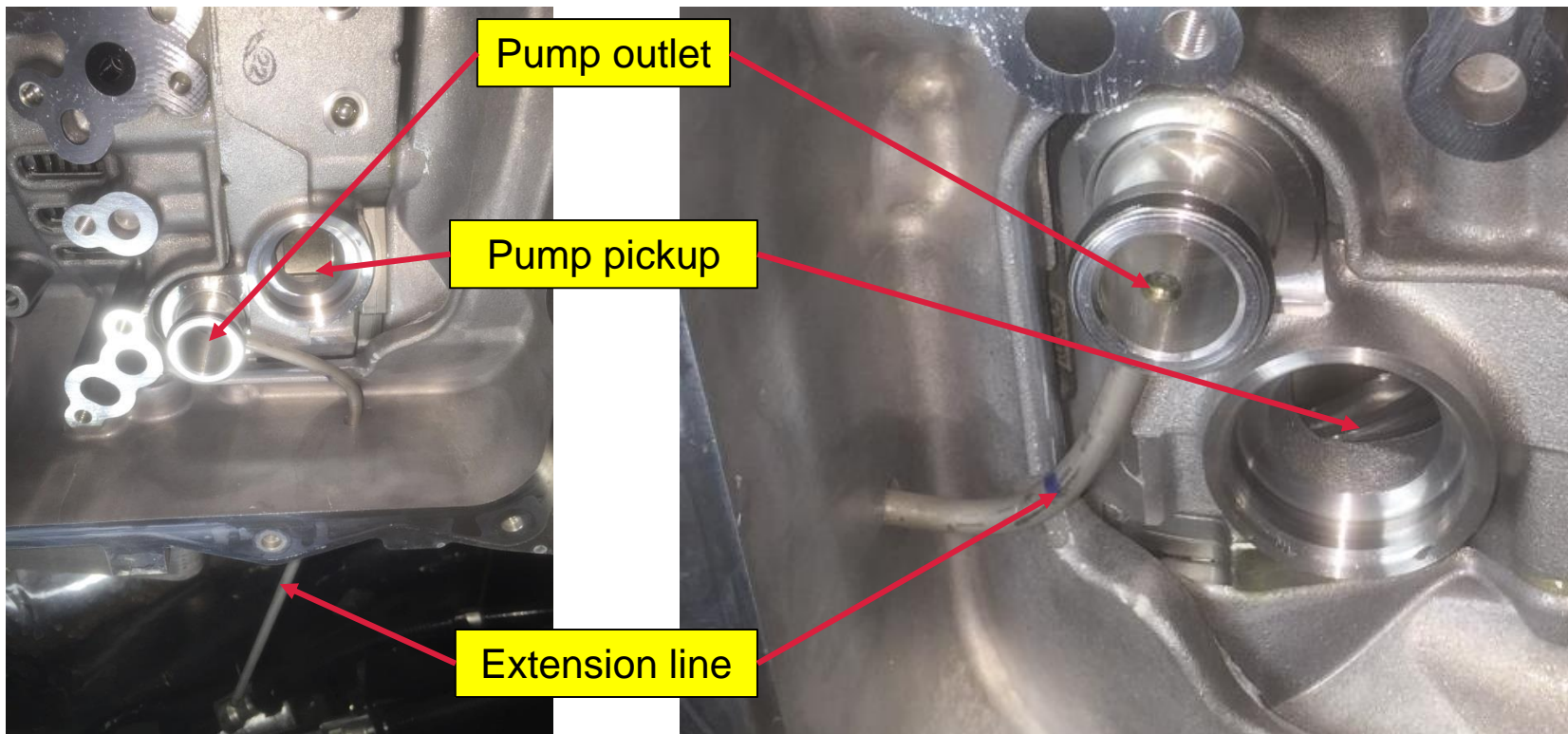
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Ram HFE 8-Speed – Benchmark Vehicle Investigation – Instrumentation

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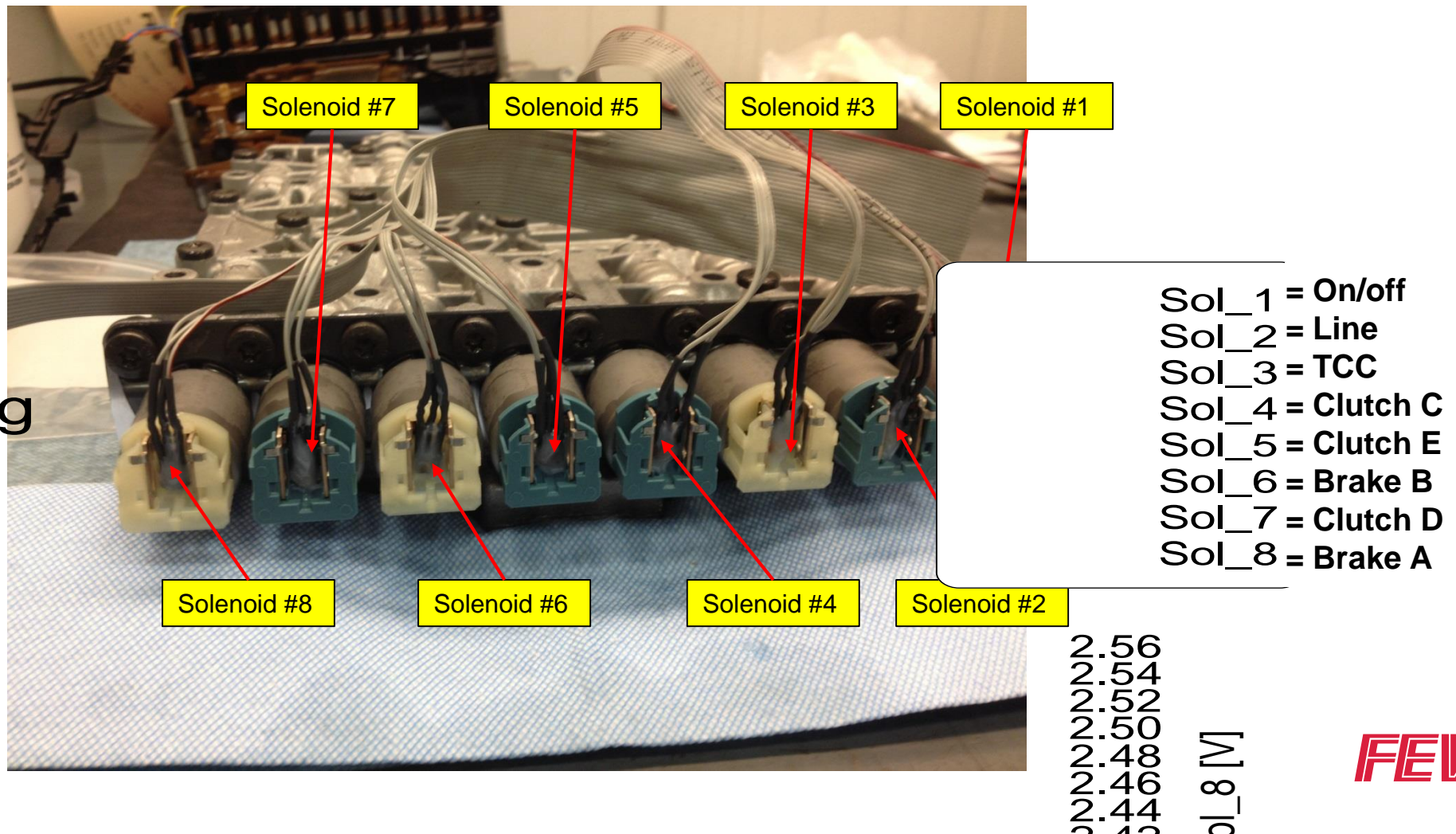
- ❑ FEV investigated requirements for transmission line pressure instrumentation
 - ❑ Line pressure tap installed by adding internal tap to oil pump discharge tube with extension to the outside of the transmission for attachment of pressure transducer



Ram HFE 8-Speed – Benchmark Vehicle Investigation – Instrumentation

Contract No. EP-C-12-014, Work Assignment 3-11
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- ❑ FEV instrumented the transmission shift solenoids using hall-effect sensors
 - ❑ Solenoid actuation logic was collected for gear selection and during neutral coast down maneuver
 - ❑ FEV used observed solenoid logic to select gears on test bench



Ram HFE 8-Speed – Benchmark Vehicle Investigation – Test Procedure

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



☐ Transmission Strategy & Line Pressure Assessment (In-vehicle)

☐ Vehicle instrumented to measure:

☐ Line pressure

☐ External port for line pressure

☐ Solenoid actuation

☐ Torque converter clutch state

☐ Via TISS monitoring or TCC state via CAN

☐ Engine torque

☐ Via CAN or PID

☐ Line pressure assessment measurements:

☐ Range of speeds/loads/gears to cover test bench target matrix

☐ Utilize chassis dyno and manual shift feature to hold transmission in gear and apply load

☐ Operator set engine speed/load by adjusting the accelerator position

Ram HFE 8-Speed – Benchmark Vehicle Investigation – Vehicle Results

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015

- ☐ Solenoid activation and polarity was instrumented and mapped
 - ☐ Vehicle results were confirmed to match published gear configurations
- ☐ Line pressure was mapped to be used in subsequent evaluations

Gear	Ratio	Ratio Step	Clutch A	Clutch B	Clutch C	Clutch D	Clutch E
1 st	4.71		x	x	x		
2 nd	3.14	1.50	x	x			x
3 rd	2.10	1.49		x	x		x
4 th	1.67	1.26		x		x	x
5 th	1.29	1.30		x	x	x	
6 th	1.00	1.29			x	x	x
7 th	0.84	1.19	x		x	x	
8 th	0.67	1.26	x			x	x
Rev	3.30		x	x		x	
Spread	7.03						
Park Neutral			x	x			
Default	6 th Gear				x	x	x

Ram HFE 8-Speed – Benchmark Vehicle Investigation – Vehicle Results

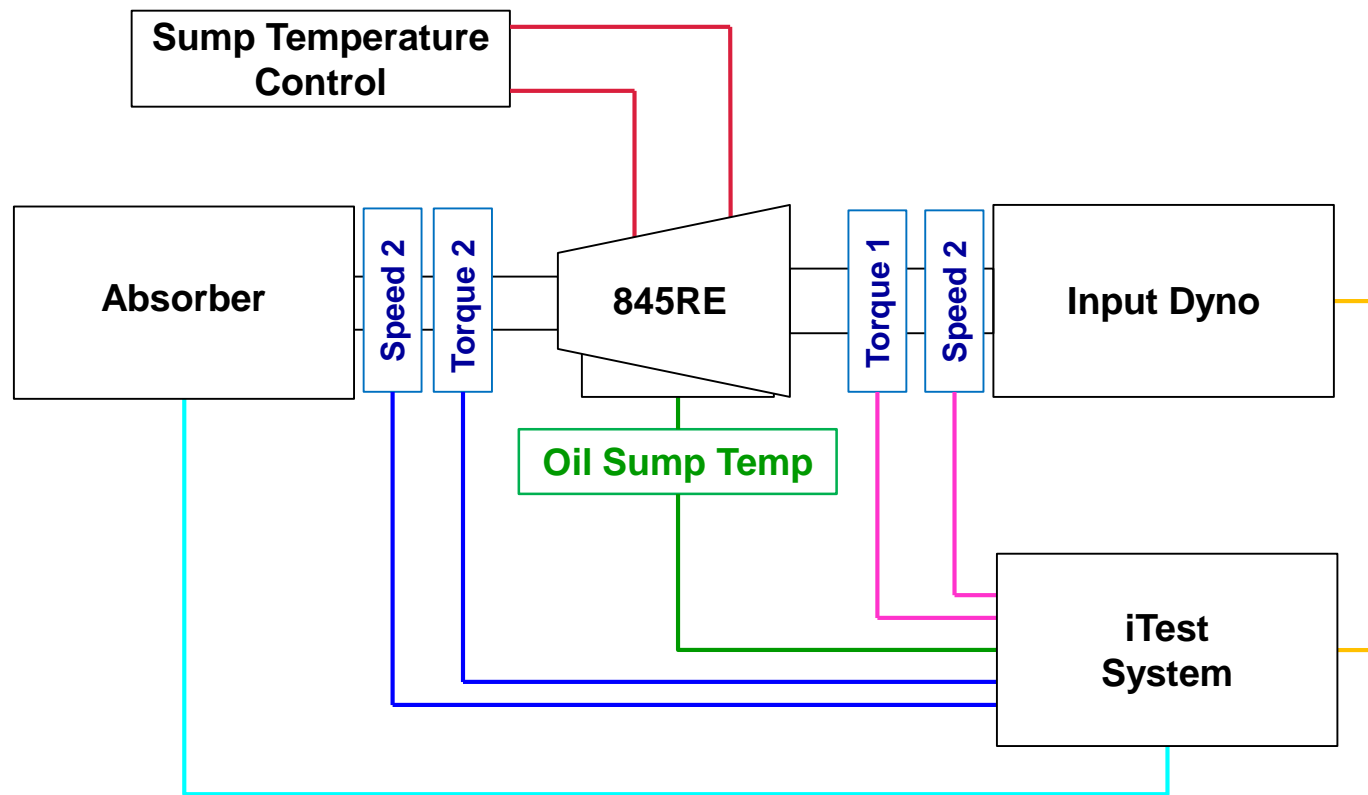
Contract No. EP-C-12-014, Work Assignment 3-11
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- ☐ Line pressure was mapped to be used in subsequent evaluations
- ☐ All gears were tested at all loads

		Torque [Nm]									Torque [Nm]									Torque [Nm]									Torque [Nm]										
		1st	25	50	75	100	150	200	250			2nd	25	50	75	100	150	200	250			3rd	25	50	75	100	150	200	250			4th	25	50	75	100	150	200	250
Speed [rpm]	500	5.2	5.2	5.2	5.9	7.7				Speed [rpm]	500	5.2	5.2	5.2	5.2	5.9	7.1			Speed [rpm]	500	5.2	5.2	5.2	5.9	7.6	9.3	10.9	Speed [rpm]	500	5.2	5.2	5.2	5.2	5.7	7.0	8.3		
	750	5.2	5.2	5.2	5.9	7.7			750		5.2	5.2	5.2	5.2	5.9	7.1			750		5.2	5.2	5.2	5.9	7.6	9.3	10.9	750		5.2	5.2	5.2	5.2	5.7	7.0	8.3			
	1000	5.2	5.2	5.2	5.9	7.7			1000		5.2	5.2	5.2	5.2	5.9	7.1			1000		5.2	5.2	5.2	5.9	7.6	9.3	10.9	1000		5.2	5.2	5.2	5.2	5.7	7.0	8.3			
	1250	5.2	5.2	5.2	5.9	7.7			1250		5.2	5.2	5.2	5.2	5.9	7.1			1250		5.2	5.2	5.2	5.9	7.6	9.3	10.9	1250		5.2	5.2	5.2	5.2	5.7	7.0	8.3			
	1500	5.2	5.2	5.2	5.9	7.7			1500		5.2	5.2	5.2	5.2	5.9	7.1			1500		5.2	5.2	5.2	5.9	7.6	9.3	10.9	1500		5.2	5.2	5.2	5.2	5.7	7.0	8.3			
	1750	5.2	5.2	5.2	5.9	7.7			1750		5.2	5.2	5.2	5.2	5.9	7.1			1750		5.2	5.2	5.2	5.9	7.6	9.3	10.9	1750		5.2	5.2	5.2	5.2	5.7	7.0	8.3			
	2000	5.2	5.2	5.2	5.9	7.7			2000		5.2	5.2	5.2	5.2	5.9	7.1			2000		5.2	5.2	5.2	5.9	7.6	9.3	10.9	2000		5.2	5.2	5.2	5.2	5.7	7.0	8.3			
	2500	5.2	5.2	5.2	5.9	7.7			2500		5.2	5.2	5.2	5.2	6.0	7.1			2500		5.2	5.2	5.2	5.9	7.6	9.3	10.9	2500		5.2	5.2	5.2	5.2	5.7	7.0	8.3			
	3000	5.2	5.2	5.2	5.9	7.7			3000		5.1	5.1	5.1	5.1	5.8	6.9			3000		5.2	5.2	5.2	5.9	7.6	9.3	10.9	3000		5.2	5.2	5.2	5.2	5.7	7.0	8.6			
	4000	5.2	5.2	6.1	6.6	7.9			4000		5.1	5.1	5.4	5.8	6.8	7.5			4000		5.1	5.4	5.9	6.6	7.9	9.9	11.4	4000		5.1	5.1	5.3	5.9	6.8	7.6	8.6			
5000	5.9	6.6	7.1	7.6	8.4			5000	6.0	6.1	6.6						5000	6.0	6.6	6.9	7.6	8.5			5000	6.0	6.1	6.4	6.8	7.6	8.3	9.2							
		Torque [Nm]									Torque [Nm]									Torque [Nm]									Torque [Nm]										
		5th	25	50	75	100	150	200	250			6th	25	50	75	100	150	200	250			7th	25	50	75	100	150	200	250			8th	25	50	75	100	150	200	250
Speed [rpm]	500	5.2	5.2	5.2	5.2	6.3	7.6	8.6		Speed [rpm]	500	5.2	5.2	6.2	7.3	9.9	11.7	13.5		Speed [rpm]	500	5.3	5.3	5.3	5.4	6.8	8.3	9.2	Speed [rpm]	500	5.3	5.3	5.3	5.3	6.0	7.2	8		
	750	5.2	5.2	5.2	5.2	6.3	7.6	8.6			750	5.2	5.2	6.2	7.3	9.9	11.7	13.5			750	5.3	5.3	5.3	5.4	6.8	8.3	9.2		750	5.3	5.3	5.3	5.3	6.0	7.2	8		
	1000	5.2	5.2	5.2	5.2	6.3	7.6	8.6			1000	5.2	5.2	6.2	7.3	9.9	11.7	13.5			1000	5.3	5.3	5.3	5.4	6.8	8.3	9.2		1000	5.3	5.3	5.3	5.3	6.0	7.2	8		
	1250	5.2	5.2	5.2	5.2	6.3	7.6	8.6			1250	5.2	5.2	6.8	7.4	9.7	11.7	13.5			1250	5.3	5.3	5.3	5.4	6.8	8.3	9.2		1250	5.3	5.3	5.3	5.3	6.0	7.2	8		
	1500	5.2	5.2	5.2	5.2	6.3	7.6	8.6			1500	5.3	5.4	6.4	7.4	9.9	11.7	13.5			1500	5.3	5.3	5.3	5.4	6.8	8.3	9.2		1500	5.3	5.3	5.3	5.3	6.0	7.2	8		
	1750	5.2	5.2	5.2	5.2	6.3	7.6	8.6			1750	5.3	5.4	6.3	7.6	10.0	11.7	13.5			1750	5.3	5.3	5.3	5.4	6.8	8.3	9.2		1750	5.3	5.3	5.3	5.3	5.9	7.2	8		
	2000	5.2	5.2	5.2	5.2	6.3	7.6	8.6			2000	5.2	5.2	6.3	7.6	9.9	11.7	13.5			2000	5.2	5.2	5.2	5.5	6.7	8.3	9.2		2000	5.2	5.2	5.2	5.2	5.9	7.2	8		
	2500	5.2	5.2	5.2	5.2	6.3	7.6	8.6			2500	5.2	5.2	6.2	7.3	9.9	11.7	13.5			2500	5.2	5.2	5.2	5.4	6.7	8.3	9.2		2500									
	3000	5.2	5.2	5.2	5.2	6.3	7.6	8.6			3000	5.2	5.2	6.2	7.3	10.1	11.7	13.5			3000	5.1	5.1	5.1	5.3	6.5	8.3	9.2		3000									
	4000	5.1	5.2	5.5	5.9	6.9	7.9	9.0			4000	5.2	5.2	6.2	7.3	9.9	11.7	13.5			4000									4000									
5000									5000									5000								5000													

Ram HFE 8-Speed – Benchmark Bench Testing – Test Bench Setup

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



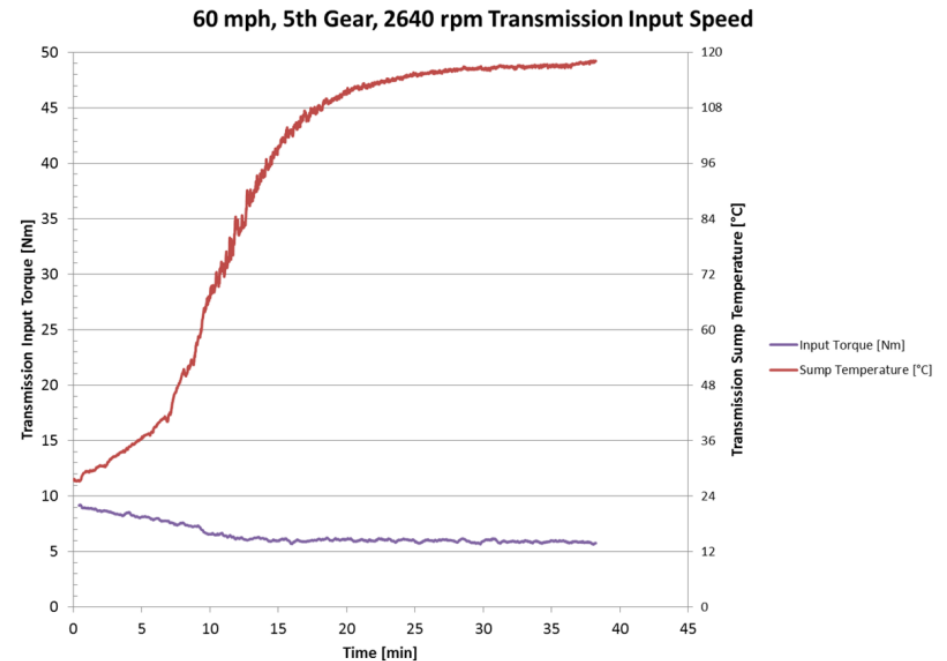
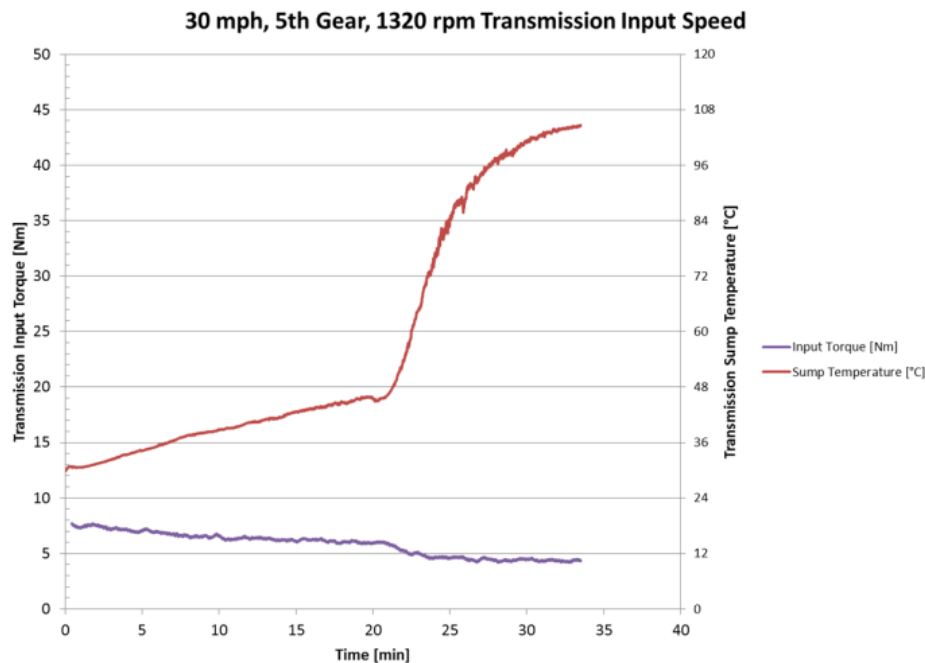
Ram HFE 8-Speed – Benchmark

Bench Testing – Spin Loss

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015

❑ Bench Test Temperature Evaluation

- ❑ Gear 1 through 8
- ❑ Torque converter clutch locked for all tests
- ❑ Transmission run at constant input speeds:
 - ❑ 30 mph, 60 mph
- ❑ External heating of OEM transmission cooler was used to induce extra heating
- ❑ Results determined test operating temperatures:
 - ❑ 35°C, 60°, 100°C



Ram HFE 8-Speed – Benchmark Bench Testing – Spin Loss

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015

☐ Spin Loss Measurements

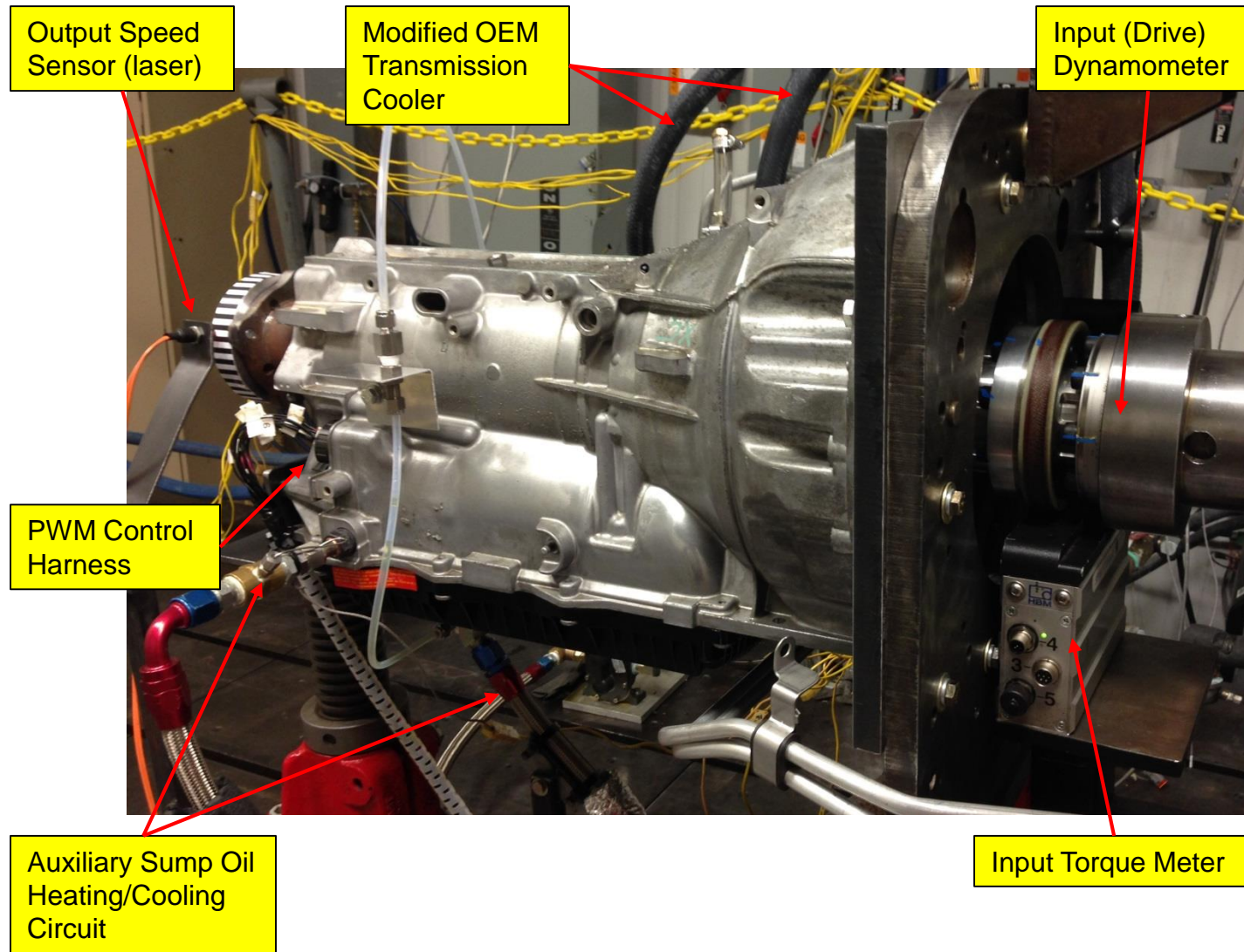
- ☐ Gear 1 through 8
- ☐ Torque converter clutch locked for all tests
- ☐ Input loads (1):
 - ☐ Unloaded (output disconnected) Nm
- ☐ Input speeds (11):
 - ☐ 500, 750, 1000, 1250, 1500 1750, 2000, 2500, 3000, 4000, 5000 rpm
- ☐ Transmission oil temperatures (3):
 - ☐ 35°C, 60°C, 100°C
- ☐ Transmission line pressure (variable):
 - ☐ Unique line pressure per each speed/gear as measured in-vehicle in unloaded condition

<i>Gear</i>			
engine speed [rpm]	Output Speed [rpm]	Turning Torque [Nm]	main line pressure [bar]
500			5.2
750			5.2
1000			5.2
1250			5.4
1500			5.4
1750			5.4
2000			5.4
2500			5.4
3000			5.3
4000			5.3
5000			6.0

Ram HFE 8-Speed – Benchmark Bench Testing – Spin Loss

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015

Spin Loss – Test Setup



Ram HFE 8-Speed – Benchmark Bench Testing – Spin Loss

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May 4, 2015



845RE Spin Loss Results, 35°C

min. [NM] :

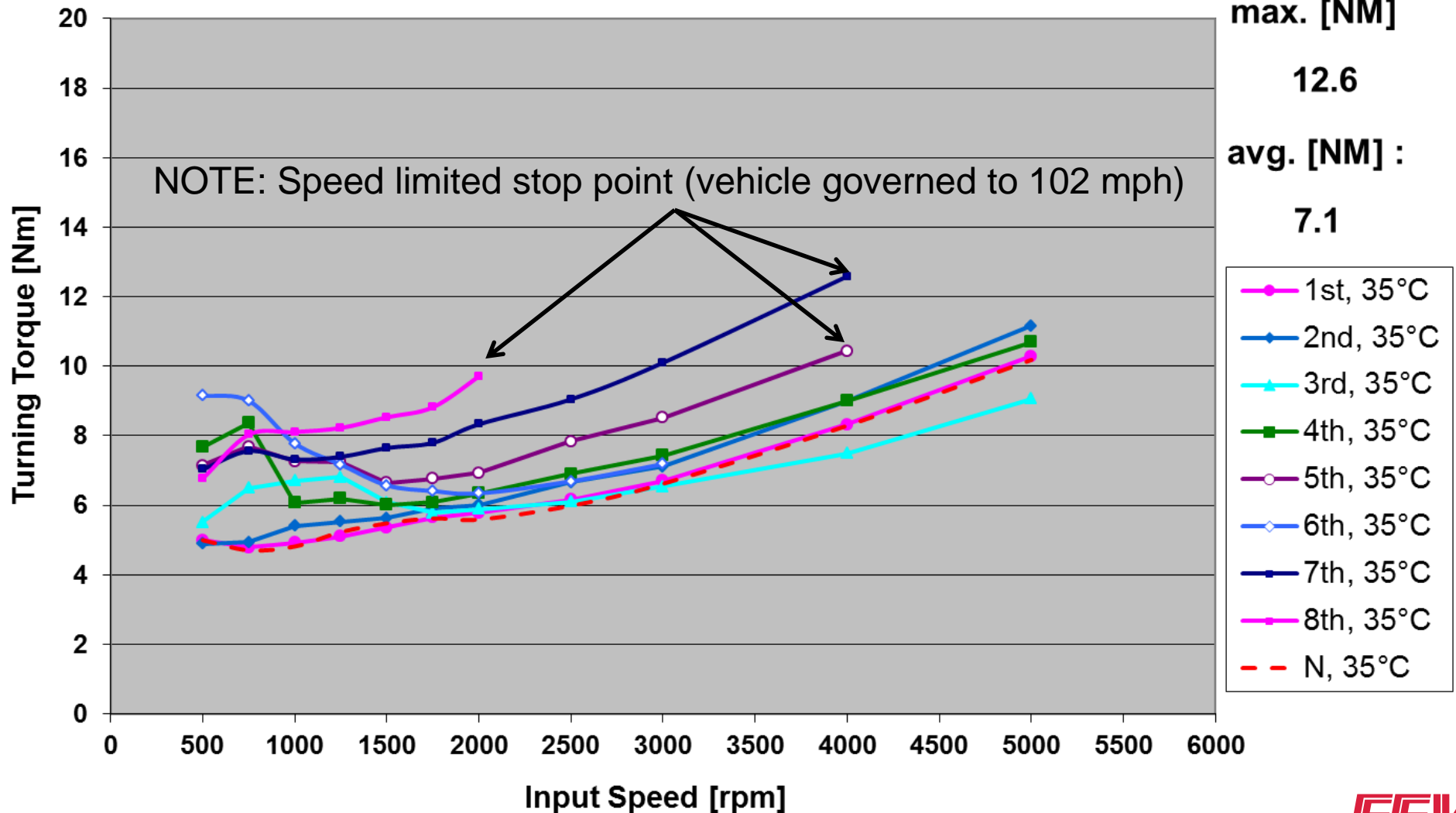
4.7

max. [NM]

12.6

avg. [NM] :

7.1



Ram HFE 8-Speed – Benchmark Bench Testing – Spin Loss

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845RE Spin Loss Results, 60°C

min. [NM] :

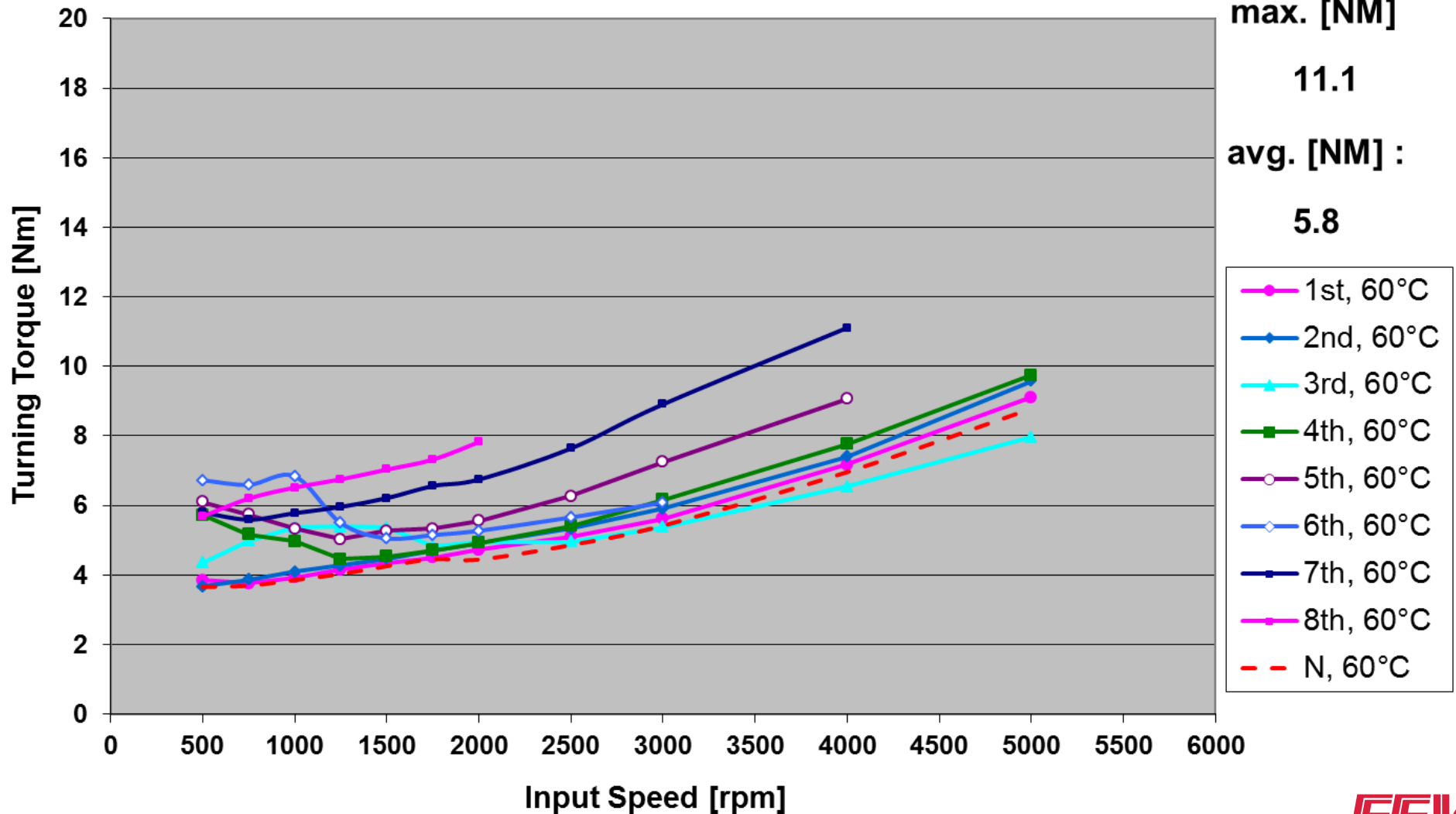
3.7

max. [NM]

11.1

avg. [NM] :

5.8



Ram HFE 8-Speed – Benchmark Bench Testing – Spin Loss

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845RE Spin Loss Results, 100°C

min. [NM] :

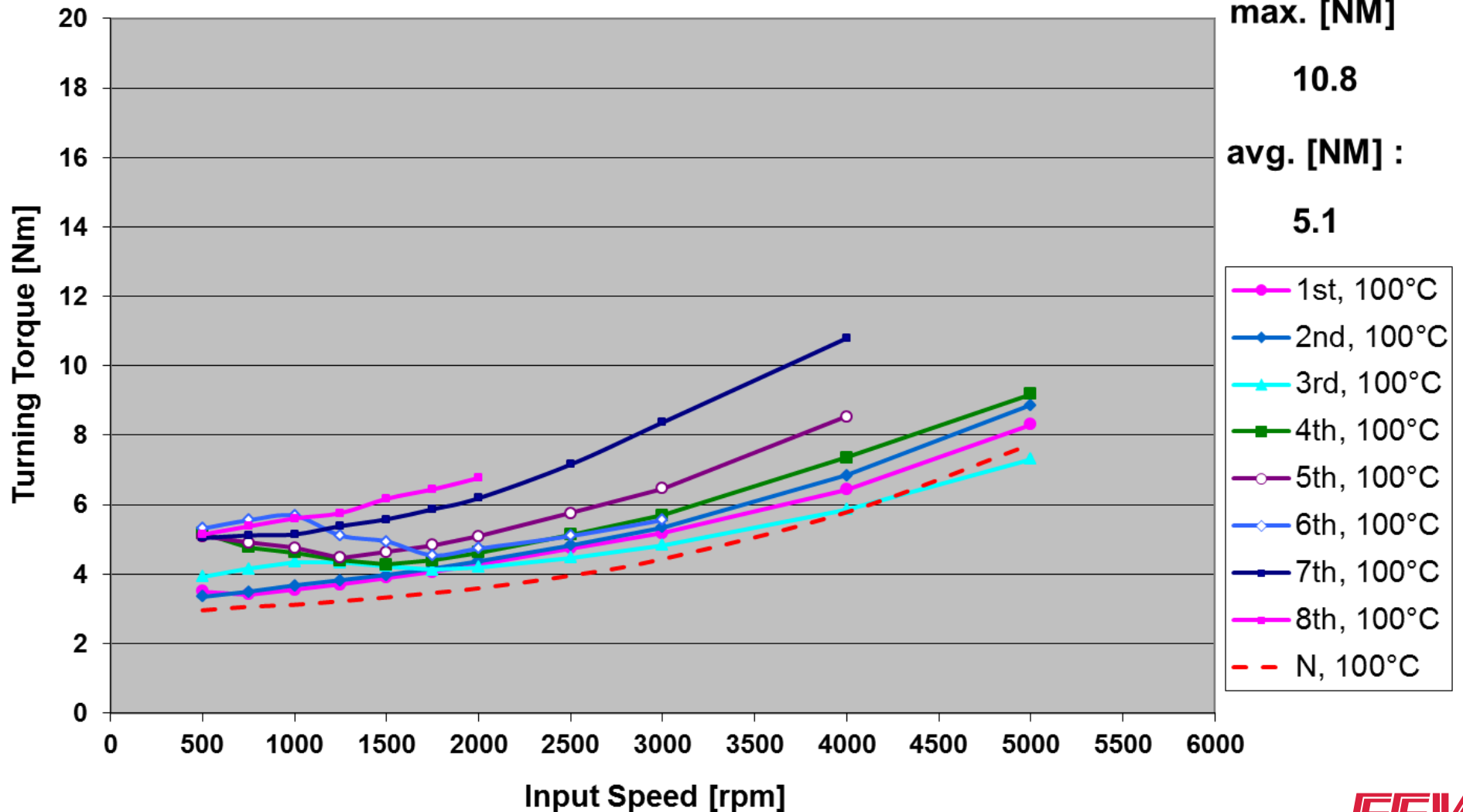
3.0

max. [NM]

10.8

avg. [NM] :

5.1

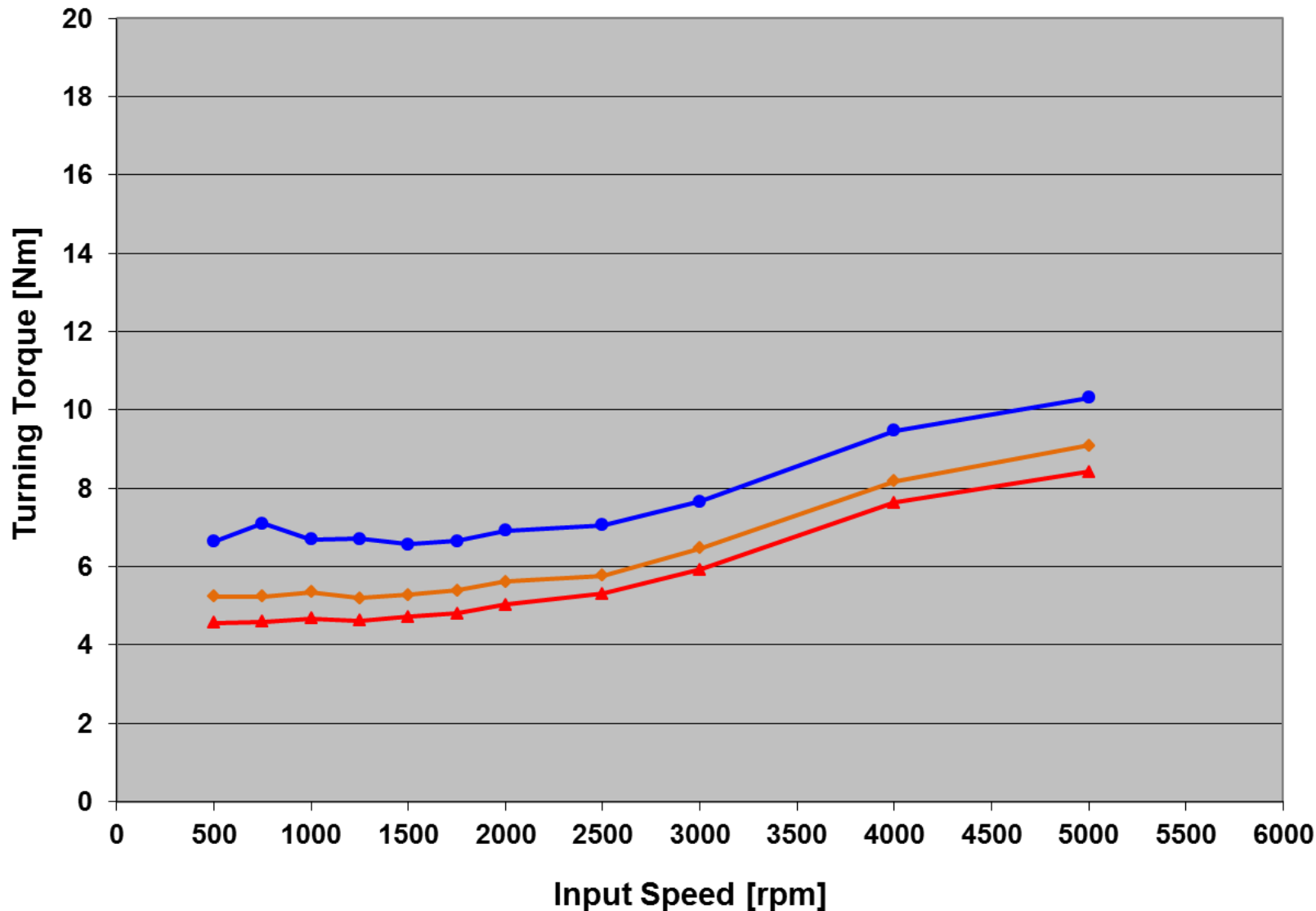


Ram HFE 8-Speed – Benchmark Bench Testing – Spin Loss

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845 RE Spin Loss Results Averaged over all Gears and Speeds

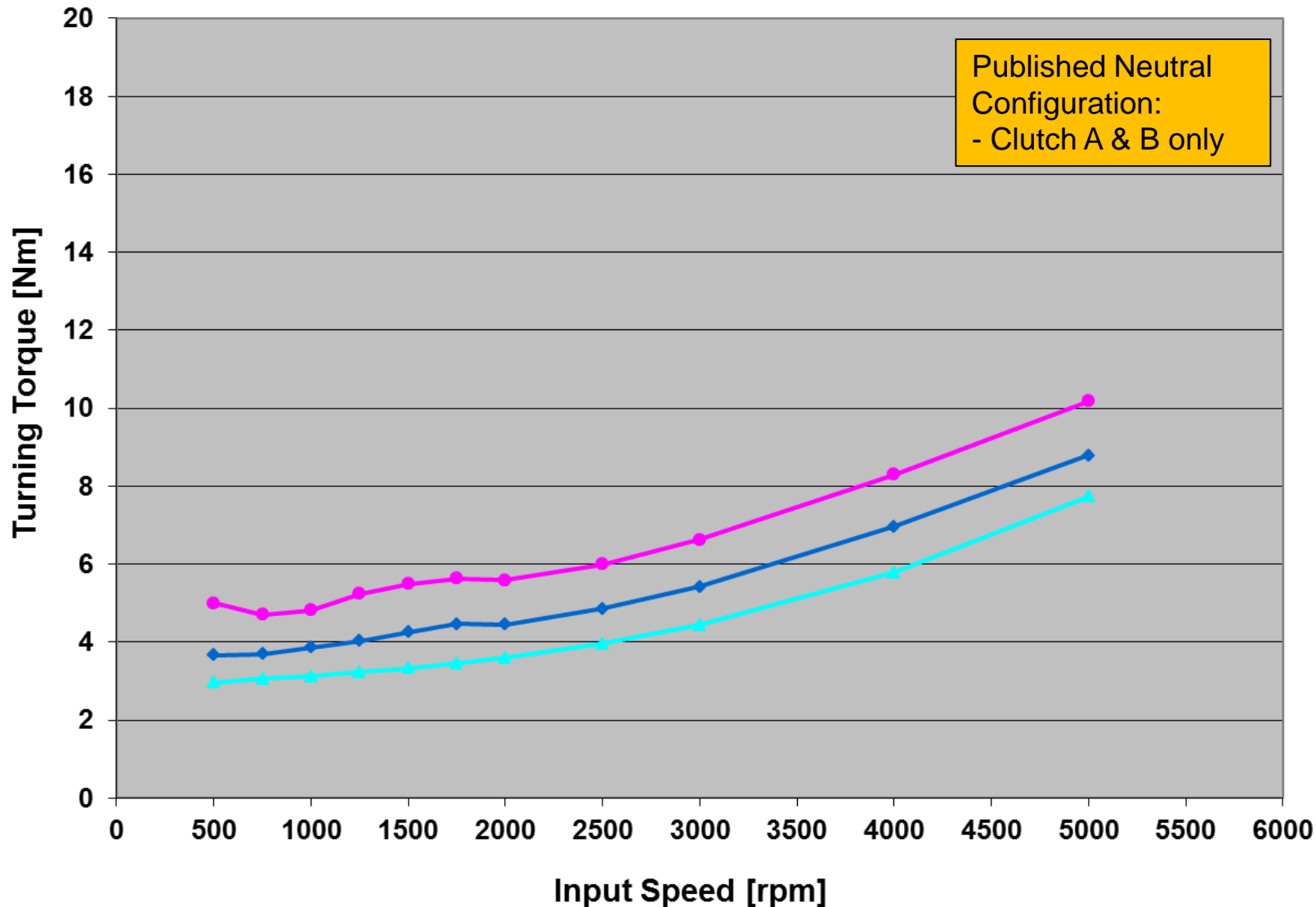


Ram HFE 8-Speed – Benchmark Bench Testing – Spin Loss

Contract No. EP-C-12-014, Work Assignment 3-11
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845RE Neutral Spin Loss Input Shaft Driven



Ram HFE 8-Speed – Benchmark

Bench Testing – Spin Loss

Contract No. EP-C-12-014, Work Assignment 3-11
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☐ Test Summary

- ☐ Spin losses were recorded for 35°C, 60°C and 100°C
- ☐ Depending on test temperature, the losses range from 3.0 Nm to 12.6 Nm
- ☐ In almost all gears, increased losses between 500 rpm and 1,500 rpm indicate the influence of open clutch drag losses
- ☐ The losses observed on the 845RE can be considered 'below average' when compared to similar transmissions

Ram HFE 8-Speed – Benchmark Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015

❑ Loaded Efficiency Measurements

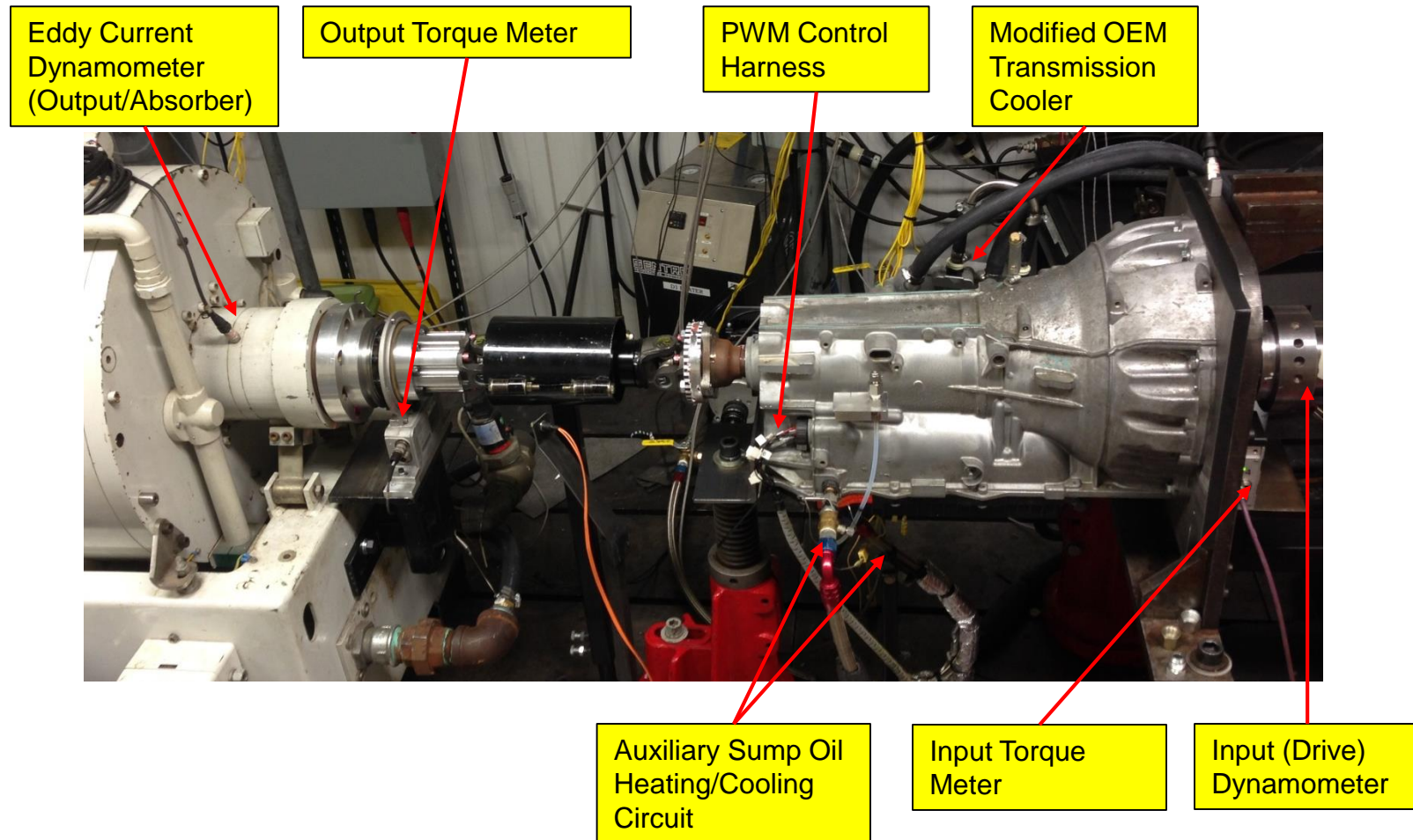
- ❑ Gear 1 through 8
- ❑ Torque converter clutch locked for all tests
- ❑ Input loads (7):
 - ❑ 25, 50, 75, 100, 150, 200, 250 Nm
- ❑ Input speeds (11):
 - ❑ 500, 750, 1000, 1250, 1500, 1750, 2000, 2500, 3000, 4000, 5000 rpm
- ❑ Transmission oil temperatures (3):
 - ❑ 35°C, 60°C, 100°C
- ❑ Transmission line pressure (variable):
 - ❑ Unique line pressure per each speed/load/gear as measured in-vehicle

		Torque [Nm]									Torque [Nm]									Torque [Nm]									Torque [Nm]										
		1st	25	50	75	100	150	200	250			2nd	25	50	75	100	150	200	250			3rd	25	50	75	100	150	200	250			4th	25	50	75	100	150	200	250
Speed [rpm]	500	5.2	5.2	5.2	5.2	5.9	7.7			Speed [rpm]	500	5.2	5.2	5.2	5.2	5.2	5.9	7.1		Speed [rpm]	500	5.2	5.2	5.2	5.2	5.9	7.6	9.3	10.9	Speed [rpm]	500	5.2	5.2	5.2	5.2	5.2	5.7	7.0	8.3
	750	5.2	5.2	5.2	5.2	5.9	7.7		750		5.2	5.2	5.2	5.2	5.2	5.9	7.1		750		5.2	5.2	5.2	5.2	5.9	7.6	9.3	10.9	750		5.2	5.2	5.2	5.2	5.2	5.7	7.0	8.3	
	1000	5.2	5.2	5.2	5.2	5.9	7.7		1000		5.2	5.2	5.2	5.2	5.2	5.9	7.1		1000		5.2	5.2	5.2	5.2	5.9	7.6	9.3	10.9	1000		5.2	5.2	5.2	5.2	5.2	5.7	7.0	8.3	
	1250	5.2	5.2	5.2	5.2	5.9	7.7		1250		5.2	5.2	5.2	5.2	5.2	5.9	7.1		1250		5.2	5.2	5.2	5.2	5.9	7.6	9.3	10.9	1250		5.2	5.2	5.2	5.2	5.2	5.7	7.0	8.3	
	1500	5.2	5.2	5.2	5.2	5.9	7.7		1500		5.2	5.2	5.2	5.2	5.2	5.9	7.1		1500		5.2	5.2	5.2	5.2	5.9	7.6	9.3	10.9	1500		5.2	5.2	5.2	5.2	5.2	5.7	7.0	8.3	
	1750	5.2	5.2	5.2	5.2	5.9	7.7		1750		5.2	5.2	5.2	5.2	5.2	5.9	7.1		1750		5.2	5.2	5.2	5.2	5.9	7.6	9.3	10.9	1750		5.2	5.2	5.2	5.2	5.2	5.7	7.0	8.3	
	2000	5.2	5.2	5.2	5.2	5.9	7.7		2000		5.2	5.2	5.2	5.2	5.2	5.9	7.1		2000		5.2	5.2	5.2	5.2	5.9	7.6	9.3	10.9	2000		5.2	5.2	5.2	5.2	5.2	5.7	7.0	8.3	
	2500	5.2	5.2	5.2	5.2	5.9	7.7		2500		5.2	5.2	5.2	5.2	5.2	6.0	7.1		2500		5.2	5.2	5.2	5.2	5.9	7.6	9.3	10.9	2500		5.2	5.2	5.2	5.2	5.2	5.7	7.0	8.3	
	3000	5.2	5.2	5.2	5.2	5.9	7.7		3000		5.1	5.1	5.1	5.1	5.1	5.8	6.9		3000		5.2	5.2	5.2	5.2	5.9	7.6	9.3	10.9	3000		5.2	5.2	5.2	5.2	5.2	5.7	7.0	8.6	
	4000	5.2	5.2	5.2	6.1	6.6	7.9		4000		5.1	5.1	5.1	5.4	5.8	6.8	7.5		4000		5.1	5.4	5.9	6.6	7.9	9.9	11.4	4000	5.1		5.1	5.3	5.9	6.8	7.6	8.6	9.6		
5000	5.9	6.6	7.1	7.6	8.4			5000	6.0	6.1	6.6						5000	6.0	6.6	6.9	7.6	8.5			5000	6.0	6.1	6.4	6.8	7.6	8.3	9.2							
		Torque [Nm]									Torque [Nm]									Torque [Nm]									Torque [Nm]										
		5th	25	50	75	100	150	200	250			6th	25	50	75	100	150	200	250			7th	25	50	75	100	150	200	250			8th	25	50	75	100	150	200	250
Speed [rpm]	500	5.2	5.2	5.2	5.2	5.2	6.3	7.6	8.6	Speed [rpm]	500	5.2	5.2	6.2	7.3	9.9	11.7	13.5		Speed [rpm]	500	5.3	5.3	5.3	5.4	6.8	8.3	9.2	Speed [rpm]	500	5.3	5.3	5.3	5.3	6.0	7.2	8		
	750	5.2	5.2	5.2	5.2	6.3	7.6	8.6			750	5.2	5.2	6.2	7.3	9.9	11.7	13.5			750	5.3	5.3	5.3	5.4	6.8	8.3	9.2		750	5.3	5.3	5.3	5.3	6.0	7.2	8		
	1000	5.2	5.2	5.2	5.2	6.3	7.6	8.6			1000	5.2	5.2	6.2	7.3	9.9	11.7	13.5			1000	5.3	5.3	5.3	5.4	6.8	8.3	9.2		1000	5.3	5.3	5.3	5.3	6.0	7.2	8		
	1250	5.2	5.2	5.2	5.2	6.3	7.6	8.6			1250	5.2	5.2	6.2	7.4	9.7	11.7	13.5			1250	5.3	5.3	5.3	5.4	6.8	8.3	9.2		1250	5.3	5.3	5.3	5.3	6.0	7.2	8		
	1500	5.2	5.2	5.2	5.2	6.3	7.6	8.6			1500	5.3	5.3	5.4	6.4	7.4	9.9	11.7	13.5		1500	5.3	5.3	5.3	5.4	6.8	8.3	9.2	1500	5.3	5.3	5.3	5.3	6.0	7.2	8			
	1750	5.2	5.2	5.2	5.2	6.3	7.6	8.6			1750	5.3	5.3	5.4	6.3	7.6	10.0	11.7	13.5		1750	5.3	5.3	5.3	5.4	6.8	8.3	9.2	1750	5.3	5.3	5.3	5.3	5.9	7.2	8			
	2000	5.2	5.2	5.2	5.2	6.3	7.6	8.6			2000	5.2	5.2	6.3	7.6	9.9	11.7	13.5		2000	5.2	5.2	5.2	5.5	6.7	8.3	9.2	2000	5.2	5.2	5.2	5.2	5.9	7.2	8				
	2500	5.2	5.2	5.2	5.2	6.3	7.6	8.6			2500	5.2	5.2	6.2	7.3	9.9	11.7	13.5		2500	5.2	5.2	5.2	5.4	6.7	8.3	9.2	2500											
	3000	5.2	5.2	5.2	5.2	6.3	7.6	8.6			3000	5.2	5.2	6.2	7.3	10.1	11.7	13.5		3000	5.1	5.1	5.1	5.3	6.5	8.3	9.2	3000											
	4000	5.1	5.2	5.5	5.9	6.9	7.9	9.0			4000	5.2	5.2	6.2	7.3	9.9	11.7	13.5		4000								4000											
5000									5000									5000								5000													

Ram HFE 8-Speed – Benchmark Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015

Loaded Efficiency – Test Setup



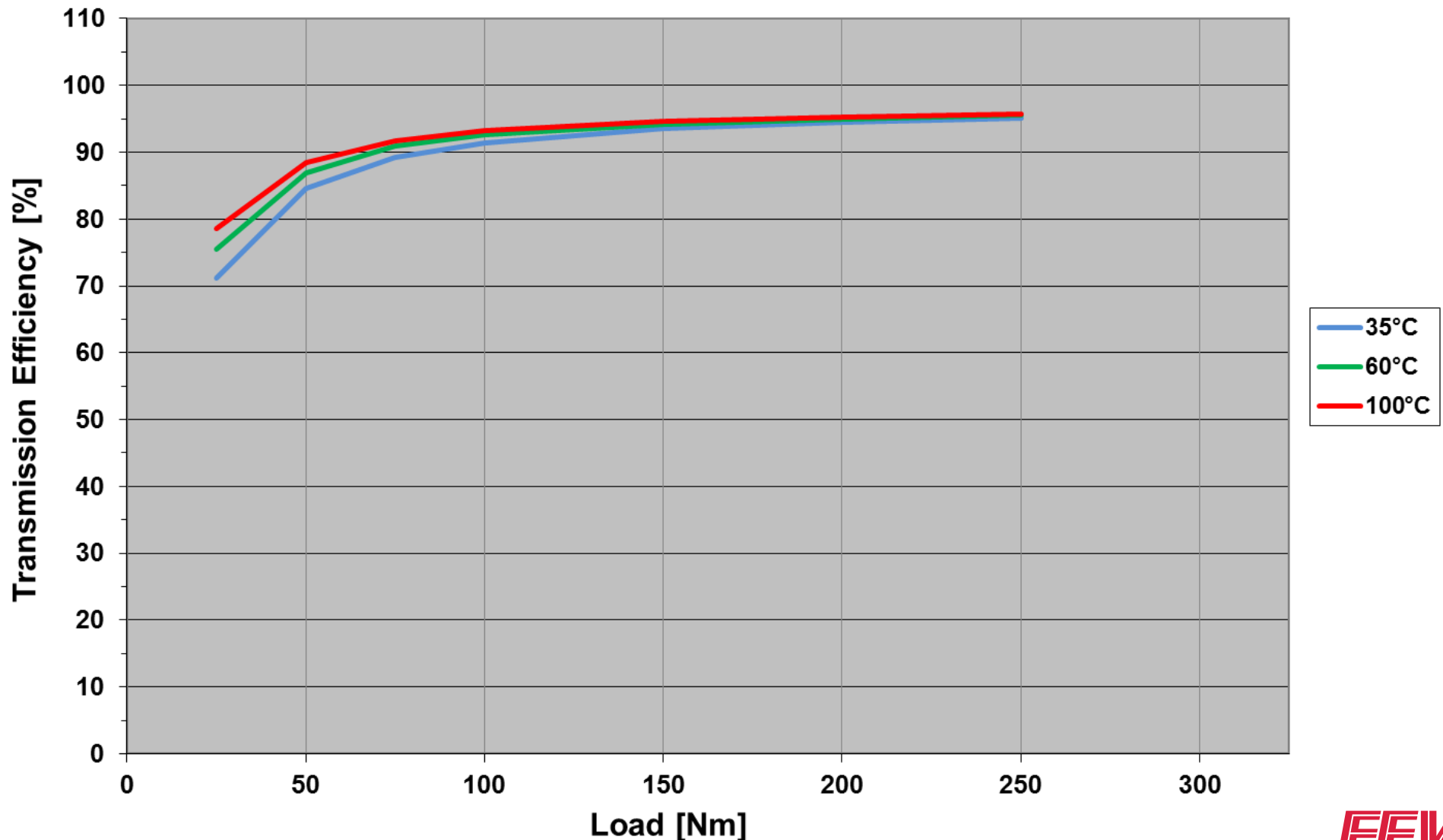
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



**Influence of Temperature and Load on Efficiency
(Averaged Over All Gears and Speeds)**



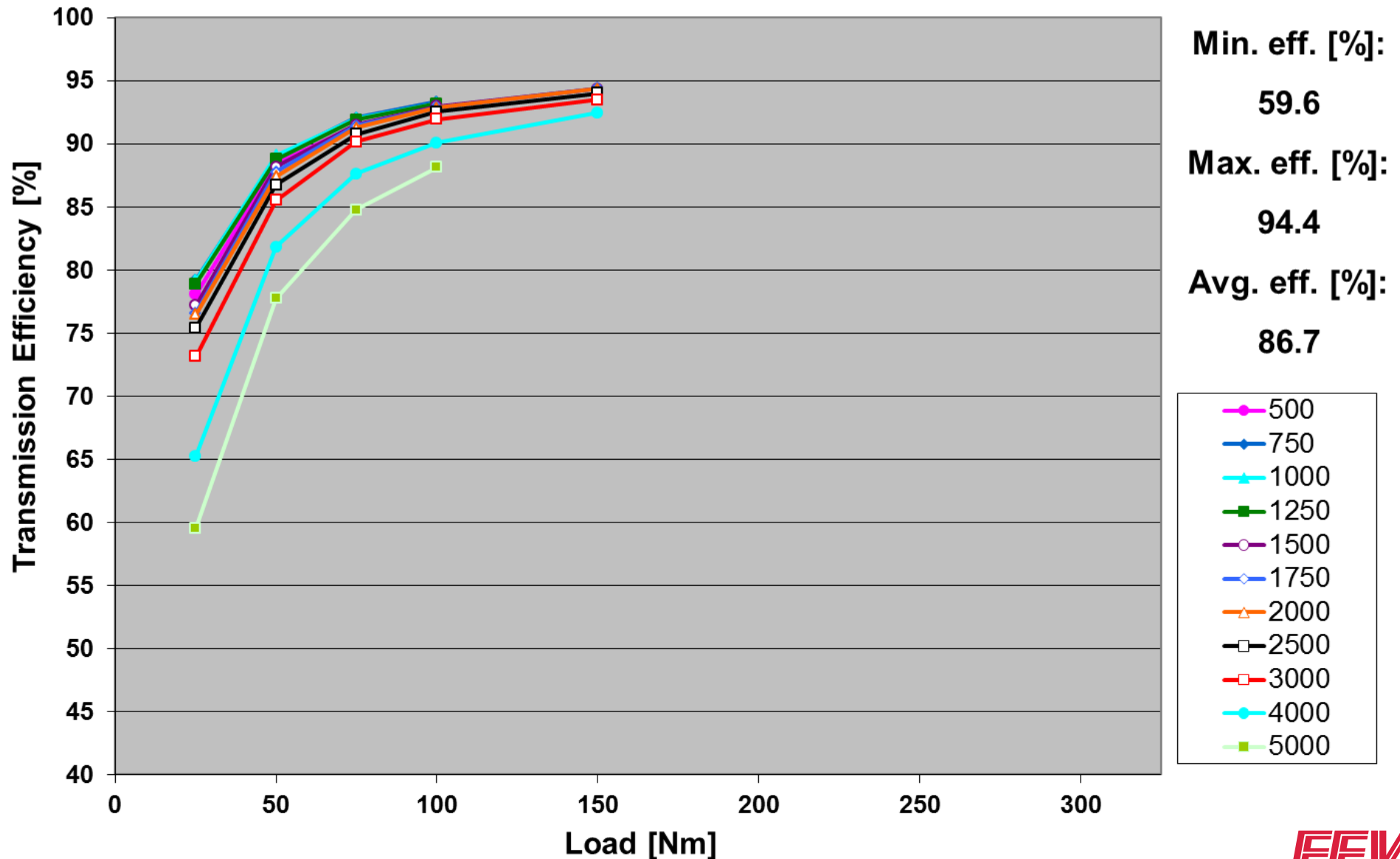
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



1st Gear, Eff. vs. Load, 35°C Oil Temp.



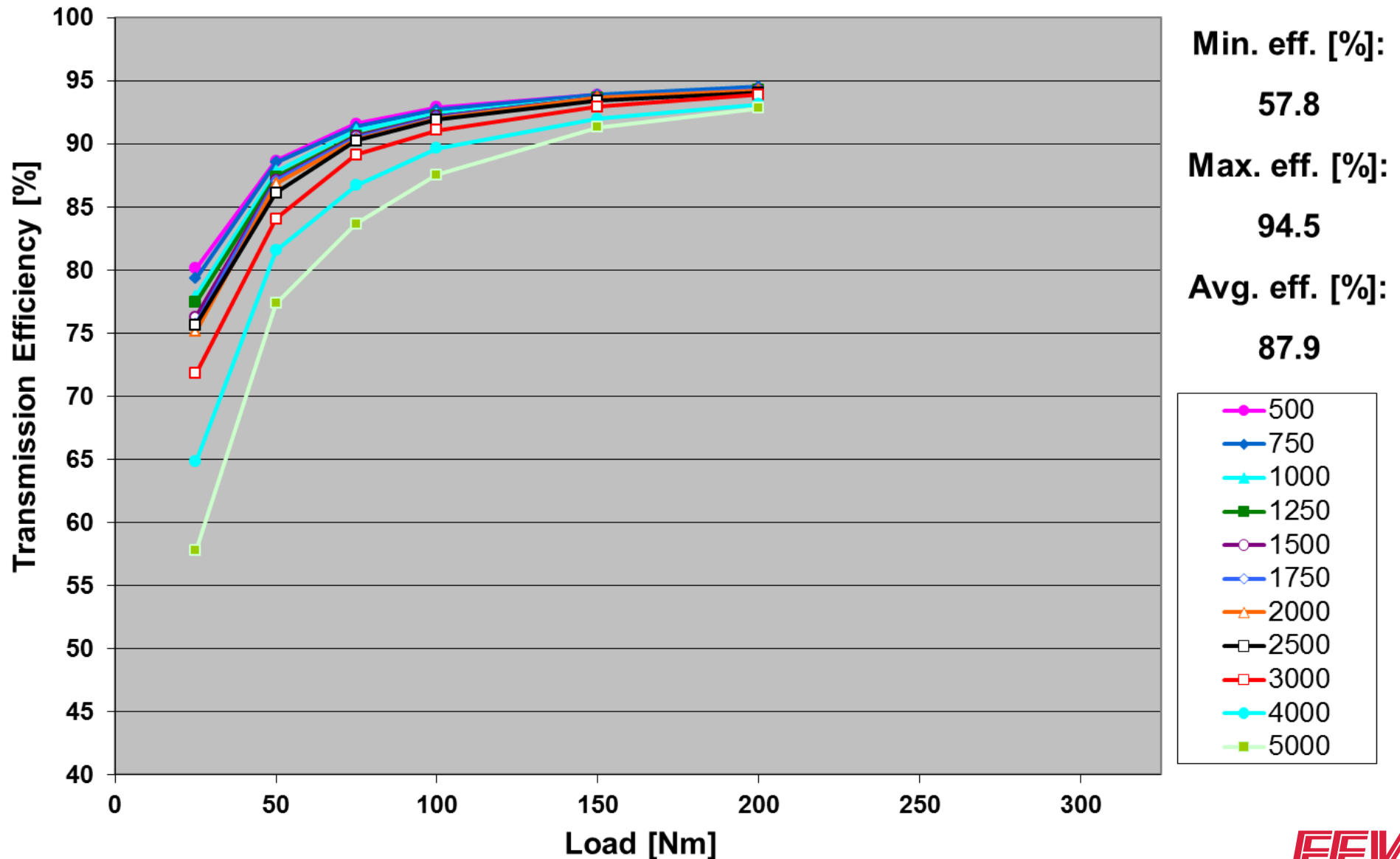
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



2nd Gear, Eff. vs. Load, 35°C Oil Temp.



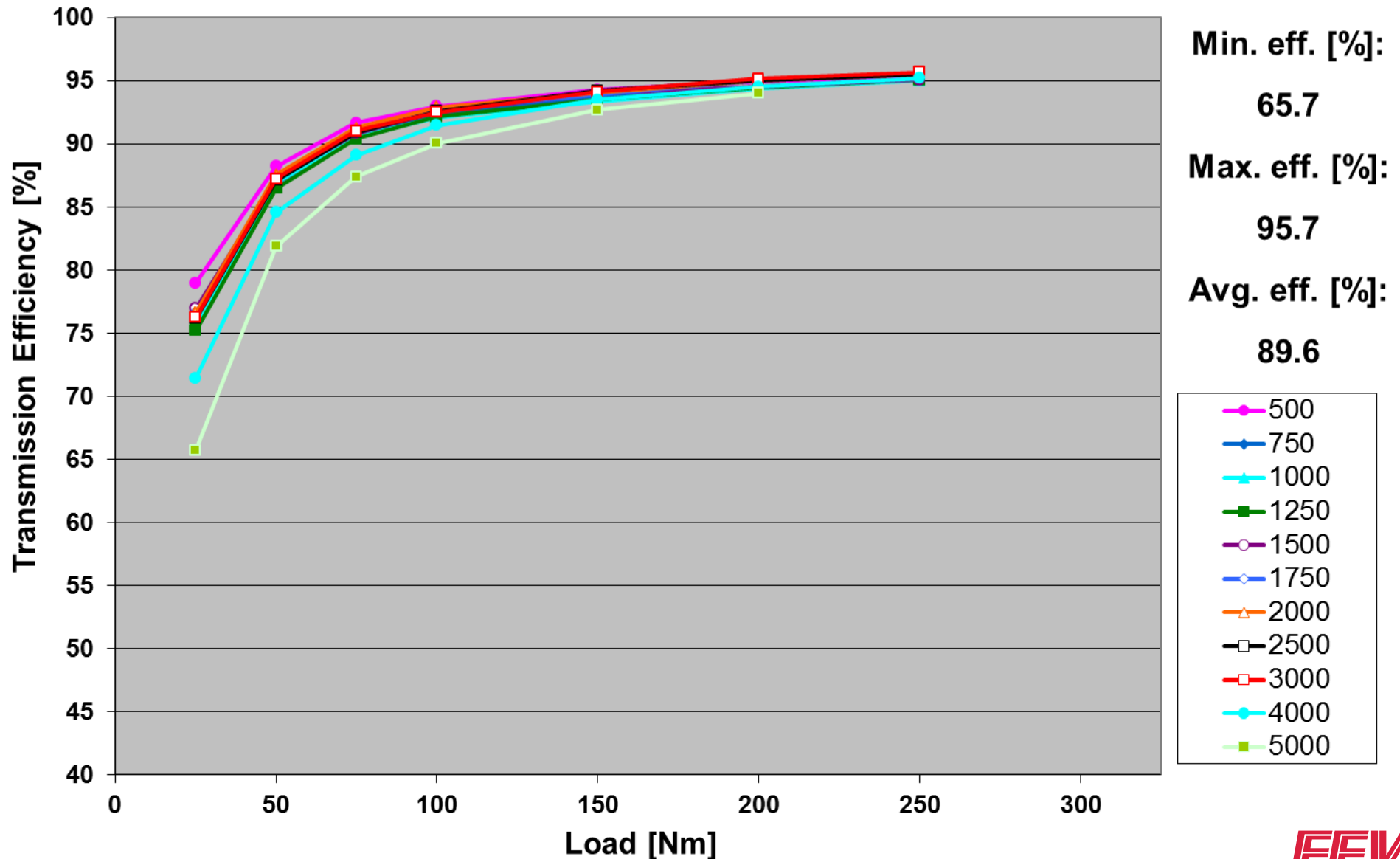
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



3rd Gear, Eff. vs. Load, 35°C Oil Temp.



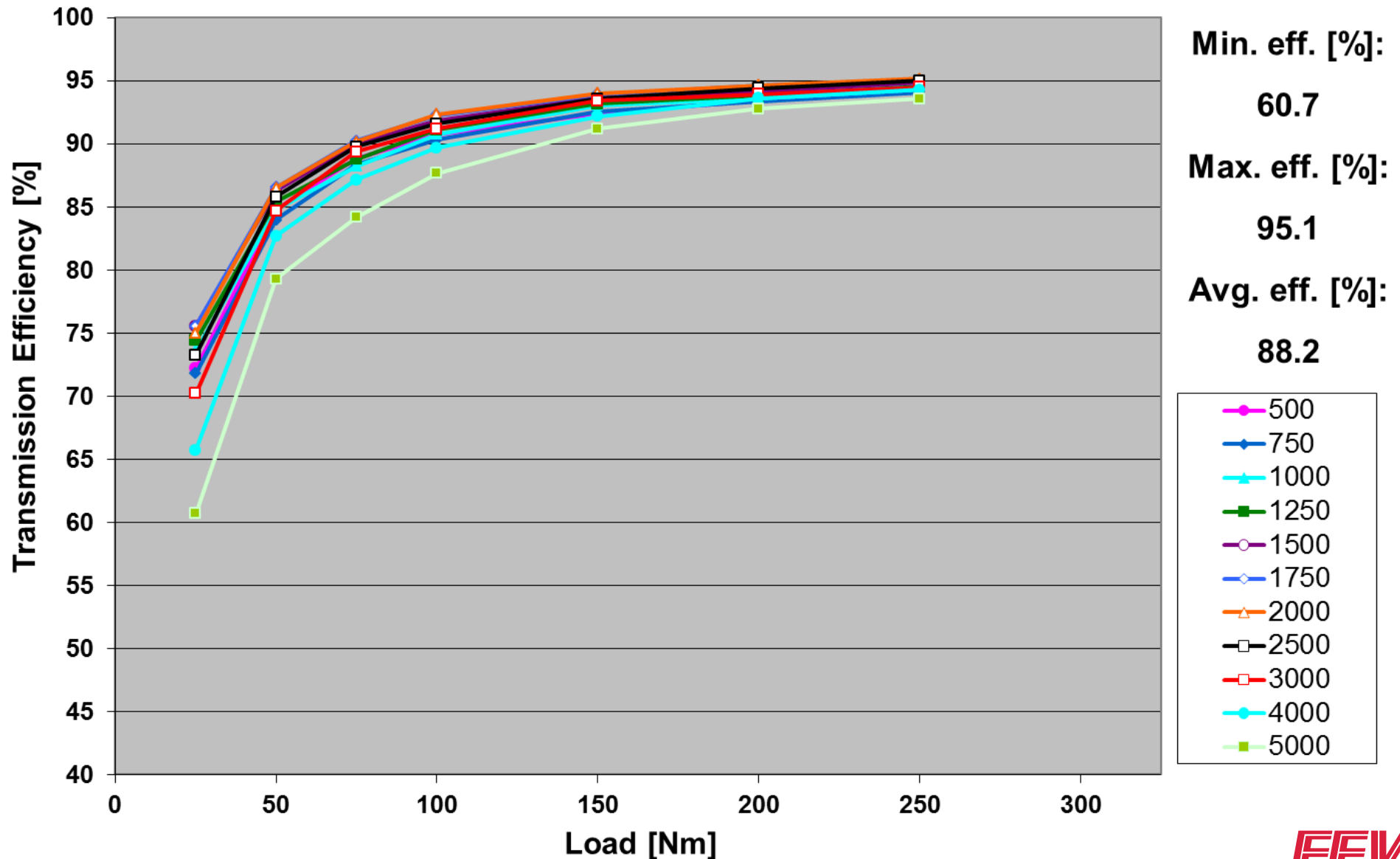
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



4th Gear, Eff. vs. Load, 35°C Oil Temp.

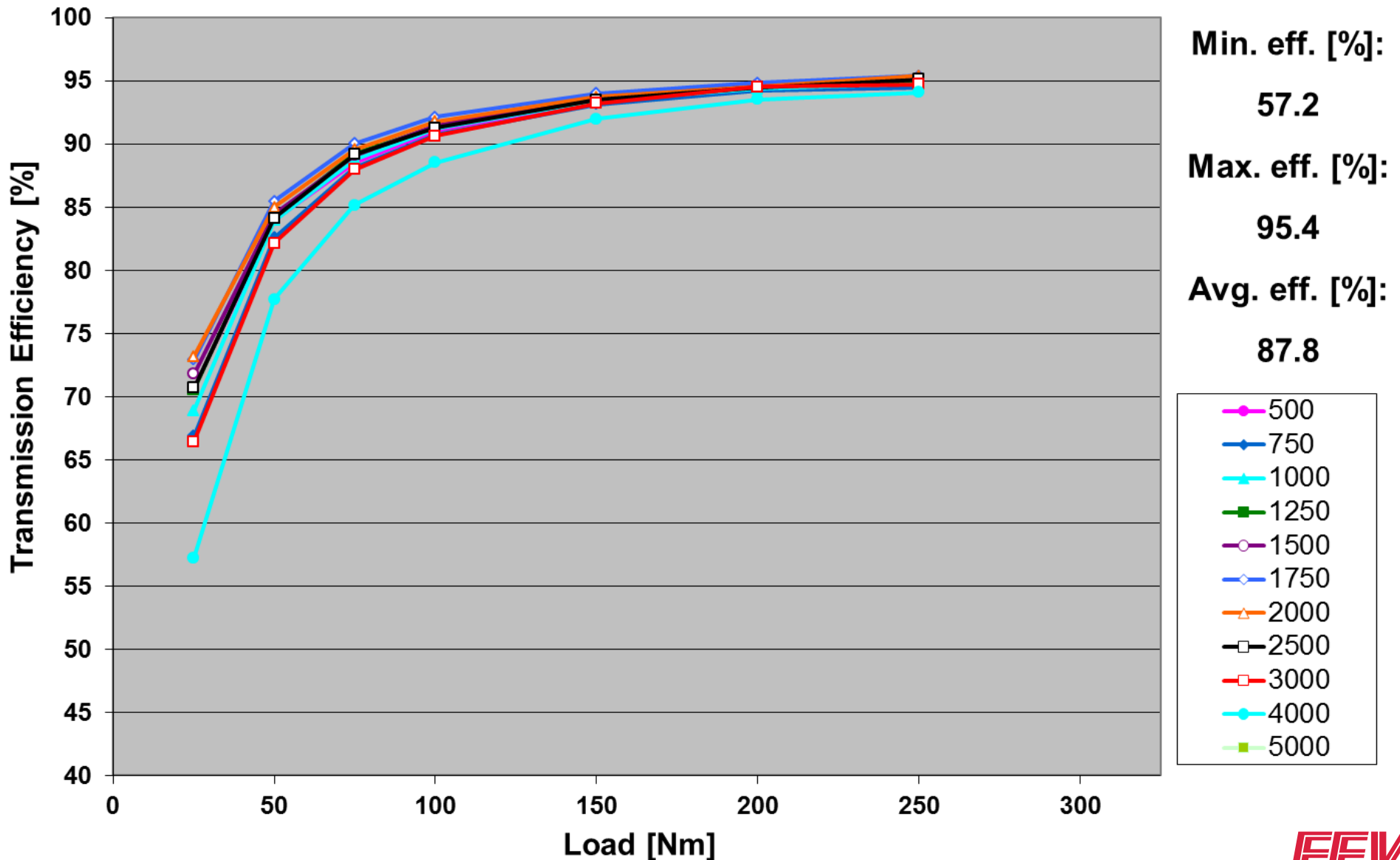


Ram HFE 8-Speed – Benchmark Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



5th Gear, Eff. vs. Load, 35°C Oil Temp.

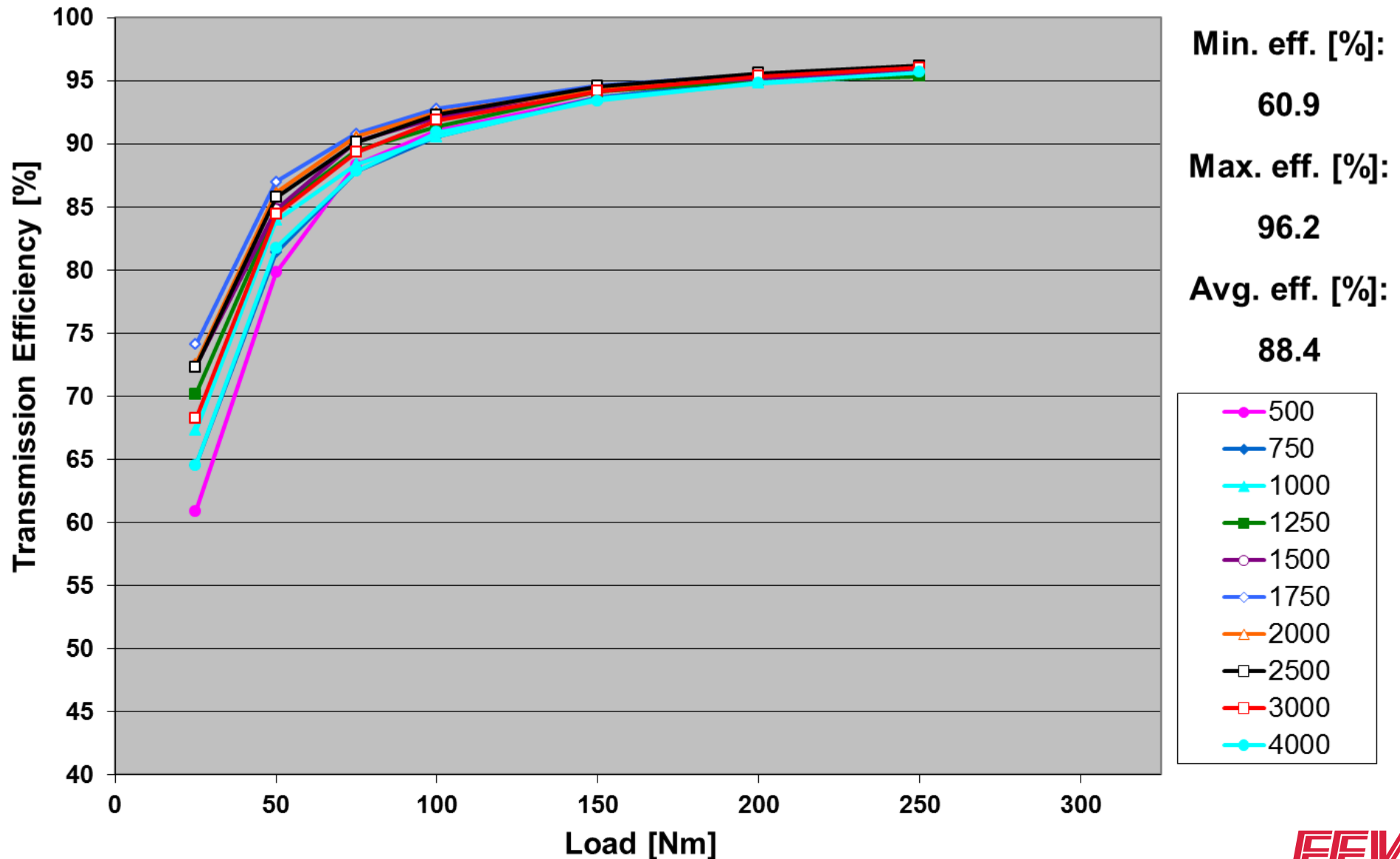


Ram HFE 8-Speed – Benchmark Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



6th Gear, Eff. vs. Load, 35°C Oil Temp.



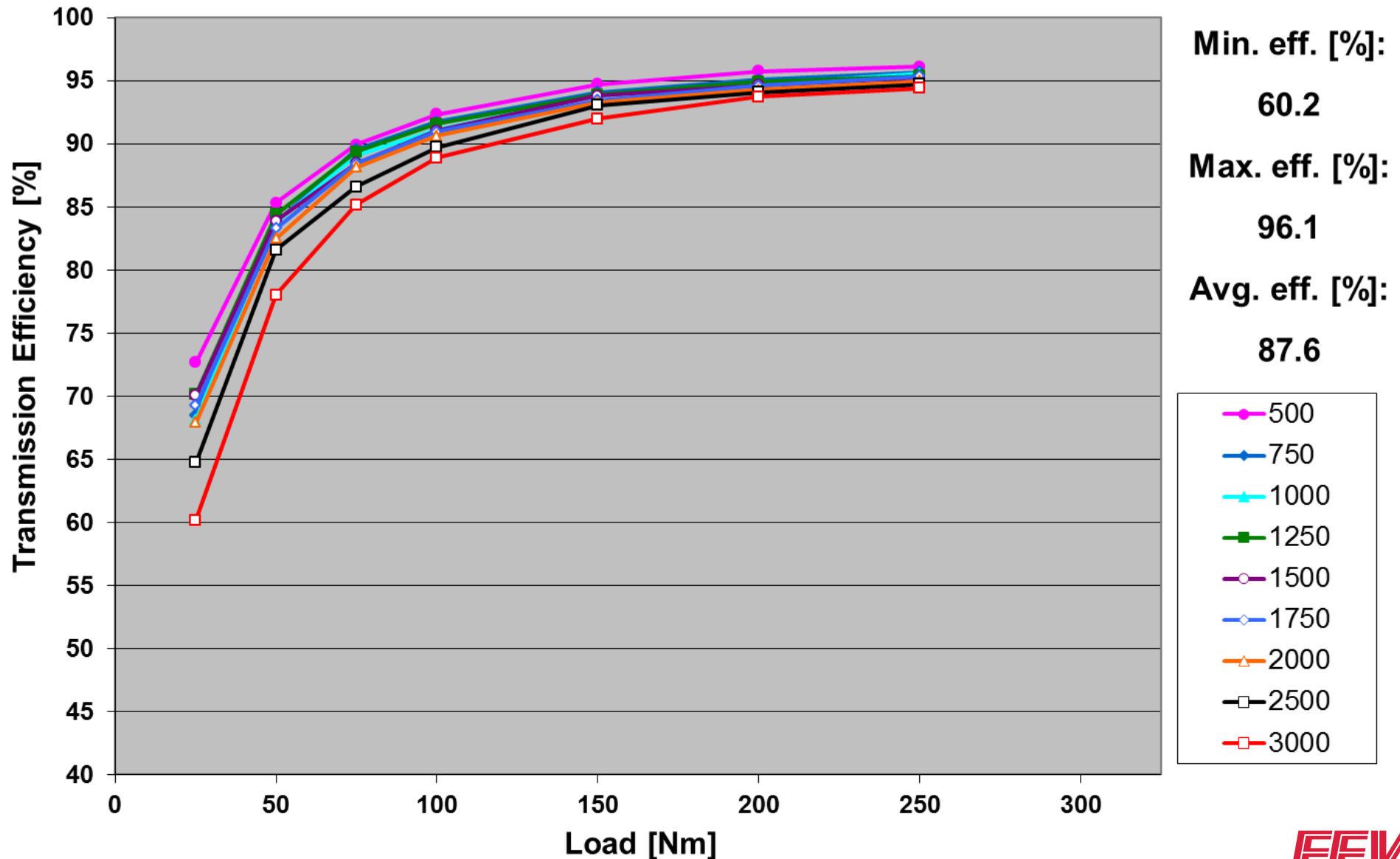
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



7th Gear, Eff. vs. Load, 35°C Oil Temp.



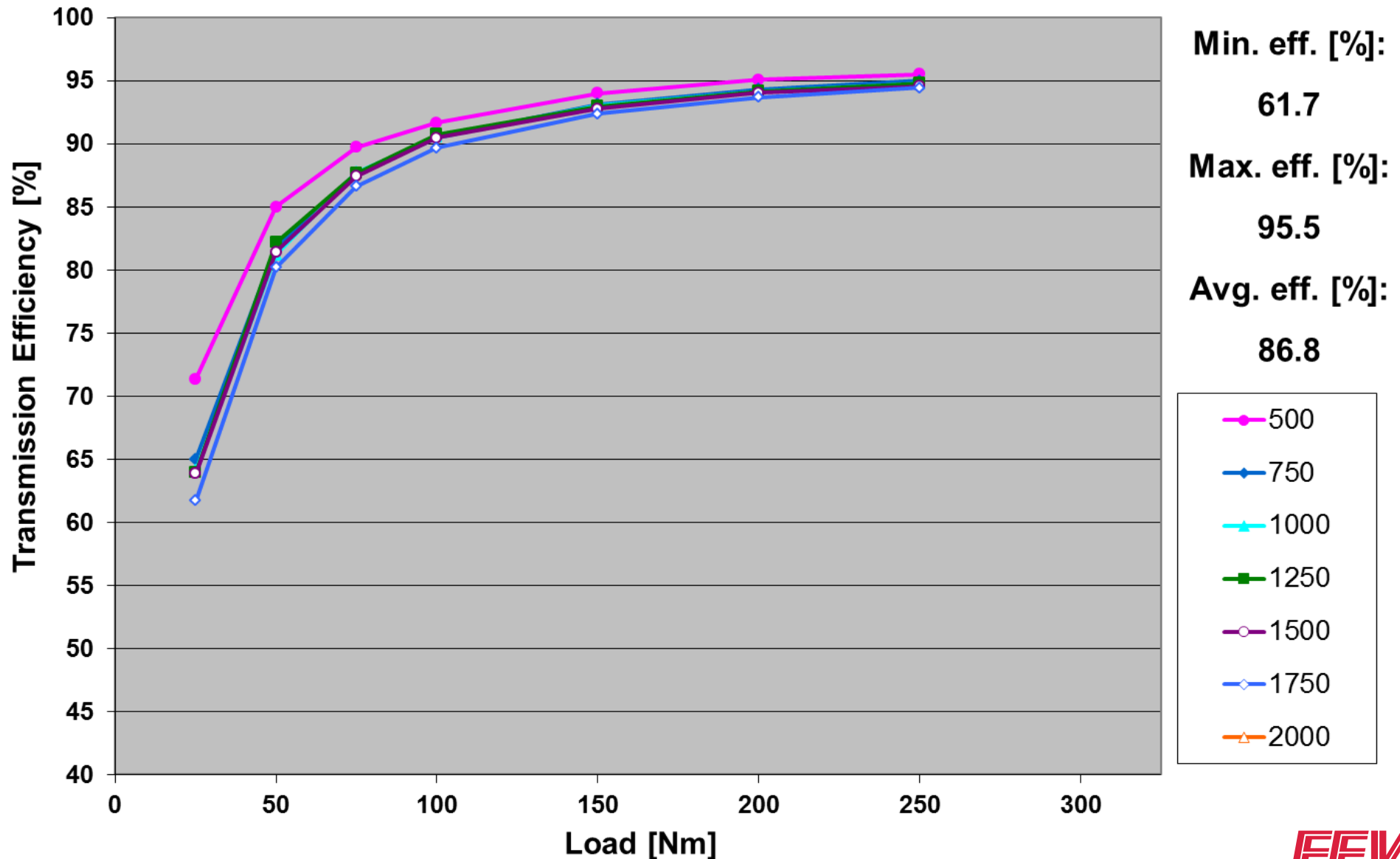
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



8th Gear, Eff. vs. Load, 35°C Oil Temp.



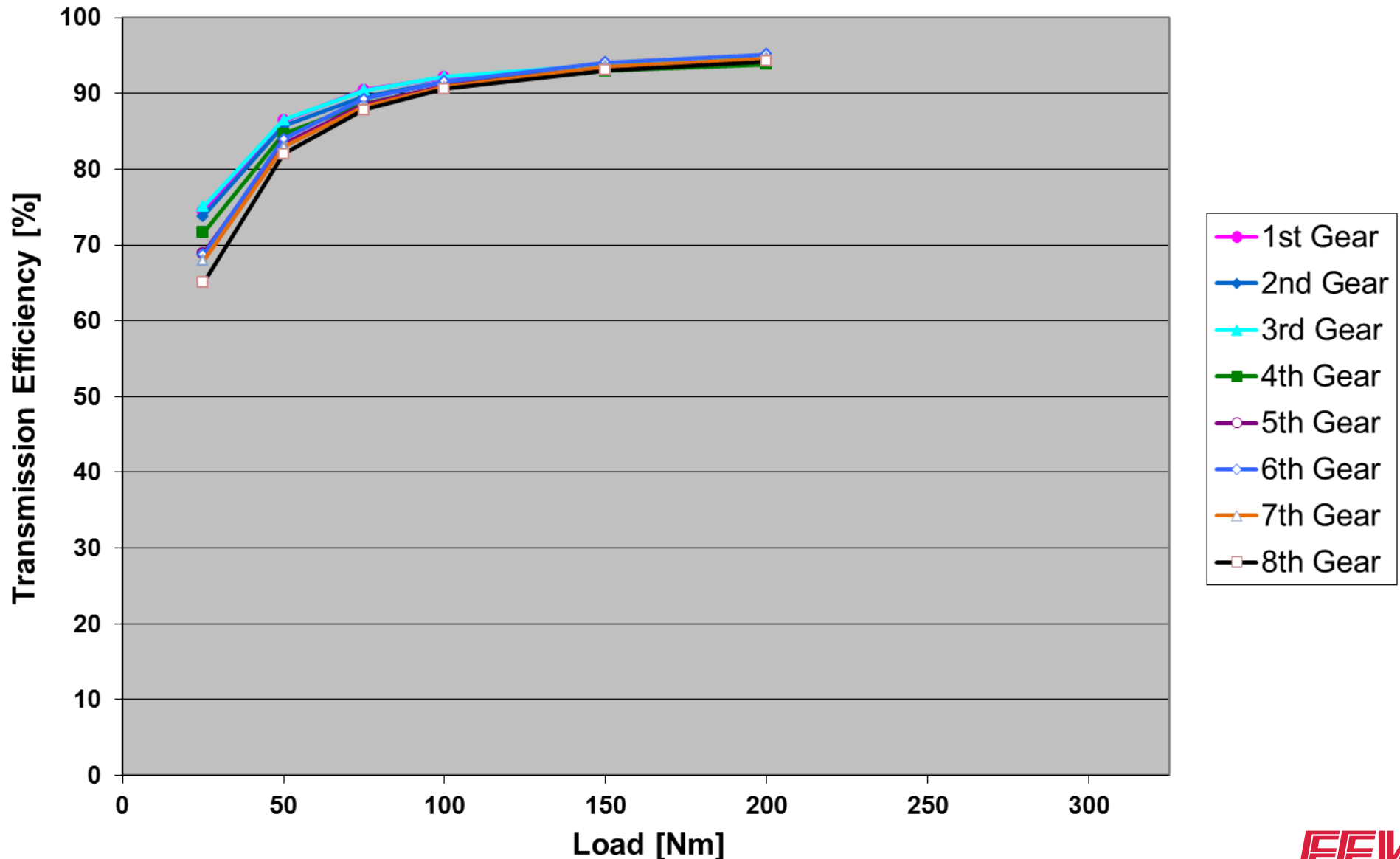
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



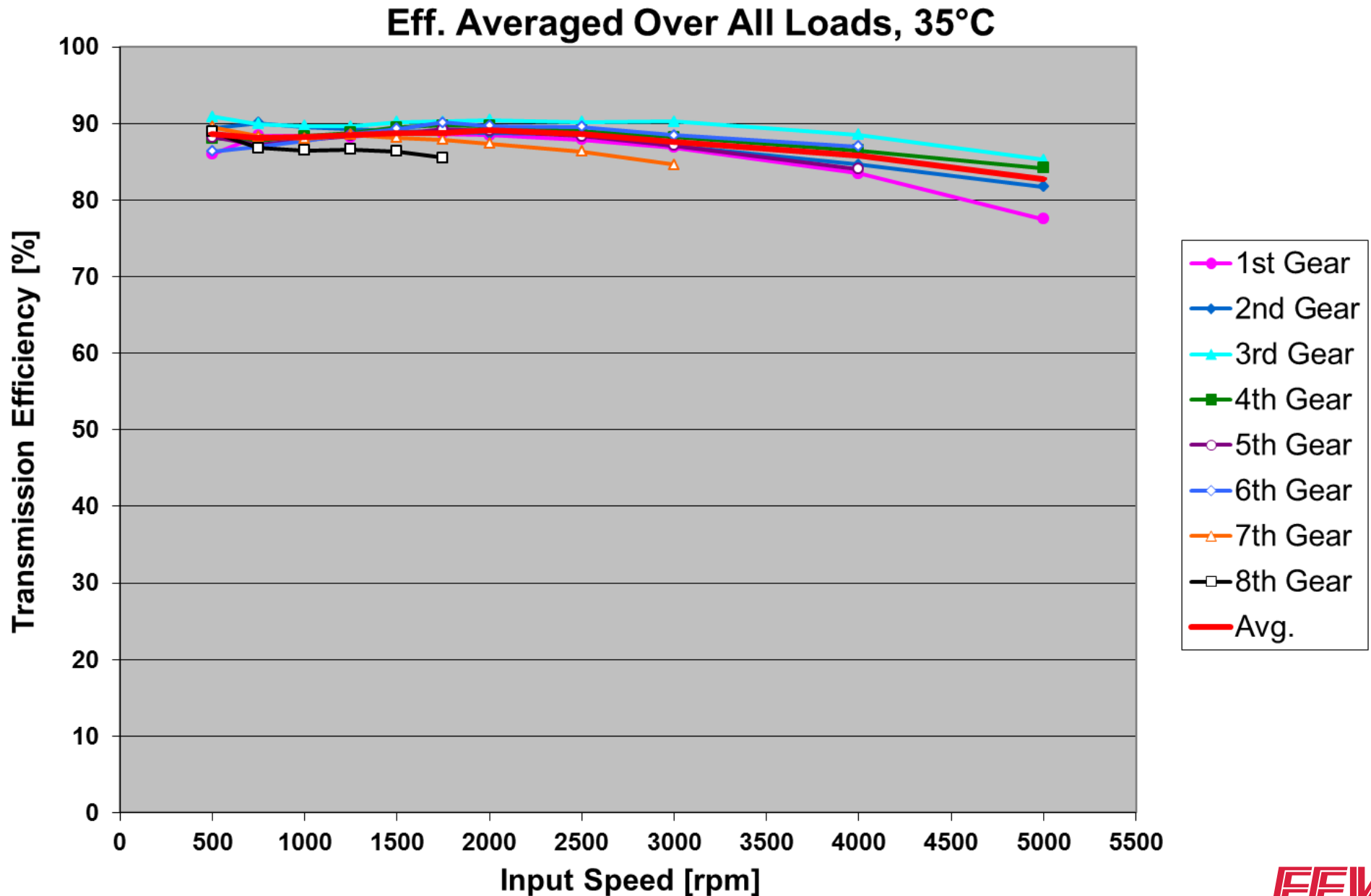
Eff. Averaged Over All Speeds, 35°C



Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



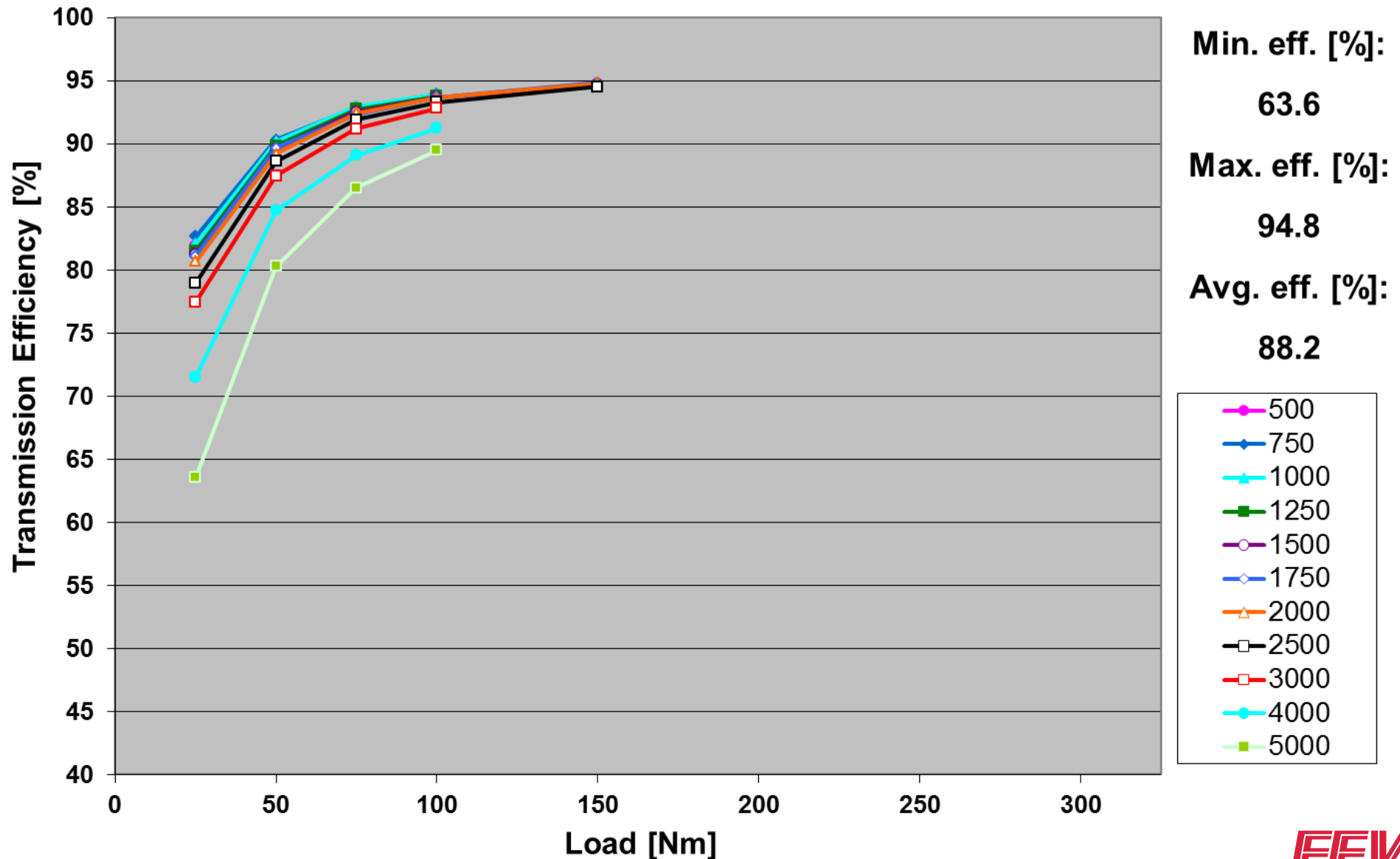
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



1st Gear, Eff. vs. Load, 60°C Oil Temp.

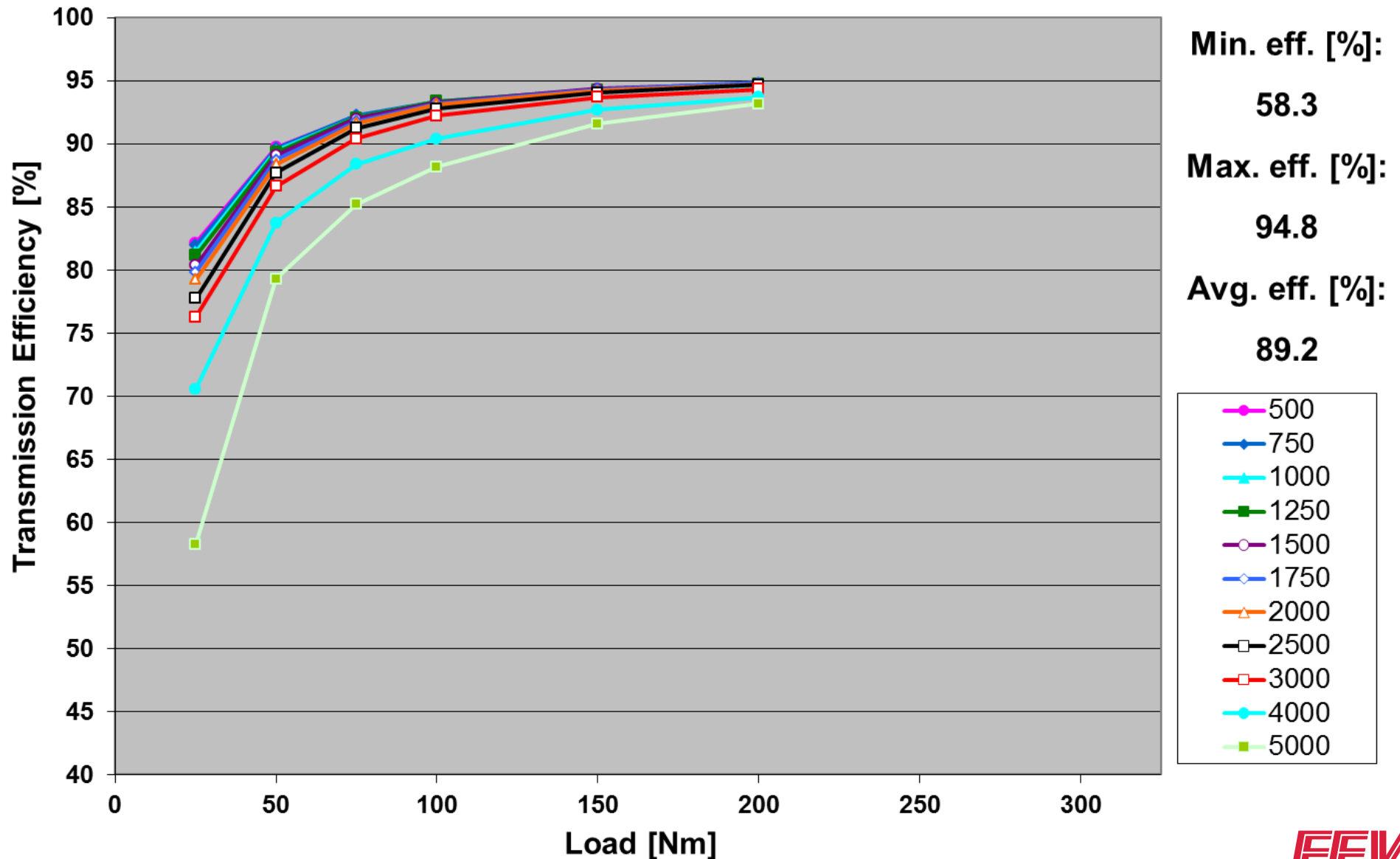


Ram HFE 8-Speed – Benchmark Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



2nd Gear, Eff. vs. Load, 60°C Oil Temp.



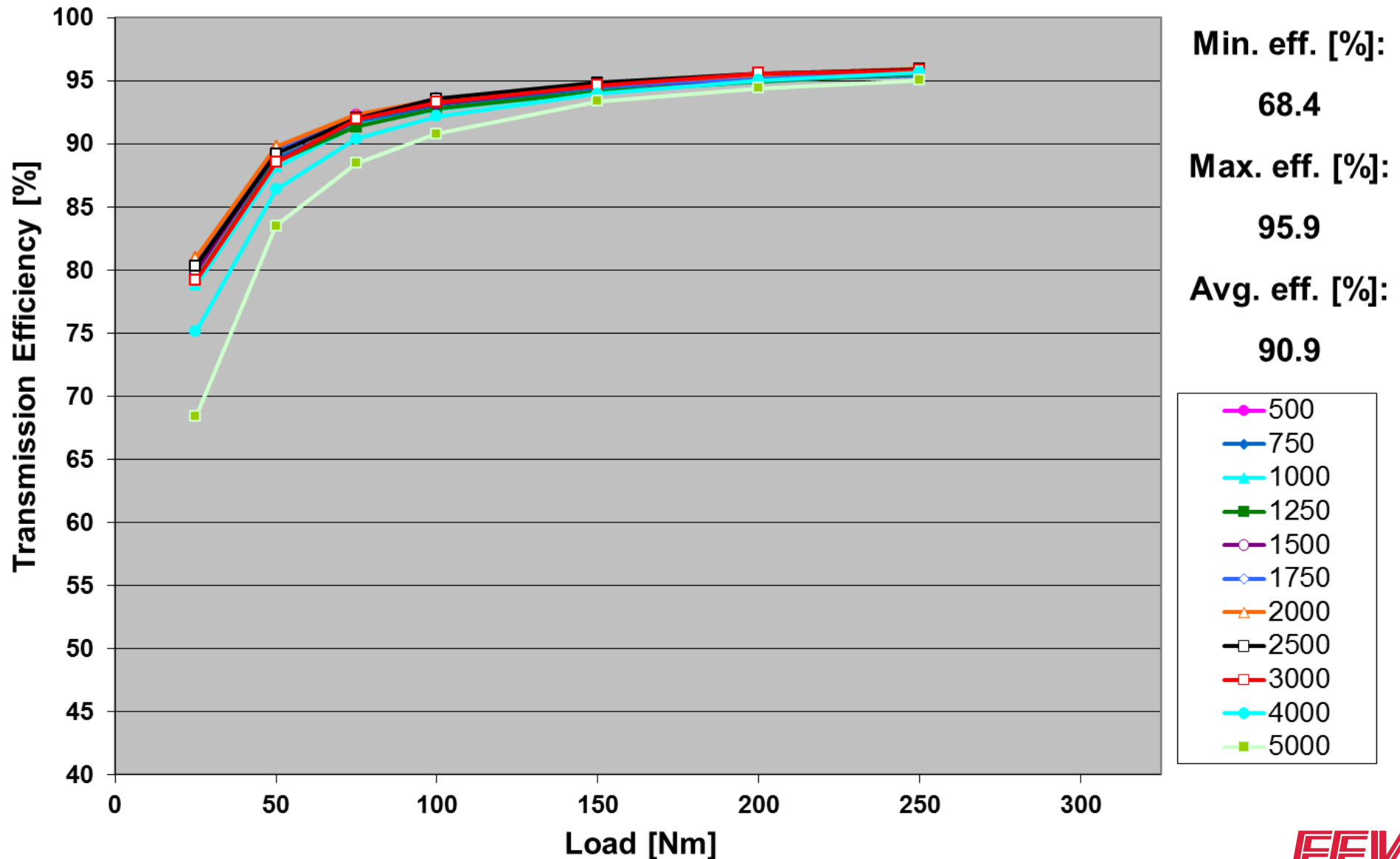
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



3rd Gear, Eff. vs. Load, 60°C Oil Temp.



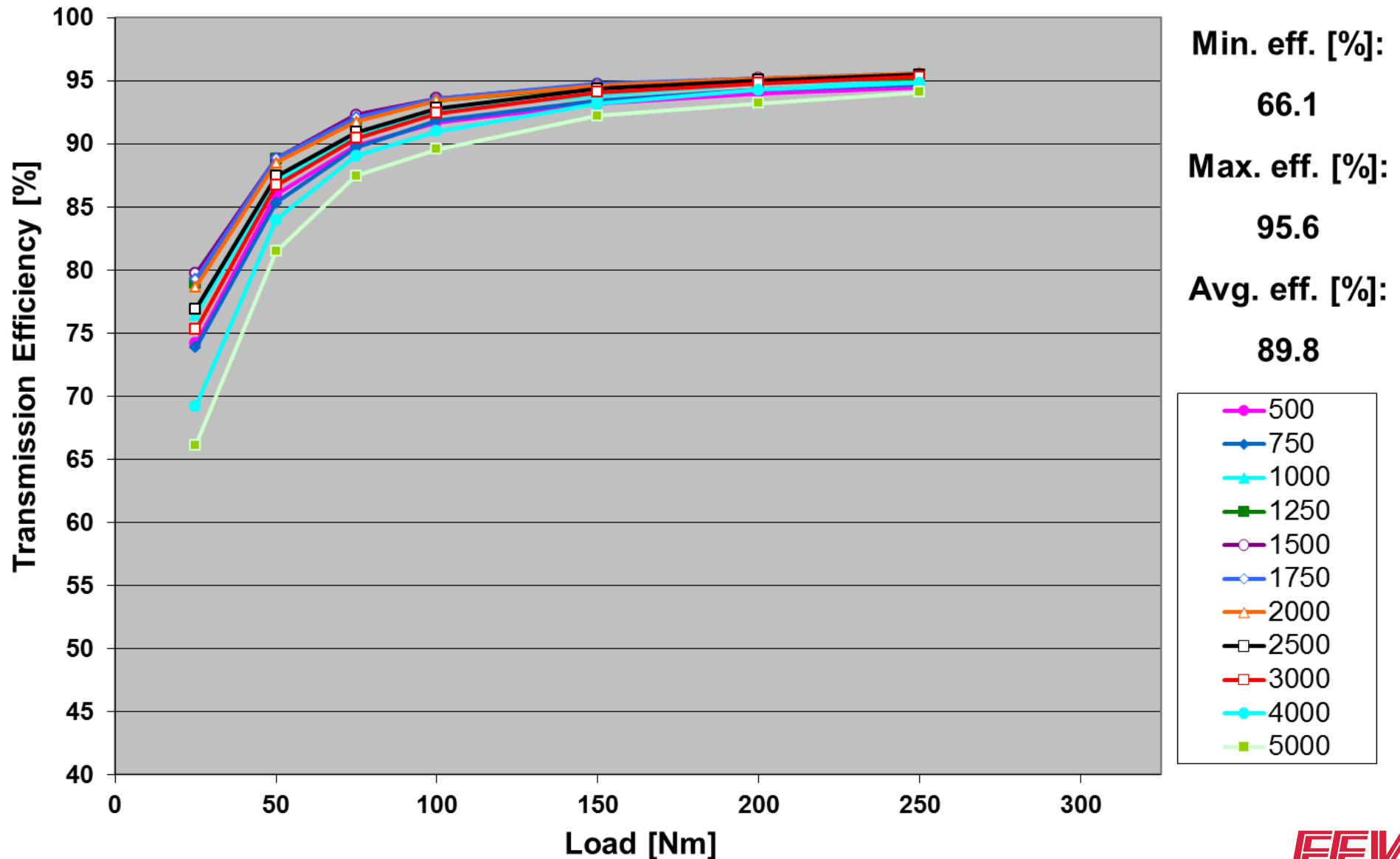
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



4th Gear, Eff. vs. Load, 60°C Oil Temp.



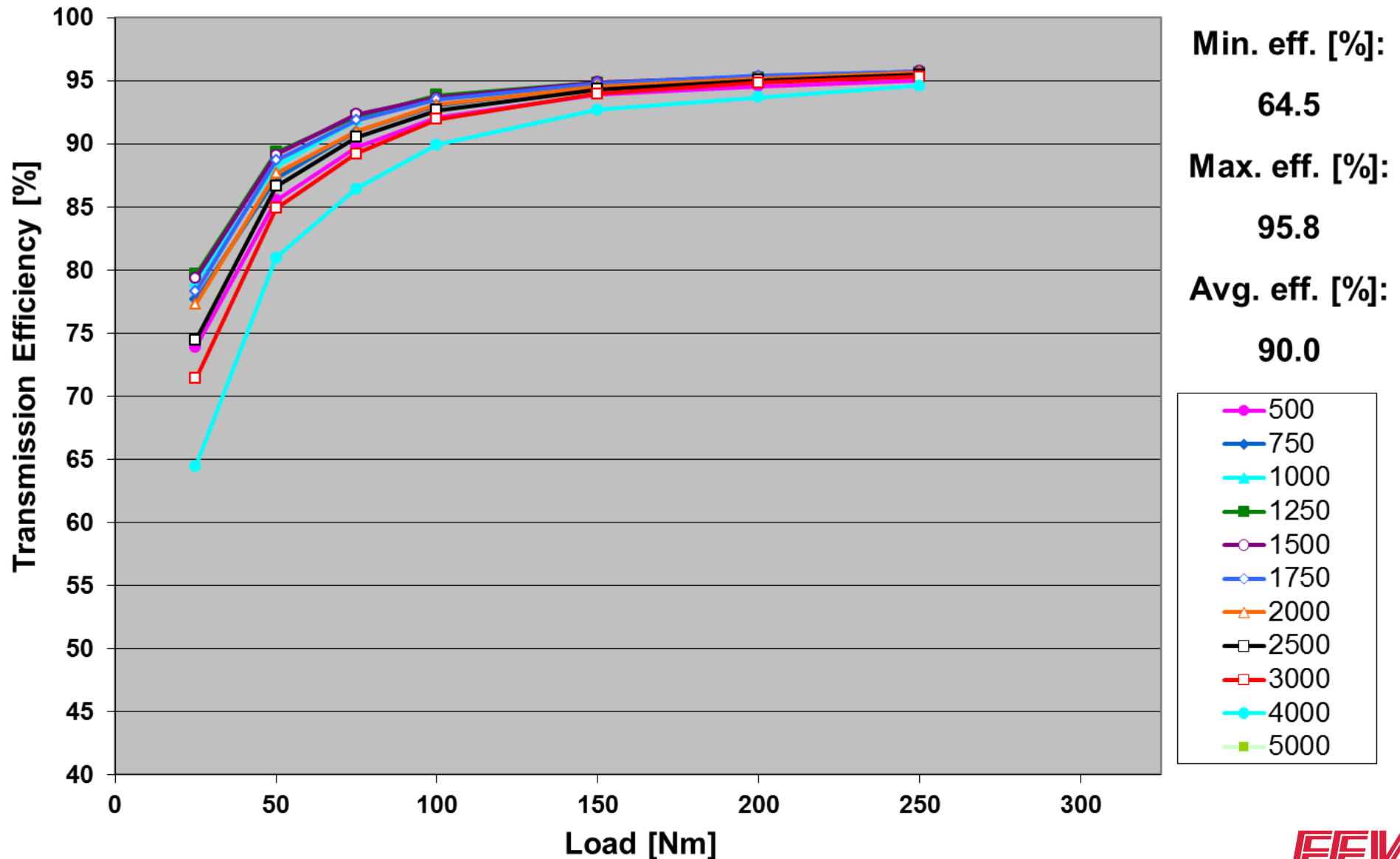
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



5th Gear, Eff. vs. Load, 60°C Oil Temp.



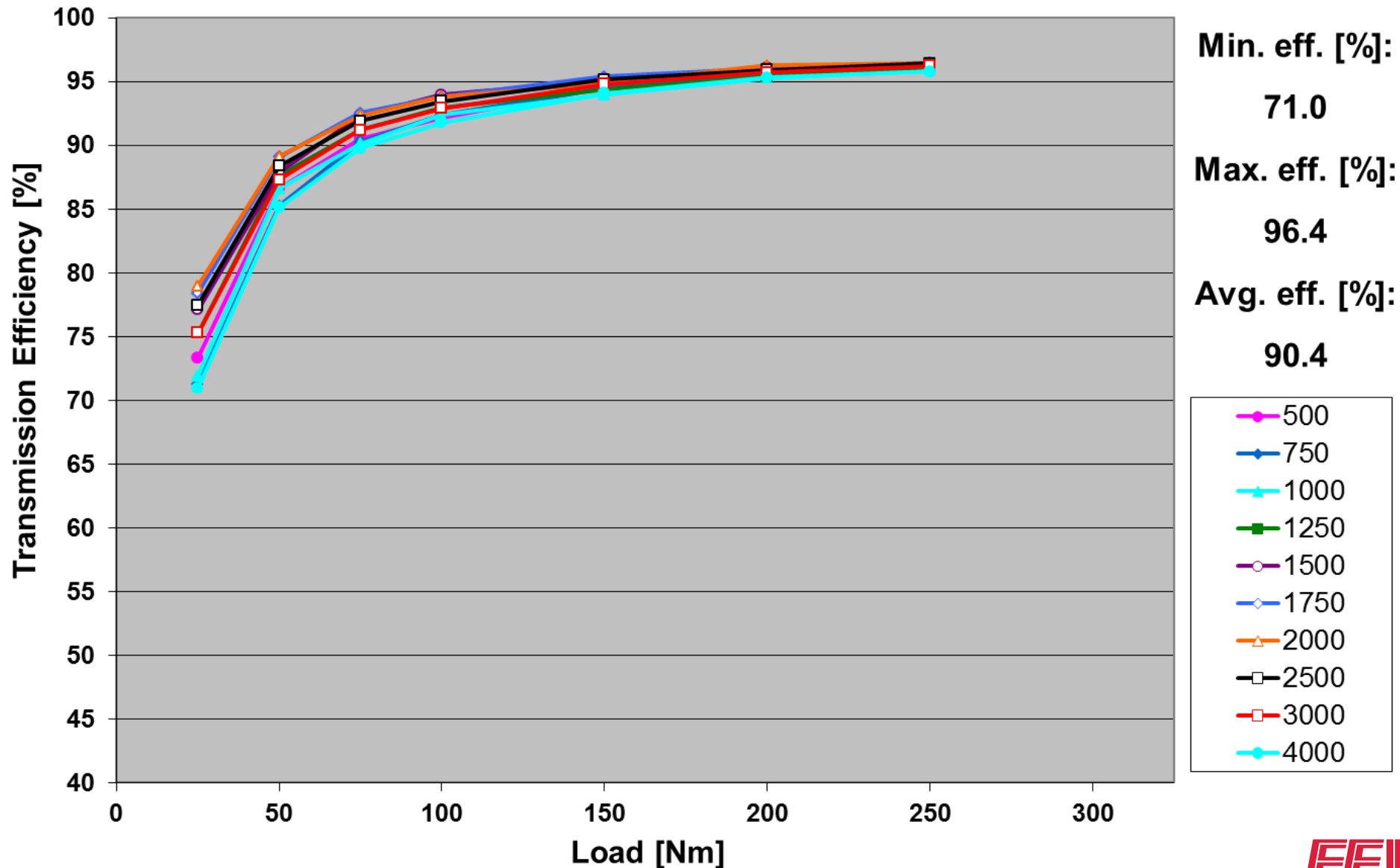
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



6th Gear, Eff. vs. Load, 60°C Oil Temp.



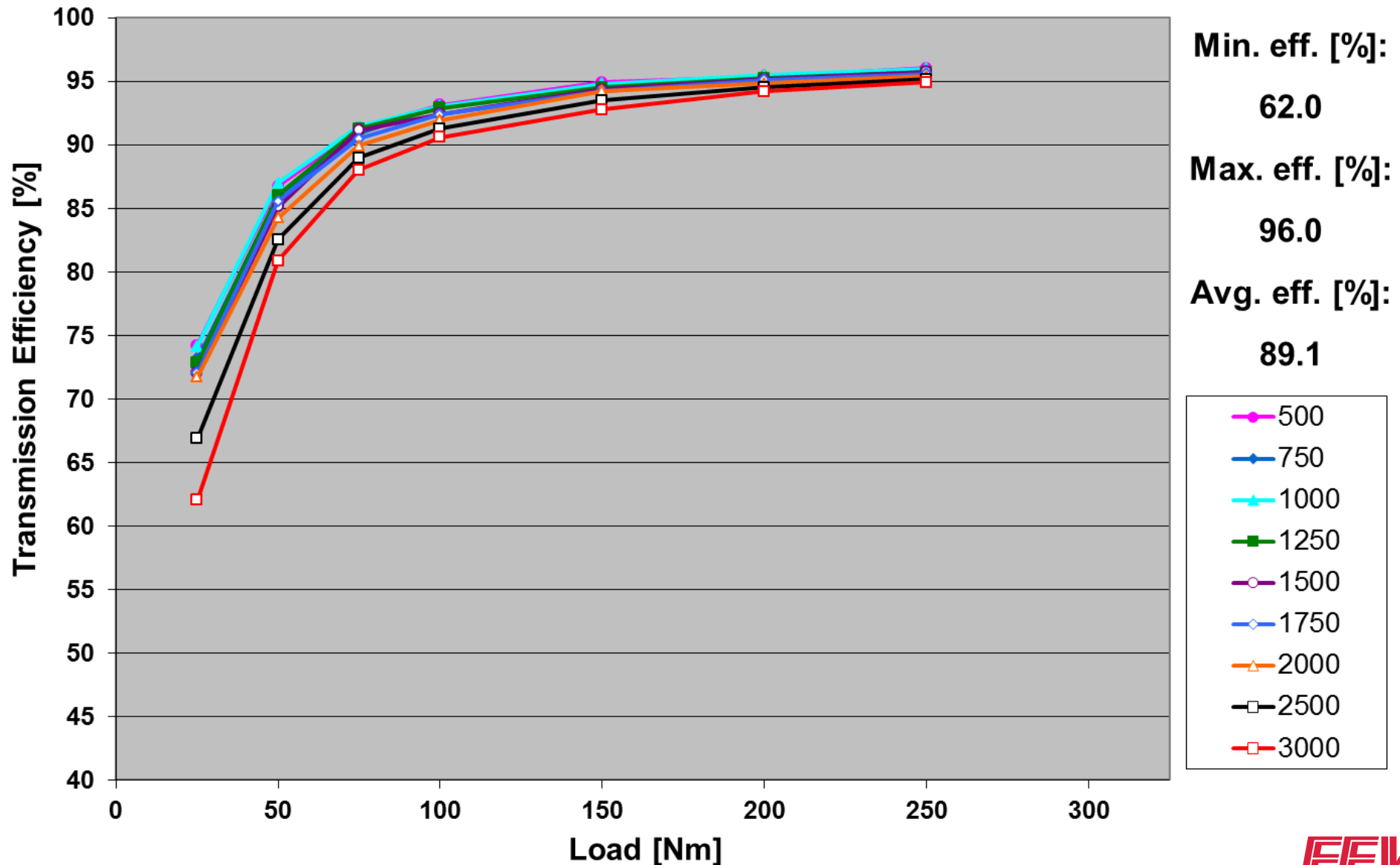
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



7th Gear, Eff. vs. Load, 60°C Oil Temp.



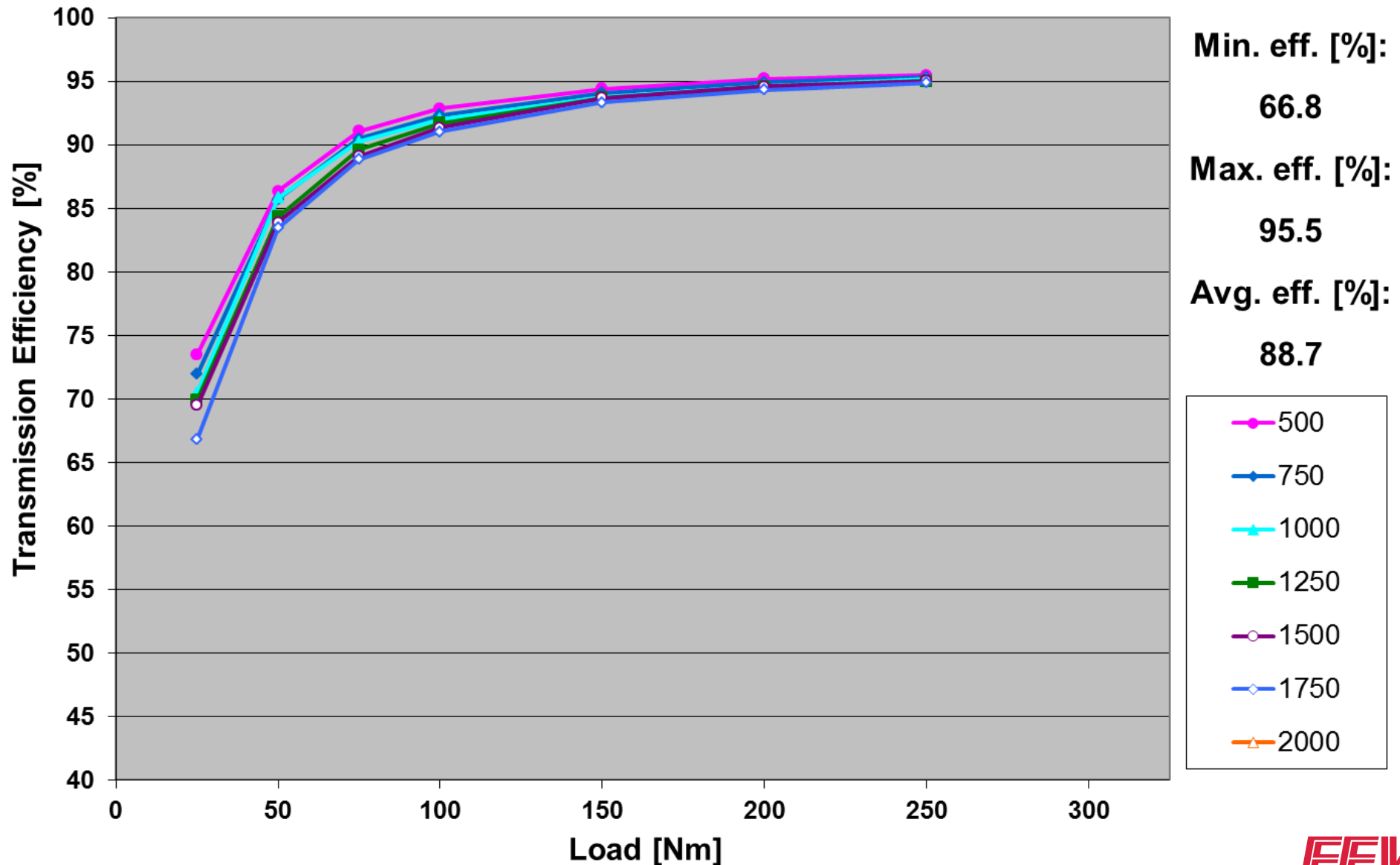
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



8th Gear, Eff. vs. Load, 60°C Oil Temp.



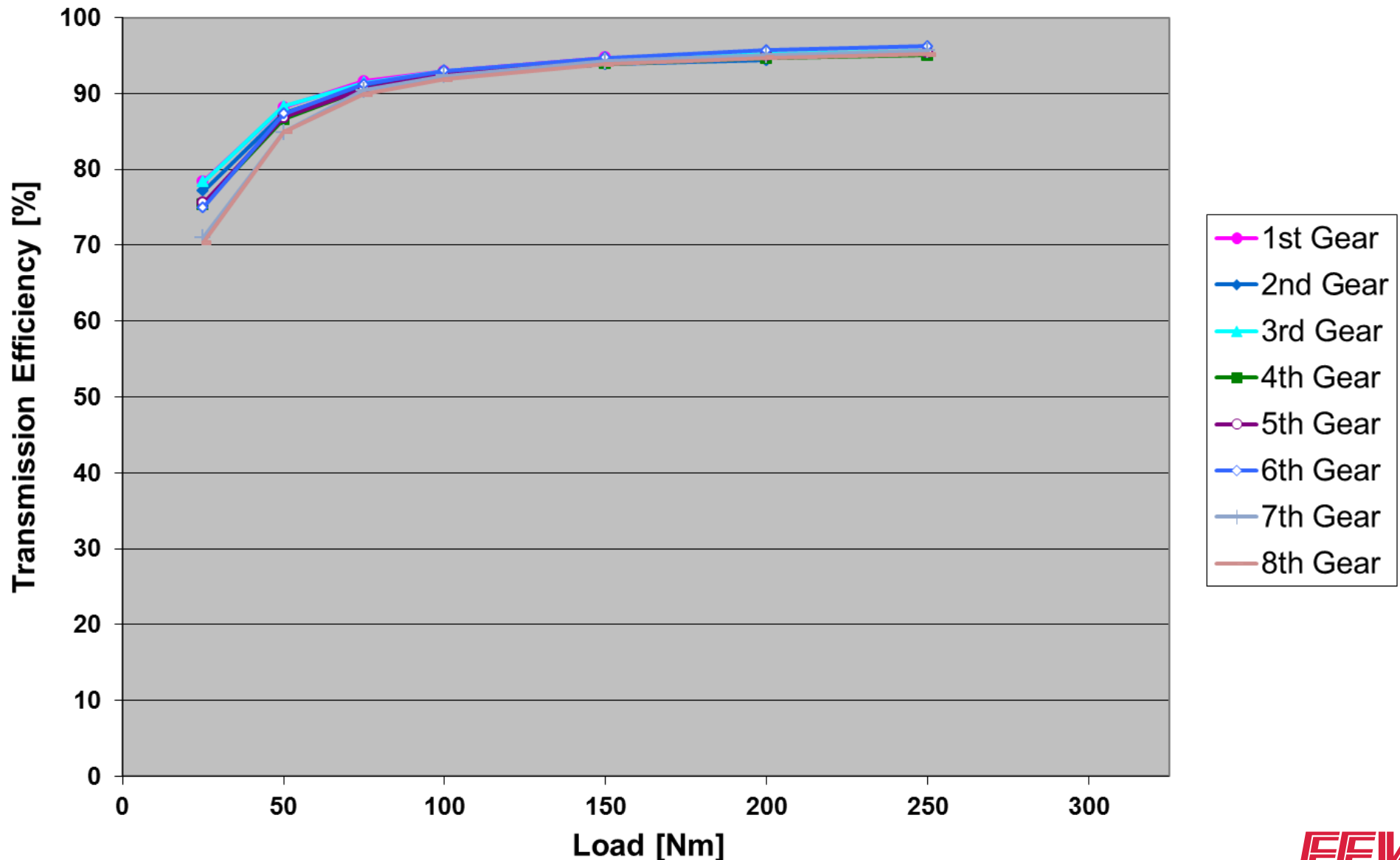
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



Eff. Averaged Over All Speeds, 60°C



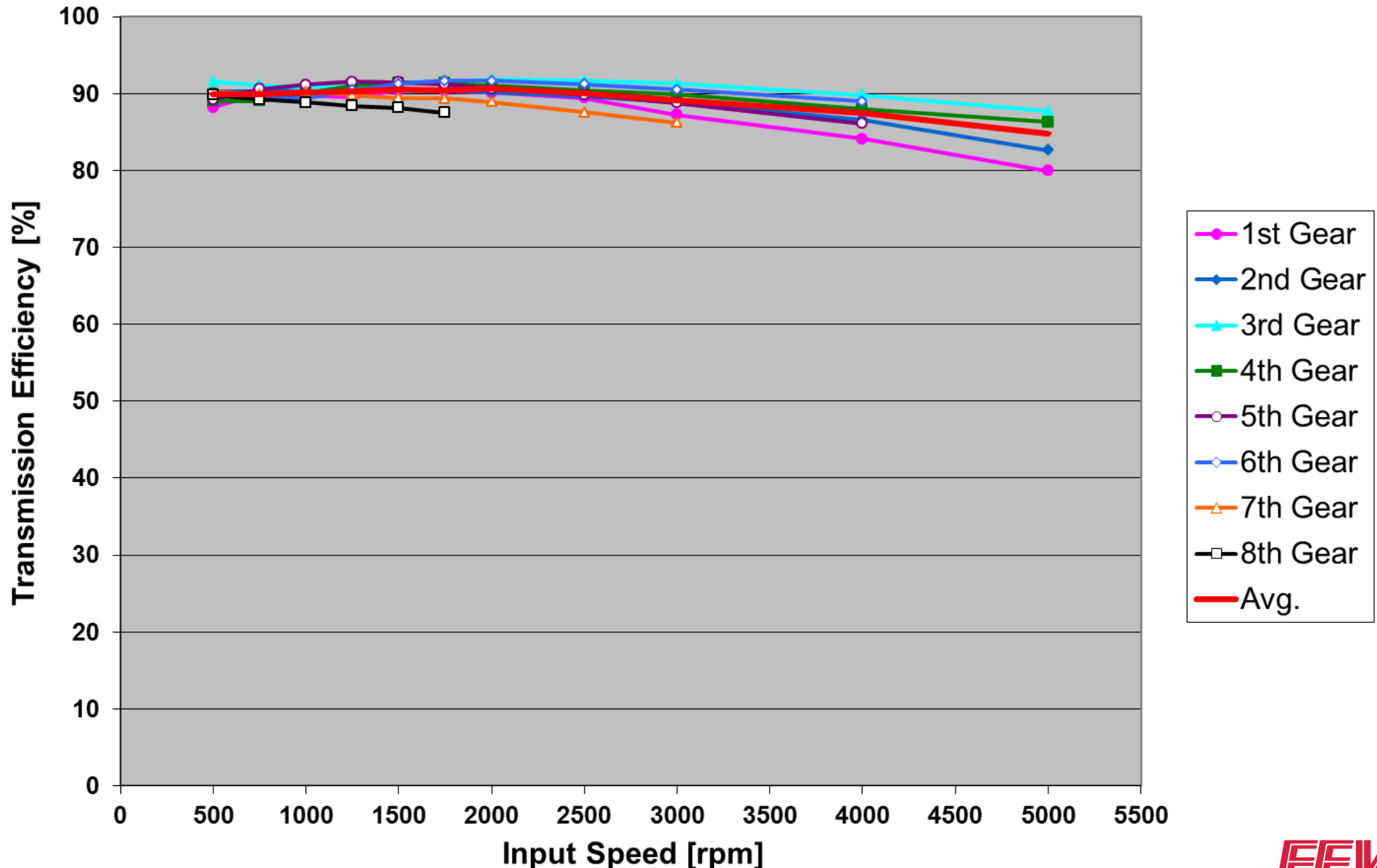
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



Eff. Averaged Over All Loads, 60°C



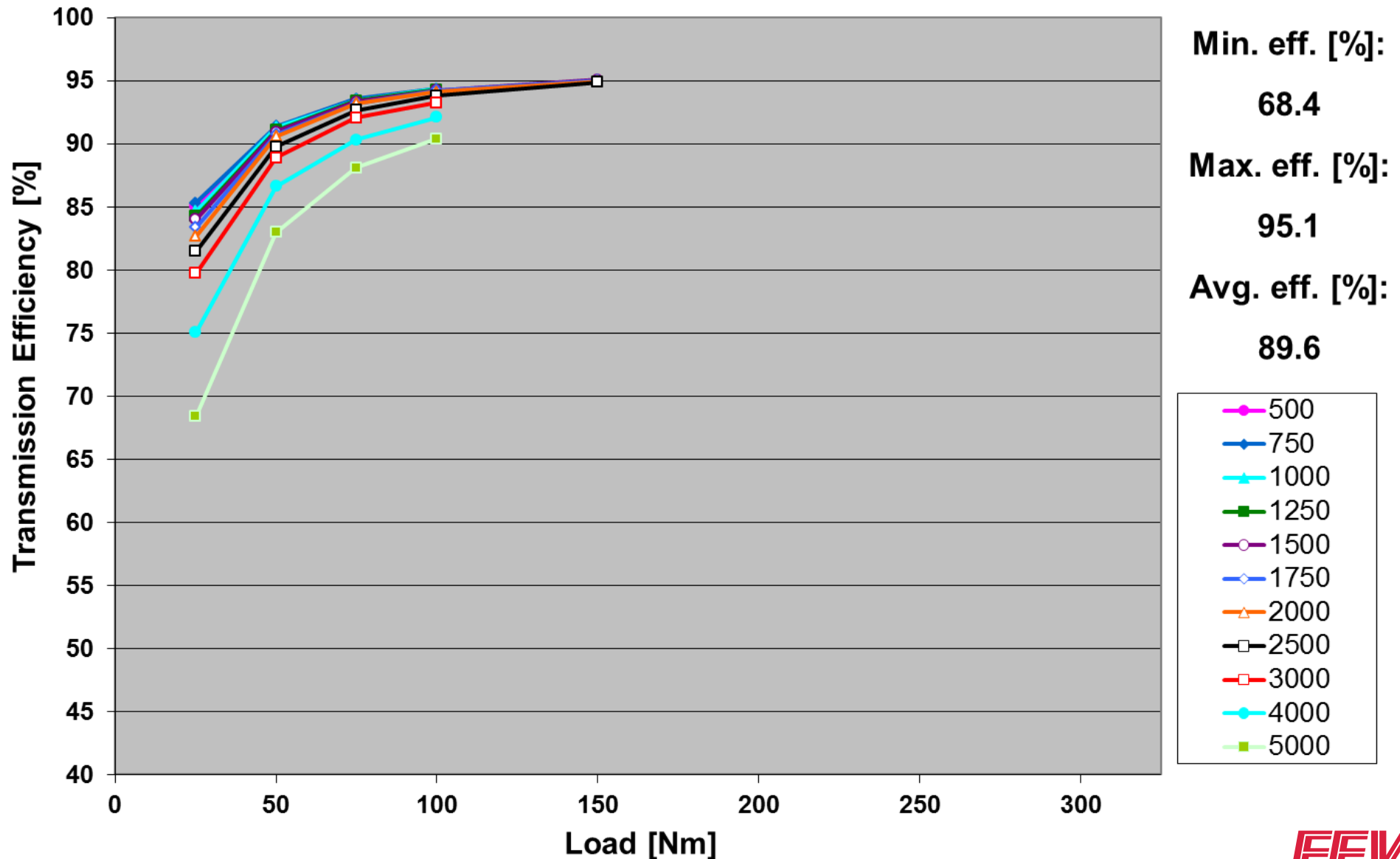
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



1st Gear, Eff. vs. Load, 100°C Oil Temp.



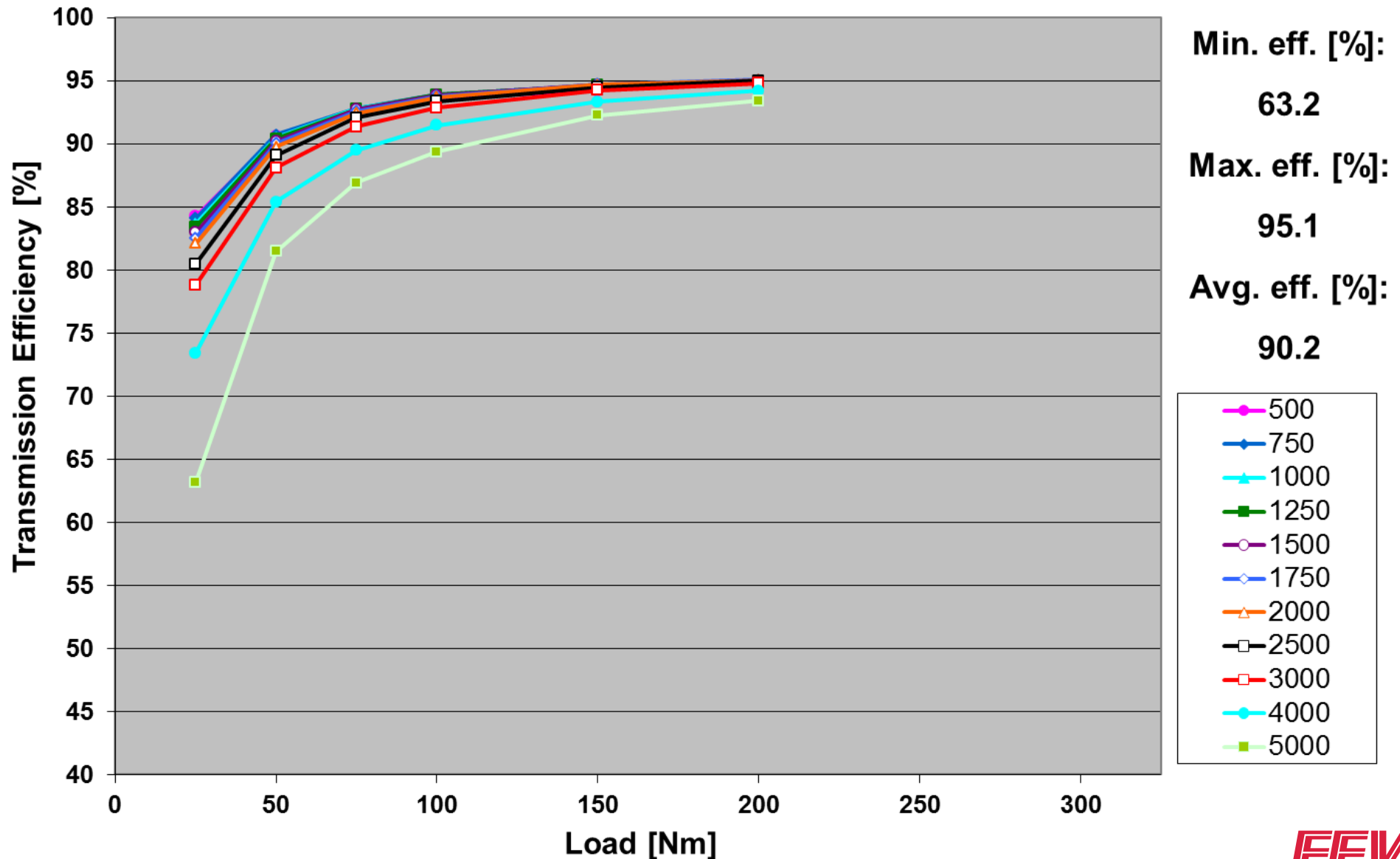
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



2nd Gear, Eff. vs. Load, 100°C Oil Temp.

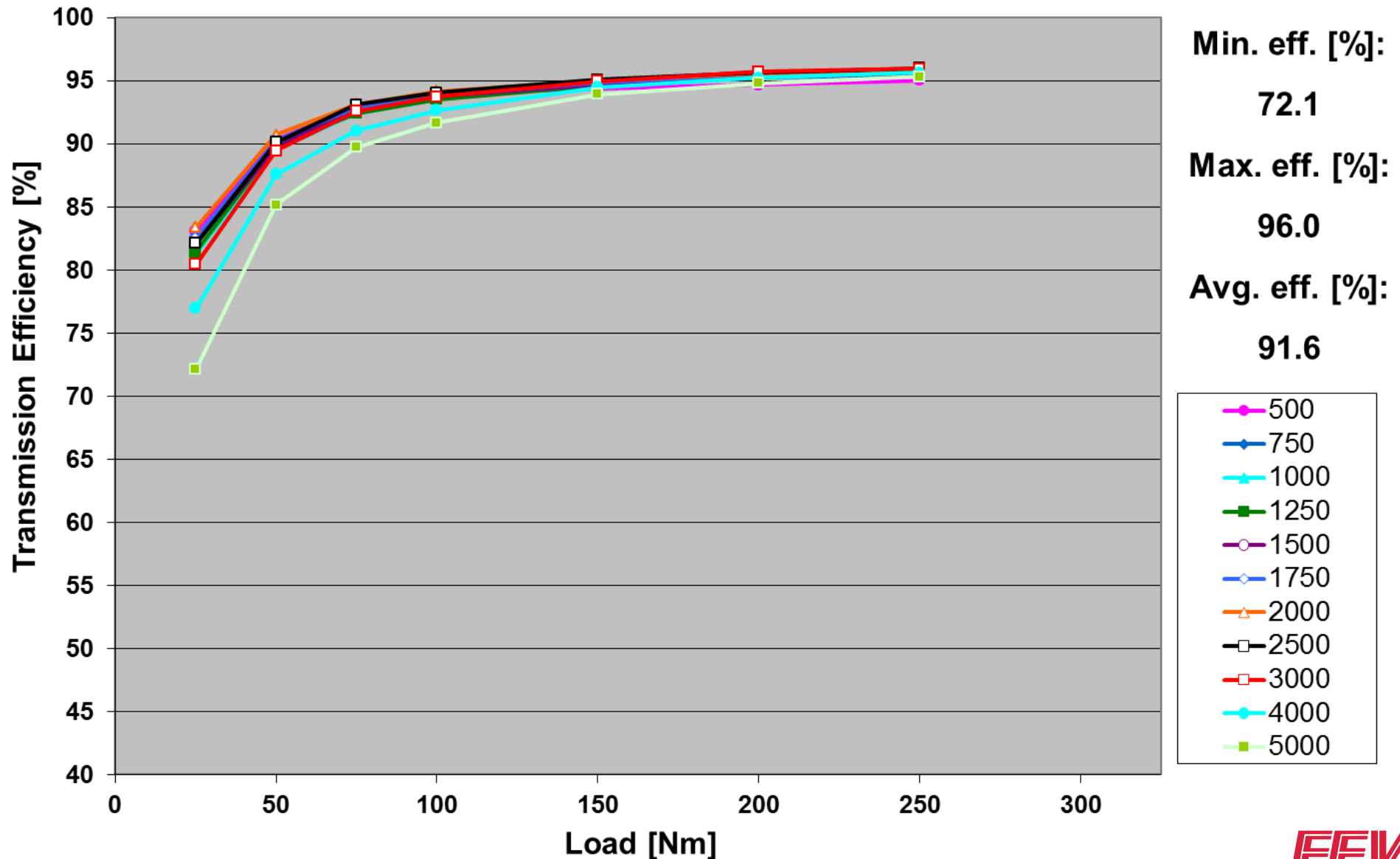


Ram HFE 8-Speed – Benchmark Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



3rd Gear, Eff. vs. Load, 100°C Oil Temp.



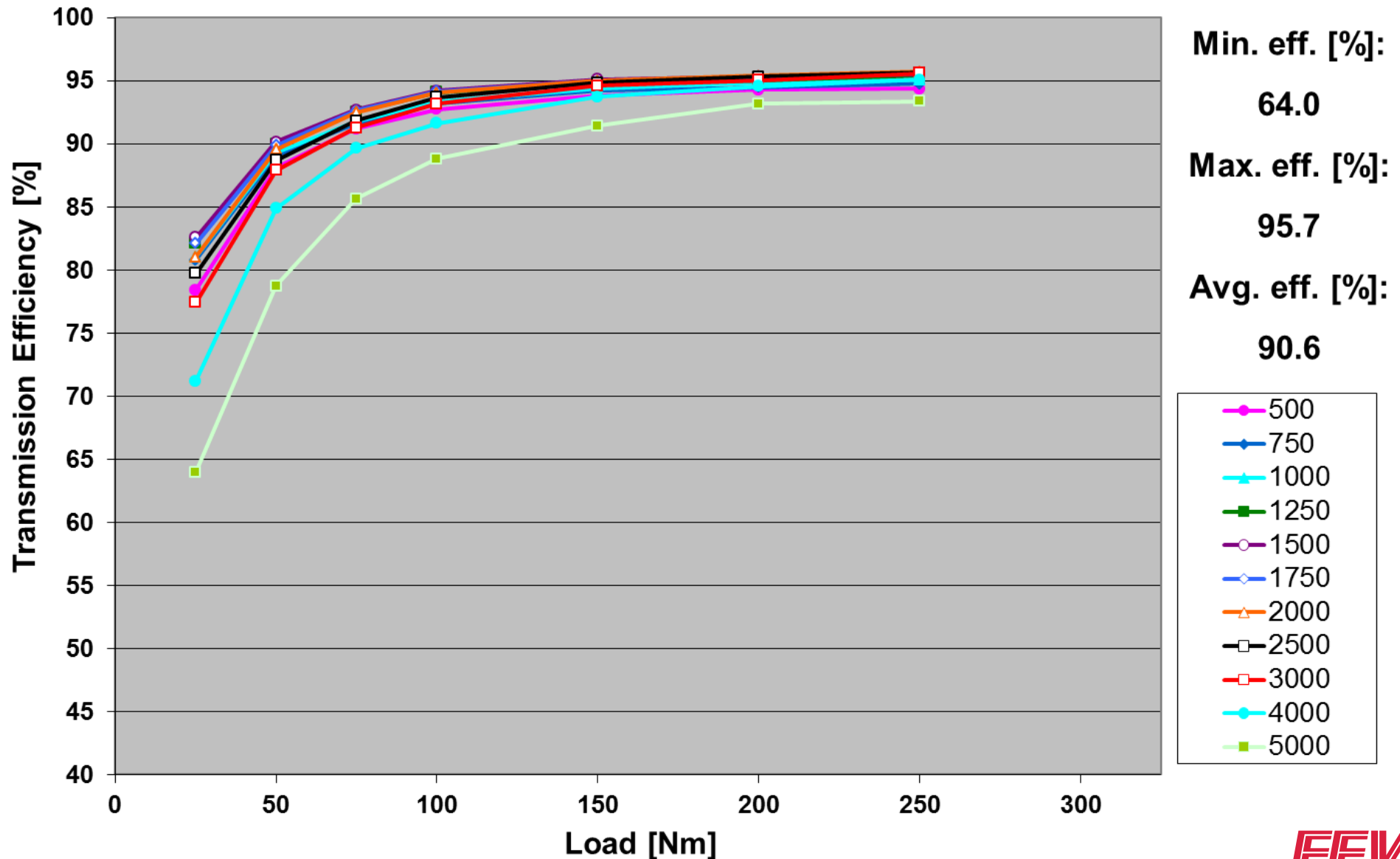
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



4th Gear, Eff. vs. Load, 100°C Oil Temp.



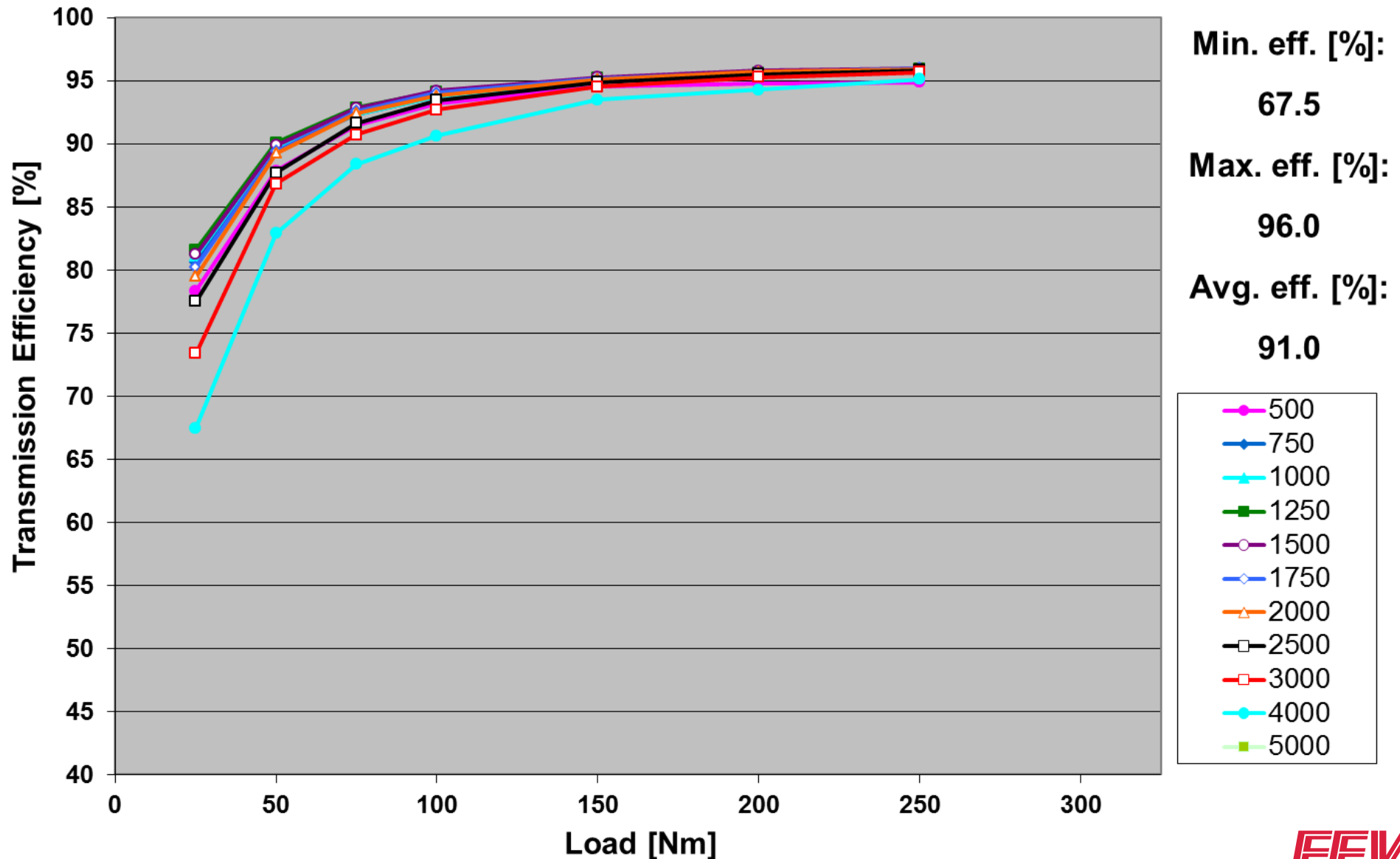
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



5th Gear, Eff. vs. Load, 100°C Oil Temp.

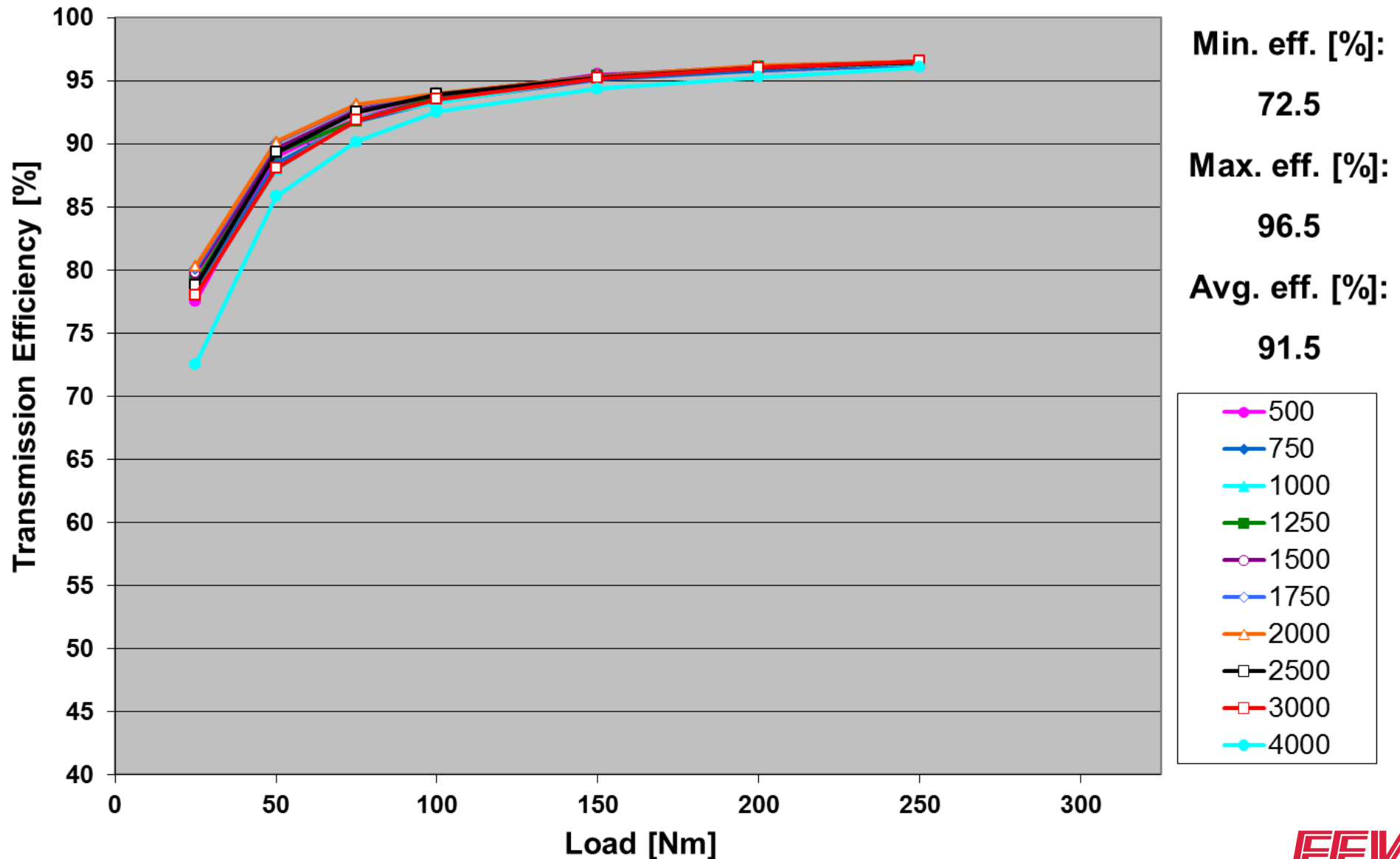


Ram HFE 8-Speed – Benchmark Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



6th Gear, Eff. vs. Load, 100°C Oil Temp.



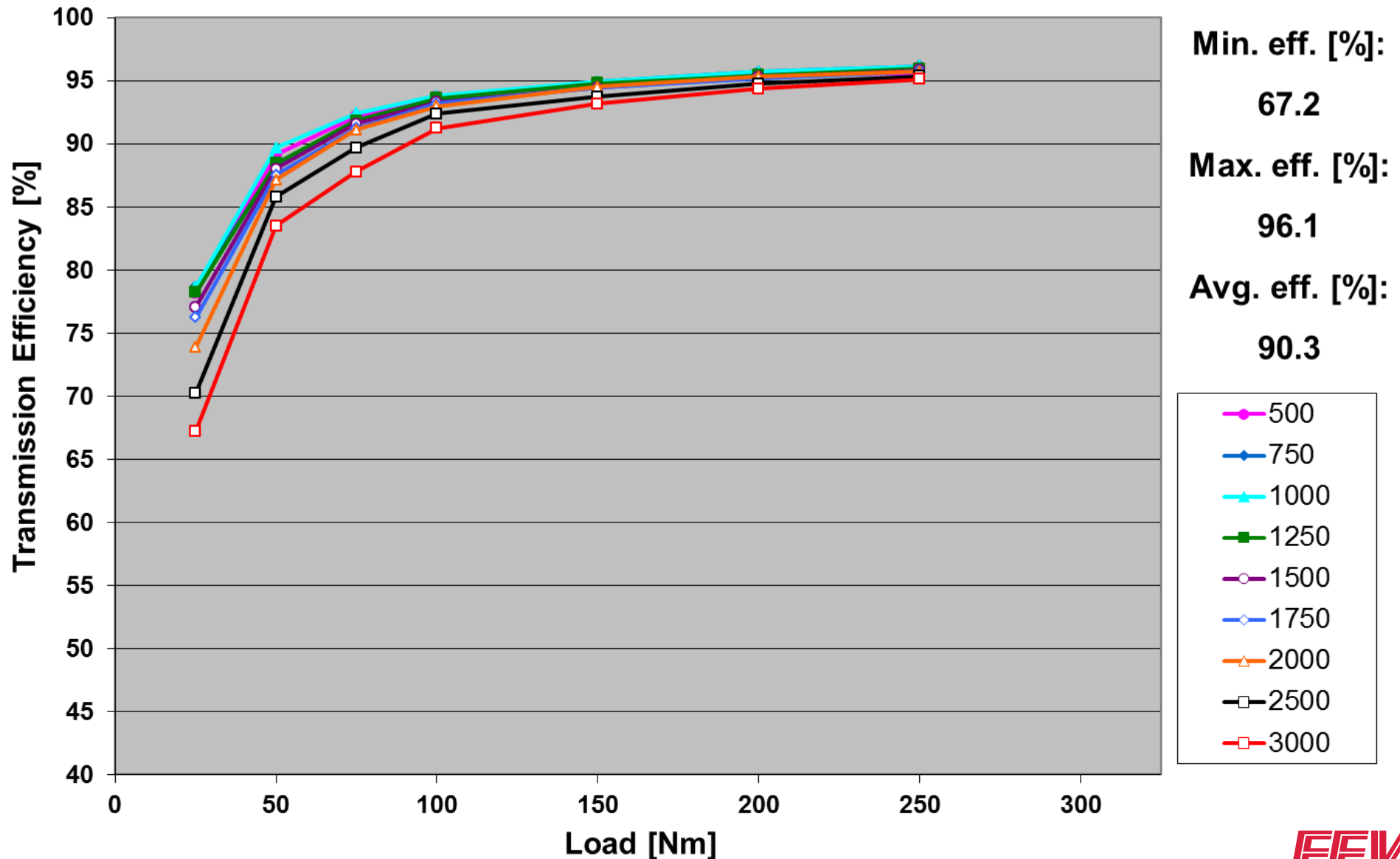
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



7th Gear, Eff. vs. Load, 100°C Oil Temp.

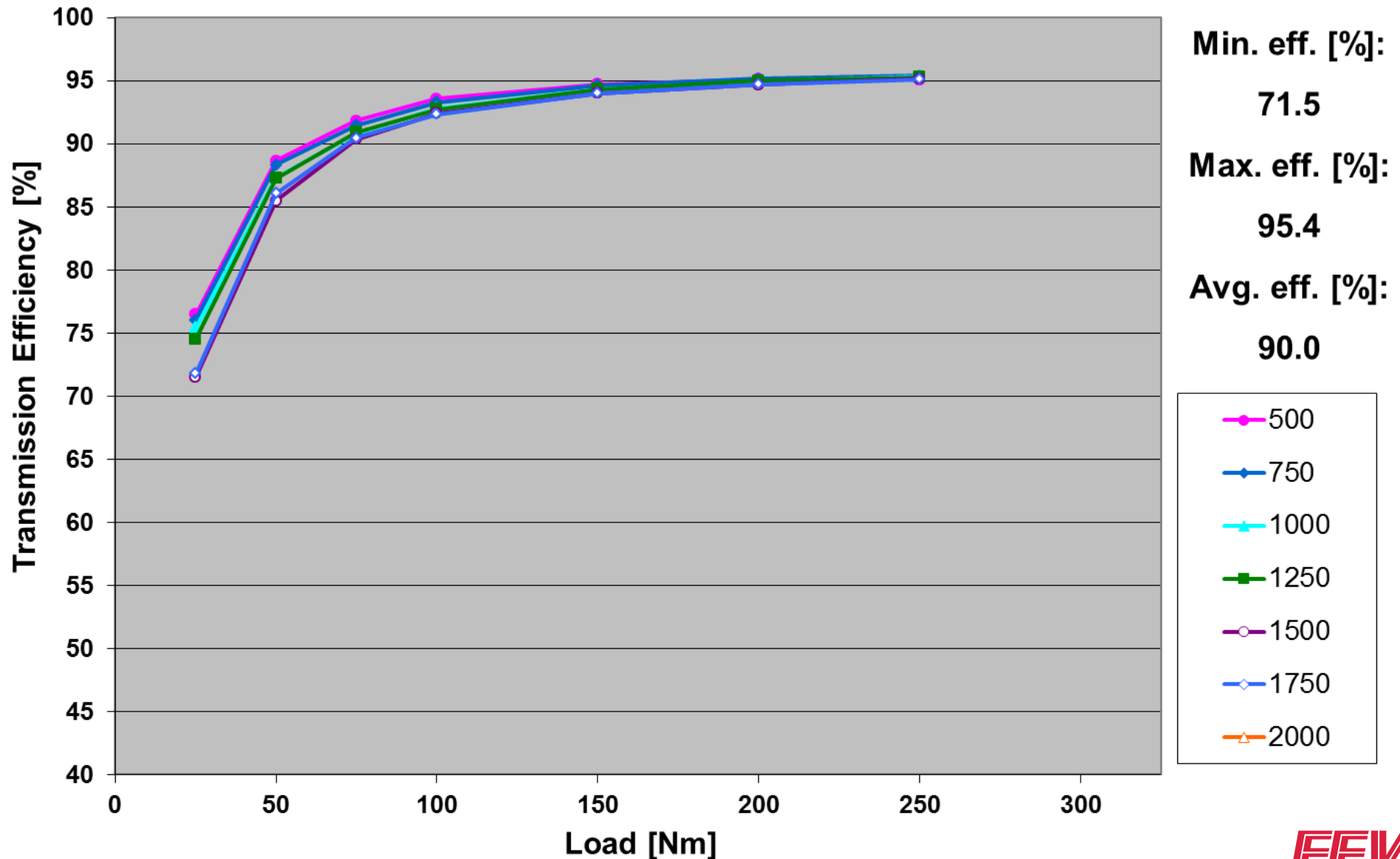


Ram HFE 8-Speed – Benchmark Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



8th Gear, Eff. vs. Load, 100°C Oil Temp.



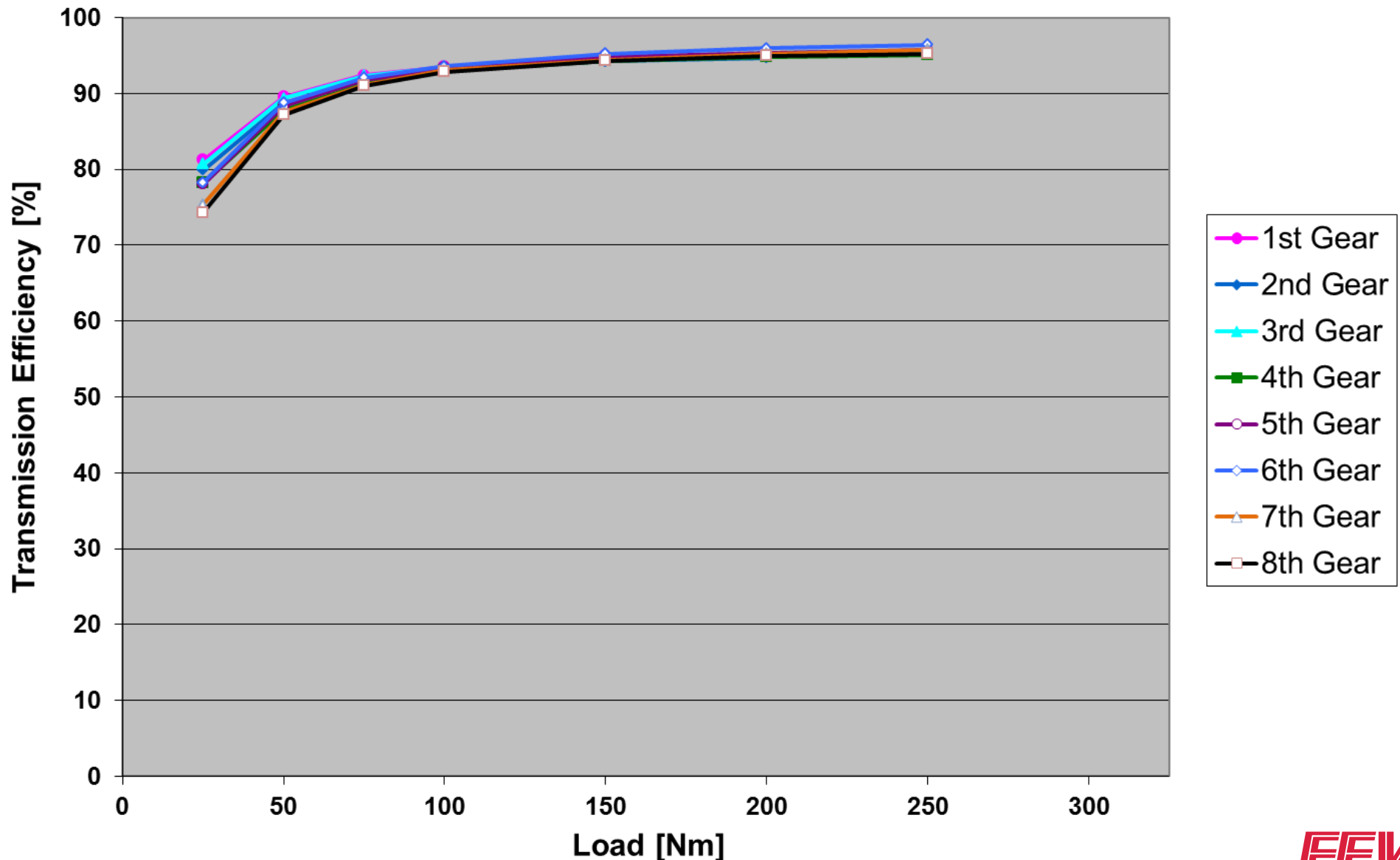
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



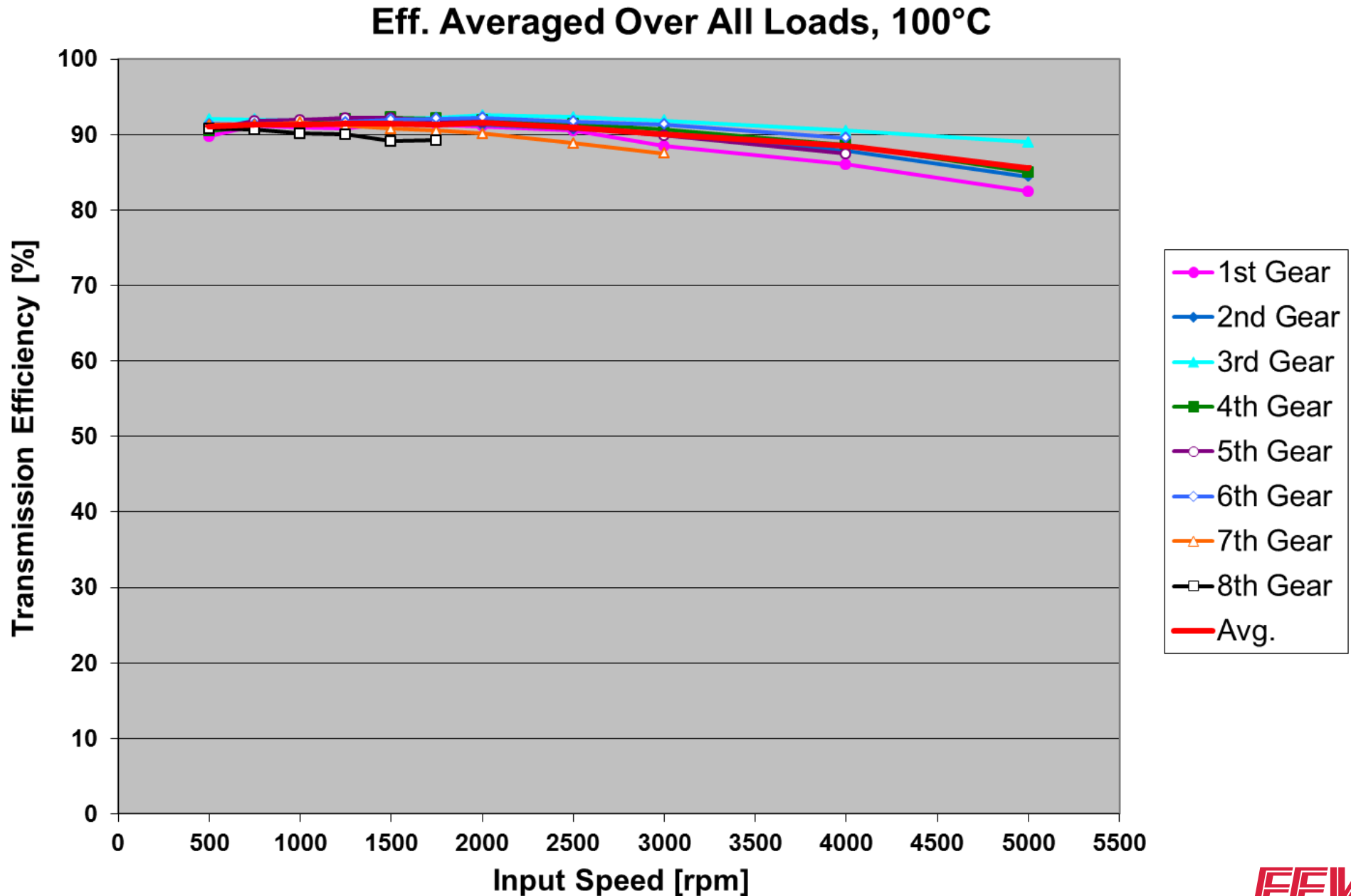
Eff. Averaged Over All Speeds, 100°C



Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

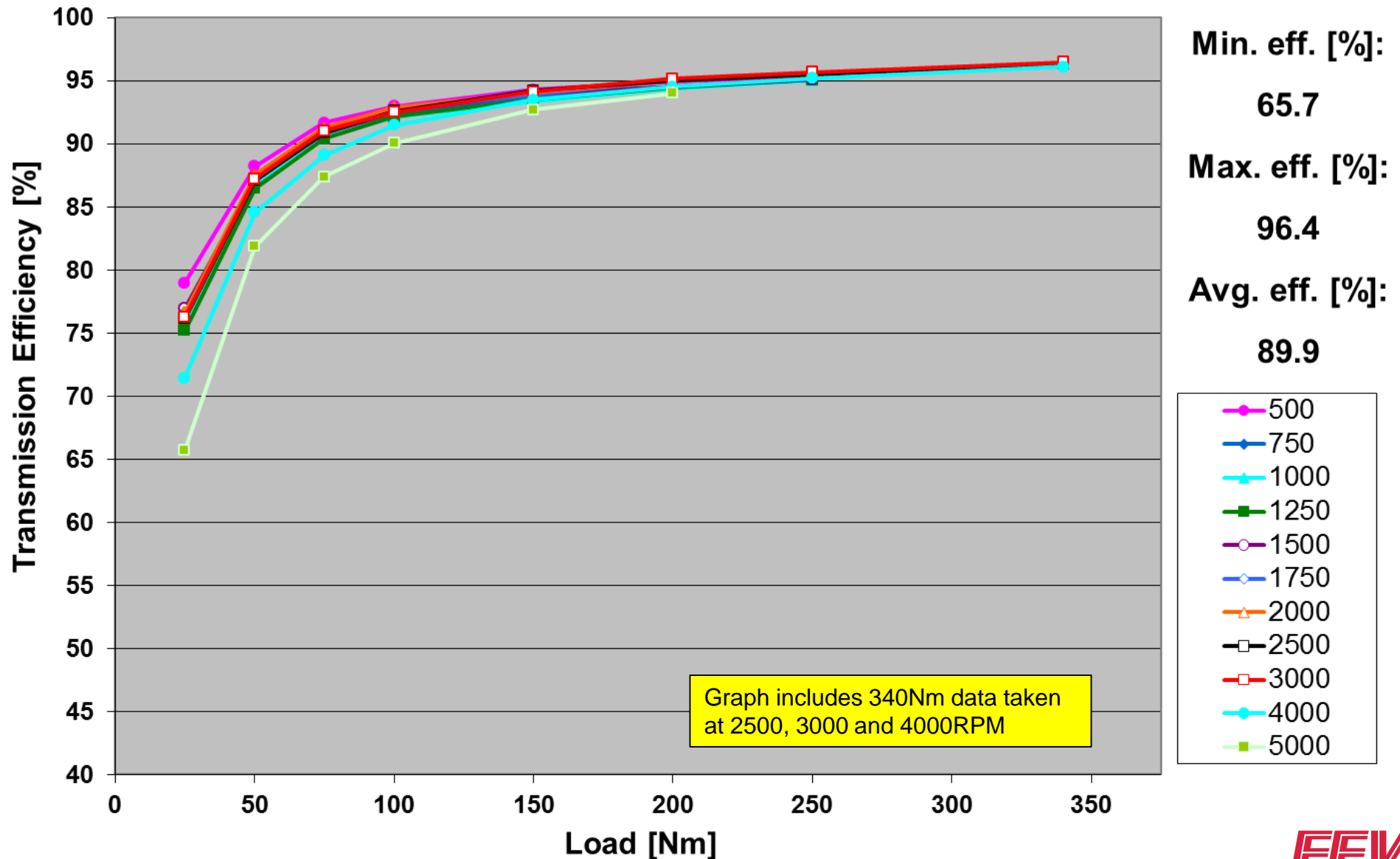
Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



Ram HFE 8-Speed – Benchmark Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015

3rd Gear, Eff. vs. Load, 35°C Oil Temp.



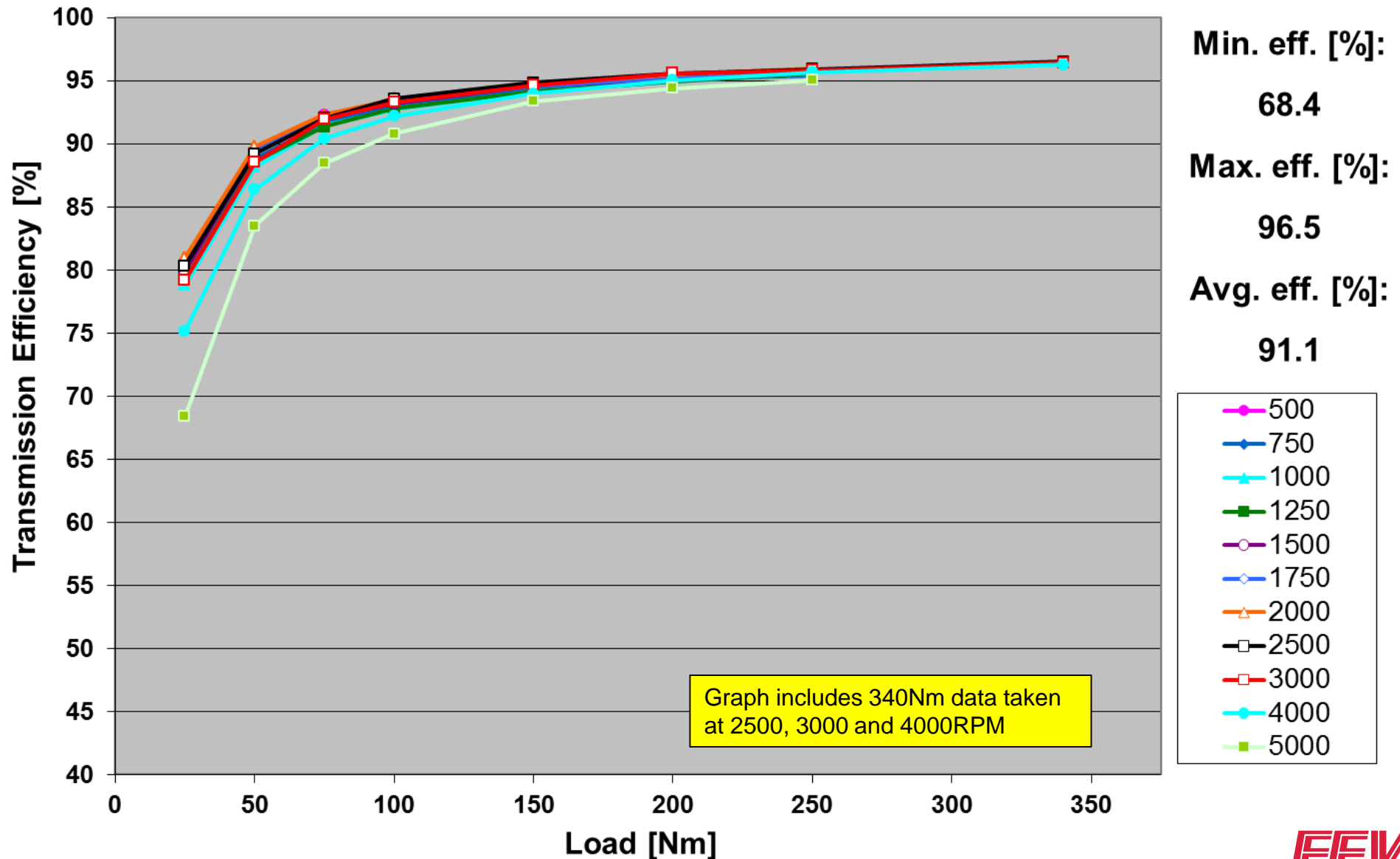
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
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3rd Gear, Eff. vs. Load, 60°C Oil Temp.



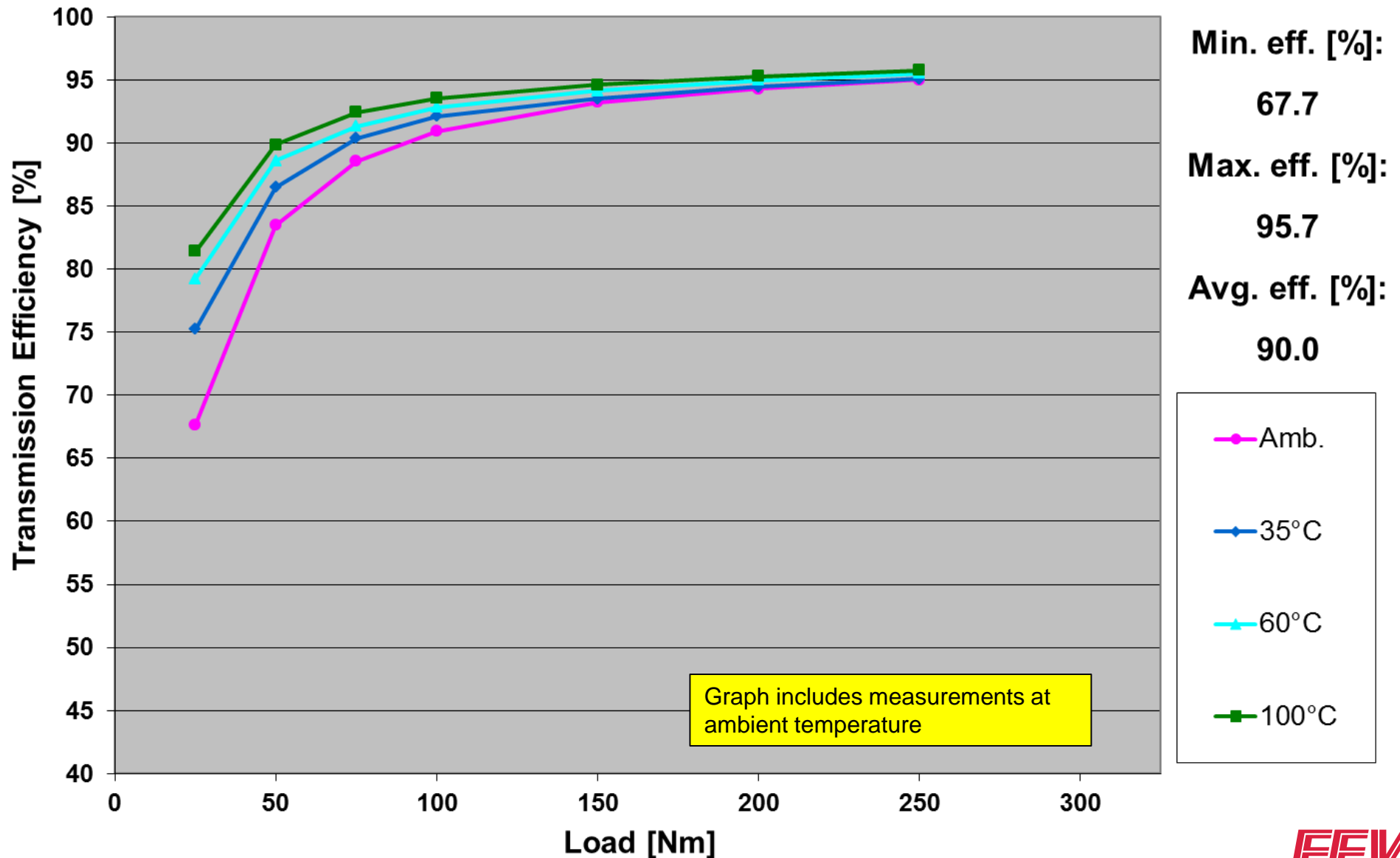
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



3rd Gear, Eff. vs. Load, All Oil Temps, 1250 RPM



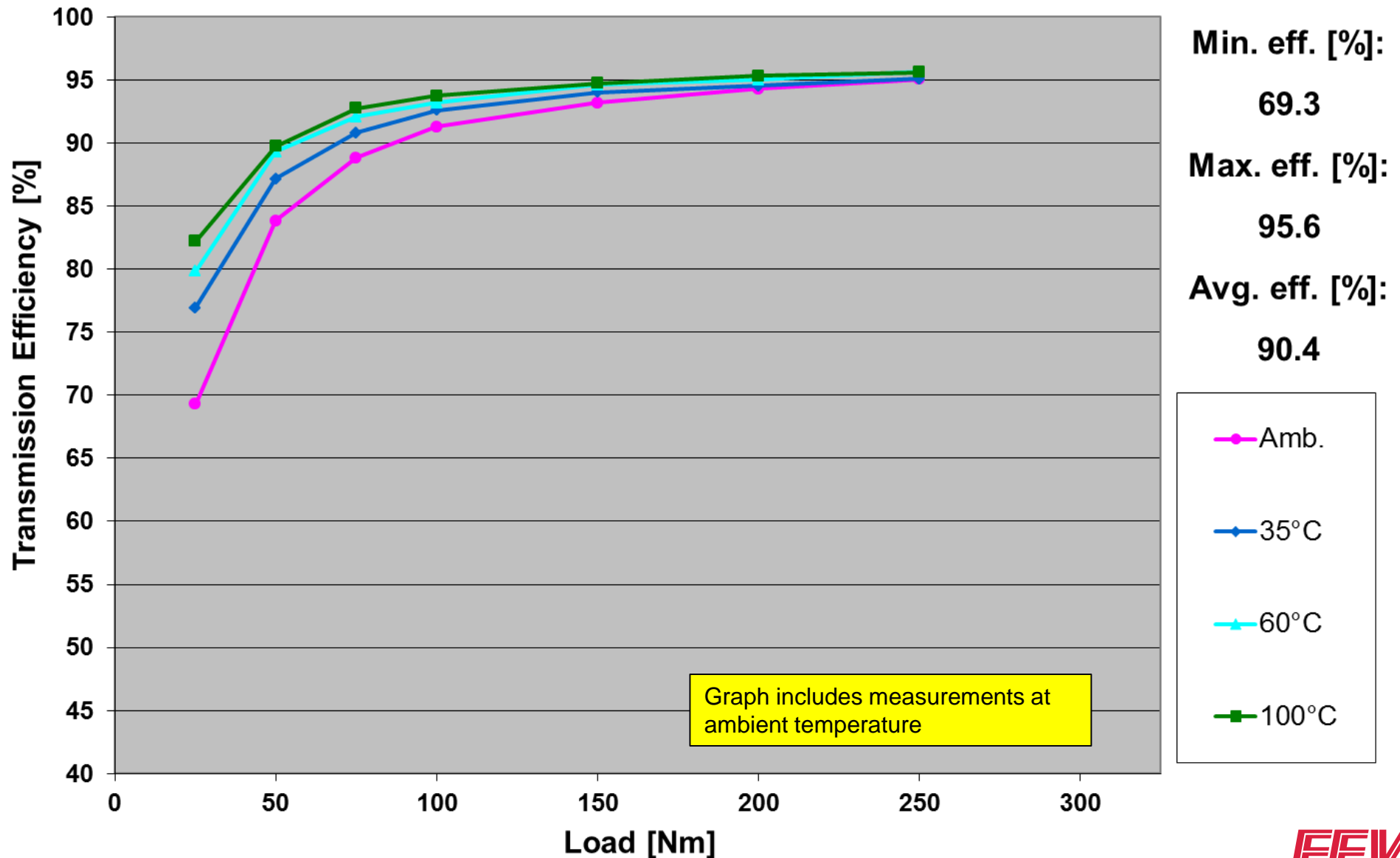
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



3rd Gear, Eff. vs. Load, All Oil Temps, 1500 RPM



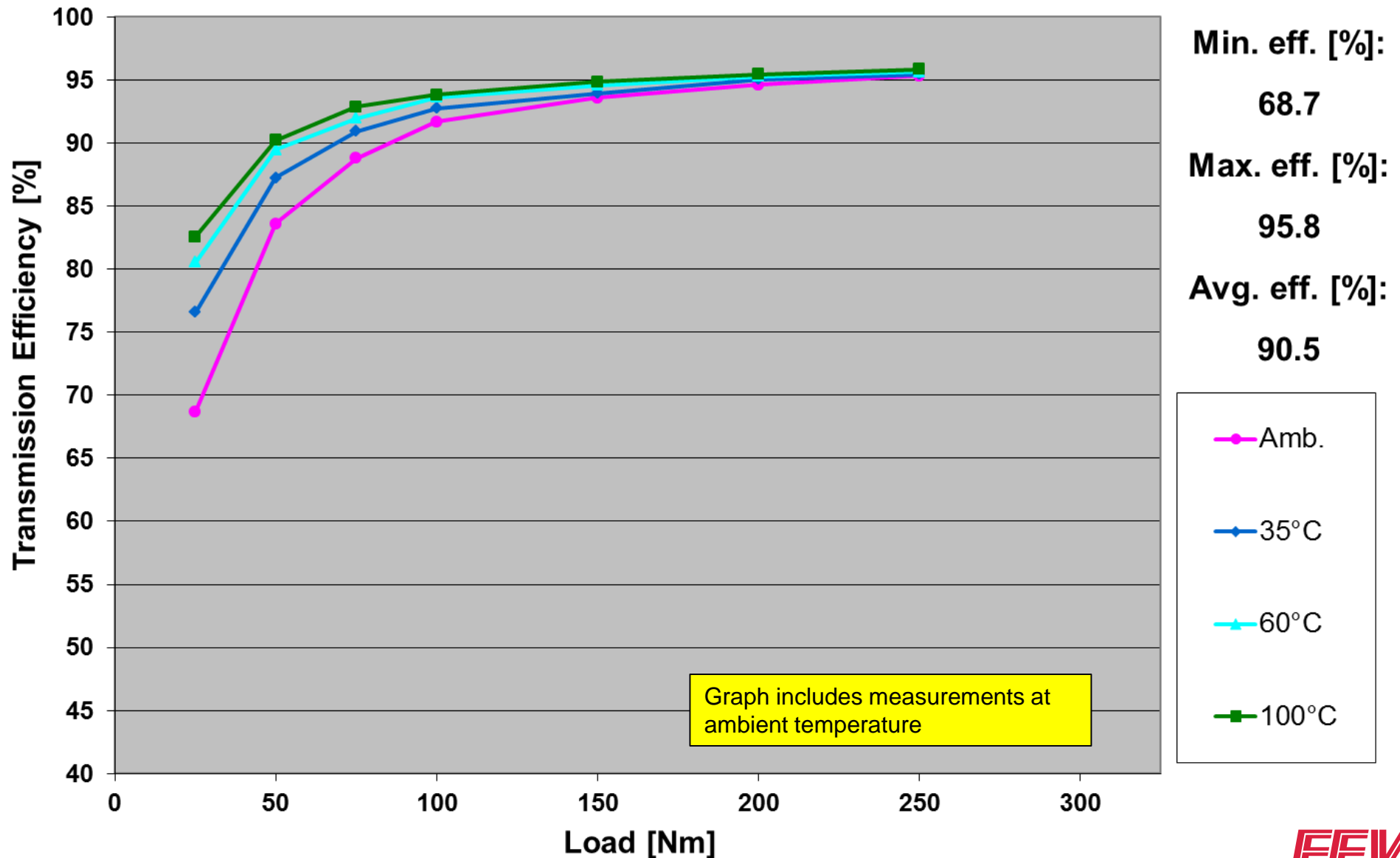
Ram HFE 8-Speed – Benchmark

Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
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3rd Gear, Eff. vs. Load, All Oil Temps, 1750 RPM

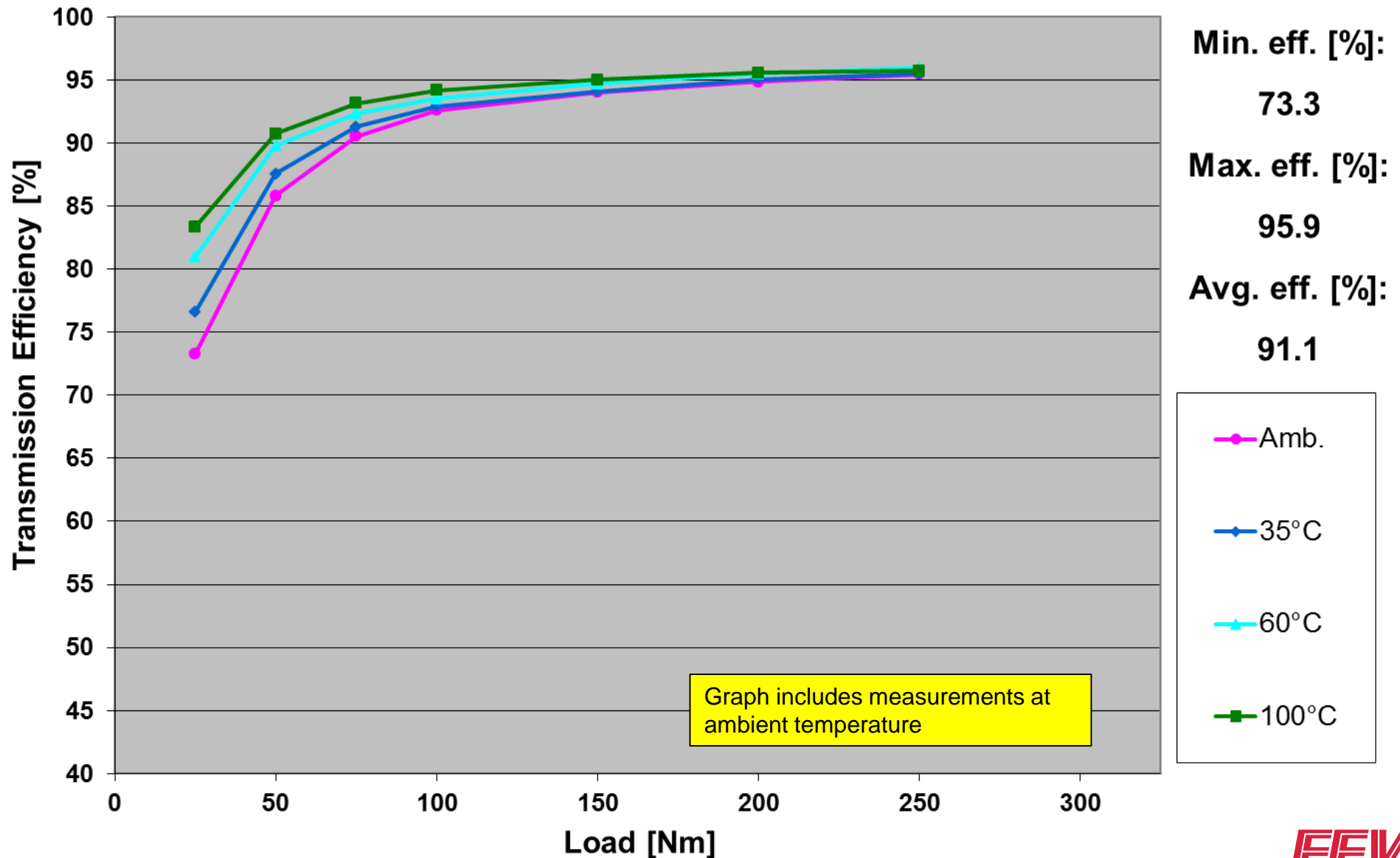


Ram HFE 8-Speed – Benchmark Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



3rd Gear, Eff. vs. Load, All Oil Temps, 2000 RPM



Ram HFE 8-Speed – Benchmark Bench Testing – Loaded Efficiency

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



☐ Test Summary

- ☐ The transmission efficiency was measured at 35°C, 60°C and 100°C
- ☐ Depending on test temperature, the losses range from 57.8% to 96.2 %
- ☐ The efficiency was measured at transmission main line pressures as observed in the vehicle
- ☐ The efficiency results observed on the 845RE can be considered 'average' when compared to similar transmissions

Ram HFE 8-Speed – Benchmark

Bench Testing – Neutral Coast Down

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015

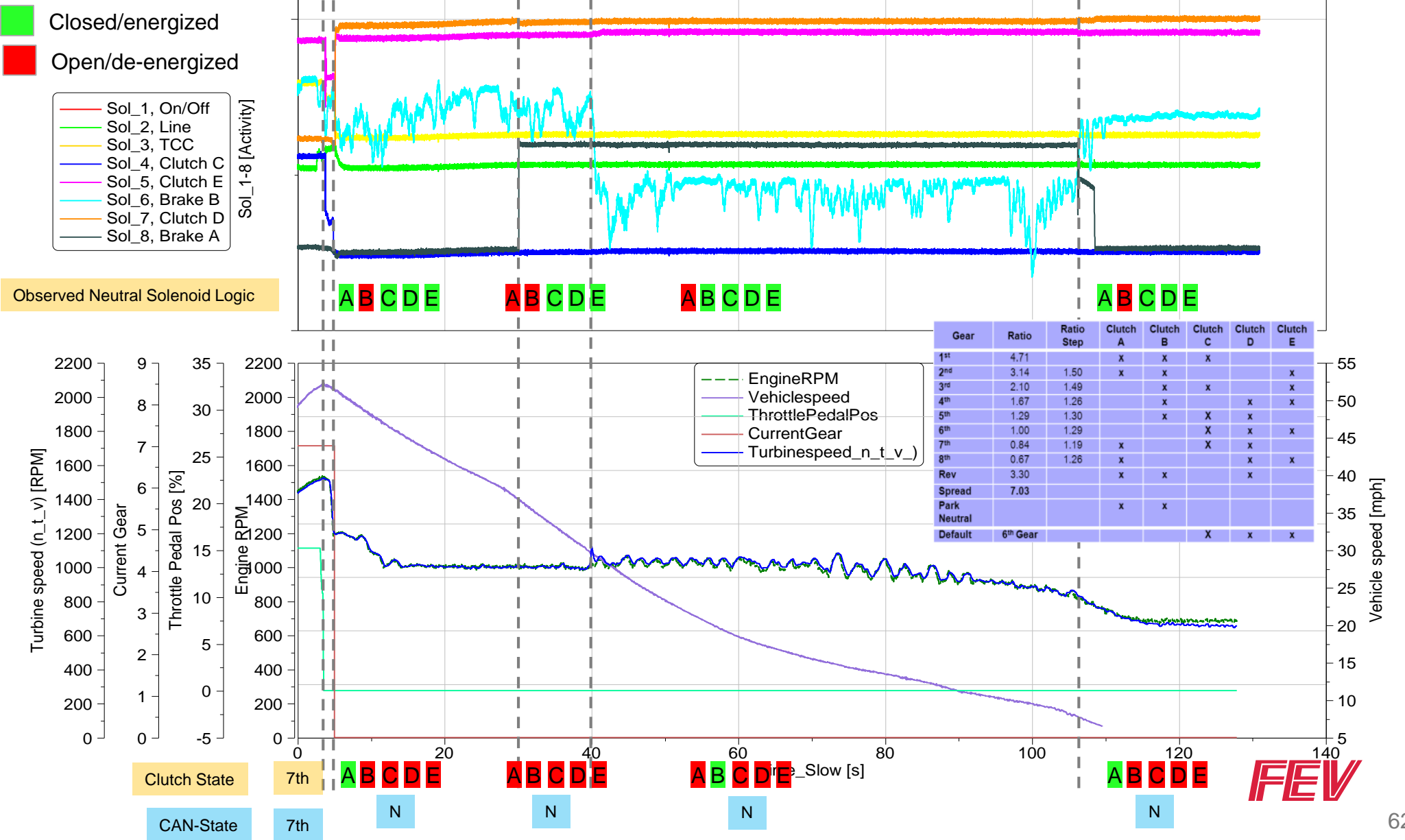
- ☐ **Neutral Coast Down (Input and Output Driven)**
 - ☐ Gear: Neutral
 - ☐ Torque converter clutch state: as observed in vehicle during neutral coast down
 - ☐ Input speed (1):
 - ☐ 675 rpm – equivalent to vehicle idle speed
 - ☐ Output speeds (9):
 - ☐ 171, 341, 683, 1024, 1366, 1707, 2048, 2390, 2731 rpm – equivalent to 5-80 mph
 - ☐ Transmission oil temperatures (3):
 - ☐ 35°C, 60°C, 100°C
 - ☐ Transmission line pressure (variable):
 - ☐ Unique line pressure as measured in-vehicle during neutral coasting

Ram HFE 8-Speed – Benchmark

Bench Testing – Neutral Coast Down

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015

50mph Neutral Coastdown, Start/Stop On

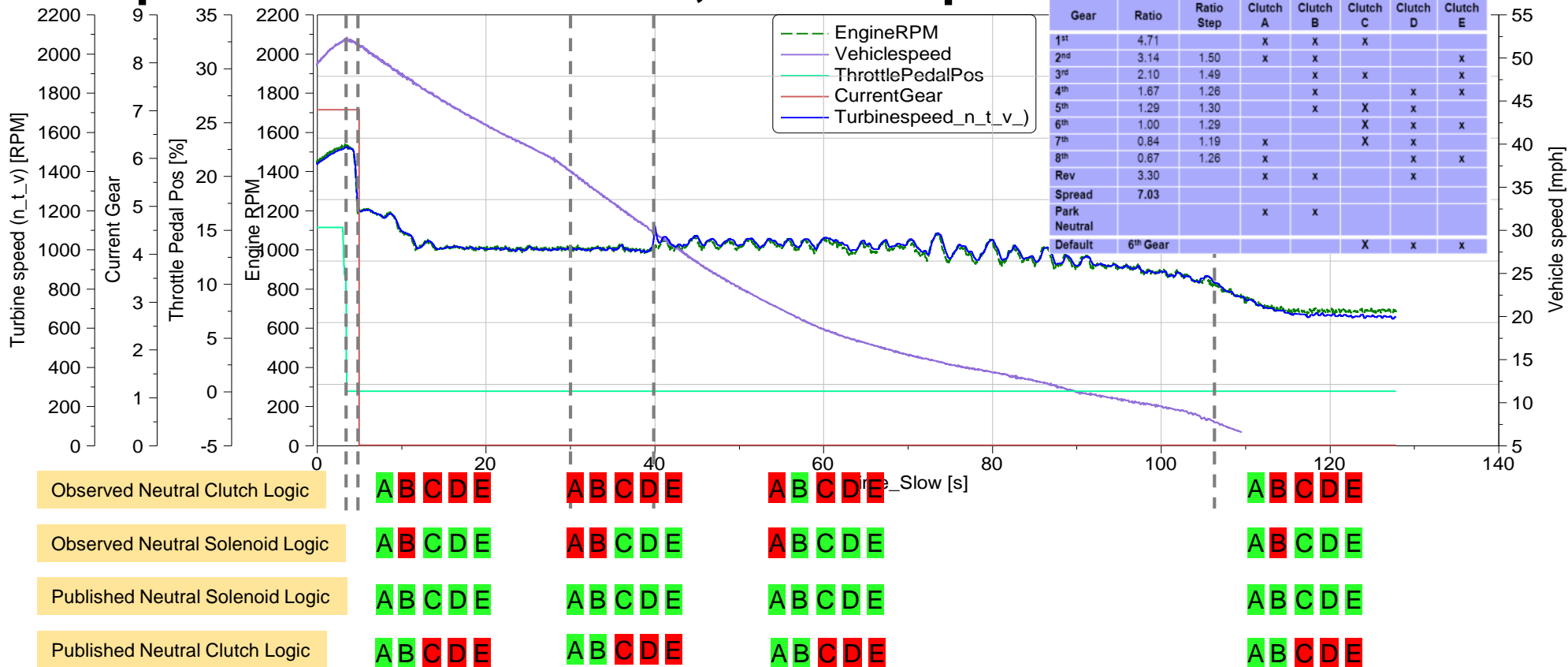


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Ram HFE 8-Speed – Benchmark Bench Testing – Neutral Coast Down

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015

50mph Neutral Coastdown, Start/Stop On



❑ Vehicle behavior does not represent the published solenoid sequence for Neutral

❑ Vehicle turns operates brakes A and B depending on vehicle speed:

❑ 50 – 37.5 mph: Brake A closed, all others open

❑ 37.5 mph – 30 mph: All brakes and clutches open

❑ 30 mph – 7.5 mph: Brake B closed, all others open

❑ Below 7.5 mph: Brake A closed, all others open

■ Closed/energized
■ Open/de-energized

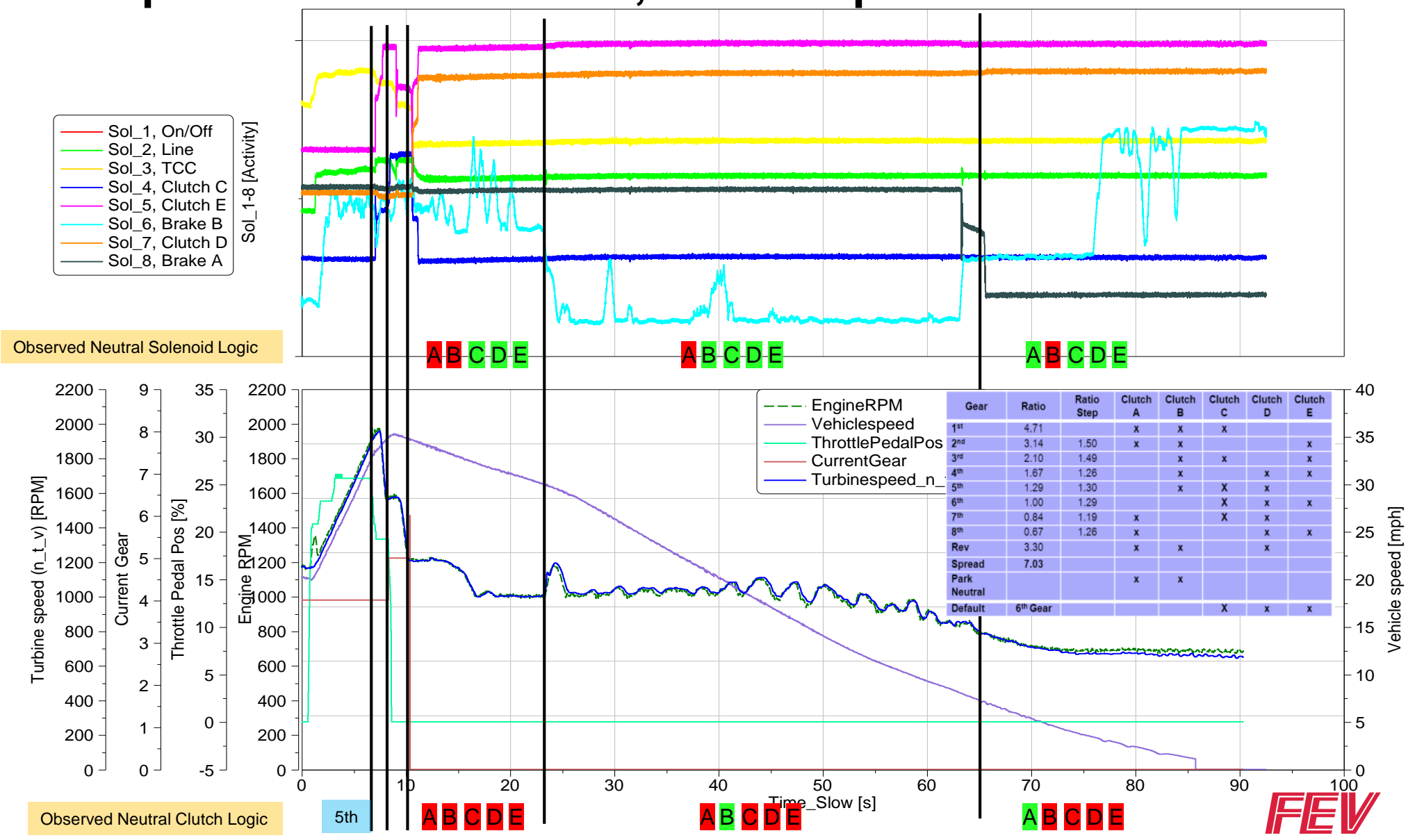
FEV

Ram HFE 8-Speed – Benchmark

Bench Testing – Neutral Coast Down

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015

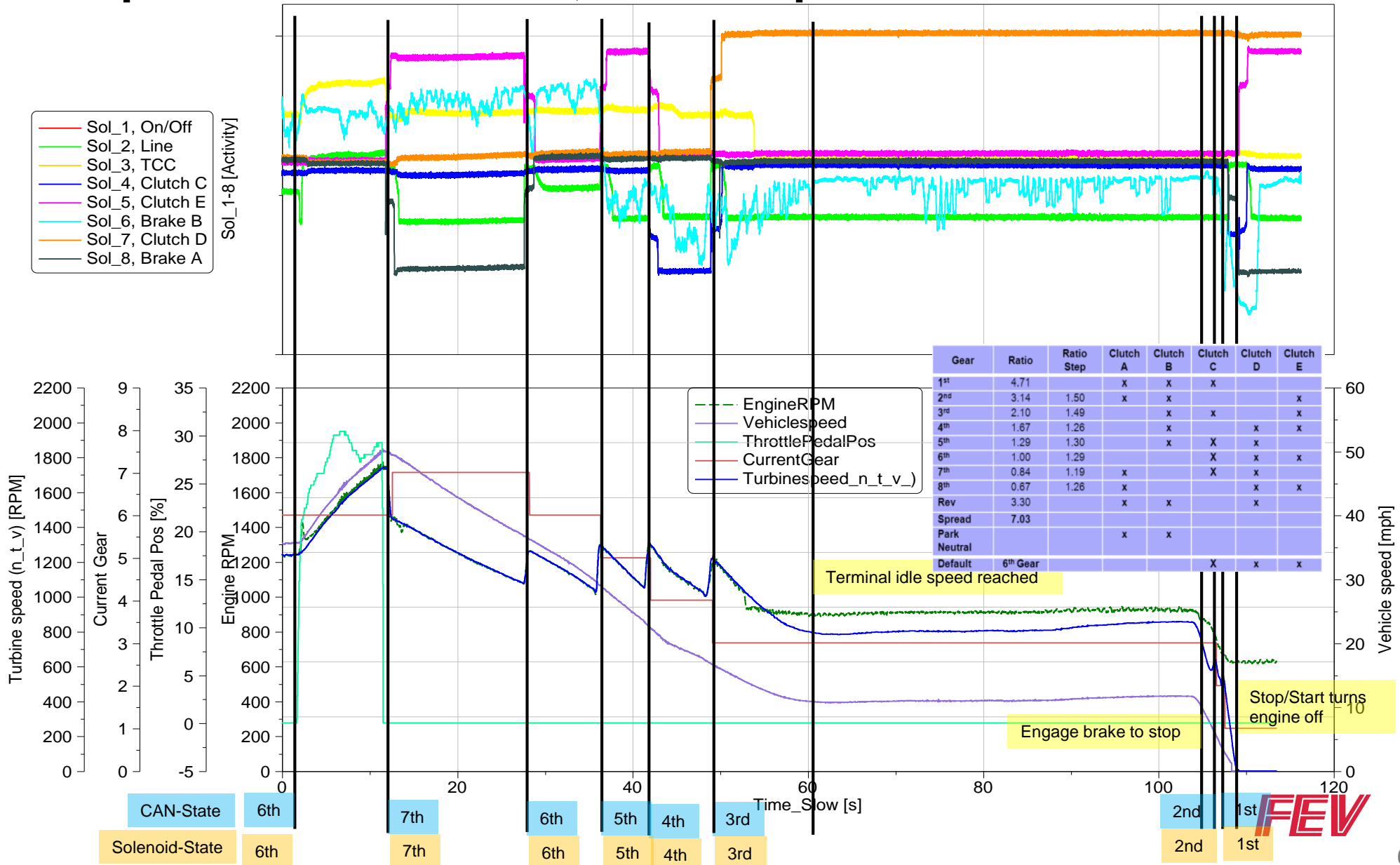
30mph Neutral Coastdown, Start/Stop On



Ram HFE 8-Speed – Benchmark

Bench Testing – Neutral Coast Down

50mph Drive Coastdown, Start/Stop On



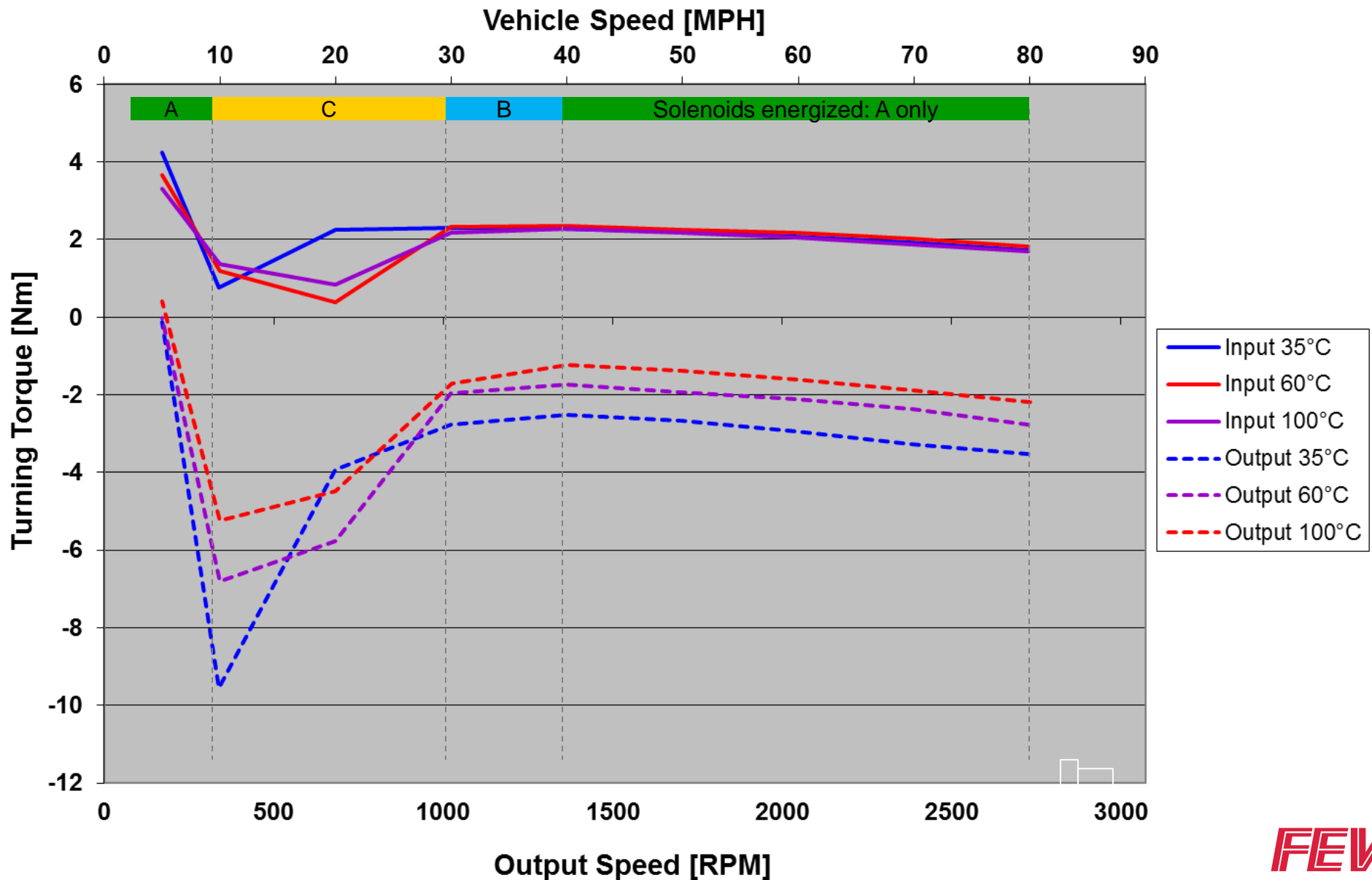
Ram HFE 8-Speed – Benchmark

Bench Testing – Neutral Coast Down

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Neutral Coast Down Temperature Comparison



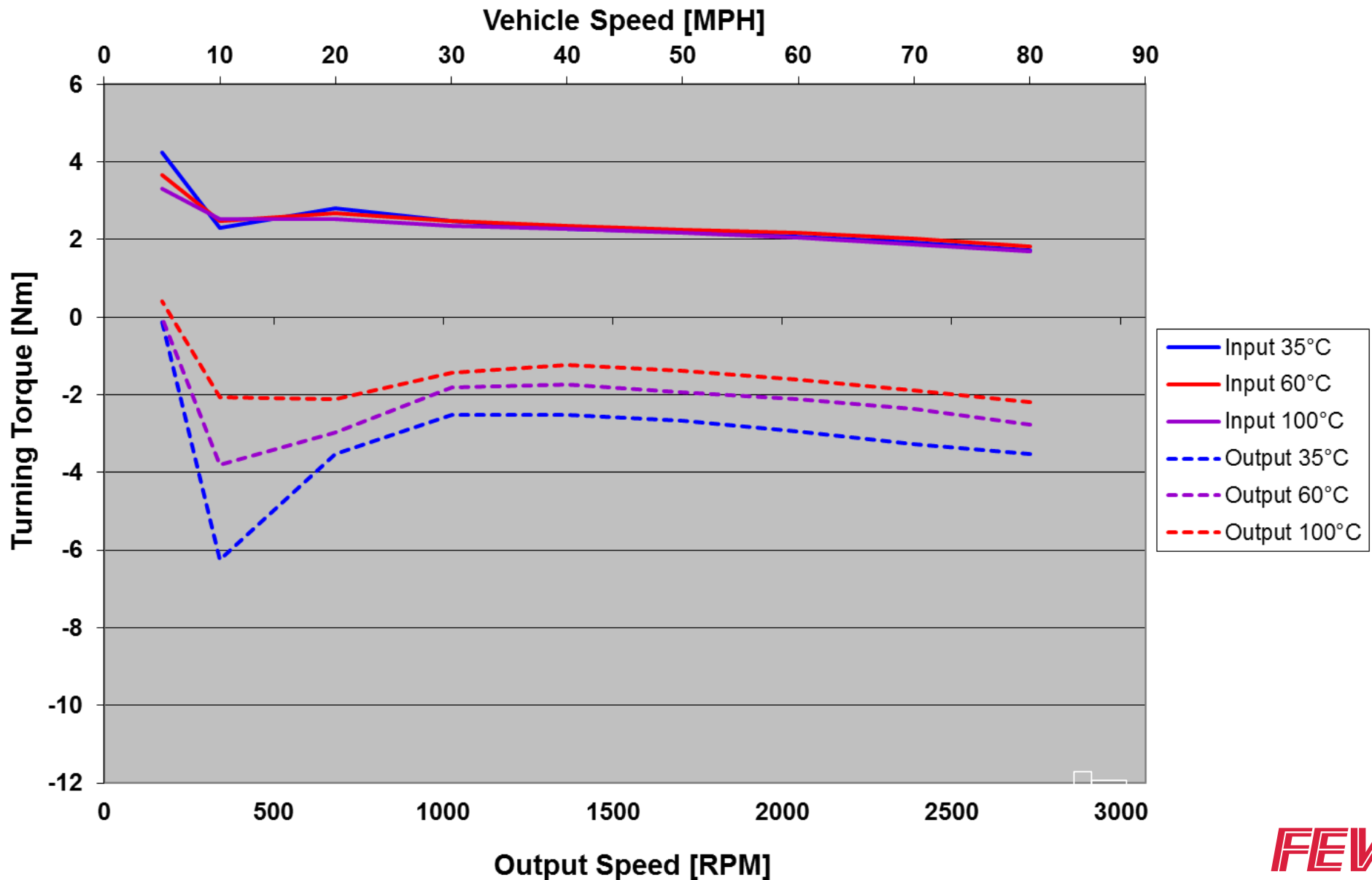
Ram HFE 8-Speed – Benchmark

Bench Testing – Neutral Coast Down

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Neutral A Coast Down Temperature Comparison



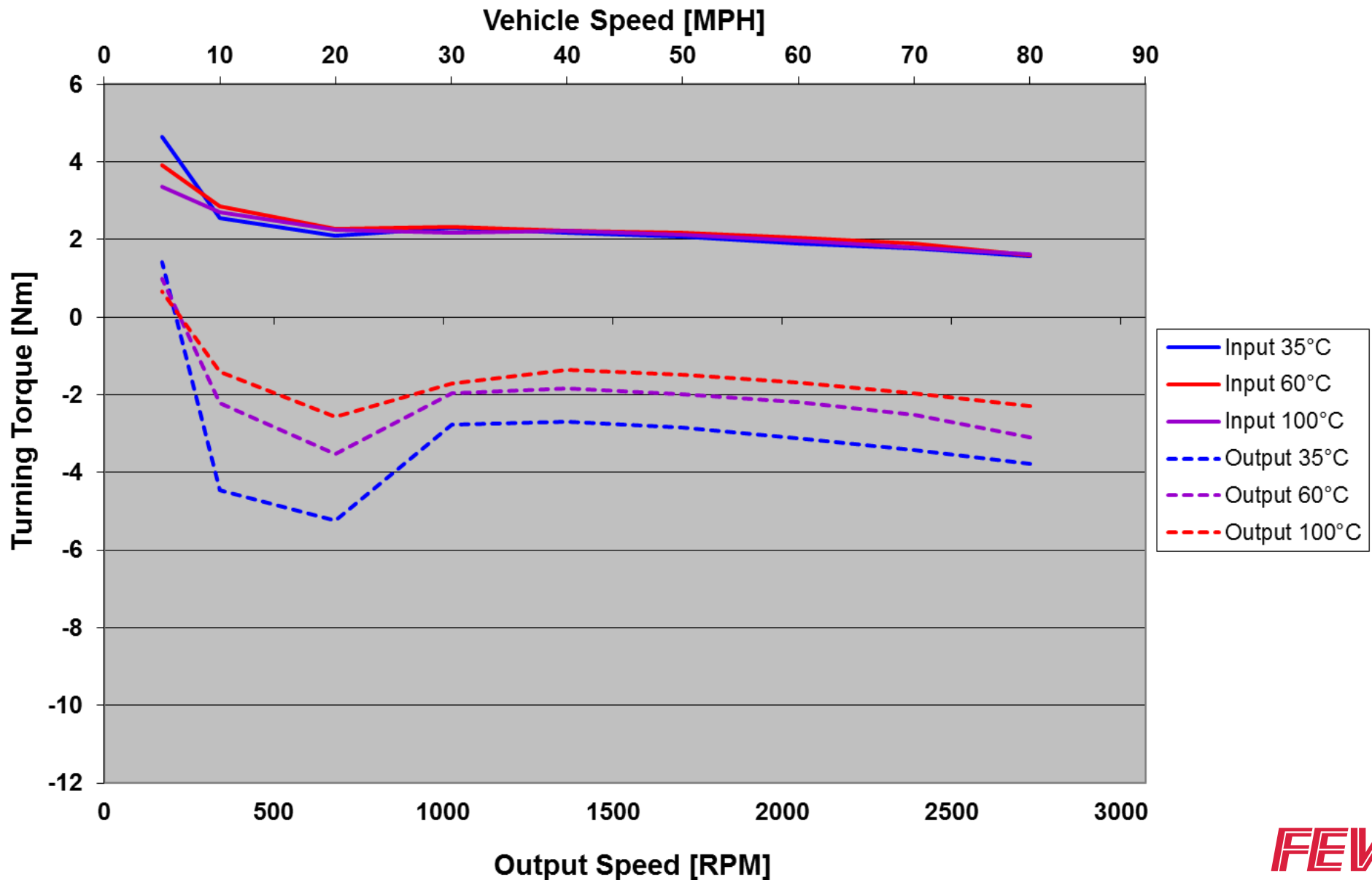
Ram HFE 8-Speed – Benchmark

Bench Testing – Neutral Coast Down

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Neutral B Coast Down Temperature Comparison



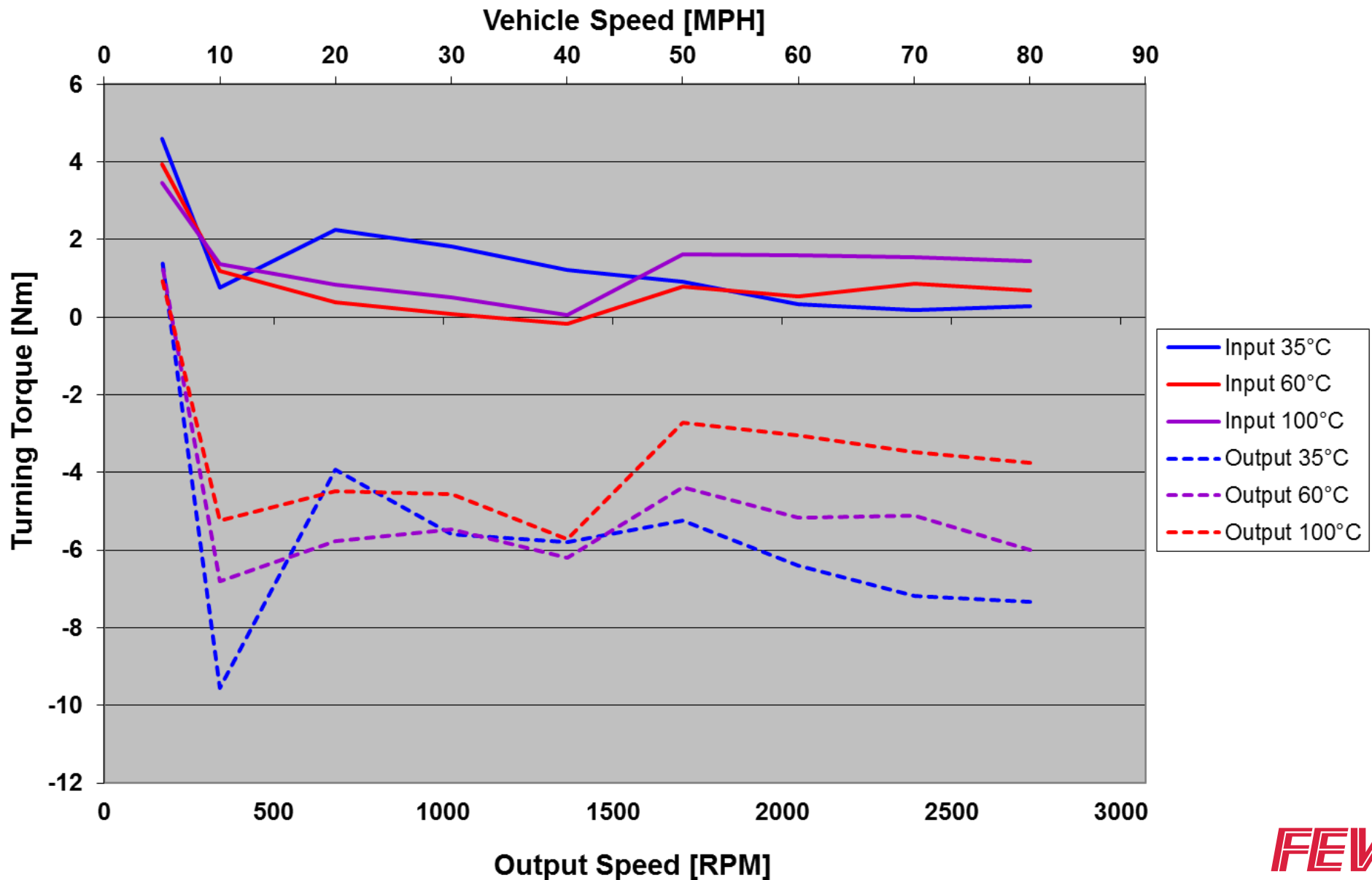
Ram HFE 8-Speed – Benchmark

Bench Testing – Neutral Coast Down

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Neutral C Coast Down Temperature Comparison



Ram HFE 8-Speed – Benchmark

Bench Testing – Neutral Coast Down

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☐ Test Summary

- ☐ The transmission neutral coast down losses were measured at 35°C, 60°C and 100°C
- ☐ The Ram 1500 HFE performs several transmission solenoid shifts during a vehicle coast down in 'N'
- ☐ FEV reproduced the observed solenoid sequence in the test cell and recorded the associated losses on transmission input- and output shaft
- ☐ It appears that the dynamic solenoid actuation is causing more drag losses than one constant solenoid actuation sequence would
 - ☐ It is assumed that the behavior during a vehicle coast down in 'N' is intended for drivability improvement rather than fuel economy improvement

Ram HFE 8-Speed – Benchmark

Bench Testing – Gear Inertia Study

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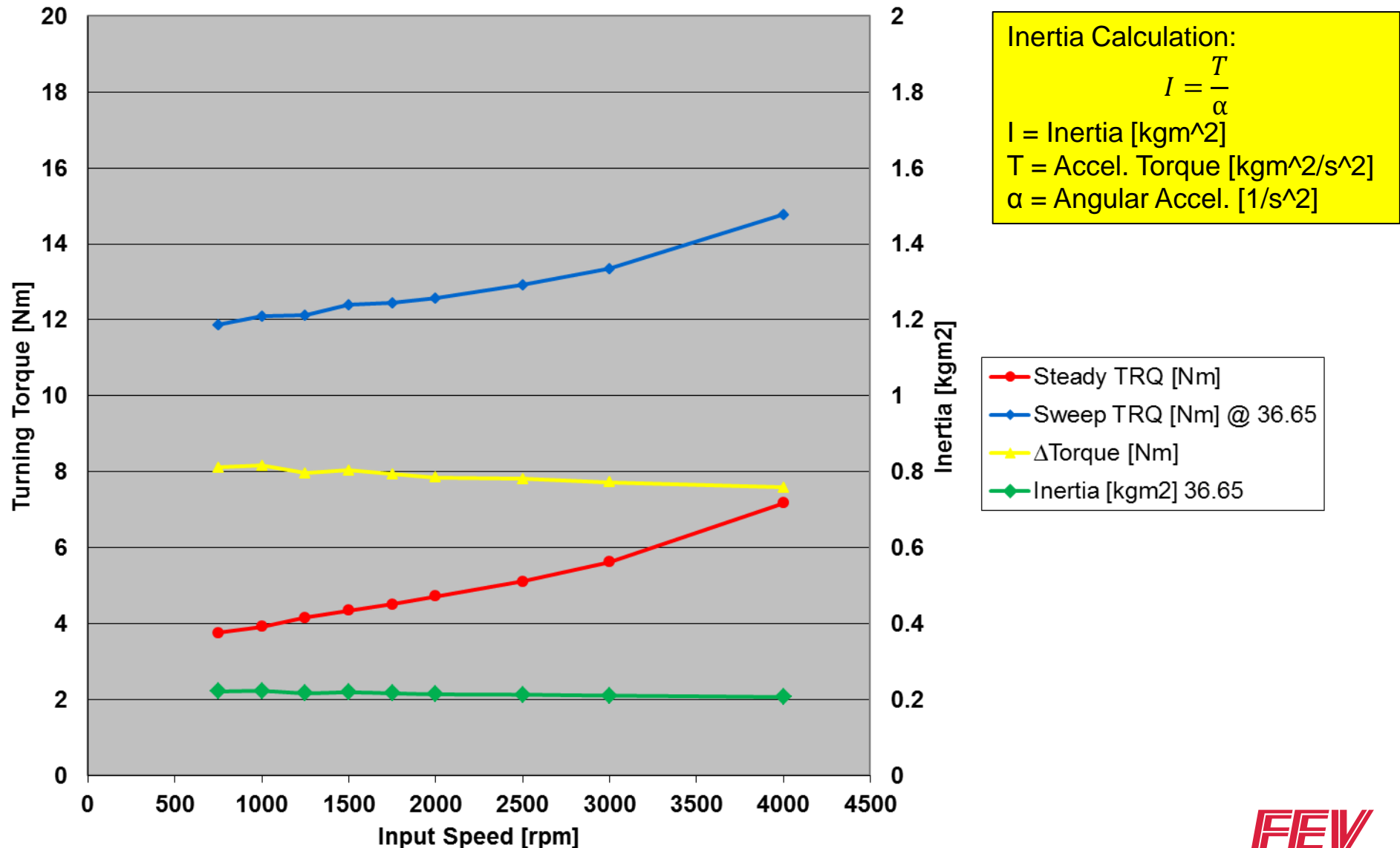
☐ Inertia Study (Input and Output Driven)

- ☐ Gears (8): All forward gears
- ☐ Torque converter clutch locked for all tests
- ☐ Sweep input/output speed from 0 – 5000 rpm at constant acceleration
 - ☐ Acceleration rates (2):
 - ☐ 24.43, 36.65 kgm²
- ☐ Transmission oil temperature = 60°C
- ☐ Transmission line pressure (variable):
 - ☐ Same as used for equivalent point during spin loss testing
- ☐ Subtract previously measured spin losses for that gear to receive a constant torque value that can be used to calculate the inertia of the selected gear
 - ☐ $I = T/\alpha$ (T = Torque, α = angular acceleration)

Ram HFE 8-Speed – Benchmark Bench Testing – Gear Inertia Study

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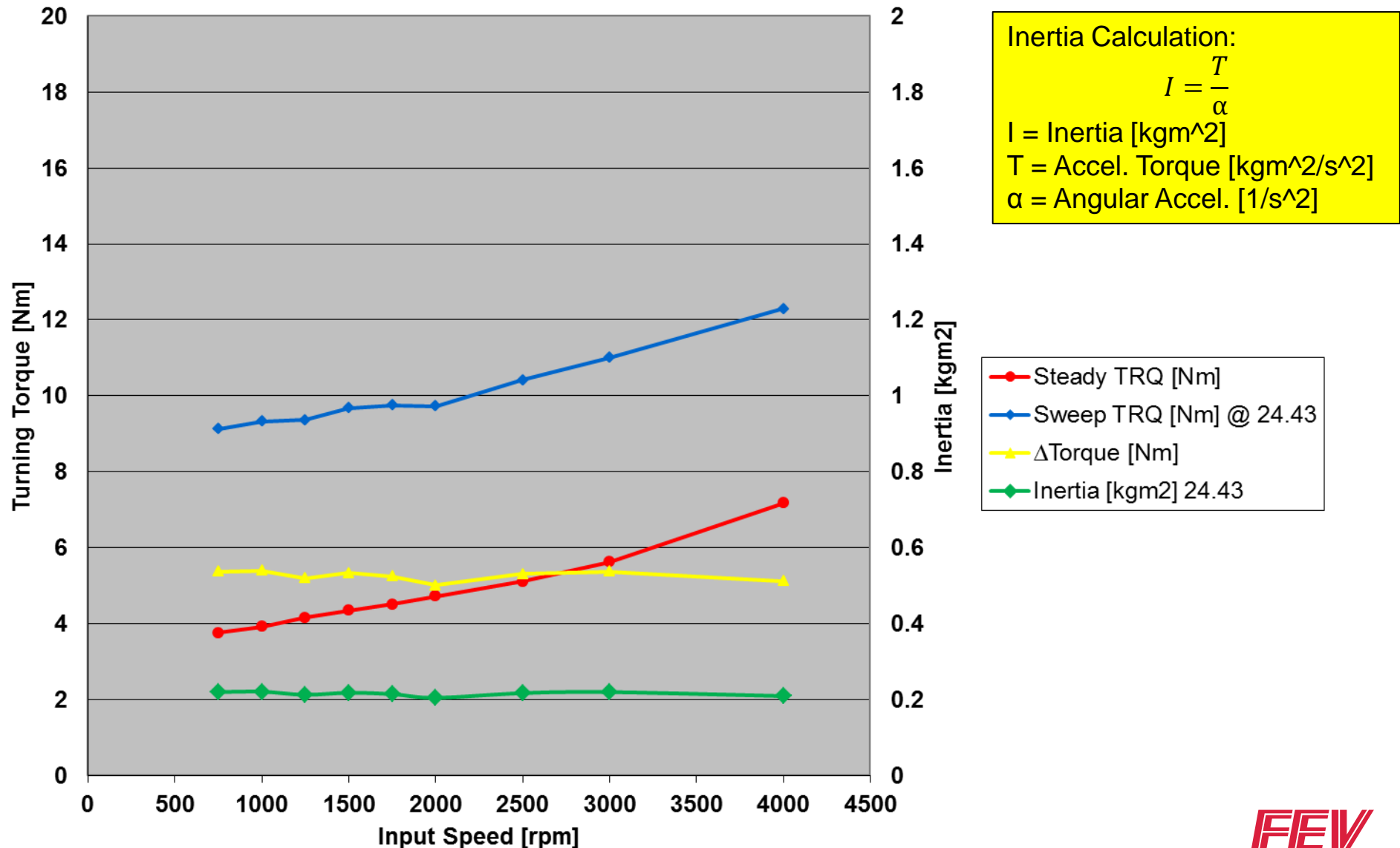
Inertia 1st Gear Results Ramp Rate = 36.65 1/s^2



Ram HFE 8-Speed – Benchmark Bench Testing – Gear Inertia Study

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Inertia 1st Gear Results Ramp Rate = 24.43 1/s^2

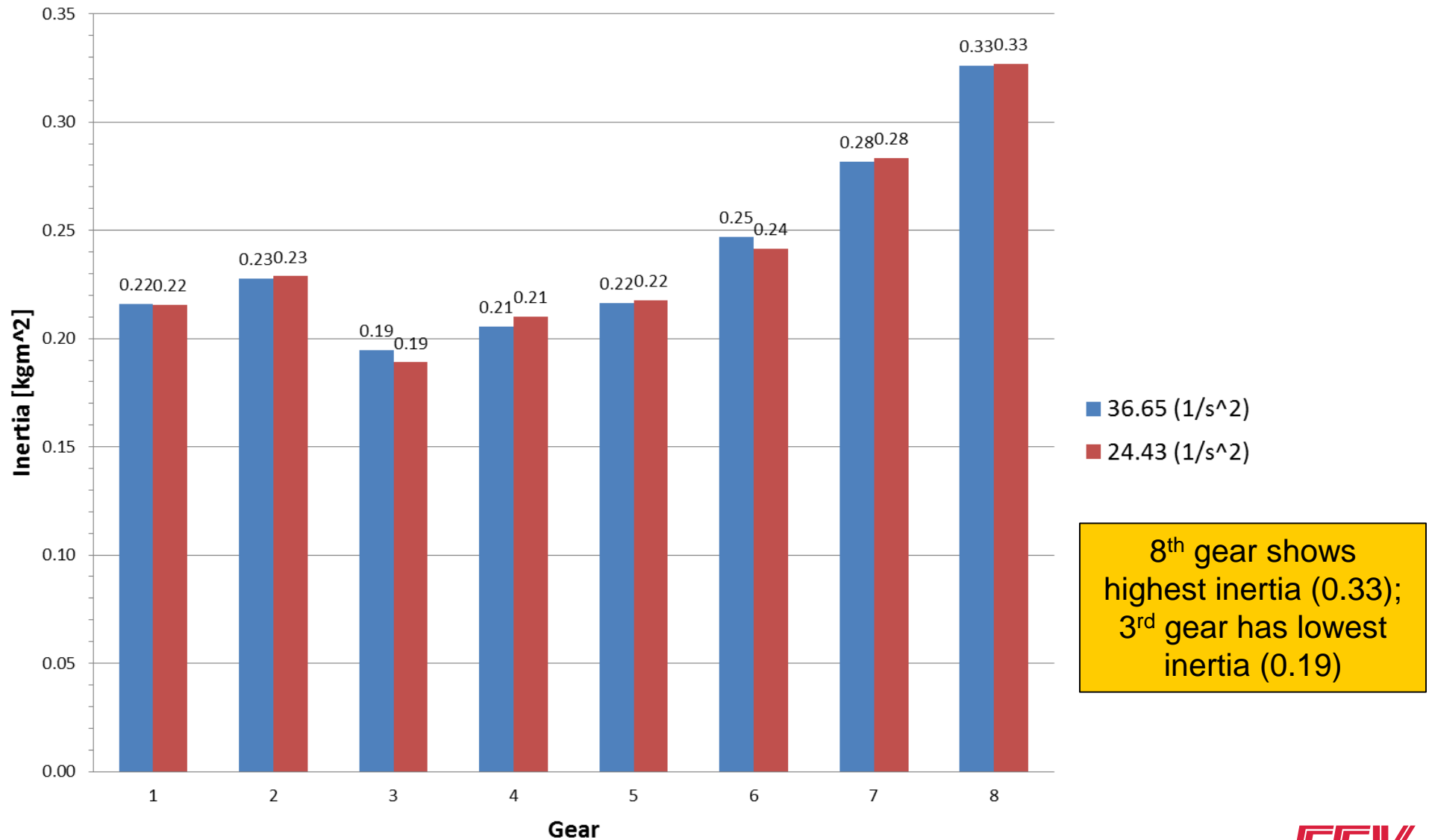


Ram HFE 8-Speed – Benchmark Bench Testing – Gear Inertia Study

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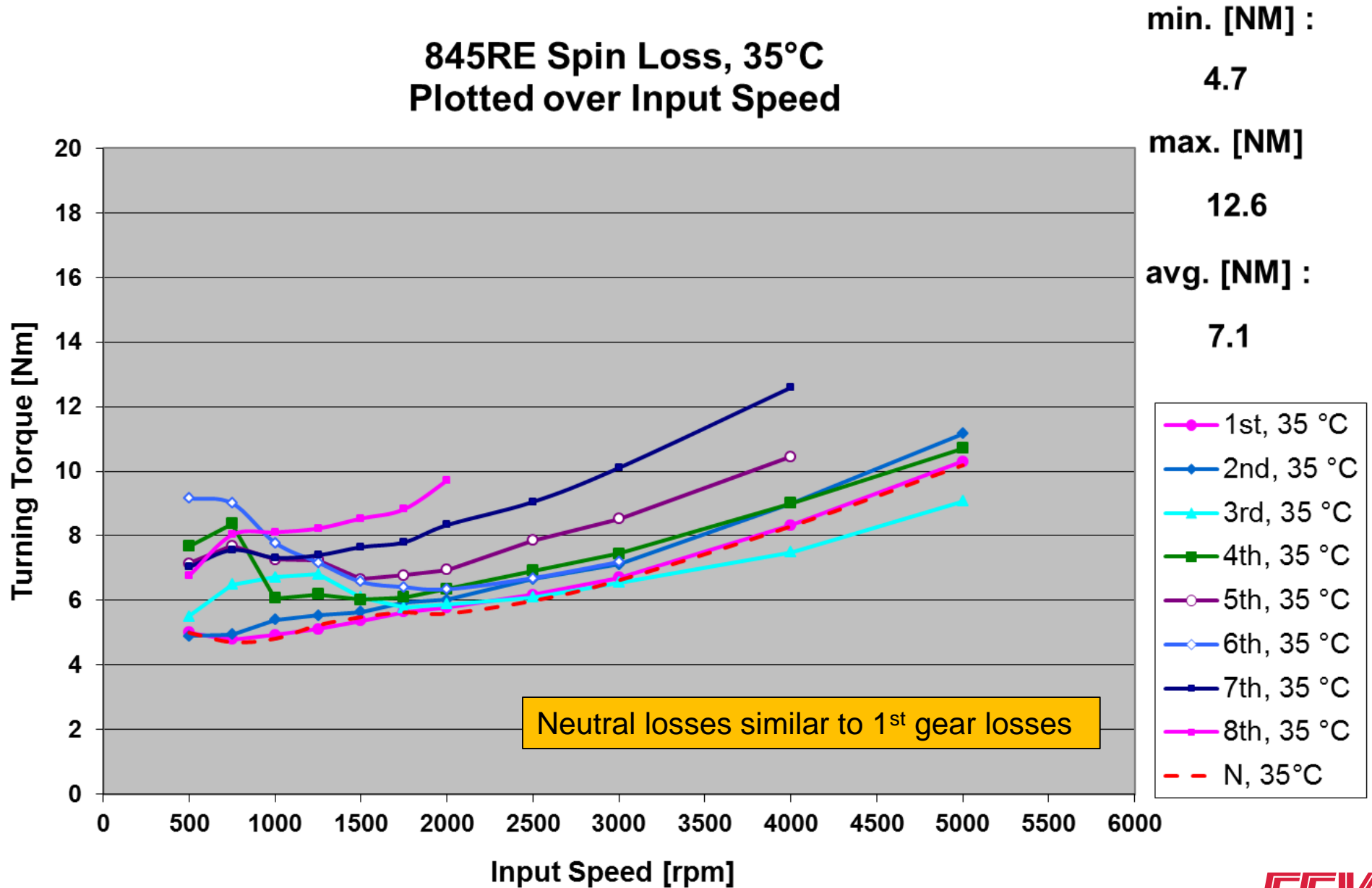


845RE Gear Train Inertia



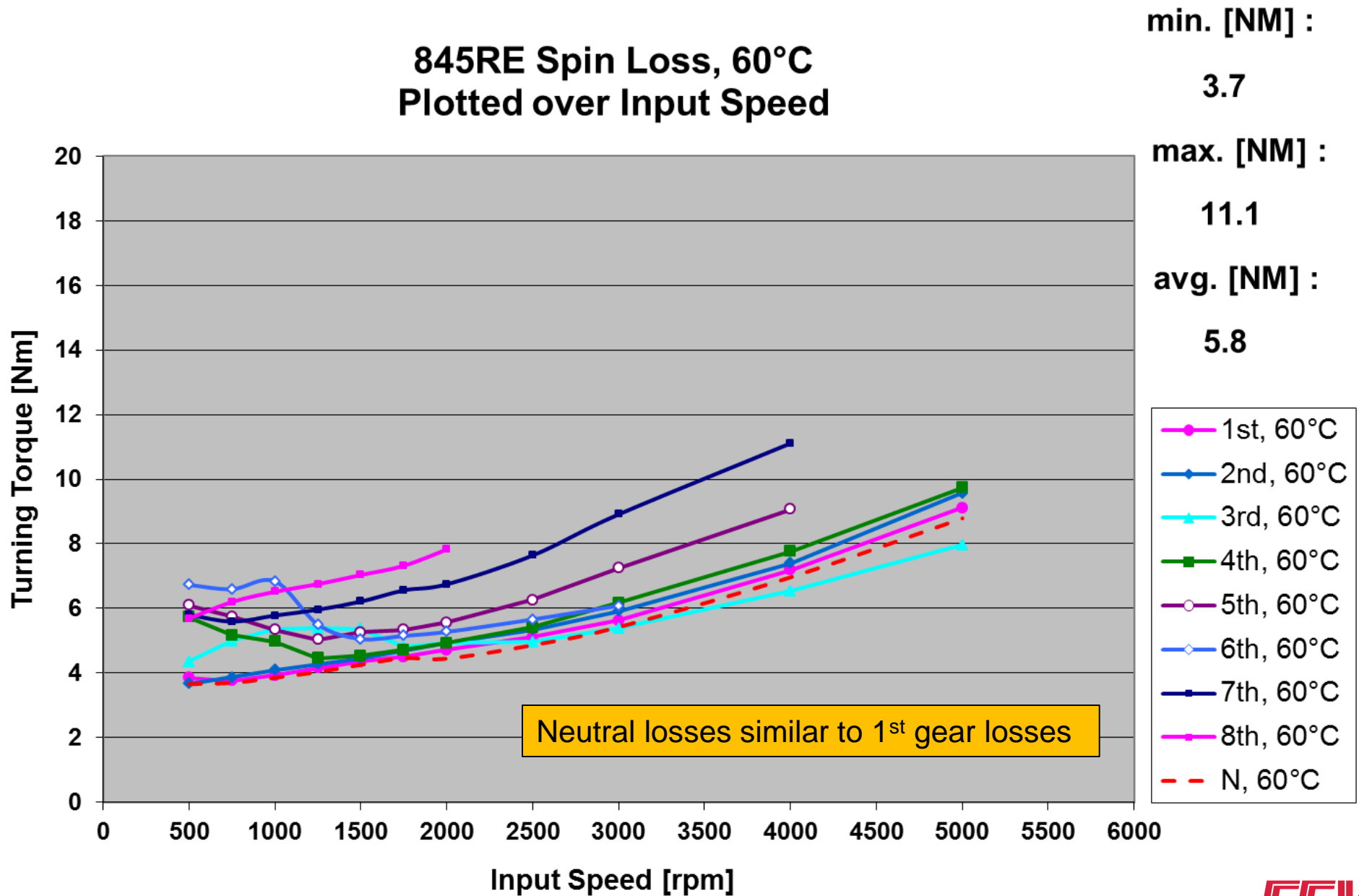
Ram HFE 8-Speed – Benchmark Bench Testing – Gear Inertia Study

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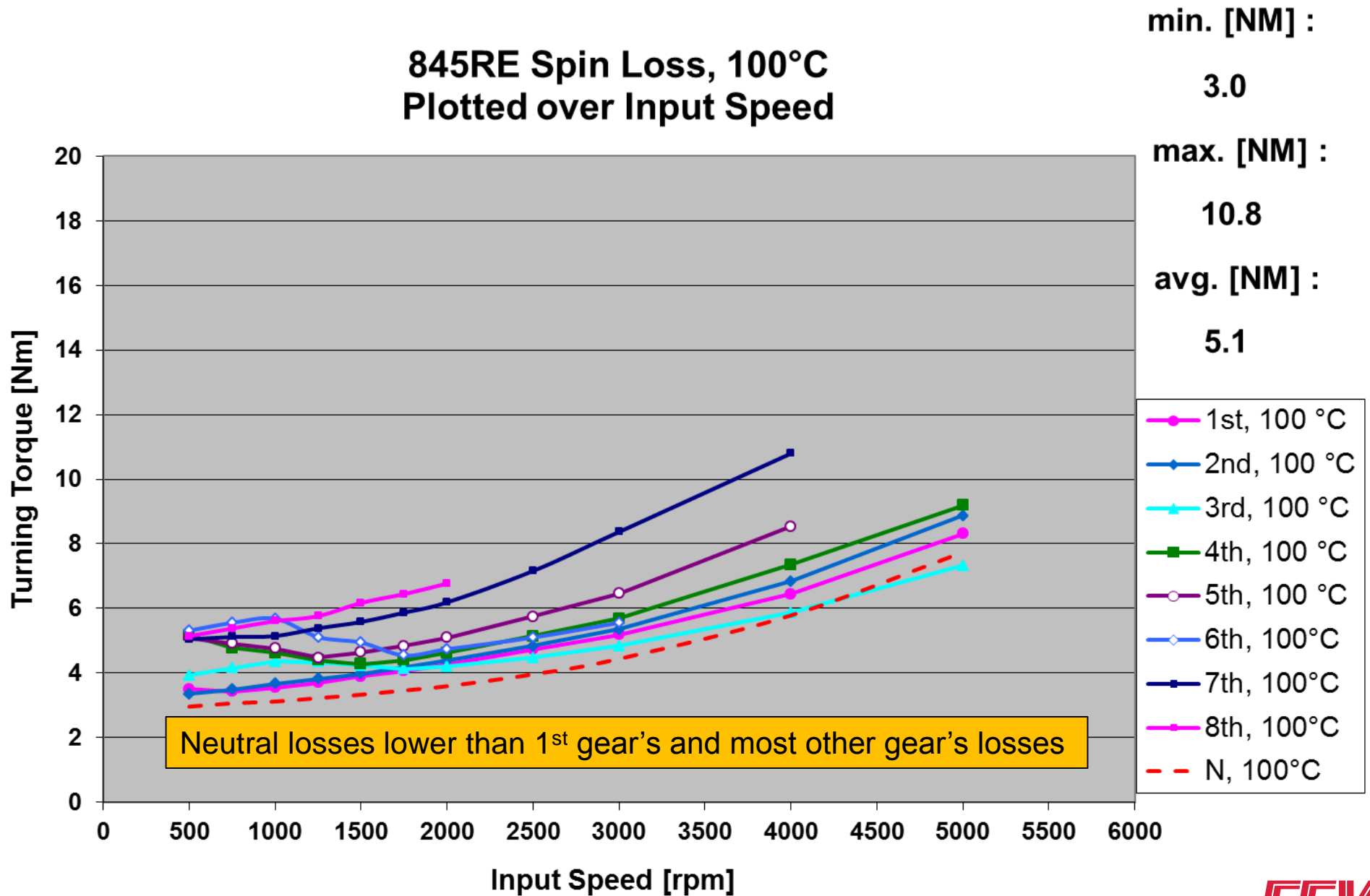
Ram HFE 8-Speed – Benchmark Bench Testing – Gear Inertia Study

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Ram HFE 8-Speed – Benchmark Bench Testing – Gear Inertia Study

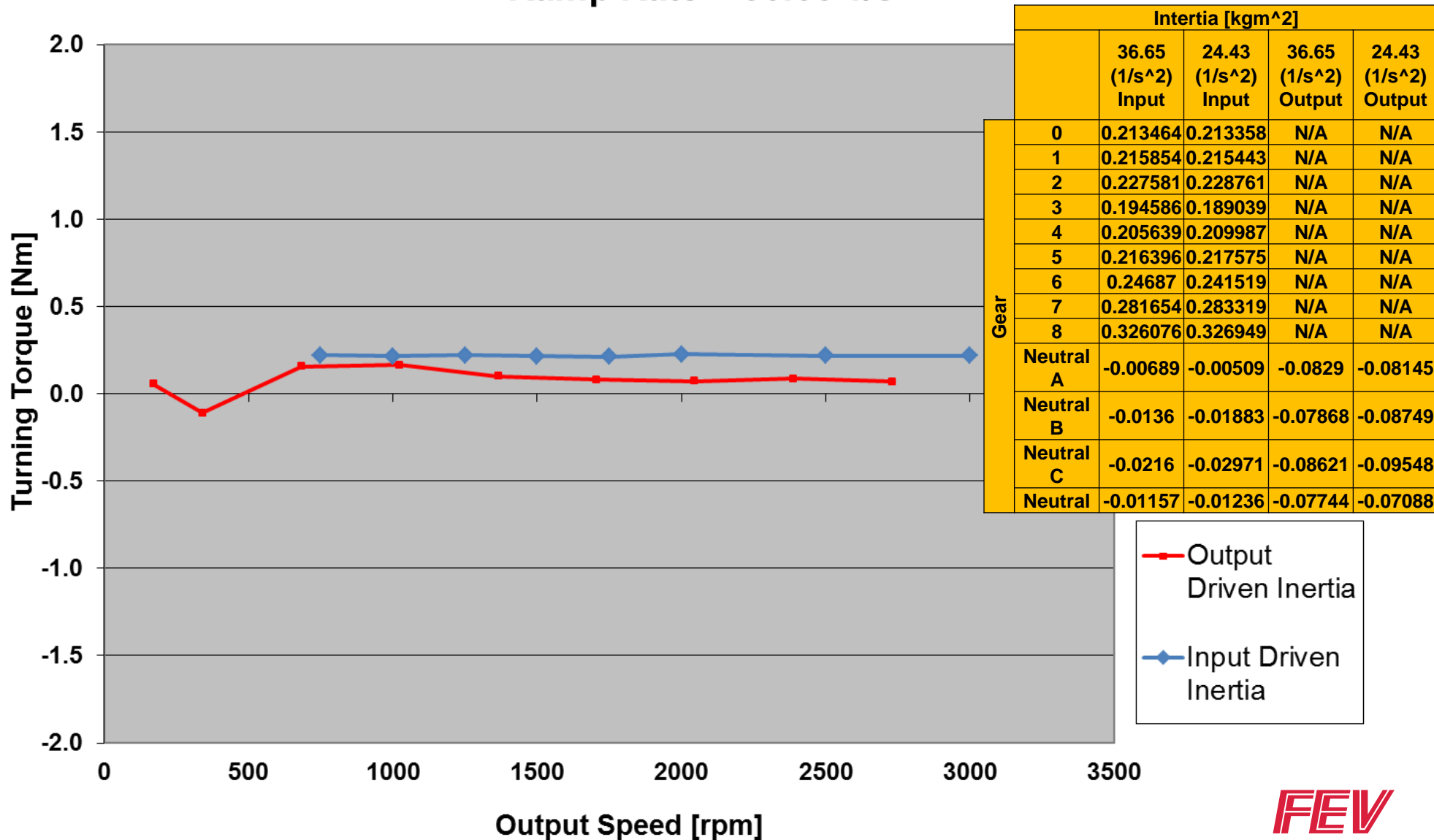
Contract No. EP-C-12-014, Work Assignment 3-11
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Ram HFE 8-Speed – Benchmark Bench Testing – Gear Inertia Study

Contract No. EP-C-12-014, Work Assignment 3-11
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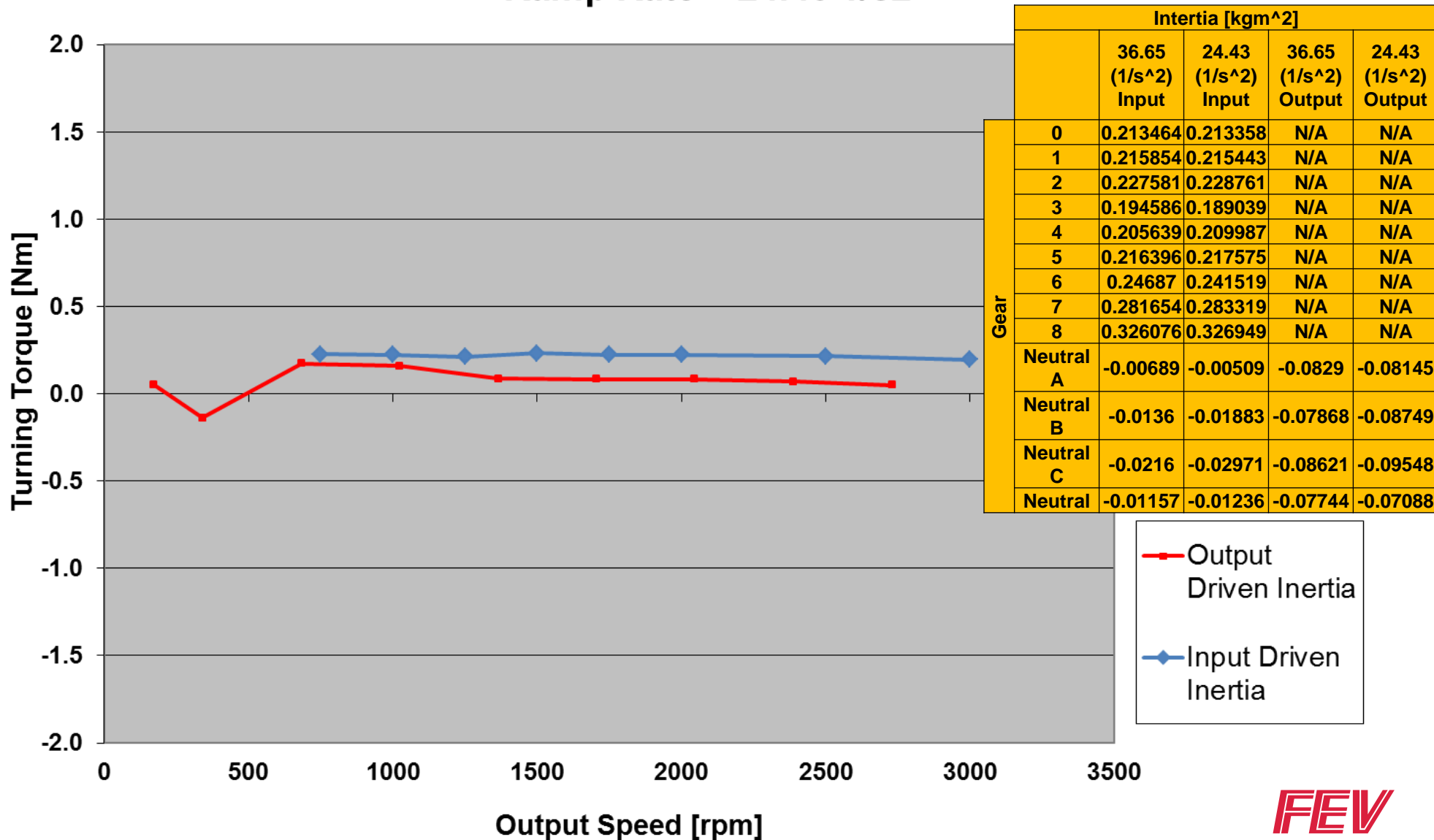
845RE Neutral Inertia Comparison Ramp Rate = 36.65 1/s²



Ram HFE 8-Speed – Benchmark Bench Testing – Gear Inertia Study

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845RE Neutral Inertia Comparison Ramp Rate = 24.43 1/s²

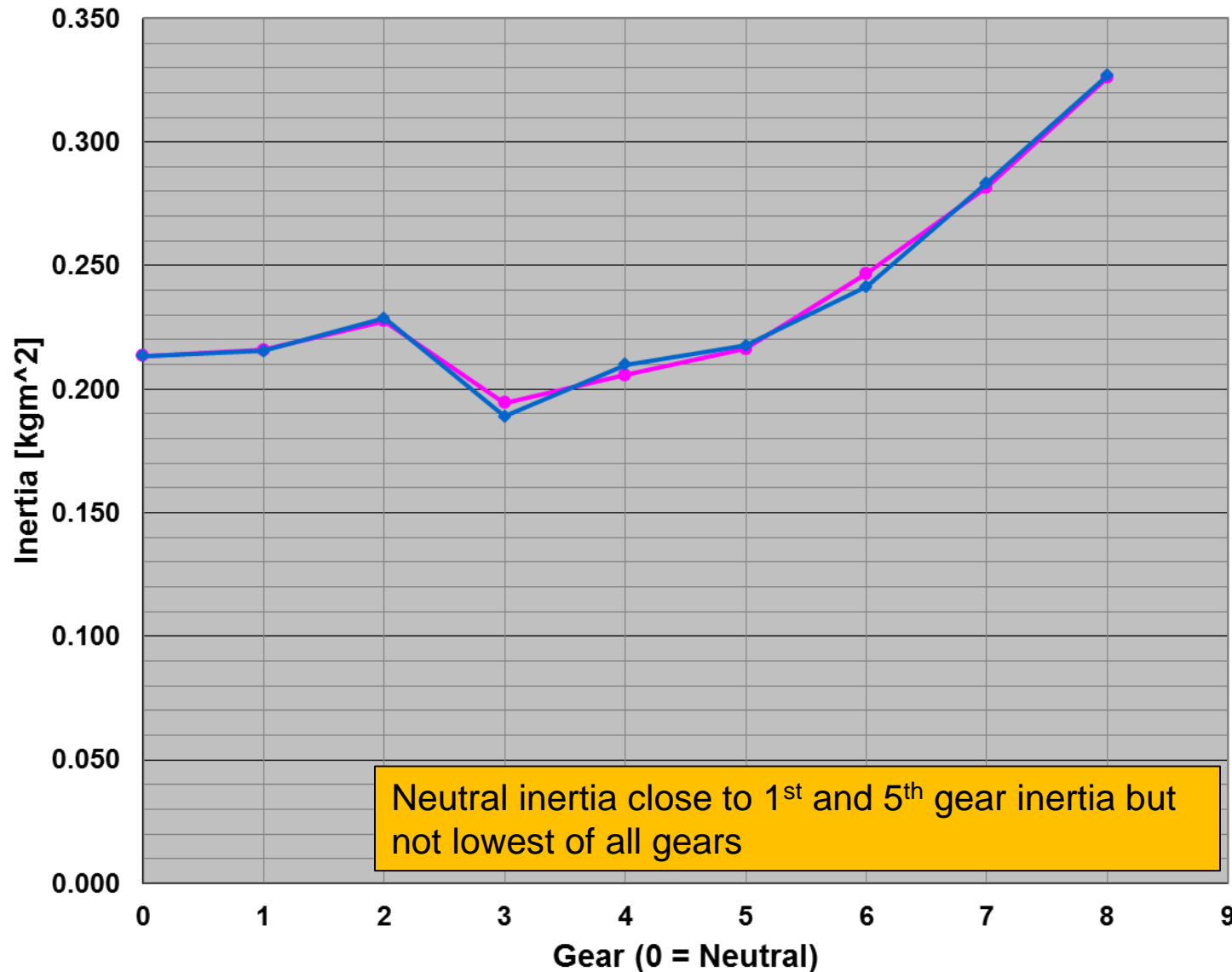


Ram HFE 8-Speed – Benchmark Bench Testing – Gear Inertia Study

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845RE In-Gear Inertia Input Shaft Driven



Intertia [kgm^2]		
	36.65 (1/s^2)	24.43 (1/s^2)
N	0.213	0.213
1	0.216	0.215
2	0.228	0.229
3	0.195	0.189
4	0.206	0.210
5	0.216	0.218
6	0.247	0.242
7	0.282	0.283
8	0.326	0.327

—●— Ramp Rate A
—●— Ramp Rate B

Ram HFE 8-Speed – Benchmark

Bench Testing – Torque Converter Testing

Contract No. EP-C-12-014, Work Assignment 3-11
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☐ Torque Converter Efficiency Measurements

☐ Gear = TBD

- ☐ Assuming 1st gear for speed tests
- ☐ Assuming 5th gear for mid and high speed tests

☐ Input speeds (TBD):

- ☐ Engine idle speed (assume 1st gear)
- ☐ 1000 rpm (assume 5th gear)
- ☐ 2000 rpm (assume 5th gear)

☐ Achieve different torque converter speed ratios (0 1)

☐ Transmission oil temperature = 100°C

☐ Transmission line pressure (variable):

- ☐ Same as used for equivalent point during loaded efficiency testing

☐ Neutral Idle Control

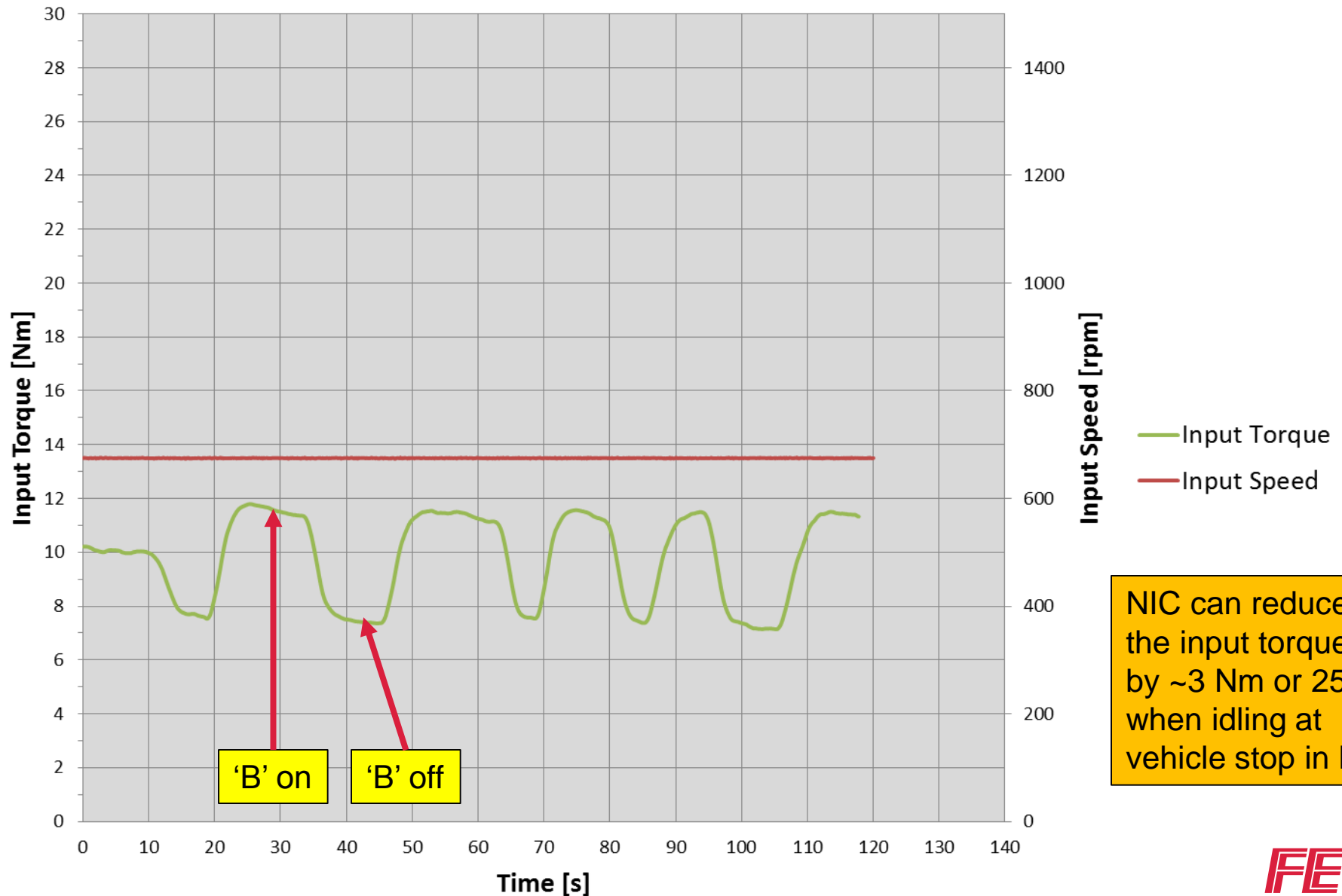
- ☐ Releases brake B when vehicle is stopped in D (i.e. 1st gear)
- ☐ Reduces drag losses to improve fuel economy when at rest

Ram HFE 8-Speed – Benchmark Bench Testing – Gear Inertia Study

Contract No. EP-C-12-014, Work Assignment 3-11
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Effect of Neutral Idle Control on Transmission Losses



Ram HFE 8-Speed – Benchmark

Bench Testing – Torque Converter Testing

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



☐ Torque Converter Efficiency Measurements

☐ Gear = TBD

- ☐ Assuming 1st gear for speed tests

- ☐ Assuming 5th gear for mid and high speed tests

☐ Input speeds (TBD):

- ☐ Engine idle speed (assume 1st gear)

- ☐ 1000 rpm (assume 5th gear)

- ☐ 2000 rpm (assume 5th gear)

☐ Achieve different torque converter speed ratios (0 1)

☐ Transmission oil temperature = 100°C

☐ Transmission line pressure (variable):

- ☐ Same as used for equivalent point during loaded efficiency testing

Ram HFE 8-Speed – Benchmark

Bench Testing – Torque Converter Testing

Contract No. EP-C-12-014, Work Assignment 3-11
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- ☐ Front driving – efficiency test (initial results acquired, analysis ongoing)
 - ☐ 5th gear
 - ☐ Transmission line pressure at maximum value observed for 5th gear
 - ☐ Sump temperature = 100°C
 - ☐ TISS at 1000 rpm
 - ☐ Engine at 1000 rpm and increasing in 10 rpm increments until 1200 rpm
 - ☐ Engine at 1200 rpm and increasing in 100 rpm increments until input torque exceeds 250 Nm
- ☐ Front driving – stall test (last test)
 - ☐ 1st gear
 - ☐ Transmission line pressure at maximum value observed for 1st gear
 - ☐ Sump temperature = 100°C
 - ☐ Output shaft at 0 rpm
 - ☐ Input shaft from 0 to stall speed rpm (input torque at 250 Nm) at 250 rpm increments

Ram HFE 8-Speed – Benchmark

Bench Testing – Torque Converter Testing

Contract No. EP-C-12-014, Work Assignment 3-11
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- ☐ Back driving – efficiency test (initial results acquired, analysis ongoing)
 - ☐ 5th gear
 - ☐ Transmission line pressure at minimum value observed for 5th gear
 - ☐ Sump temperature = 100°C
 - ☐ TISS at idle (680 rpm)
 - ☐ Engine at 1/2 idle (340 rpm) and increase to idle
 - ☐ 390, 440, 490, 540, 590, 640, 680 rpm
 - ☐ TISS at 2x idle (1360 rpm)
 - ☐ Engine at 1/2 idle (340 rpm) and increase to 2x idle
 - ☐ 440, 540, 640, 740, 840, 940, 1040, 1140, 1240, 1360 rpm

Ram HFE 8-Speed – Benchmark

Bench Testing – Torque Converter Testing

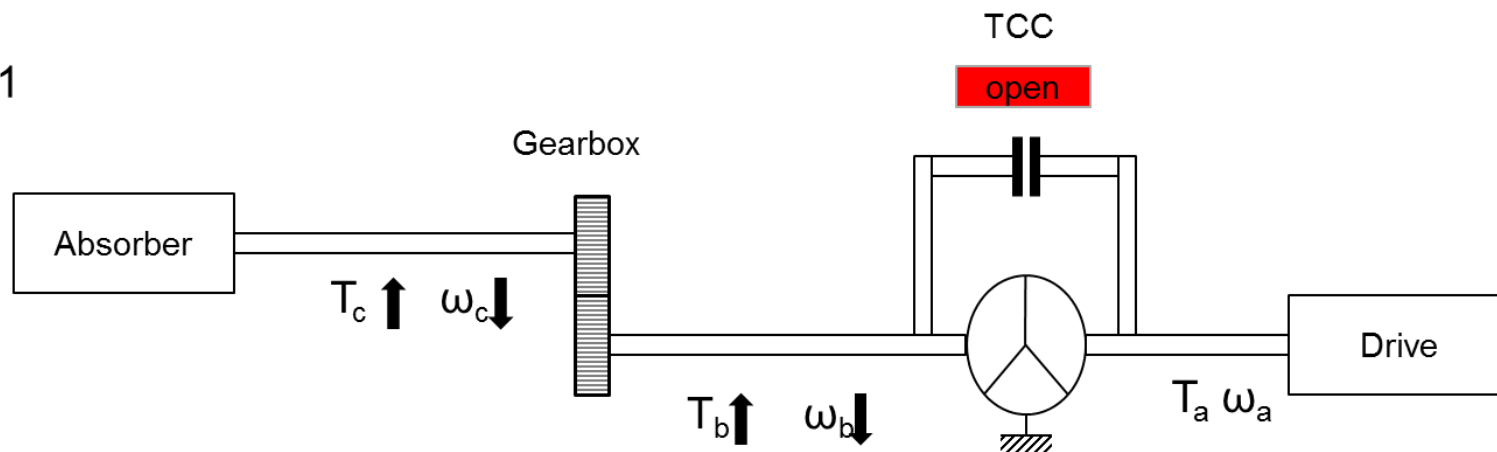
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❑ Evaluation of torque converter efficiency

1. Conduct measurements as outlined, recording input/output speeds & torques
 - i. Pump side power recorded (T_a , ω_a)
2. Analyze already recorded transmission efficiency results to determine turbine torque values:
 - i. Find LE data which can be matched to TC run in terms of transmission output speed & torque (T_c , ω_c) – inter/extrapolation may be required
 - ii. Back calculate output torque (considering gear ratio and gear set efficiency) to receive TC turbine side torque and speed (T_b , ω_b)
 - iii. Calculate TC efficiency: $\eta = (T_b * \omega_b) / (T_a * \omega_a) * 100$

1



Ram HFE 8-Speed – Benchmark

Bench Testing – Torque Converter Testing

Contract No. EP-C-12-014, Work Assignment 3-11
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☐ Sample Calculation

☐ Input:

- ☐ Gear: 5th, Torque: 25 Nm, Engine speed: 1080 rpm
- ☐ Power on TC pump: 2,827 W

☐ Output:

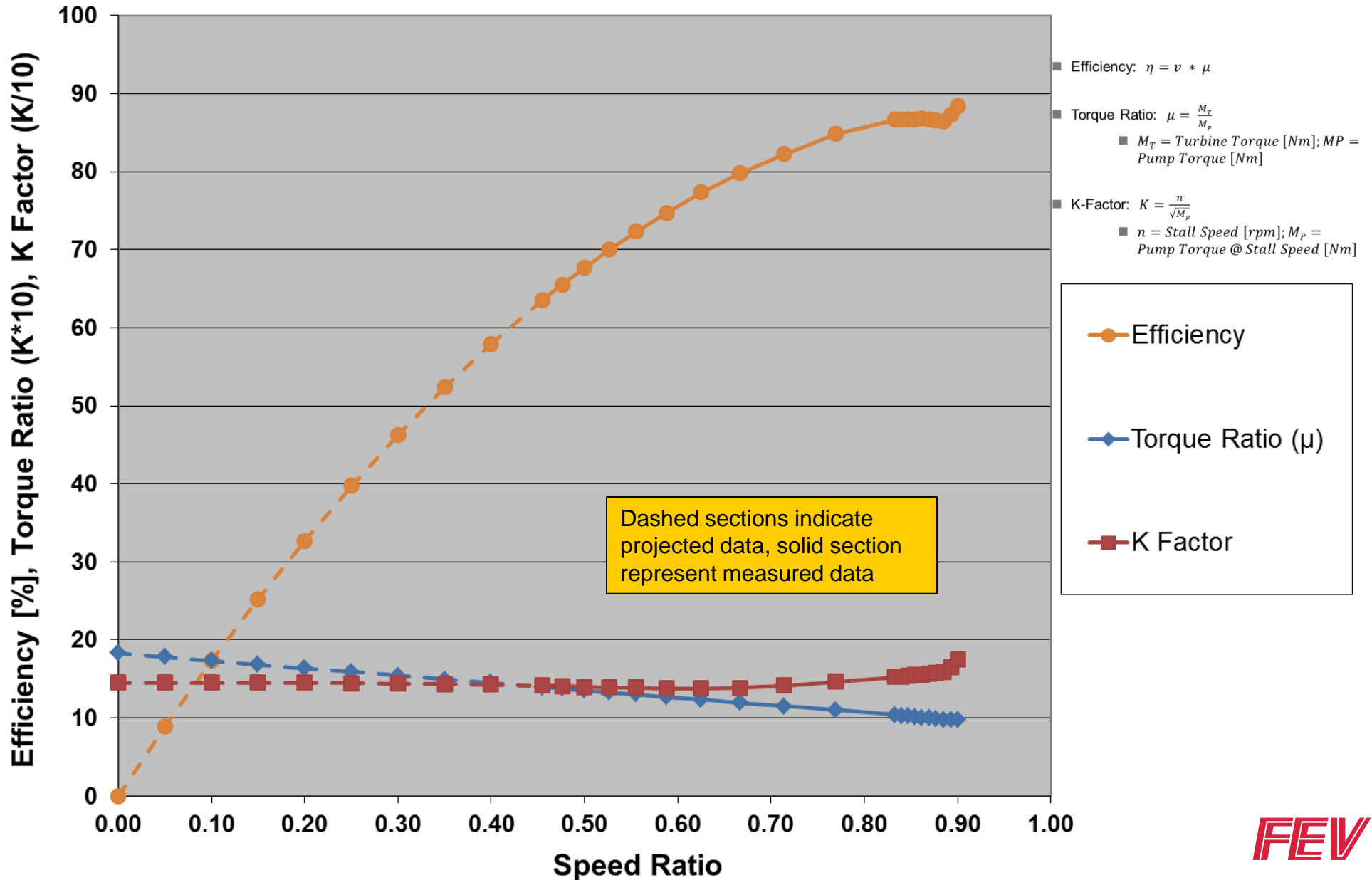
- ☐ Torque: 24.8 Nm, TISS = 1000 rpm, TOSS: 780 rpm
- ☐ Transmission efficiency in 5th gear at 780 rpm output, 5th gear and 24.8 Nm output torque: ~80%
- ☐ Torque on TC turbine = Output torque / 1.285 / 0.8 = 24.12 Nm
 - ☐ Power on TC turbine: 2,525 W
 - ☐ Efficiency TC = Power turbine/Power pump*100
 - ☐ $\eta = 2,525W / 2,827W * 100$
 - ☐ $\eta = 89.34 \%$

Ram HFE 8-Speed – Benchmark

Bench Testing – Torque Converter Testing

Contract No. EP-C-12-014, Work Assignment 3-11
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Torque Converter Characteristics vs. Speed Ratio



Ram HFE 8-Speed – Benchmark

Bench Testing – Oil Pump Testing

Contract No. EP-C-12-014, Work Assignment 3-11
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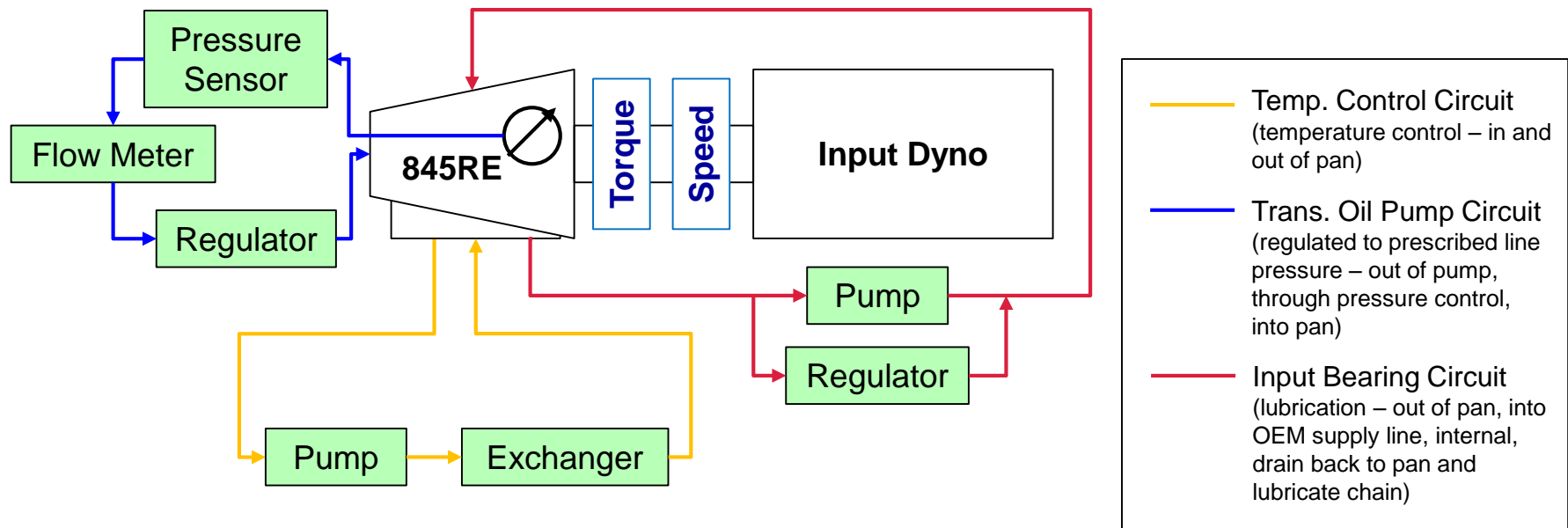
☐ Oil Pump Efficiency Measurements

- ☐ Transmission disassembled and reassembled to only contain oil pump, drive sprocket and chain
 - ☐ Performed loss measurements on de-vaaned pump to evaluate the pump chain drive losses
- ☐ Input speeds (11):
 - ☐ 500, 750, 1000, 1250, 1500 1750, 2000, 2500, 3000, 4000, 5000 rpm
- ☐ Pump pressures (3):
 - ☐ 5.2, 8, 11.5 bar
- ☐ Transmission oil temperatures (3):
 - ☐ 35°C, 60°C, 100°C
- ☐ Transmission line pressure (variable):
 - ☐ Same as used for equivalent point during loaded efficiency testing

Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

Contract No. EP-C-12-014, Work Assignment 3-11
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Oil Pump Test Schematic



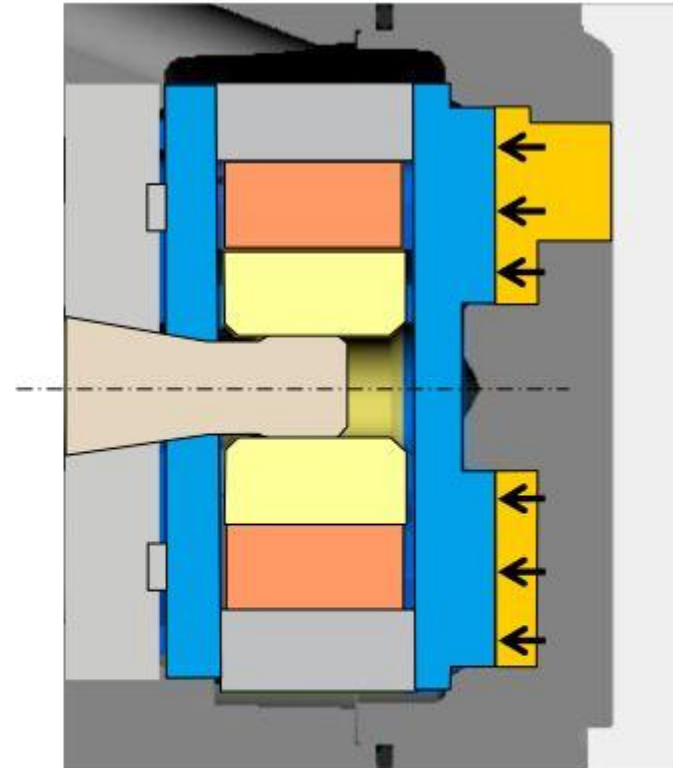
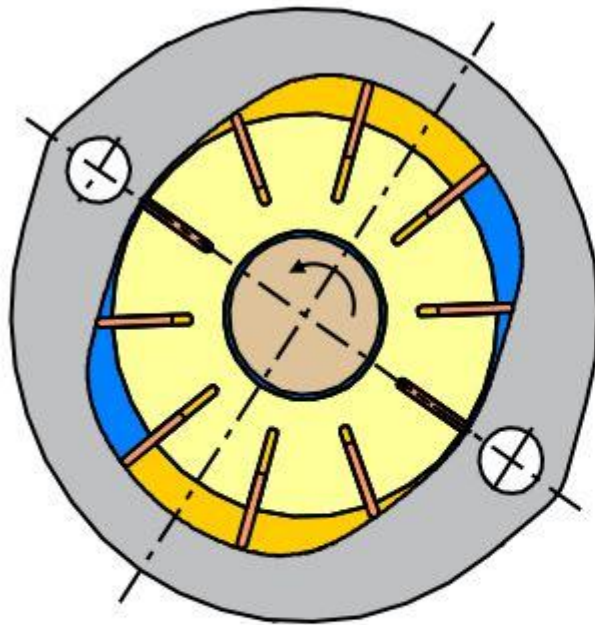
Oil Pump Test Schematic

[illegible]

Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Low Pressure Operation

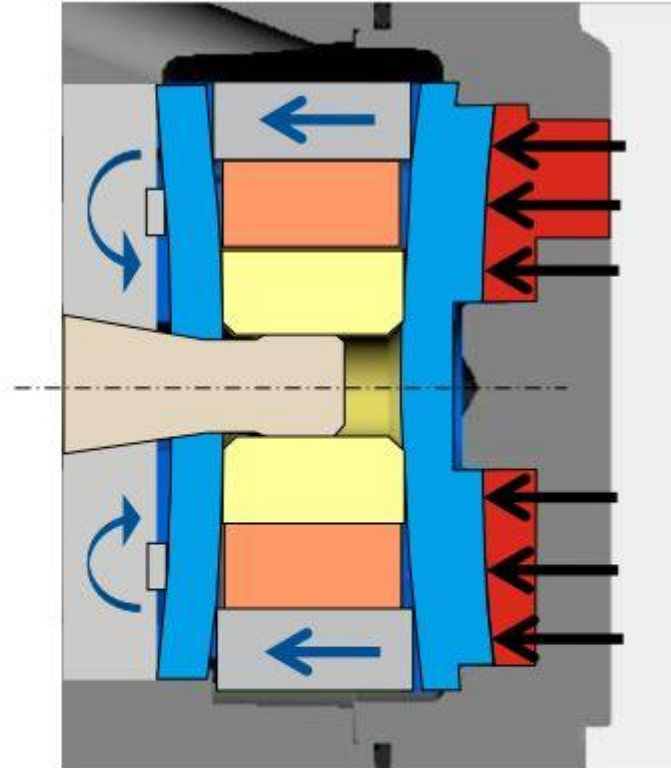
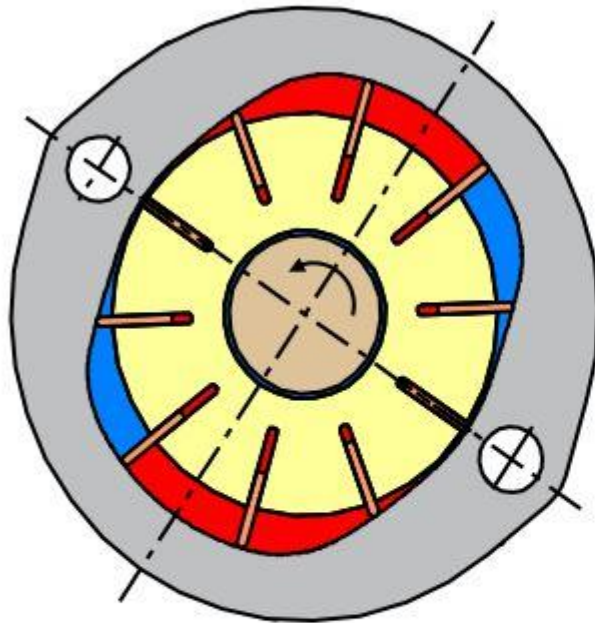


- Axial gap compensation by pressure - deflection of side plates
- Radial gap compensation by pressure support of vanes

Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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High Pressure Operation

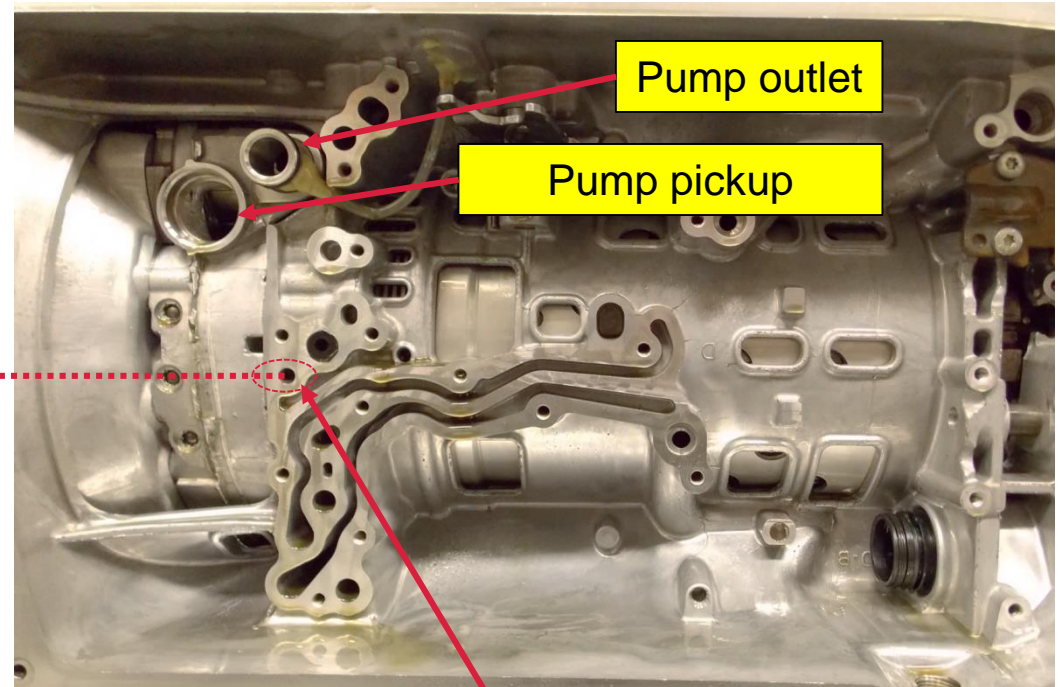
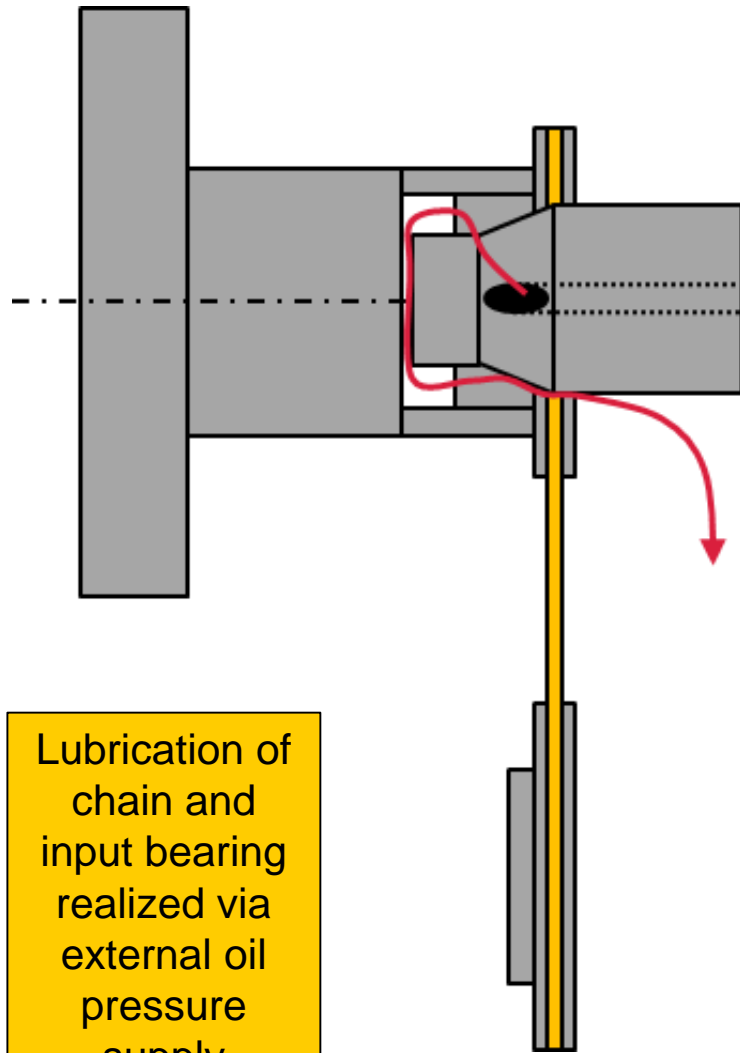


- Axial gap compensation by pressure - deflection of side plates
- Radial gap compensation by pressure support of vanes

Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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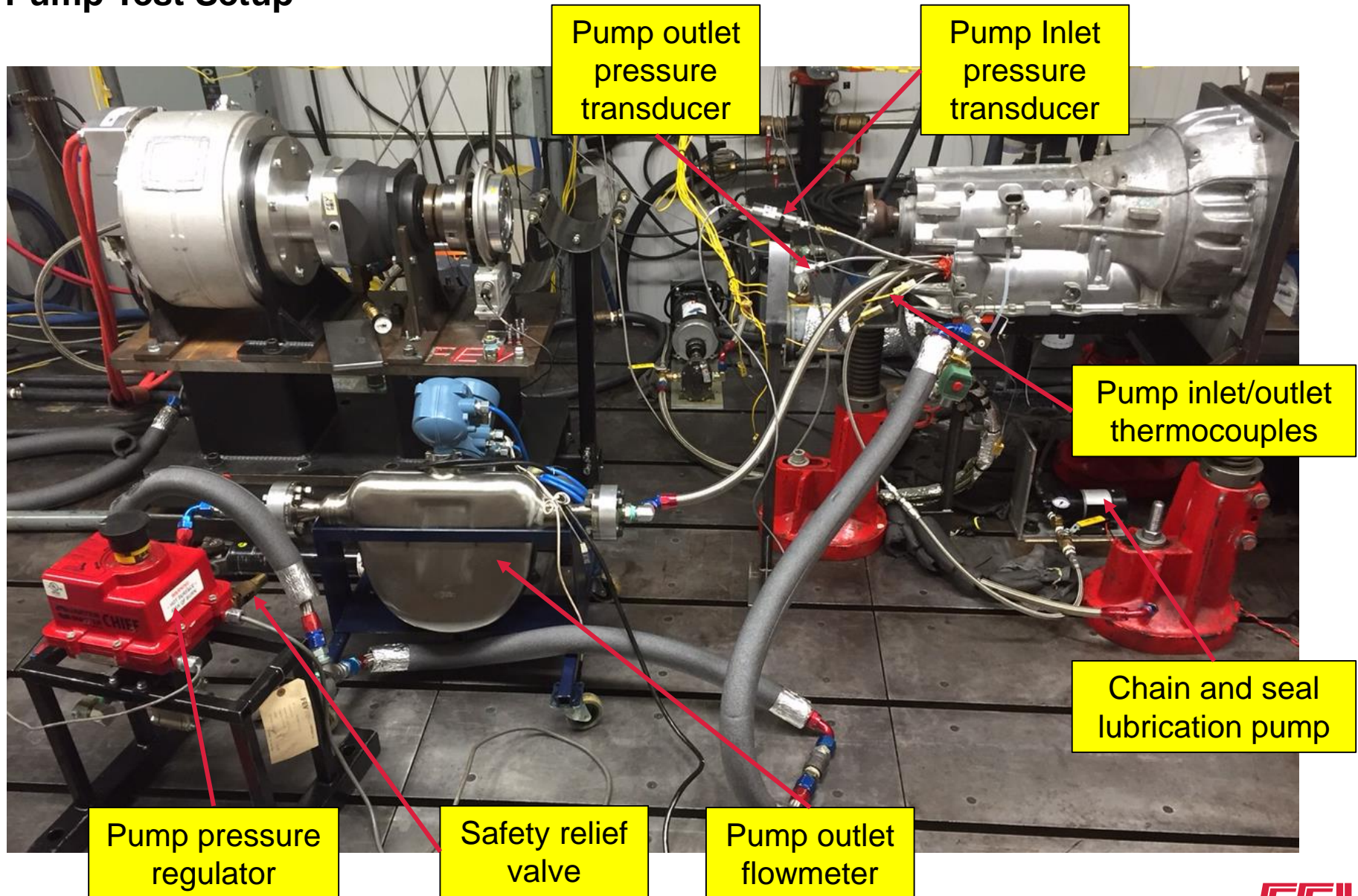
Oil Pump Test Schematic



Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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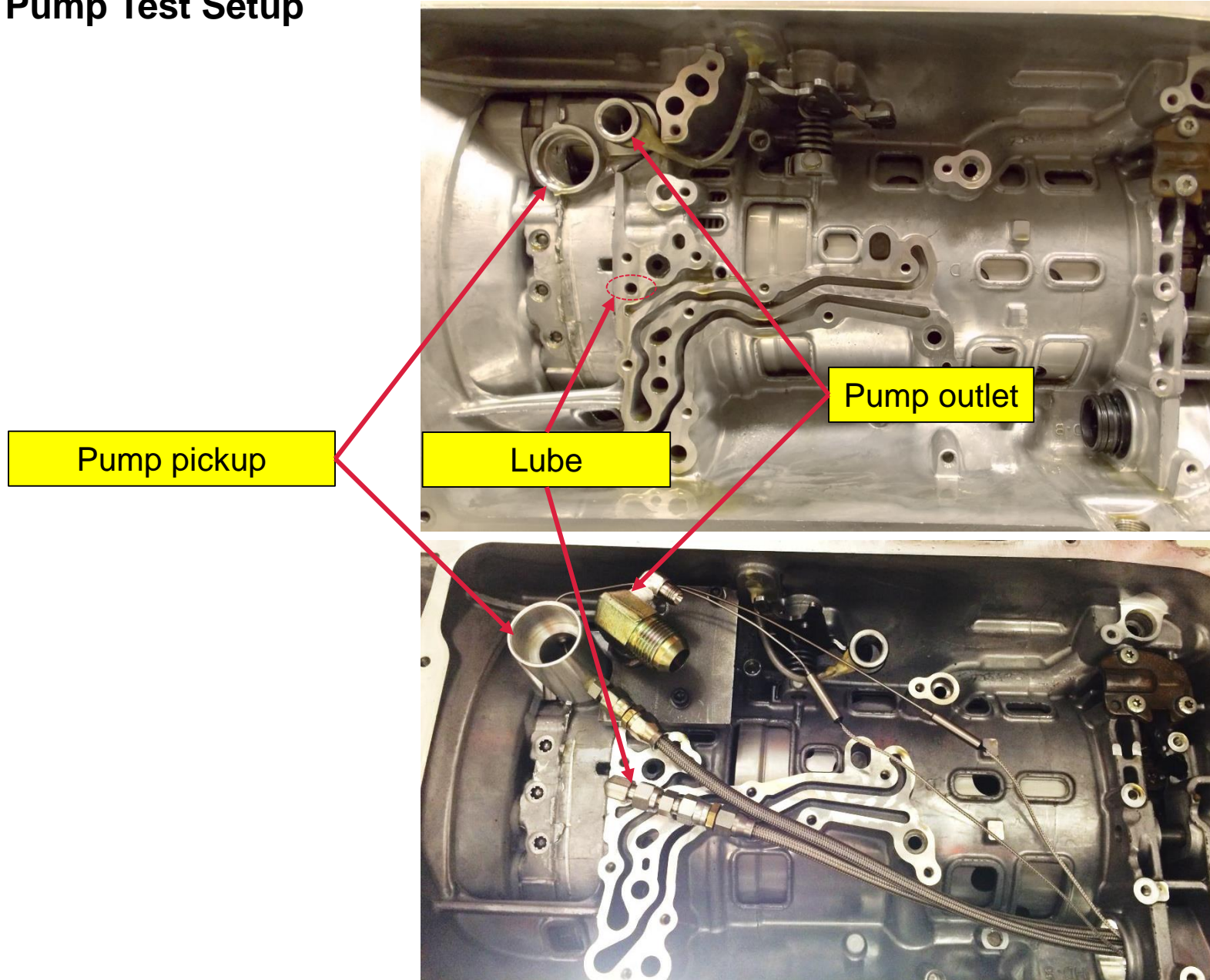
Oil Pump Test Setup



Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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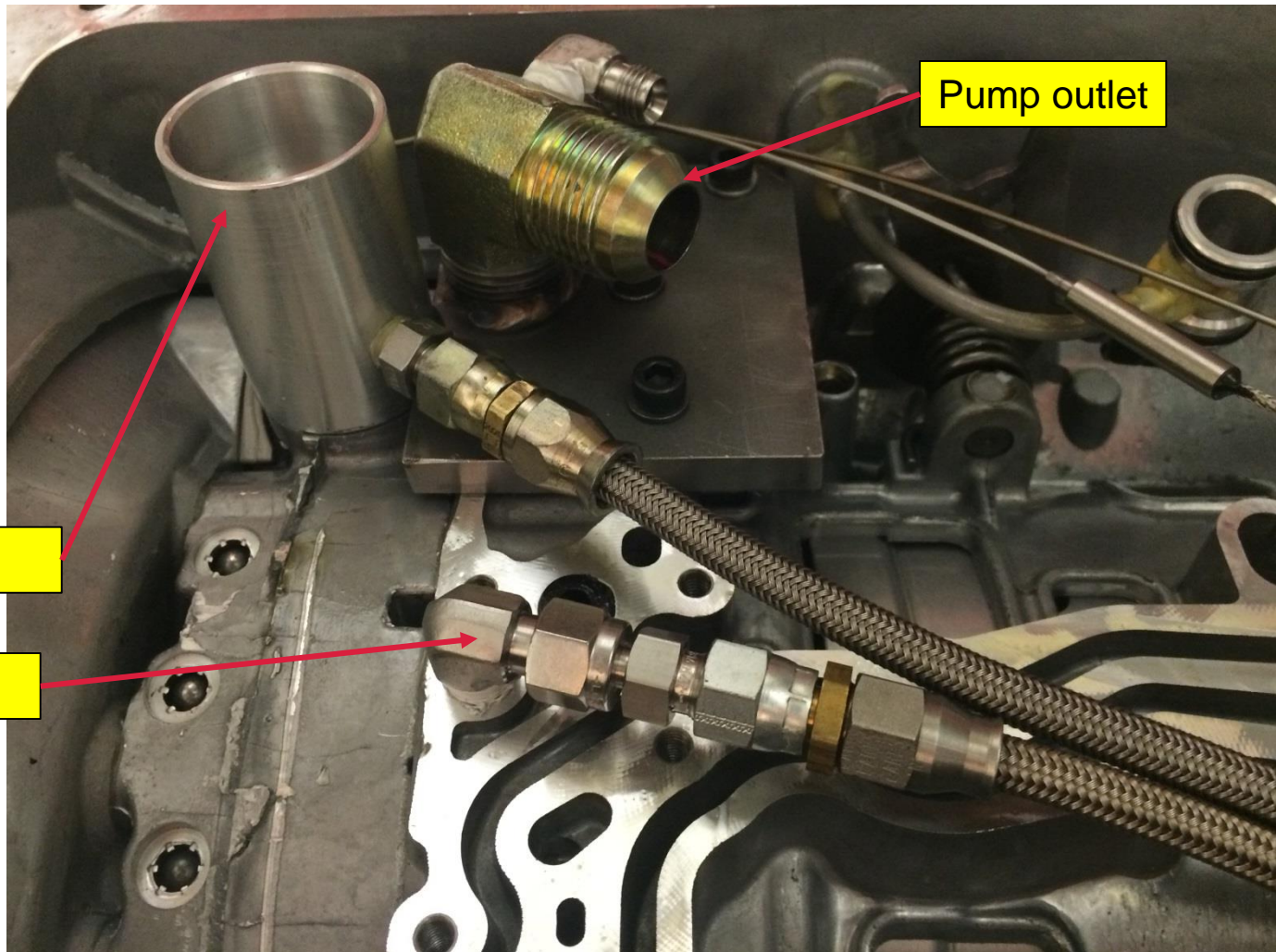
Oil Pump Test Setup



Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Oil Pump Test Setup



Pump pickup

Pump outlet

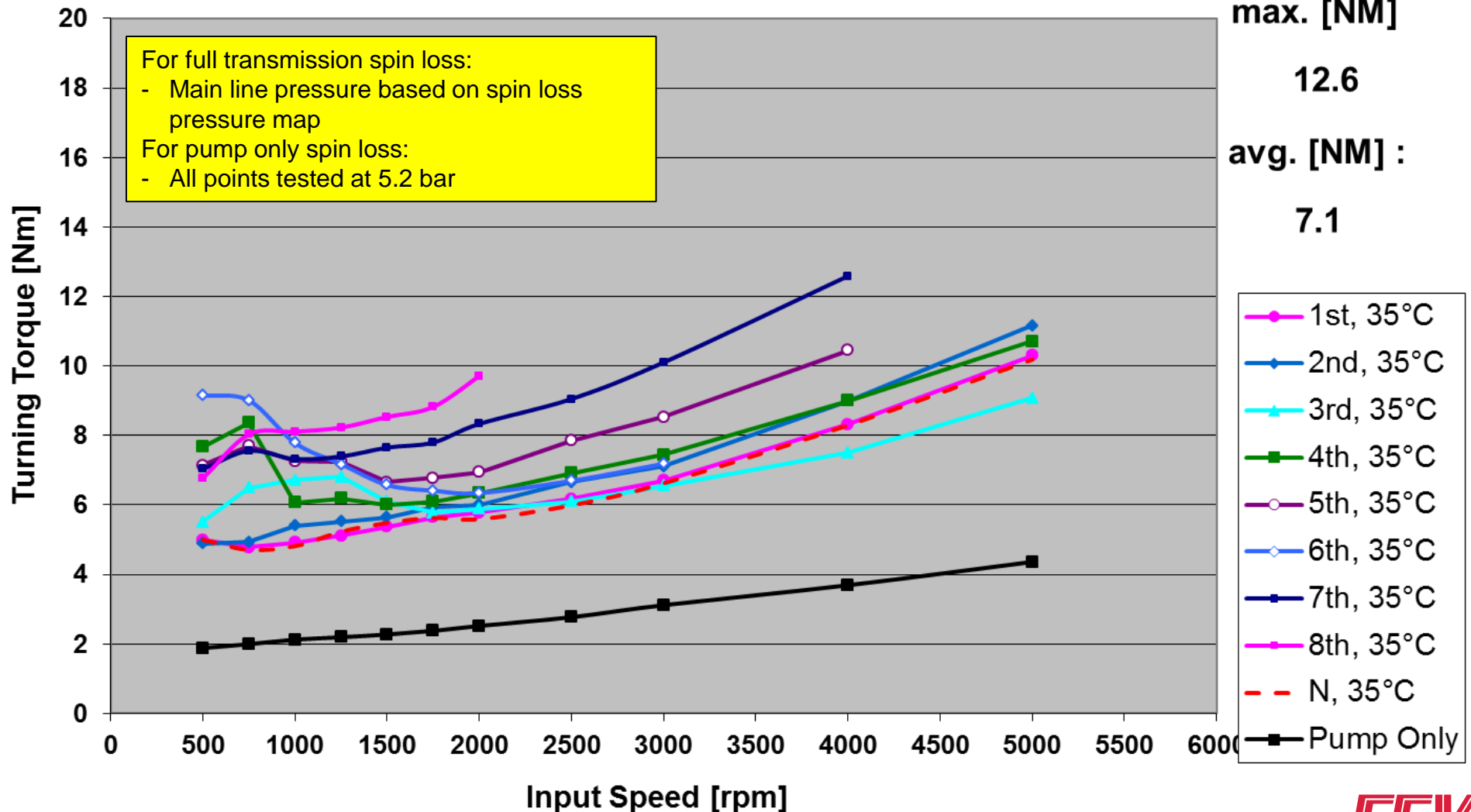
Lube

Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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845RE Spin Loss, 35°C Plotted over Input Speed



Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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845RE Spin Loss, 60°C Plotted over Input Speed

min. [NM] :

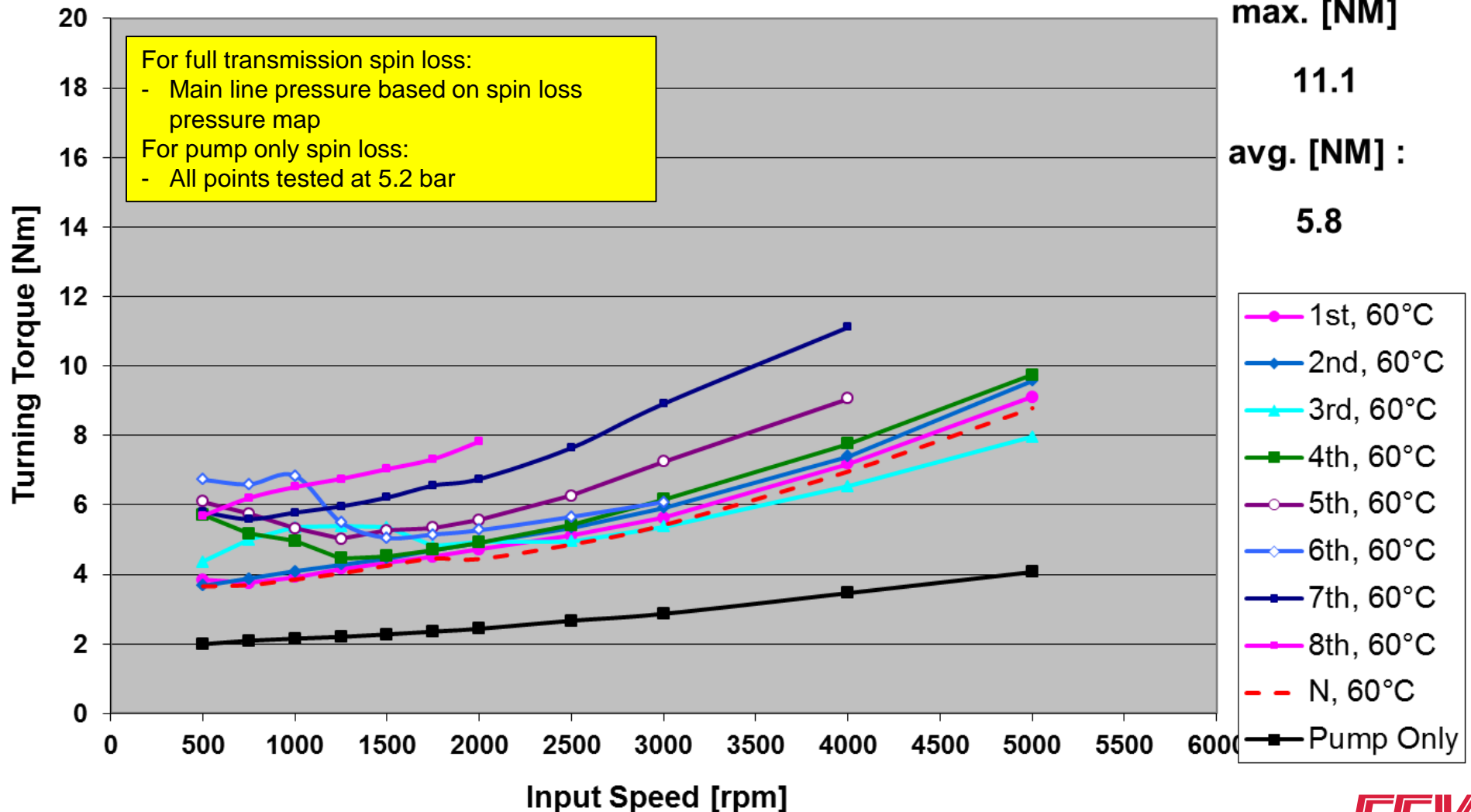
3.7

max. [NM]

11.1

avg. [NM] :

5.8

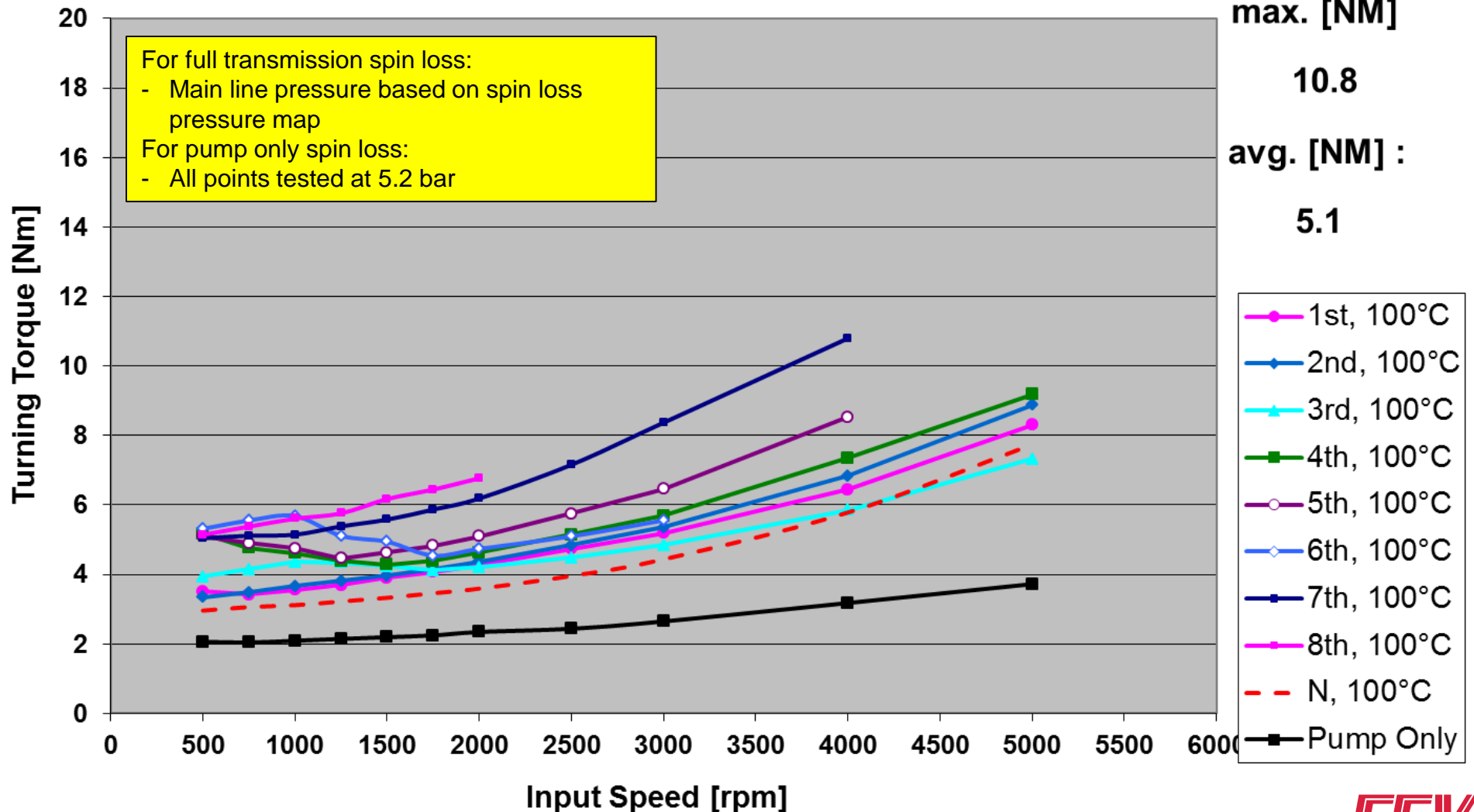


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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845RE Spin Loss, 100°C Plotted over Input Speed

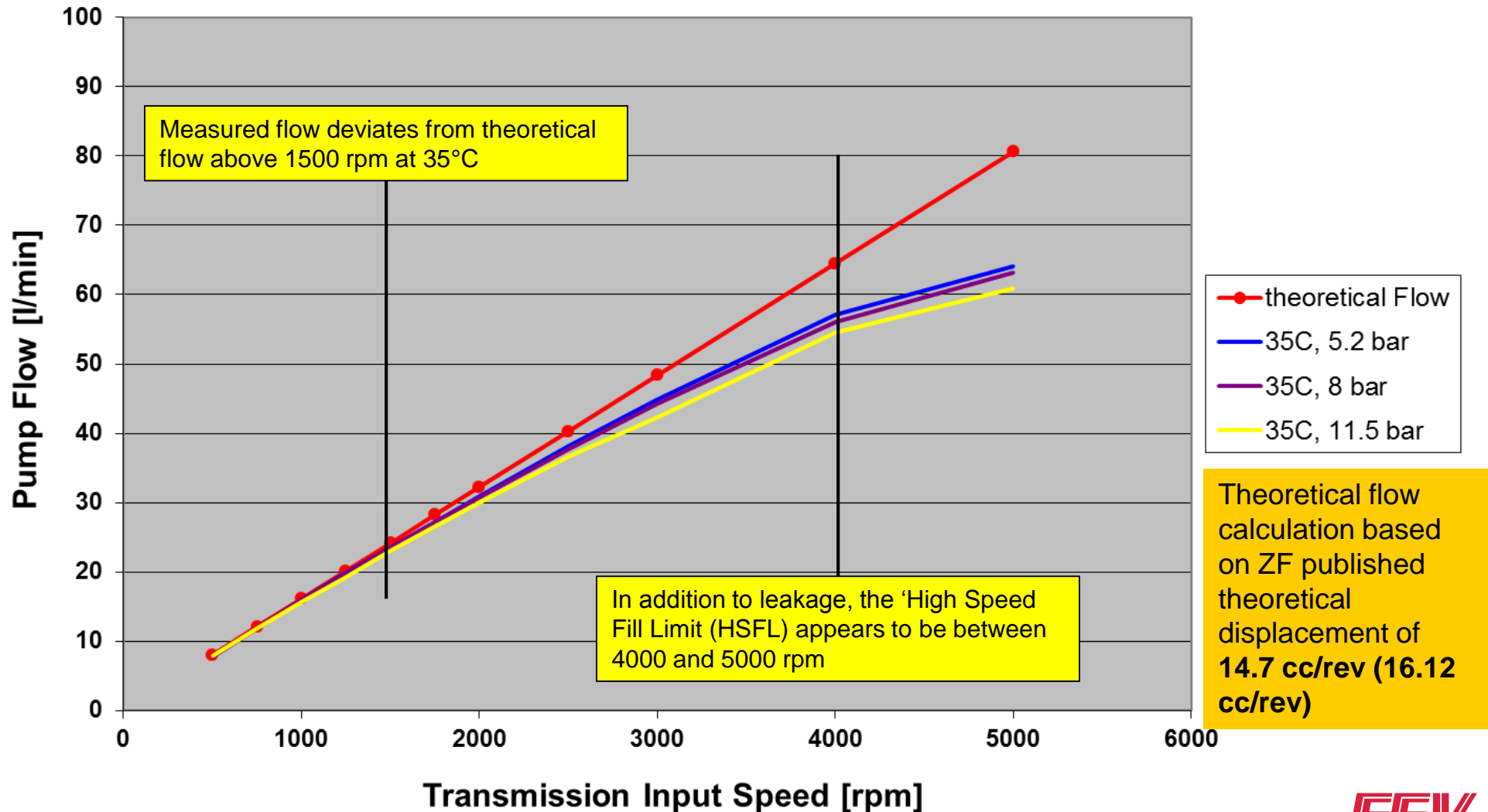


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Pump Flow vs. Input Speed - 35°C

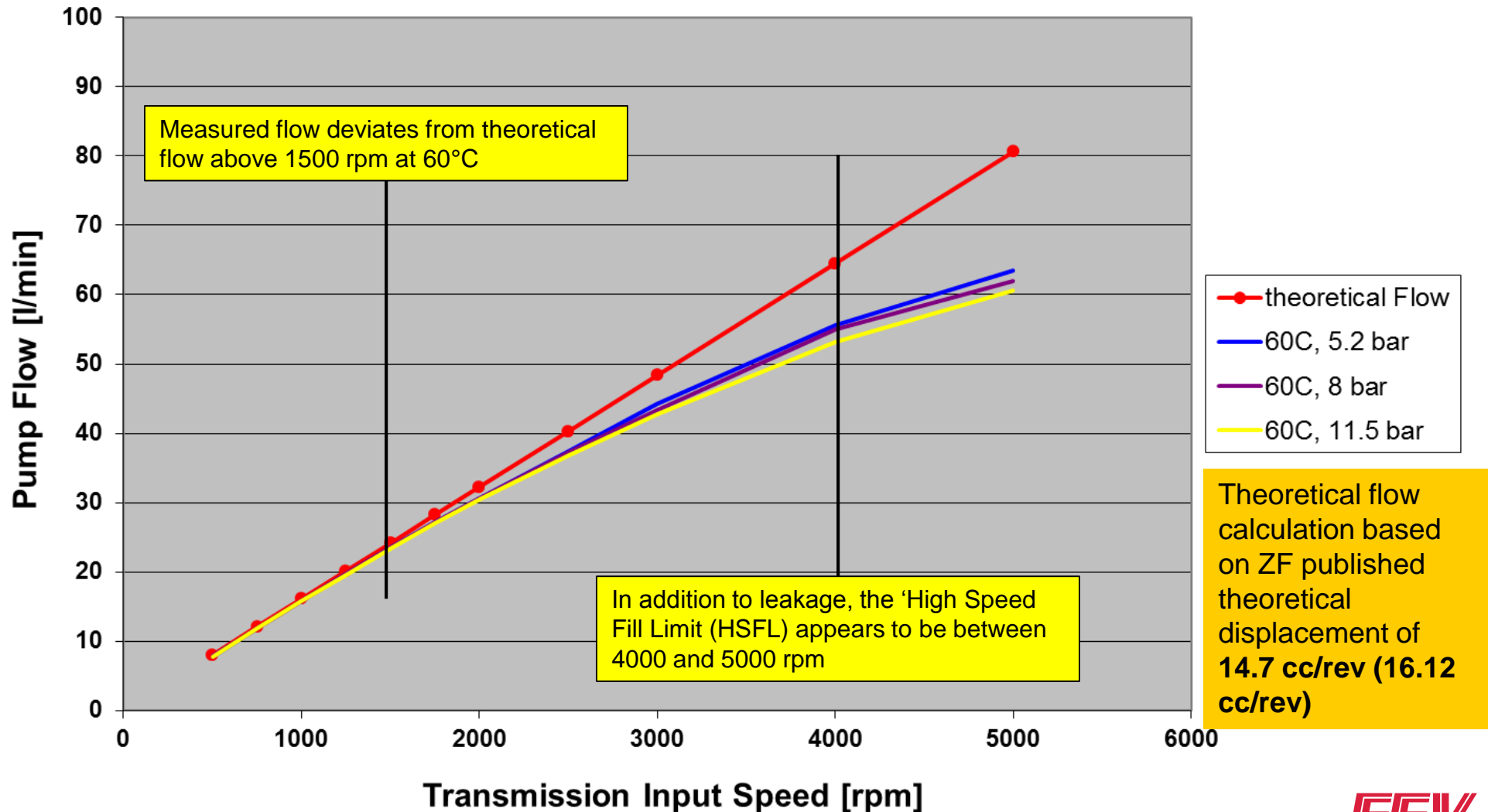


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Pump Flow vs. Input Speed - 60°C

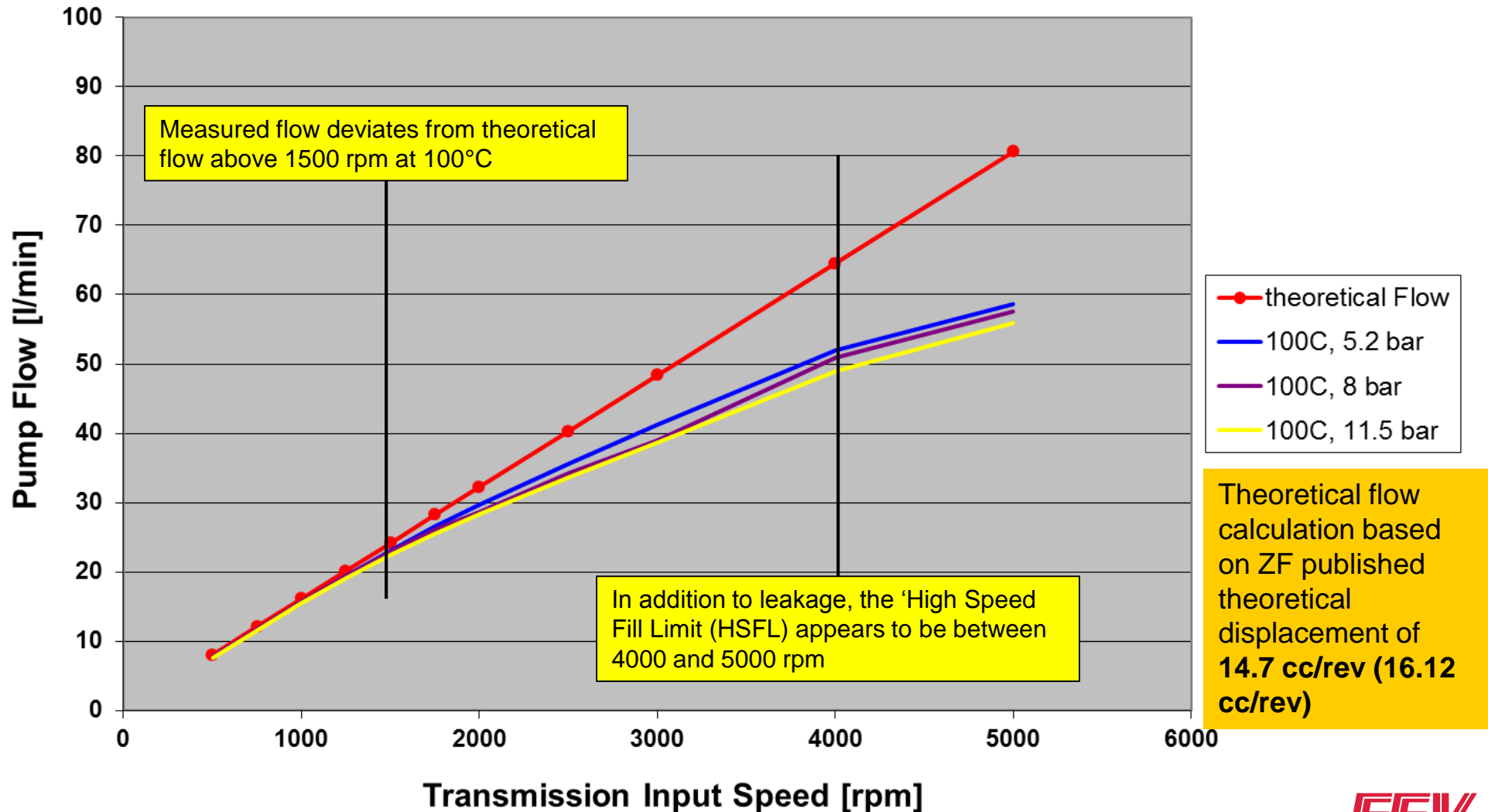


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Pump Flow vs. Input Speed - 100°C

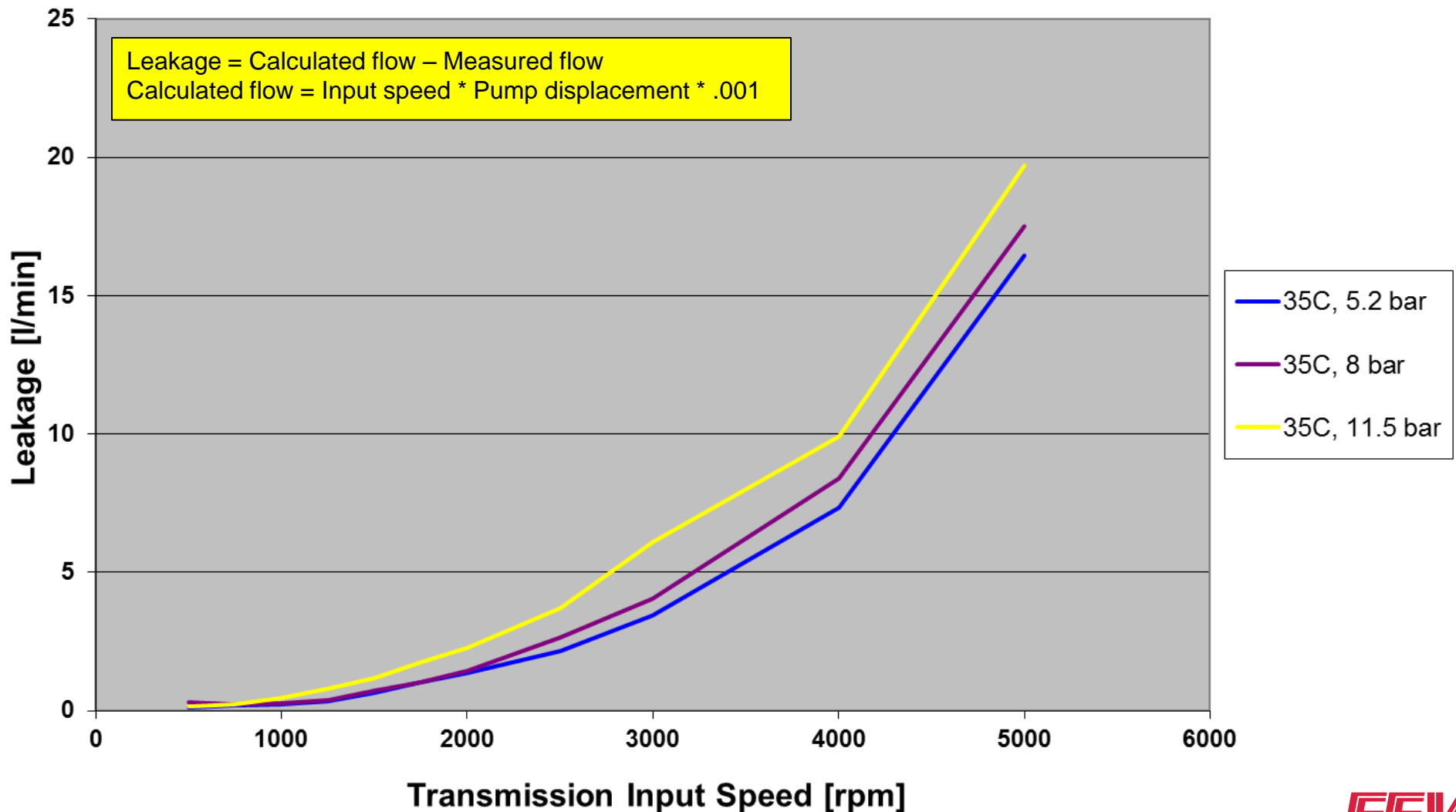


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Leakage vs. Input Speed - 35°C

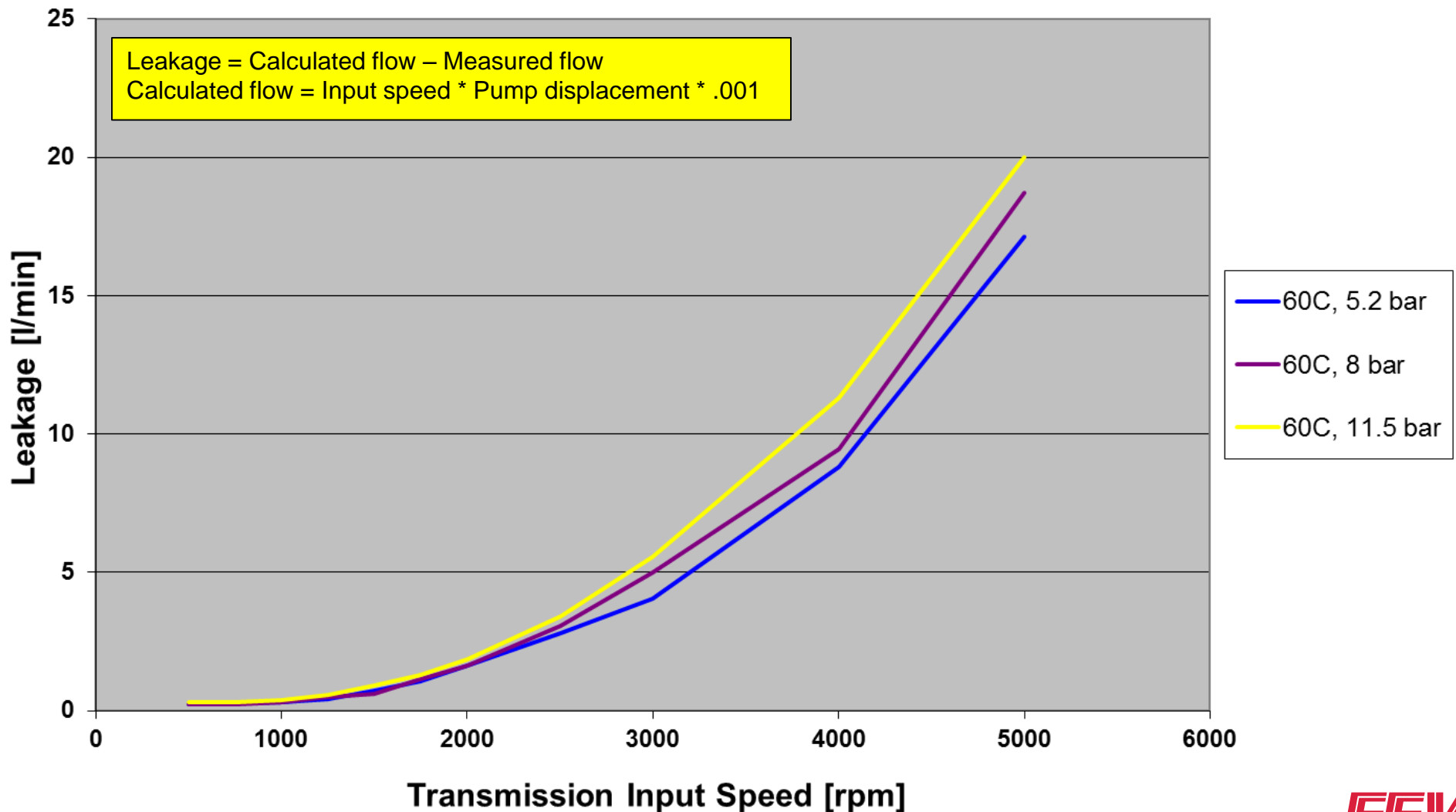


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Leakage vs. Input Speed - 60°C

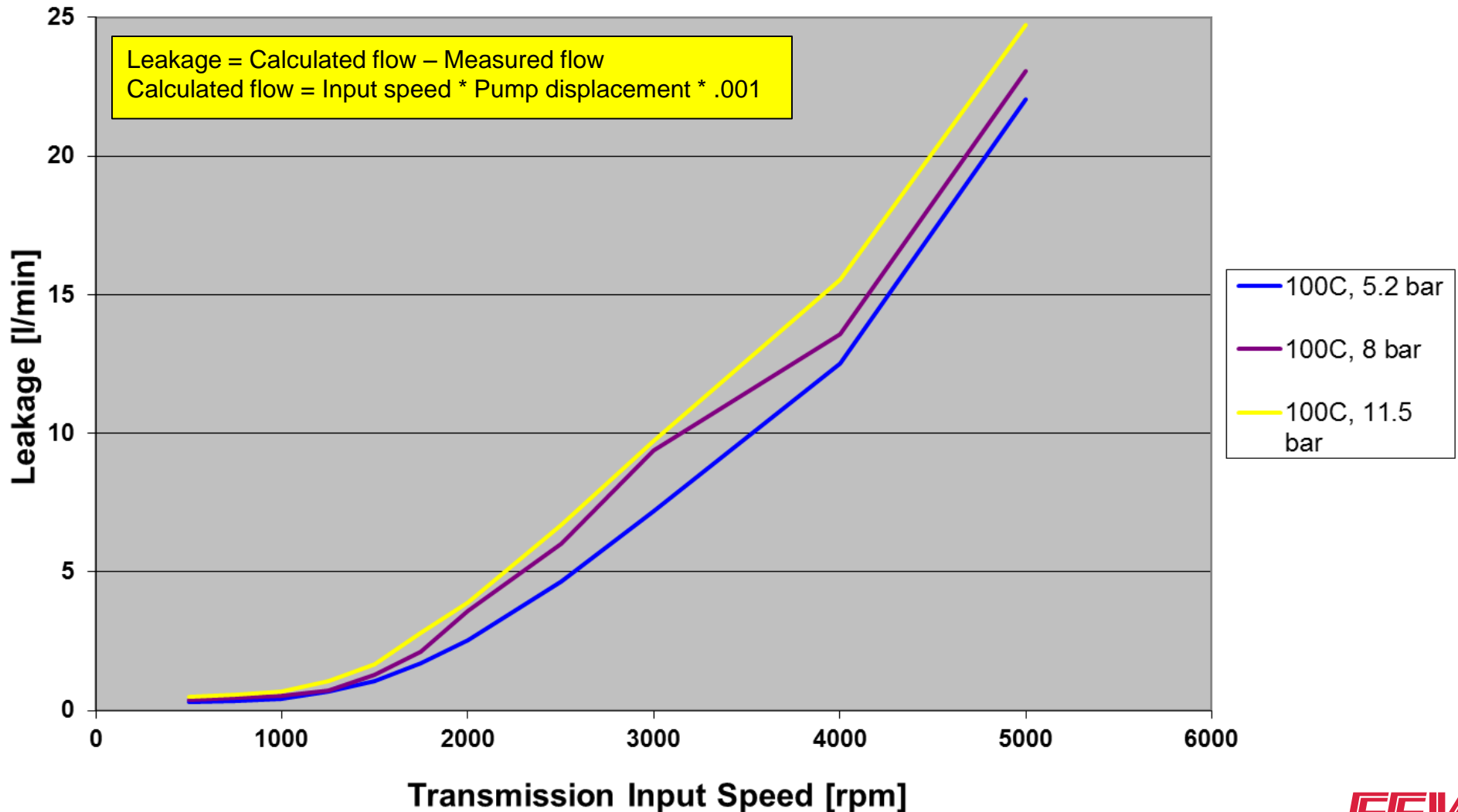


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Leakage vs. Input Speed - 100°C

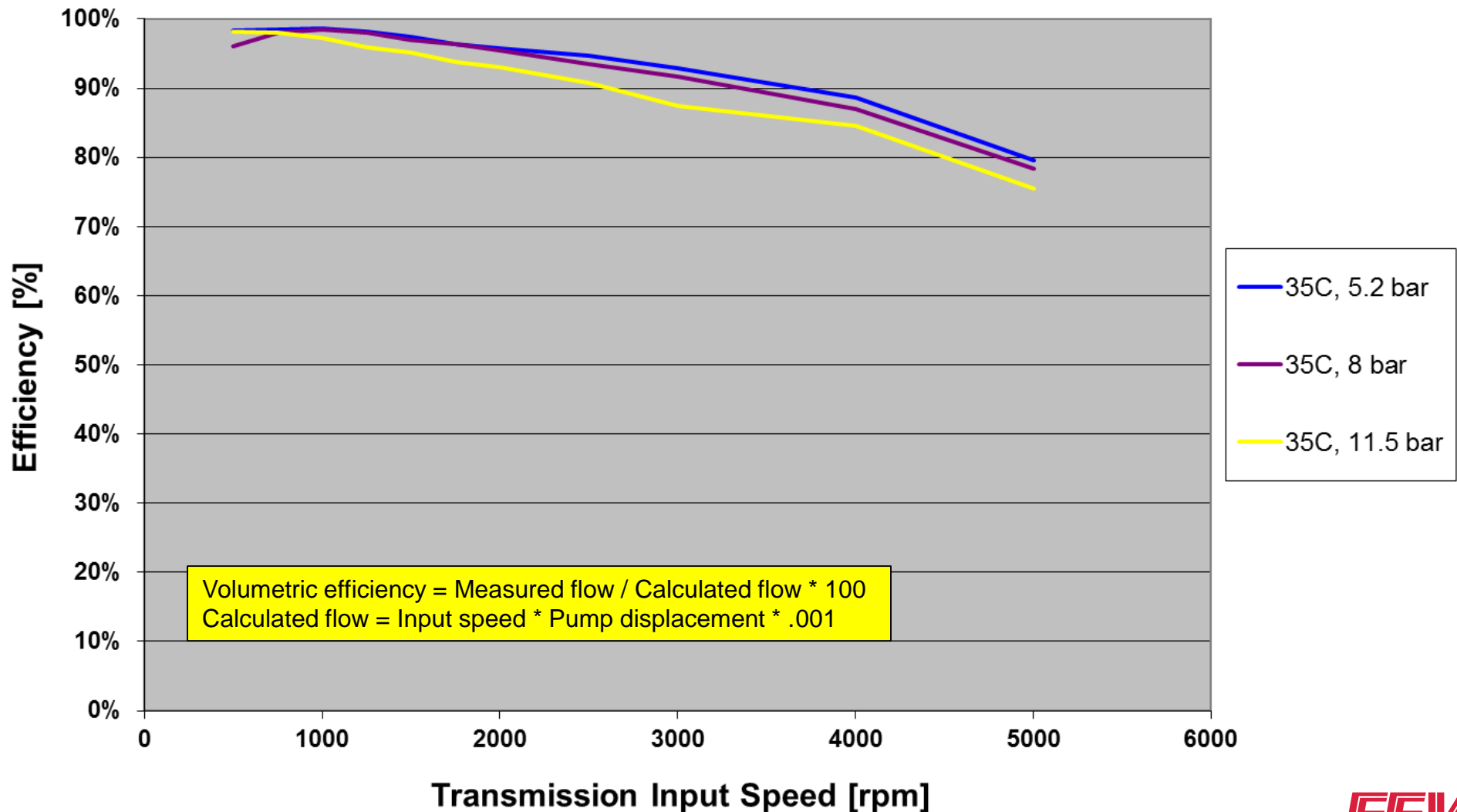


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Volumetric Efficiency vs. Input Speed - 35°C

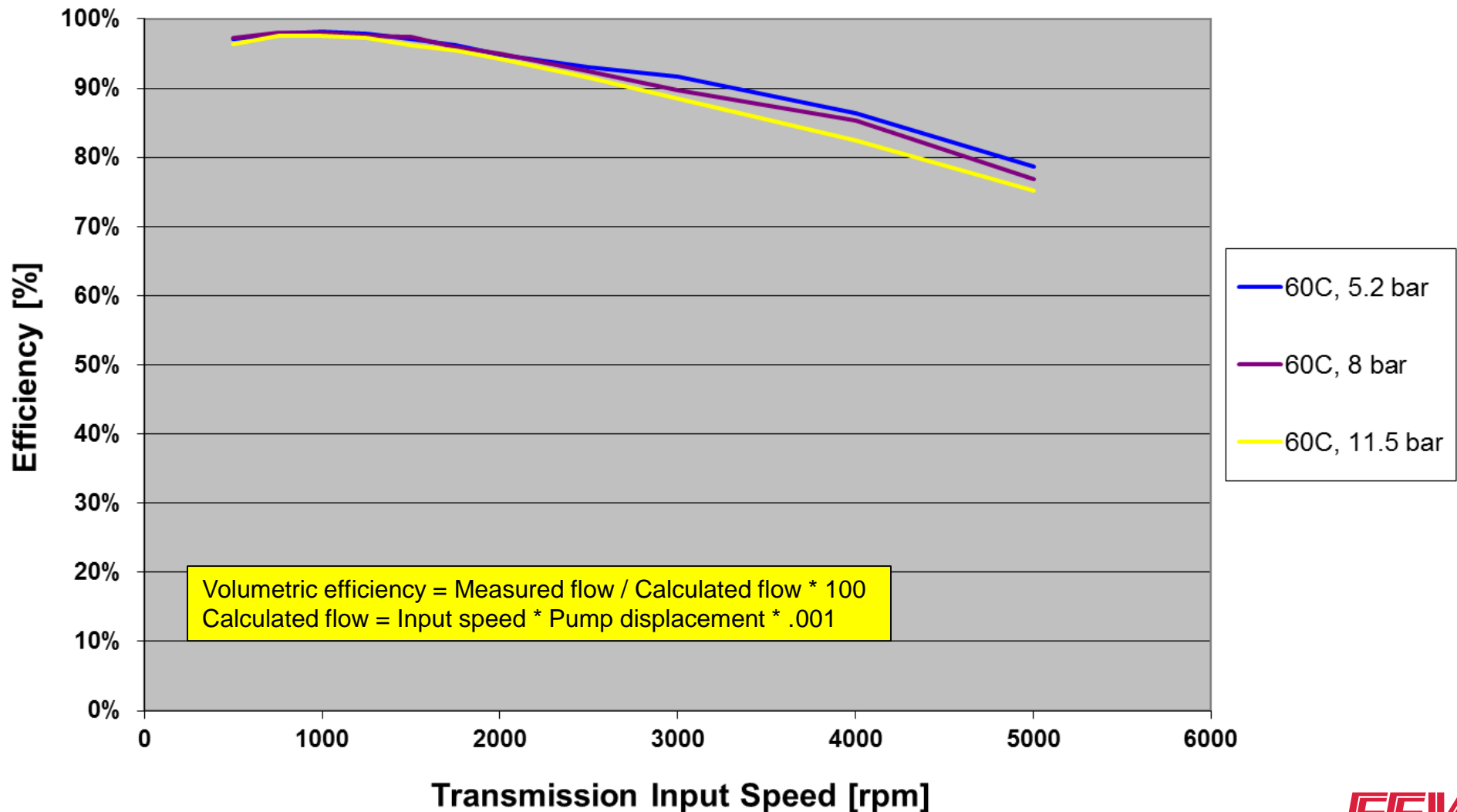


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Volumetric Efficiency vs. Input Speed - 60°C

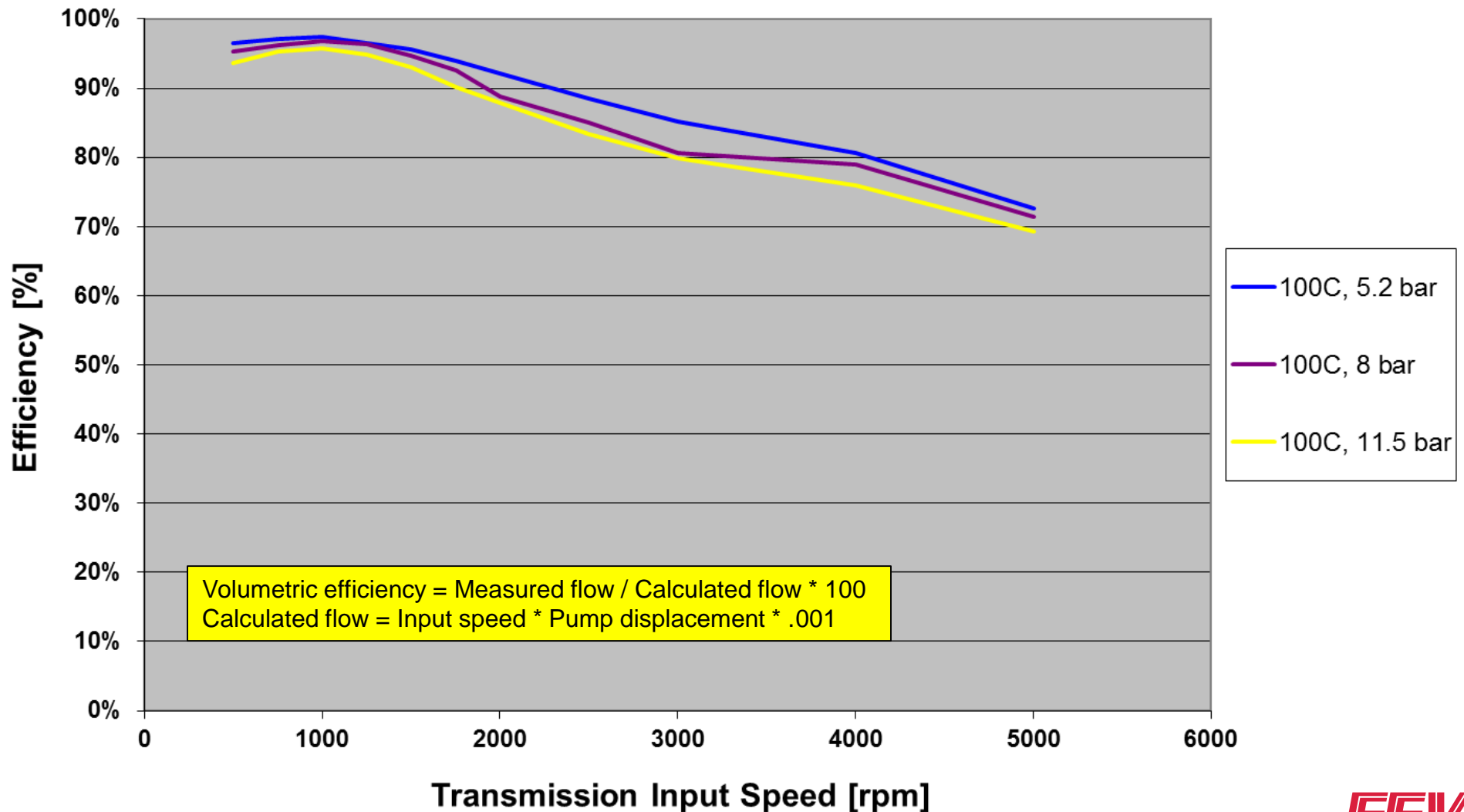


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Volumetric Efficiency vs. Input Speed - 100°C

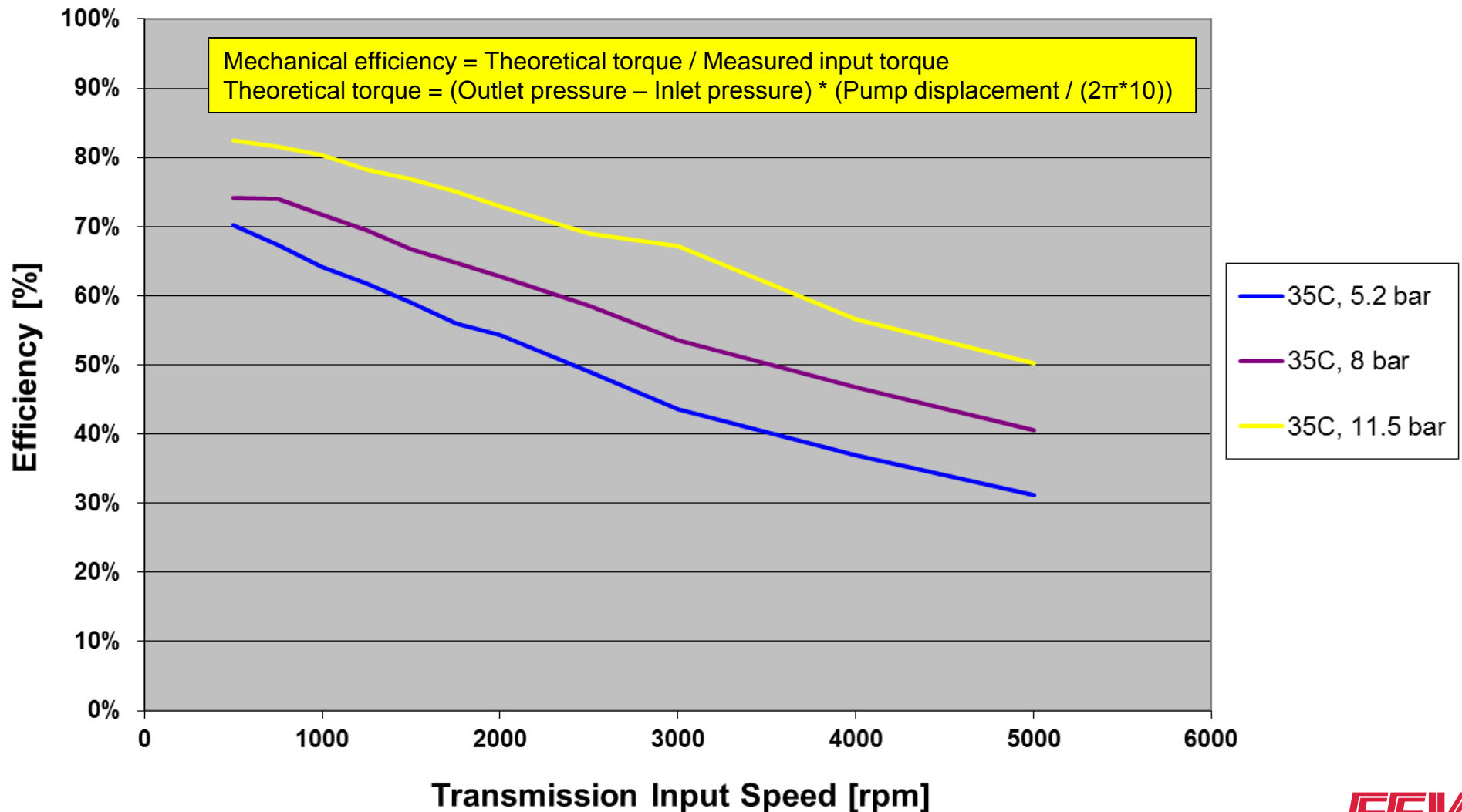


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Mechanical Efficiency vs. Input Speed - 35°C

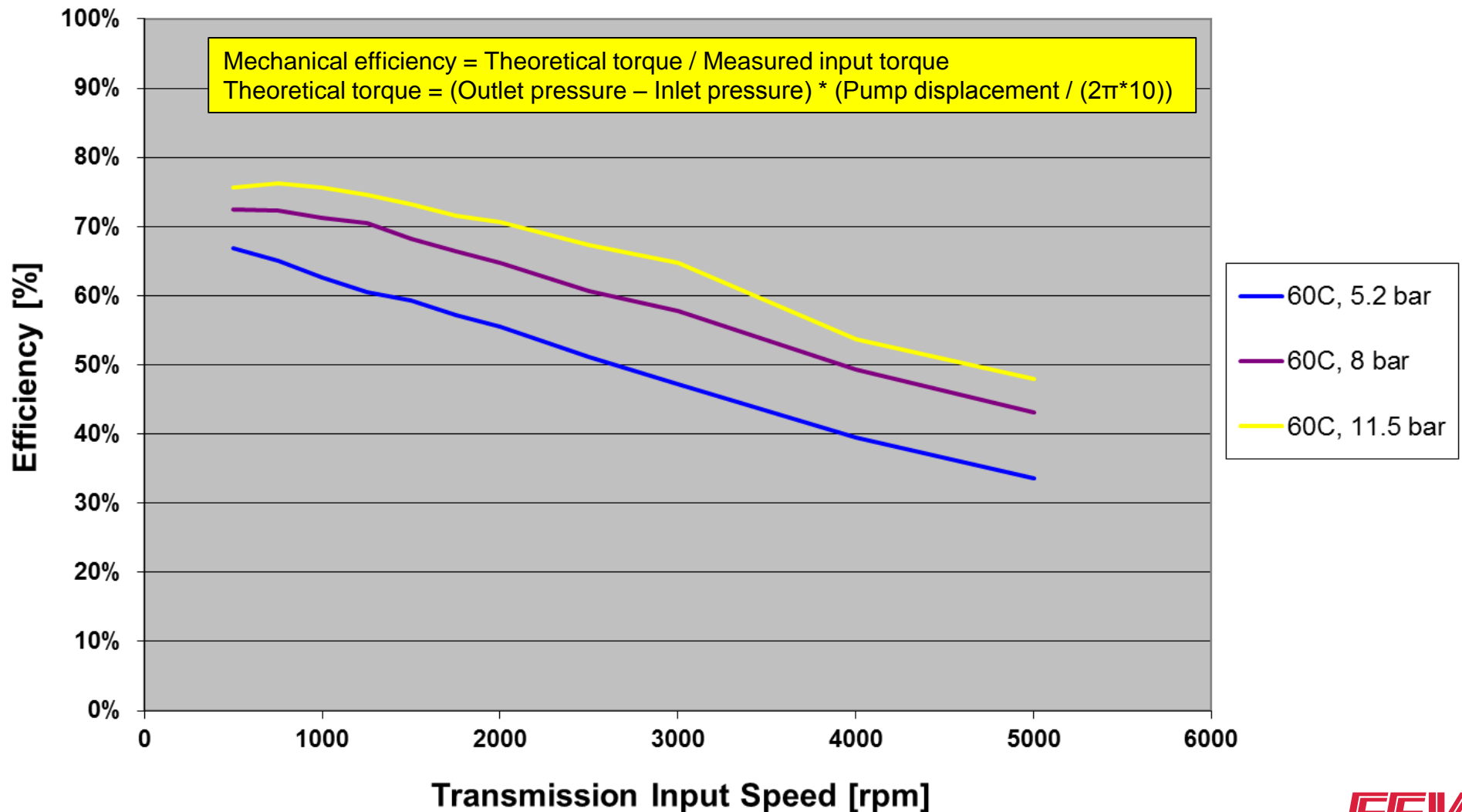


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Mechanical Efficiency vs. Input Speed - 60°C

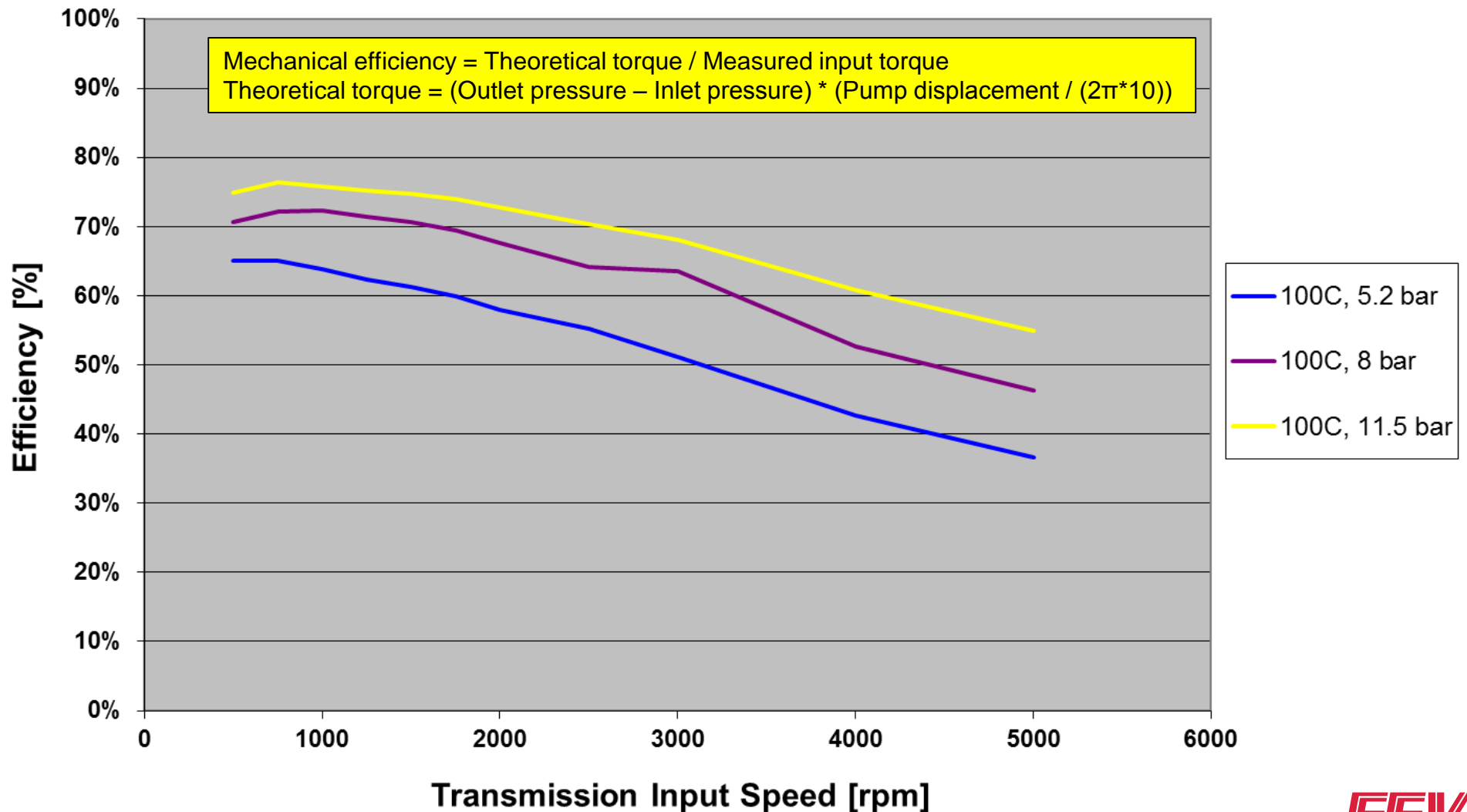


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Mechanical Efficiency vs. Input Speed - 100°C

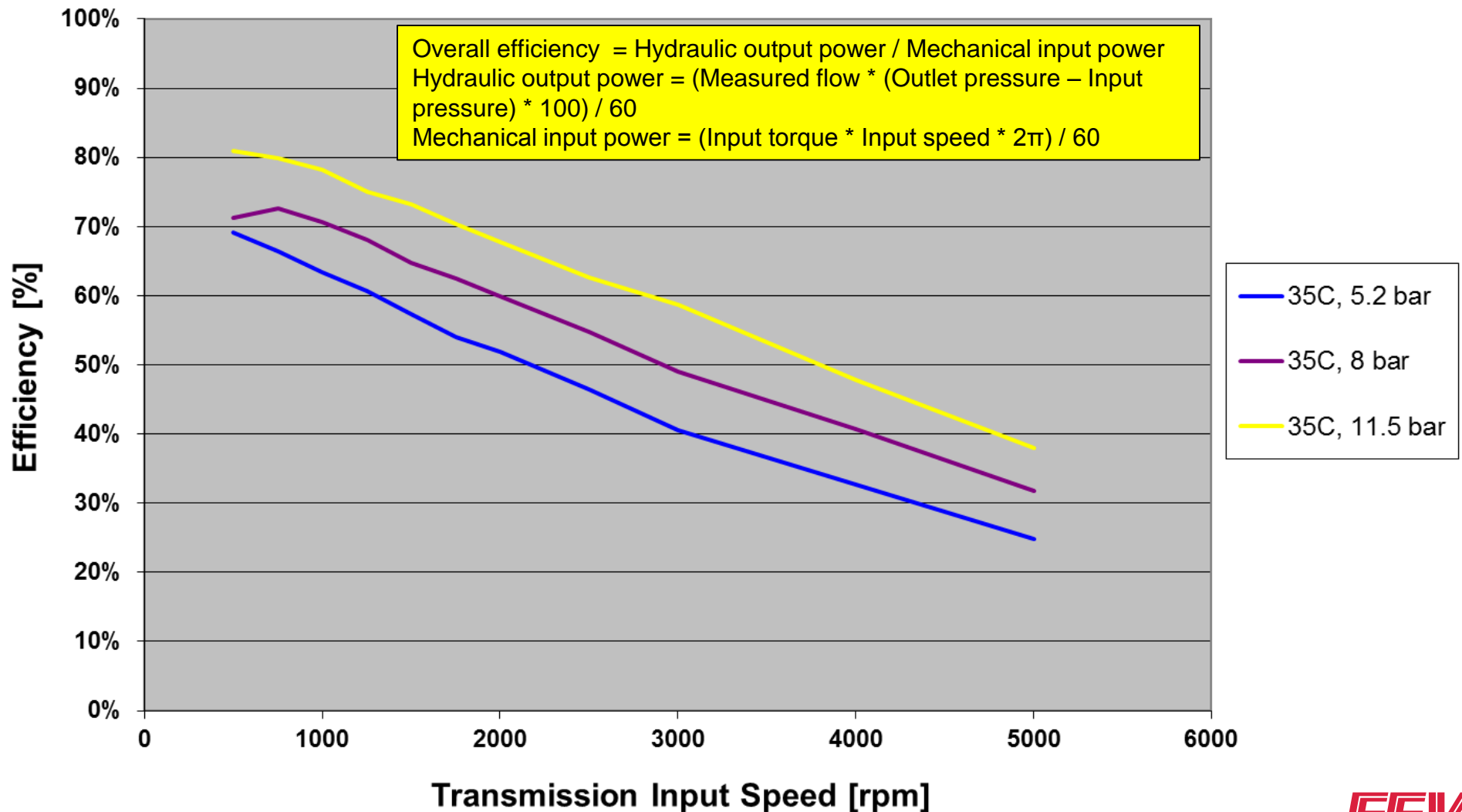


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Overall Efficiency vs. Input Speed - 35°C

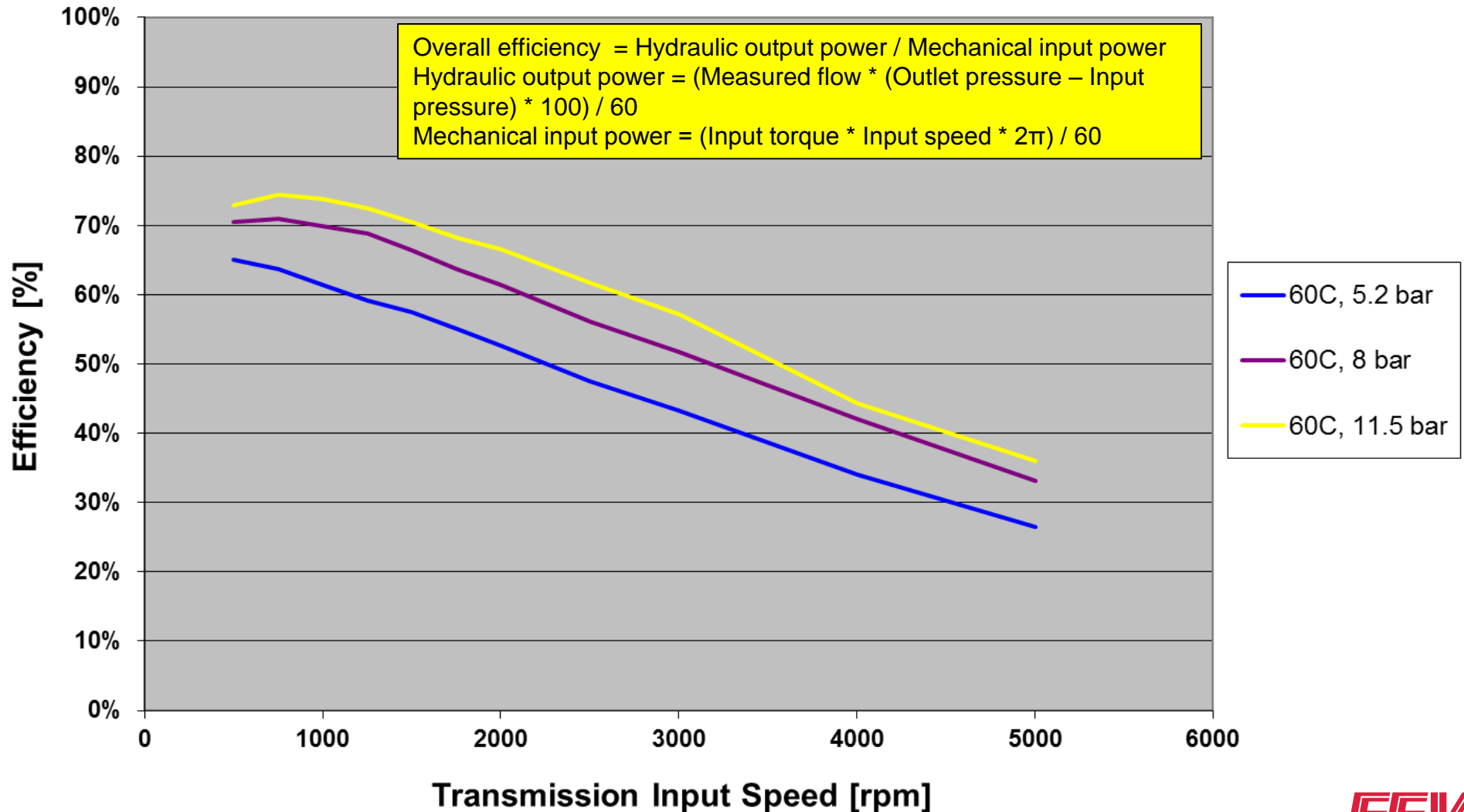


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Overall Efficiency vs. Input Speed - 60°C

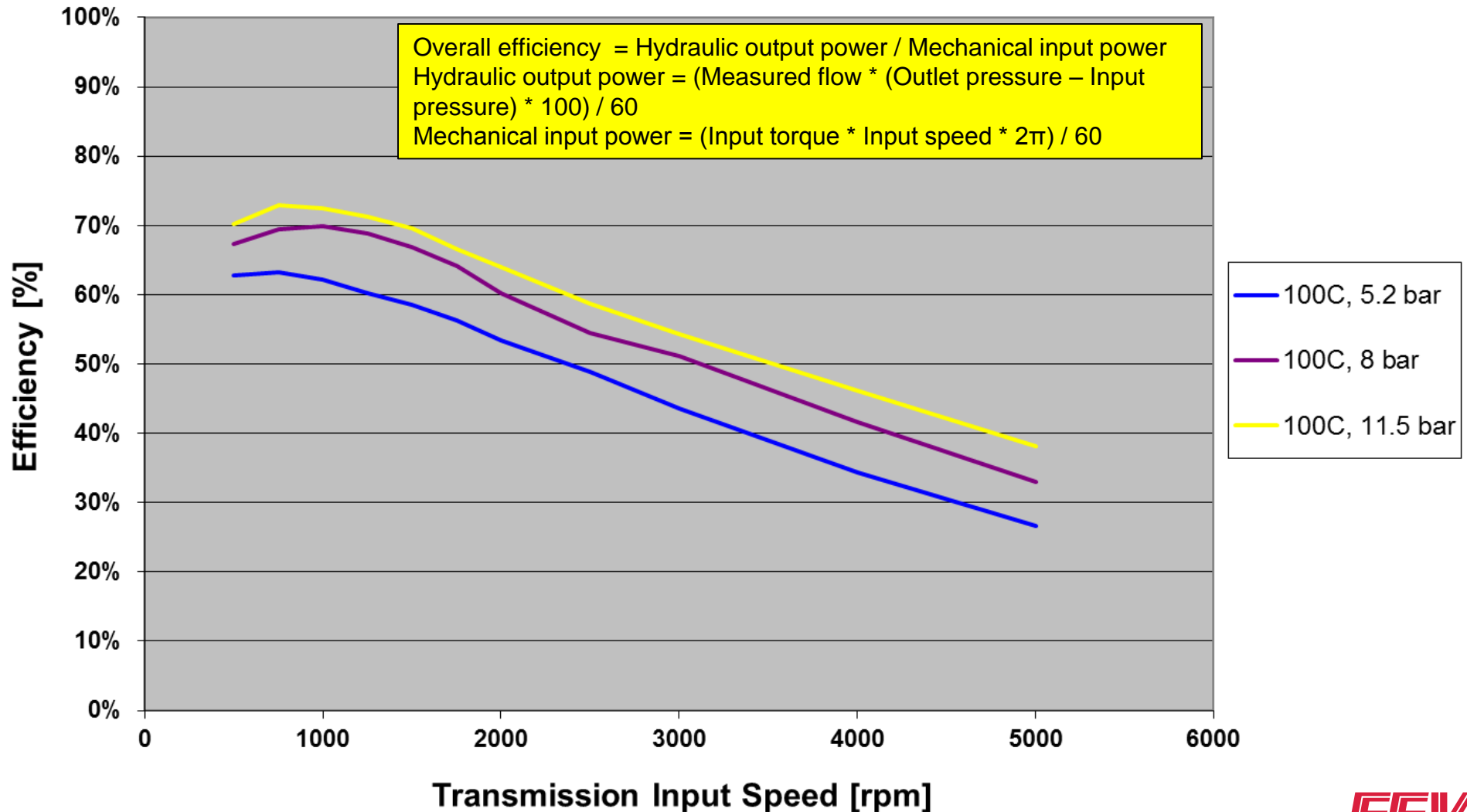


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

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Overall Efficiency vs. Input Speed - 100°C

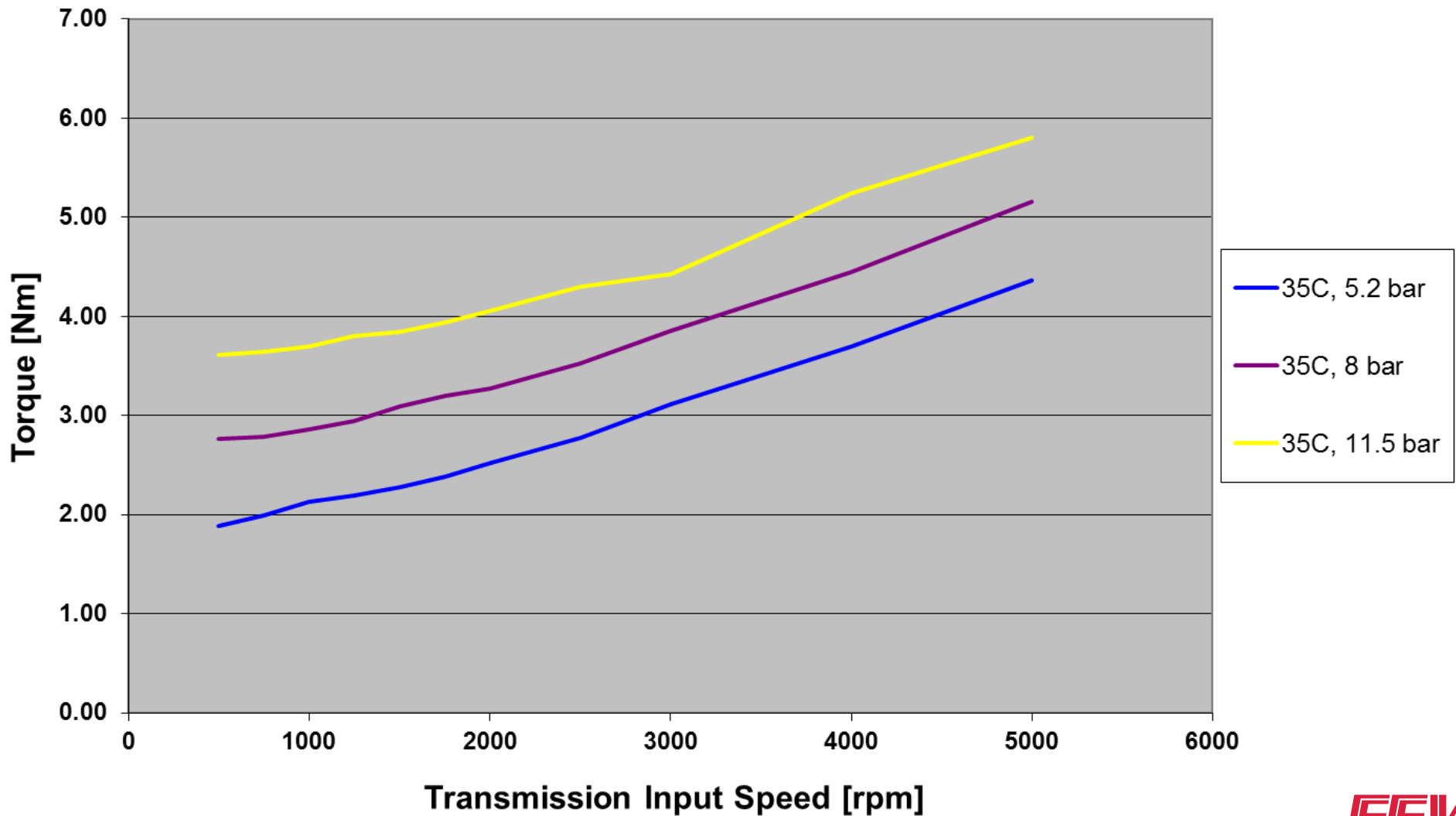


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



Pump Turning Torque (Nm) - 35°C

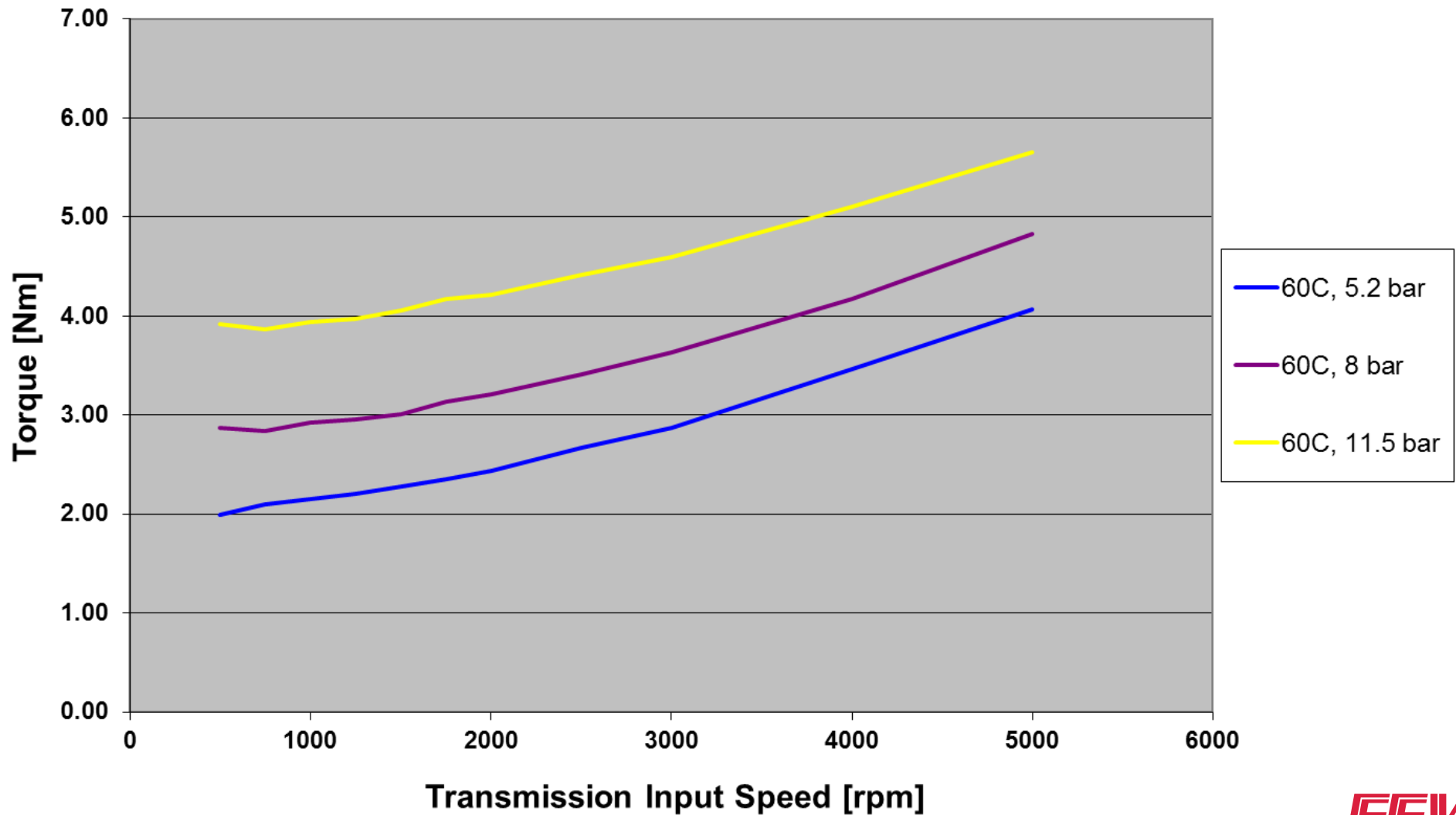


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



Pump Turning Torque (Nm) - 60°C

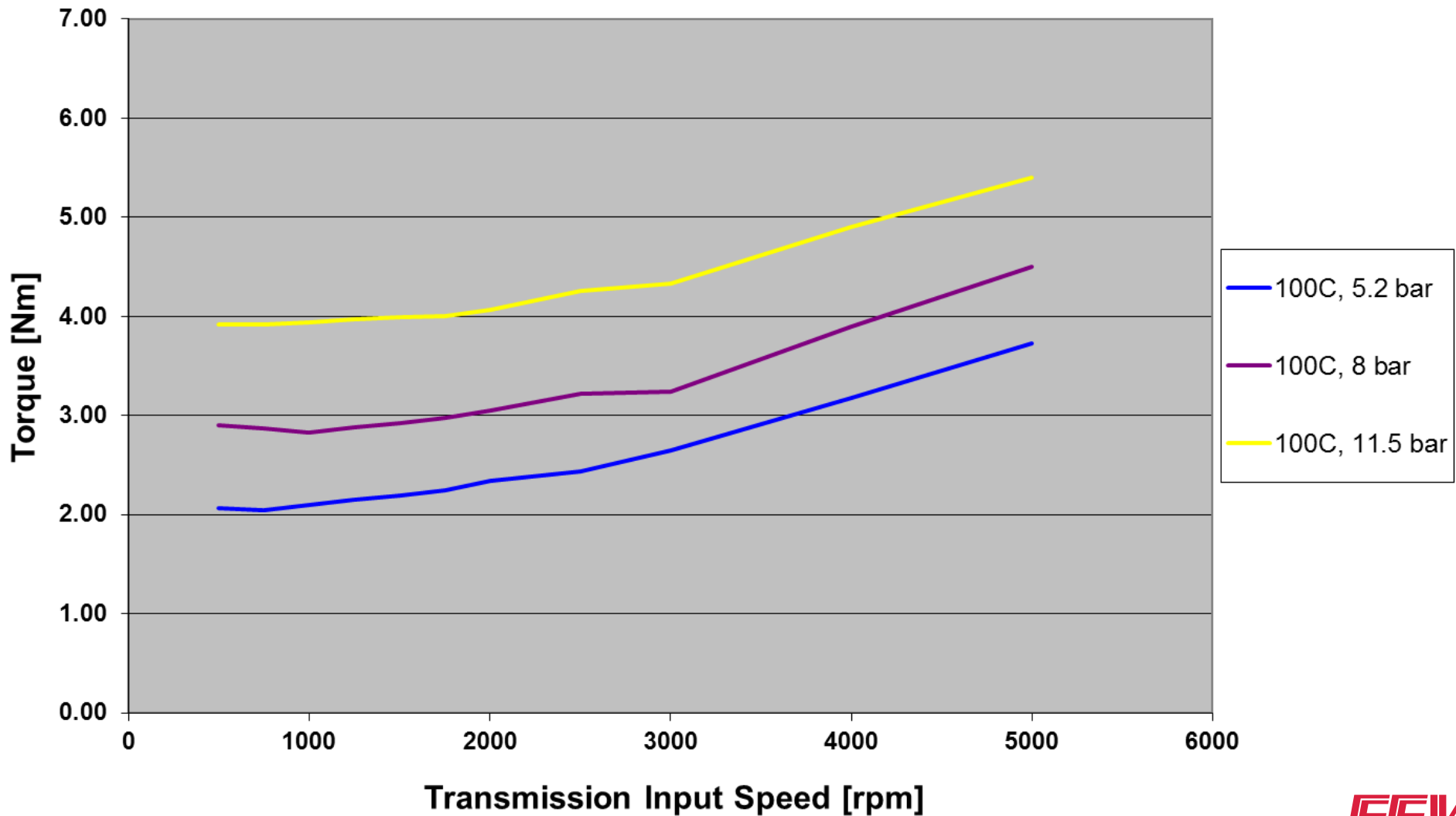


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



Pump Turning Torque (Nm) - 100°C

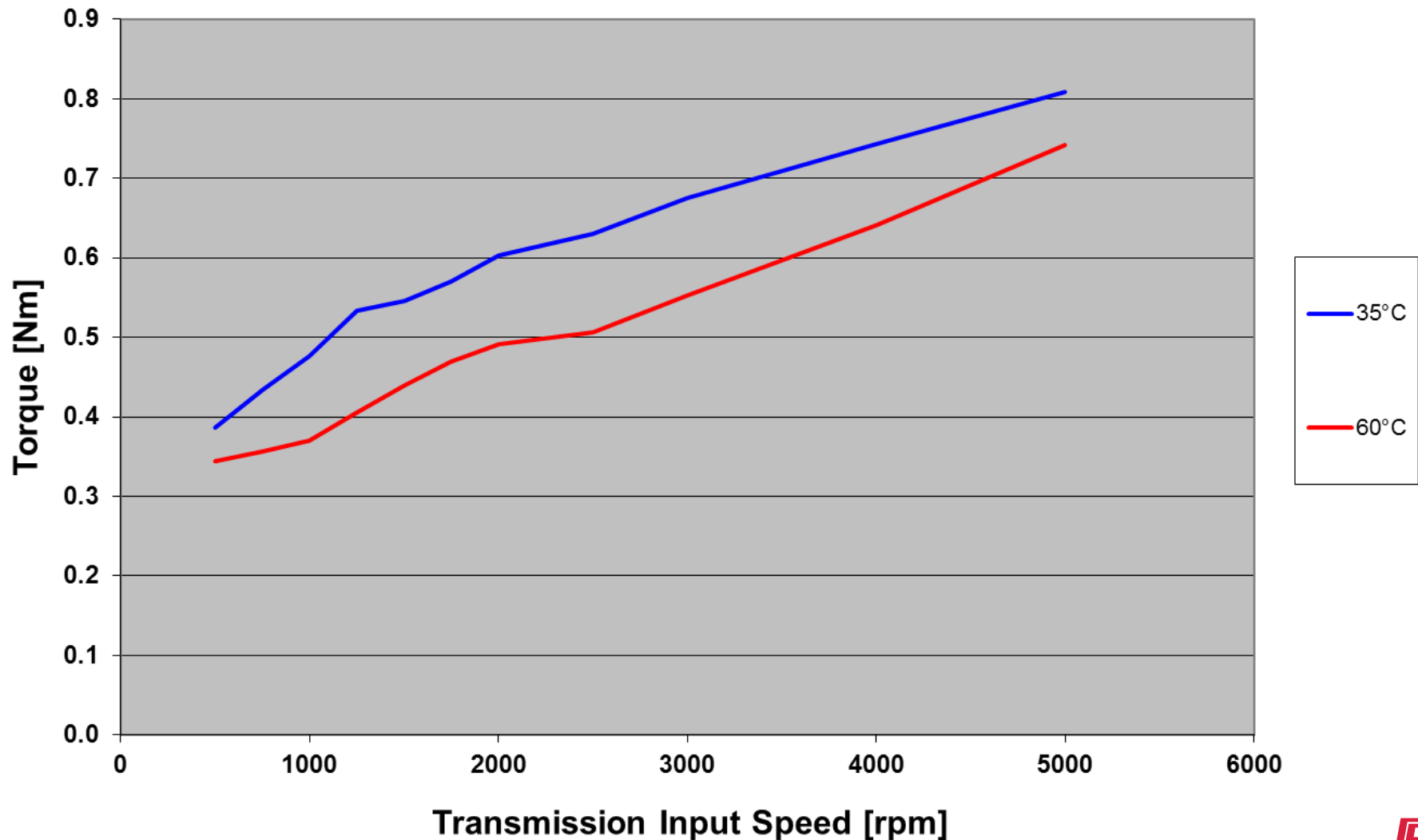


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



Oil Pump Turning Torque Chain Drive and Bushings

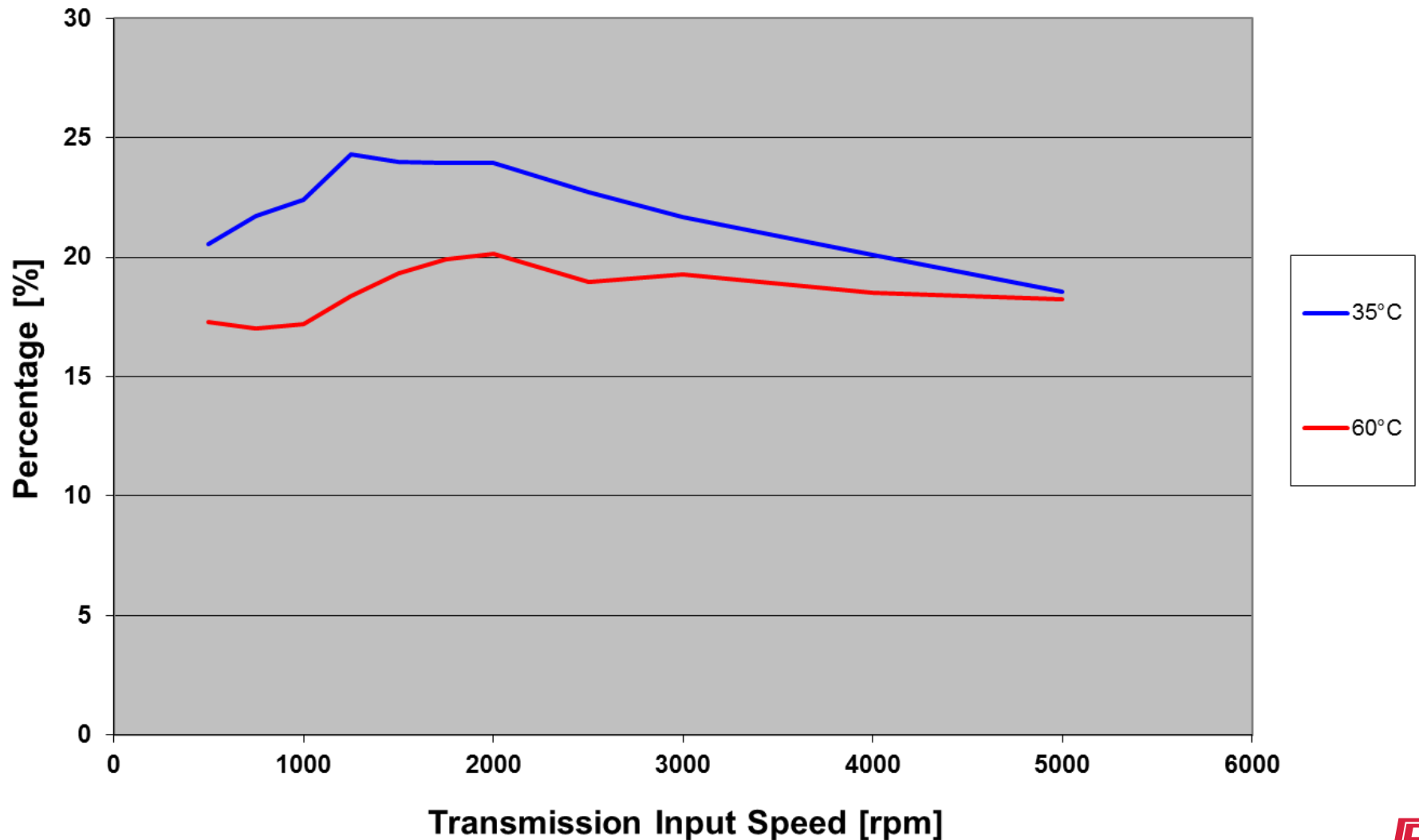


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



Oil Pump Turning Torque - 5.2 bar Share of Chain Drive and Bushings

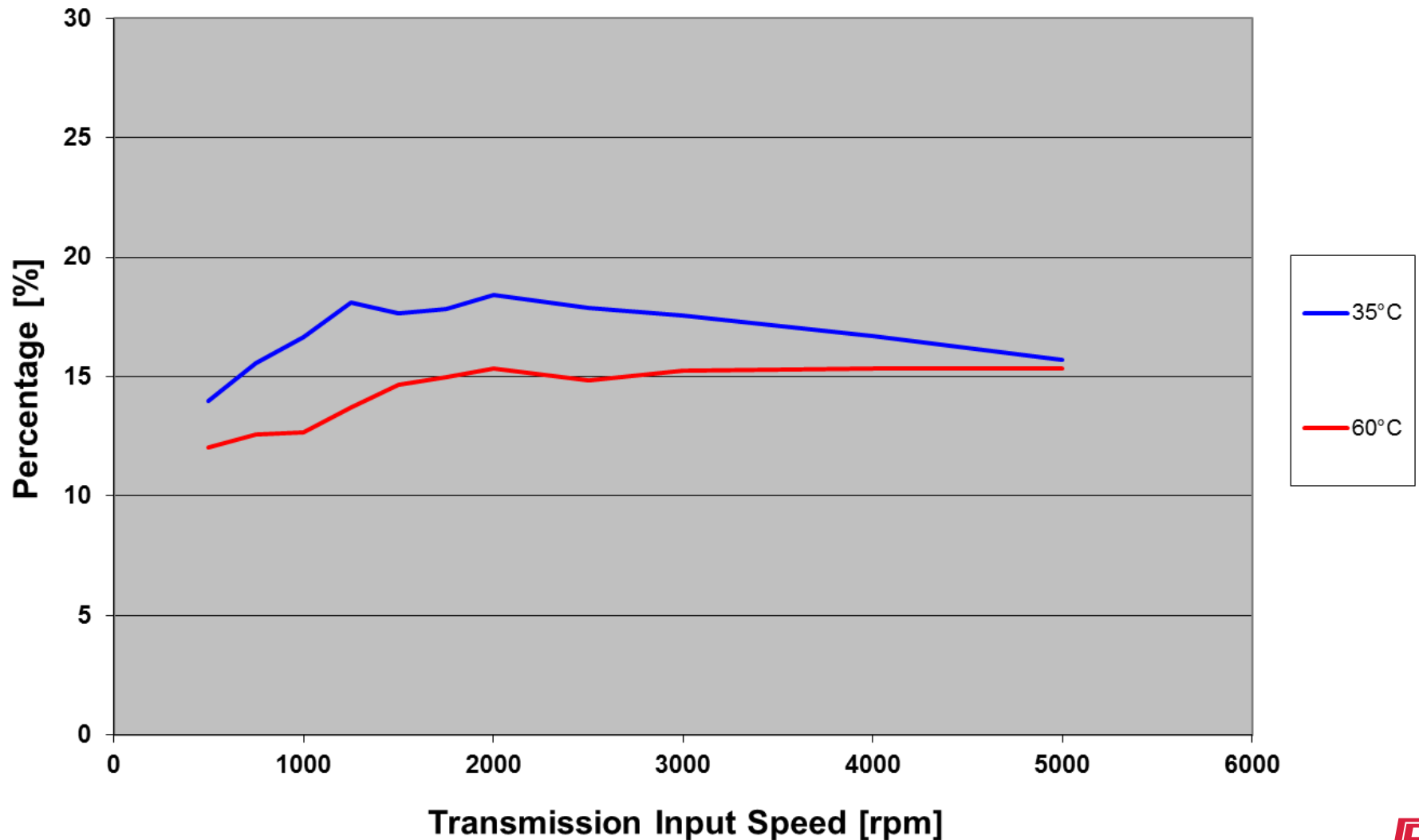


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



Oil Pump Turning Torque - 8 bar Share of Chain Drive and Bushings

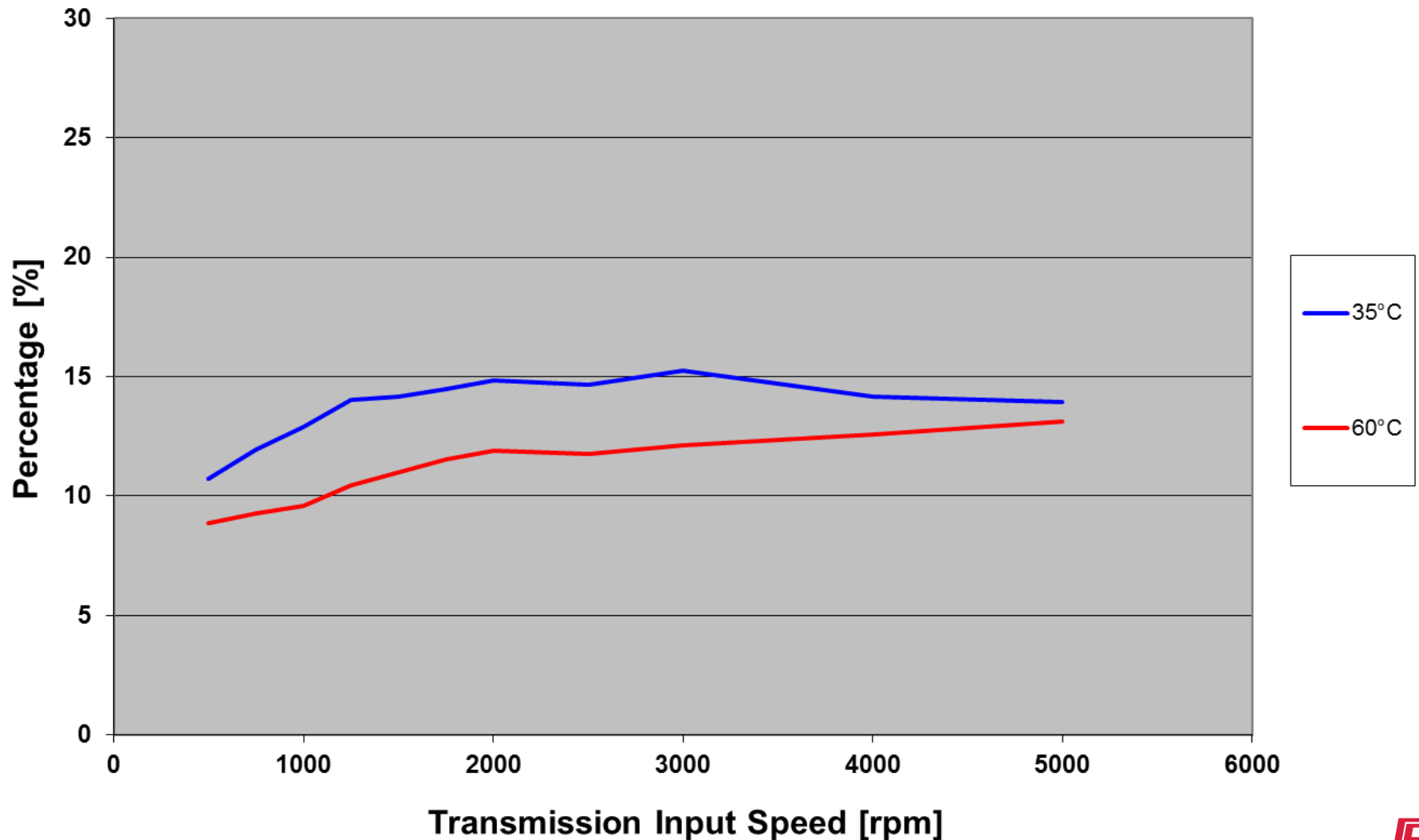


Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



Oil Pump Turning Torque - 11.5 bar Share of Chain Drive and Bushings



Ram HFE 8-Speed – Benchmark Bench Testing – Oil Pump Testing

Contract No. EP-C-12-014, Work Assignment 3-11
May 4, 2015



❑ Test Summary

- ❑ The transmission oil pump efficiency was measured at 35°C, 60°C and 100°C
- ❑ The Ram 1500 HFE transmission oil pump is a vane-type, off-axis pump with fixed displacement
- ❑ It spins slightly faster than the transmission input (ratio 1: 0.911) which is realized by different size sprockets in the pump drive system
 - ❑ Hence, the theoretical displacement of 14.7 cc/rev (ZF) converts to 16.12 cc/revolution on the transmission input shaft
- ❑ It is assumed that the oil pump is equipped with a pressure-based axial gap compensation as its volumetric efficiency stays nearly constant across the tested pressure levels