

Test Monitoring Center

@ Carnegie Mellon University 6555 Penn Avenue, Pittsburgh, PA 15206, USA http://astmtmc.cmu.edu 412-365-1000

Sequence IX Information Letter 21-2 Sequence Number 4 June 10, 2021

## ASTM consensus has not been obtained on this information letter. An appropriate ASTM ballot will be issued in order to achieve such consensus.

- TO: Sequence IX Surveillance Panel
- SUBJECT: 1. Corrections to Tables 8, 11 and A5.2 2. Clarification to Downtime Criteria

During the May 20, 2021 Conference call, the Surveillance Panel agreed to the following items:

- 1. The Sequence IX Surveillance Panel agreed to add coolant pressure and fuel temperature to Table 8 and remove Blowby, Pedal Position and Knock from Table 11. The panel also agreed to correct the Inlet Air Pressure measurement from absolute to gauge in Table A5.2.
- 2. The panel also agreed to clarify at which point in the test where downtime is necessary to be counted. Section 13.4 has been updated to reference then end of stage 6 as the end of an iteration.

These changes are effective May 20, 2021.

These revised text and or section(s) have been highlighted in red and included in the attached. These revisions modify ASTM Test Method D8291.

|s| M. D. Deegan

Michael Deegan FCSD, Service Product Development, SEO Ford Motor Company

Frank m Faiber

Frank M. Farber Director ASTM Test Monitoring Center

Attachment

c: <u>http://www.astmtmc.cmu.edu/ftp/docs/gas/sequenceix/procedure\_and\_ils/il21-2\_ix.pdf</u>

Distribution: Email

### Revises D8291-20a as amended by Information Letter 21-1

Controlled Quantity, unit	Set Point
Inlet-air temperature, °C	30
Inlet-air pressure, kPa (gauge)	0.05
Exhaust back pressure, kPa (absolute)	104
Humidity, g/kg	11.4
Fuel pressure, kPa	450 ± 37
Coolant Pressure, kPa	70
Fuel temperature, °C	30

#### TABLE 8 Oil-Conditioning Procedure and Test Cycle Conditions

# Table 11Recorded Test Points

Engine speed         Infinition           Engine torque         Num           Coolant-out temperature         "C           Oil-galley temperature         "C           Intet-air temperature         "C           Out-temperature         "C           Crankcase pressure (absolute)         KPa           Power         "C           Coolant-the meterature         "C           Coolant-temperature         "C           Coolant-temperature         "C           Coolant-temperature         "C <th></th> <th>Test Point</th> <th>Units</th>		Test Point	Units
Engine lorque         N·m           Controlled         Colan-out trepreture         °C           Oil-gallery temperature         °C           Inite-air nessure (gauge)         kPa           Exhaust back pressure (absolute)         kPa           Colant-Out treesure (absolute)         kPa           Initake-manifold pressure (absolute)         kPa           Air-charge pressure (absolute)         kPa           Air-charge pressure (absolute)         kPa           Oil-gallery temperature         °C           Controler pressure (absolute)         kPa           Monitored         Previntercooler air pressure (absolute)         kPa           Image: State		Engine speed	r/min
Controlled Controlled Control temperature "C Controlled Control temperature "C Intel-air temperature "C Colant flow rate (absolute) KPa Barometric pressure (absolute) KPa Barometric pressure (absolute) KPa Oil-fagelery pressure (absolute) KPa Oil-fagelery pressure (absolute) KPa Oil-fagelery pressure (gauge) KPa Fuel pressure (gauge) KPa Fuel pressure (gauge) KPa Oil-fagelery pressure (gauge) KPa Oil-fagelery pressure (gauge) KPa Oil-fagelery pressure (gauge) KPa Dieter of the temperature "C Colant-out pressure (gauge) KPa Dieter of the pressure (gauge) KPa Dieter of the temperature "C Colant-out pressure (gauge) KPa Dieter of the temperature "C Colant-out pressure (gauge) KPa Dieter of the temperature "C Colant four rate Dieter of the position "k Enguivalence rate (A) dimensionless Dieter of the position "k Absolute throtti position "K Absolute hortti position "k Actual intake (A) careshaft position " Intake (A) careshaft position " Intake (A) careshaft position actuator duty cycle "S Charge-air-cooler temperature "C Cylinder 2 knowlowenbuston performance count Cylinder 2 knowlowenbuston performance count Cylinder 2 knowlowenbuston performance count Oil of the 3 knowlowenbuston performance count Oil of the 3 knowlowenbuston performance count		Engine torque	N∙m
Controlled Oil-gallery temperature "C Inite-iar itemperature "C Colanit for varie U Inite-iar itemperature (absolute) KPa Air-charge pressure (absolute) KPa Oil-gallery pressure (gauge) KPa Die Status temperature "C Coolant-out pressure (gauge) KPa Beost pressure (gauge) KPa Die Status temperature "C C Die Status temperature "C Die Status temperatus temperature "C D		Coolant-out temperature	°C
Controlled       Air-charge temperature       * C         Intel-air pressure (gauge)       KPa         Exhaust back pressure (absolute)       KPa         Exhaust back pressure (absolute)       KPa         Fuel temperature       * C         Intel-air temperature       * C         Intel-air temperature       * C         Intel-air temperature       * C         Intel-air temperature       * C         Air-charge temperature       * C         Oil-head pressure (absolute)       KPa         Barometric pressure (absolute)       KPa         Oil-head pressure (gauge)       KPa         Oil-head pressure (gauge)       KPa         Oil-head pressure (gauge)       KPa         Power       KW         Pre-intercooler air pressure (absolute)       KPa         Ambient temperature       * C         Coolant-in temperature       * C		Oil-gallery temperature	°C
Inlet-air temperature         * C           Inlet-air temperature         * C           Exhaust back pressure (absolute)         KPa           Fuel temperature         * C           Inlet-air thumidity         g/kg           Coolant flow rate         L/min           Inlet-air thumidity         g/kg           Coolant flow rate         L/min           Biometric pressure (absolute)         KPa           Air-charge pressure (absolute)         KPa           Biometric pressure (auge)         KPa           Oil-fallery pressure (auge)         KPa           Monitored         Power         KW           Pre-intercooler air pressure (absolute)         KPa           Biowy Alow rate         L/min         Coolant to meperature         * C           Coolant to meperature         * C         C         Coolant to meperature         * C           Biowy Alow rate         L/min         Equivalence ratio (\lambda)         Dimensionless           Intel-air temperature         * C         C         Cool	Controlled	Air-charge temperature	°C
Inite-in pressure (apoule) KPa Exhaust back pressure (absolute) KPa Fuel temperature 'C Initake-manifold pressure (absolute) KPa Barometric pressure (absolute) KPa Barometric pressure (absolute) KPa Oil-haad pressure (absolute) KPa Oil-haad pressure (absolute) KPa Oil-haad pressure (auge) KPa Fuel pressure (auge) KPa Fuel pressure (auge) KPa Power Carakcase pressure (auge) KPa Power Coolan-In temperature 'C Coolan-In temperature 'C C Hande-2 throot/combuston performance Coolan-In temperature 'C Coolan-In temperature 'C Coolan-In temperature 'C Coolan-In temperature 'C C Hande-2 (b) dent dent due (b) dimensionless Absolute Indo (b) dimensionl		Inlet-air temperature	°C
Exhaust back pressure (absolute) kPa Fuel temperature ° C Intet-air humidity g/kg Coolant flow rate Umin Marcharge pressure (absolute) kPa Barometric pressure (absolute) kPa Oil-gallery pressure (absolute) kPa Oil-gallery pressure (gauge) kPa Oil-fager pressure (gauge) kPa Dimensionless Ignition timing advance for #1 cylinder ° Absolute frottie position % Engine-coolant temperature °C Oil-fager pressure (faguge) kPa Dimensionless Ignition timing advance for #1 cylinder ° Absolute frottie position % Engine-coolant temperature °C Inite-air temperature °C Nobiolute food value % Absolute food value % Accelerator pressure (fauge) kPa Accelerator pressure (fauge) kPa Coolant-tut pressure (fauge) kPa Dimensionless Coolant-tut pressure (fauge) kPa Coolant-tut pressure (fauge) kPa Cool		Inlet-air pressure (gauge)	kPa
Fuel temperature     °C       Intext-in humidity     g/kg       Coolant flow rate     L/min       Intake-manifold pressure (absolute)     kPa       Ahr-charge pressure (absolute)     kPa       Barometric pressure (absolute)     kPa       Oil-gallery pressure (absolute)     kPa       Oil-daler pressure (absolute)     kPa       Fuel pressure (absolute)     kPa       Fuel pressure (absolute)     kPa       Monitored     Pre-intercooler air pressure (absolute)     kPa       Ambient temperature     °C     °C       Coolant-tot pressure (gauge)     kPa     °C       Biowy flow rate     L/min     °C       Oil-Sump Temperature     °C     °C       Coolant-tot pressure (gauge)     kPa     °C       Equivalence ratio ( $\lambda$ )     Dimensionless     °C       Ignition timing advance for #1 cylinder     °C     °C       Absolute thorate (gauge)     kPa     °C       Lequivalence ratio ( $\lambda$ )     dimensionless <td></td> <td>Exhaust back pressure (absolute)</td> <td>Exhaust back pressure (absolute) kPa</td>		Exhaust back pressure (absolute)	Exhaust back pressure (absolute) kPa
Inlet-air humidity         g/kg           Coolant flow rate         Umin           Marcharge pressure (absolute)         kPa           Air-charge pressure (absolute)         kPa           Barometric pressure (absolute)         kPa           Oil-fleat pressure (gauge)         kPa           Oil-fleat pressure (gauge)         kPa           Oil-fleat-in temperature         * C           Carankcase pressure (gauge)         kPa           Monitored         Power           KW         Pre-intercoler air pressure (gauge)         kPa           Ambient temperature         * C           Coolant-in temperature         * C           Coolant-flow rate         Lmin           Blowby-flow-rate         * C           Coolant flow rate         Lmin           Blowby-flow-rate         * C           Coolant flow rate         Lmin           Goli timing advance for #t cylinder         * C           Absolute throttle position         %           Hortecharpersure (absolute)         kPa           KPa         Solute throttle position         %           Hatter meanifold pressure (absolute)         KPa         KPa           KW         PCM CAN bus chamels         Solotet throttle positio		Fuel temperature	°C
Coolant flow rate         L/min           Intake-manifold pressure (absolute)         KPa           Air-charge pressure (absolute)         KPa           Barometric pressure (absolute)         KPa           Oli-lagalery pressure (gauge)         KPa           Oli-fuel pressure (gauge)         KPa           Monitored         Prever         KW           Pre-intercooler air pressure (absolute)         KPa           Ambient temperature         °C         Colant-tout pressure (gauge)         KPa           Ambient temperature         °C         Colant-tout pressure (gauge)         KPa           Barometric tripersture (gauge)         KPa         L/min         Colant-tout pressure (absolute)           Ver         Pre-intercooler air pressure (absolute)         KPa         L/min           Oil-Sump Temperature         °C         Colant-tout pressure (gauge)         KPa           Barometric (x)         Dimensionless         L/min         Eduivalence ratio (x)         Dimensionless <td< td=""><td rowspan="2"></td><td>Inlet-air humidity</td><td>g/kg</td></td<>		Inlet-air humidity	g/kg
Intake-manifold pressure (absolute)         kPa           Air-charge pressure (absolute)         kPa           Barometric pressure (absolute)         kPa           Oil-gallery pressure (gauge)         kPa           Oil-filter-In temperature         °C           Exhaust temperature         °C           Crankcase pressure (gauge)         kPa           Monitored         Prever         kW           Power         kW           Pre-intercooler air pressure (absolute)         kPa           Ambient temperature         °C           Coolant-out pressure (gauge)         kPa           Power         kW           Pre-intercooler air pressure (absolute)         kPa           Blooby-flow rate         Lumin           Blooby-flow rate         Lumin           Oil-stamp Temperature         °C           Coolant-out pressure (gauge)         kPa           Blooby-flow rate         Lumin           Equivalence ratio (A)         Dimensionless           Ignition timing advance for #1 cylinder         °C           Intel-air temperature         °C           Intel-air temperature         °C           Intel-air temperature         °C           Intel-air temperature         °C <td>Coolant flow rate</td> <td>L/min</td>		Coolant flow rate	L/min
Air-charge pressure (absolute)         KPa           Barometric pressure (absolute)         KPa           Oil-gallery pressure (gauge)         KPa           Oil-filter-In temperature         °C           Exhaust temperature         °C           Crankcase pressure (gauge)         KPa           Monitored         Power         KW           Pre-intercooler air pressure (gauge)         KPa           Monitored         Prever         KW           Pre-intercooler air pressure (gauge)         KPa           Coolant-to temperature         °C           Coolant-to temperature         °C           Coolant-to temperature         °C           Oil-Sump Temperature         °C           Oil-Sump Temperature         °C           Oil-Sump Temperature         °C           Coolant flow rate         Limin           Equivalence ratio (\bar)         Dimensionless           Ignition timing advance for #1 cylinder         °C           Inite-air temperature         °C           Inite-air temperature         °C           Inite-air temperature         °C           Inite-air temperature         °C           Feal         Absolute throtite position           KPa         S		Intake-manifold pressure (absolute)	kPa
Barometic pressure (absolute)         KPa           Oil-gliery pressure (gauge)         KPa           Oil-filter/interpretature         °C           Oil-filter-interpretature         °C           Crankcase pressure (gauge)         KPa           Monitored         Power         KW           Pre-intercooler air pressure (gauge)         KPa           Monitored         Power         KW           Pre-intercooler air pressure (gauge)         KPa           Ambient temperature         °C           Colant-out pressure (gauge)         KPa           Monitored         Power         KW           Pre-intercooler air pressure (gauge)         KPa           Ambient temperature         °C           Colant-out pressure (gauge)         KPa           Blowby flow-rate         Limin           Oil-Sump Temperature         °C           Colant flow rate         Limin           Equivalence ratio (\lambda)         Minensionless           Ignition timing advance for #1 cylinder         °C           Engine-coolant temperature         °C           Engine-colant temperature         °C           Engine-colant temperature         °C           Kabsolute throtite position         %		Air-charge pressure (absolute)	kPa
Oil-gallery pressure (gauge)       kPa         Oil-head pressure (gauge)       kPa         Oil-head pressure (gauge)       kPa         Oil-filter-in temperature       *C         Exhaust temperature       *C         Crankcase pressure (gauge)       kPa         Monitored       Power       kW         Pre-intercooler air pressure (gauge)       kPa         Coolant-in temperature       *C         Coolant flow rate       L/min         Dil-Sump Temperature       *C         Coolant flow rate       L/min         Equivalence ratio (\lambda)       dimensionless         Ignition timing advance for #1 cylinder       *         Absolute bostion       %         Engine-coolant temperature       *C         Coolant flow rate       L/min         Equivalence ratio (\lambda)       dimensionless         Absolute load value       %         Intek-air temperature       *C      >		Barometric pressure (absolute)	kPa
PCM CAN bus channels PCM CAN b		Oil-gallery pressure (gauge)	kPa
Oli-filter-In temperature       °C         Exhaust temperature       °C         Exhaust temperature       °C         Crankcase pressure (gauge)       kPa         Monitored       Power         Monitored       Pre-intercooler air pressure (gauge)       kW         Pre-intercooler air pressure (gauge)       kPa         Monitored       Pre-intercooler air pressure (gauge)       kW         Pre-intercooler air pressure (gauge)       kPa         Mabient temperature       °C         Coolant-in temperature       °C         Oil-Sump Temperature       °C         Coolant timing advance for #1 cylinder       *         Absolute how rate       L/min         Equivalence ratio ( $\lambda$ )       Dimensionless         Absolute how rate       C         Intake-manifold pressure (gauge)       kPa         Accuelerato-pedal position       %         PCM CAN bus channels       Boost pressure - raw value (absolute)       kPa         Accuel intake (A) camshaft position       *         Actual exhaust (B) cams		Oil-head pressure (gauge)	kPa
Exhaust temperature       °C         Crankcase pressure (gauge)       kPa         Monitored       Fuel pressure (gauge)       kPa         Power       kW         Power       kW         Pre-intercooler air pressure (absolute)       kPa         Ambient temperature       °C         Coolant-ti temperature       °C         Coolant-ti temperature       °C         Coolant-ti formerature       °C         Coolant-ti formerature       °C         Coolant-ti formerature       °C         Coolant-ti formerature       °C         Coolant flow rate       L/min         Equivalence ratio (\Lambda)       Dimensionless         Intel-air temperature       °C         Coolant flow rate       °C         Intel-air temperature       °C         Colant flow rate       °C         Intel-air temperature       °C         Colant flow rate       °C         Intel-air temperature       °C         Caclerator-pedal position       %         Hostoute load value       %         Fuel-rail pressure (gauge)       kPa         Accelerator-pedal position       %         Accelerator-pedal position       °		Oil-filter-In temperature	°C
Crankcase pressure (gauge)         kPa Fuel pressure (gauge)         kPa kW           Power         kkW           Pre-intercooler air pressure (saloulte)         kPa           Ambient temperature         °C           Coolant-in temperature         °C           Coolant-in temperature         °C           Coolant-out pressure (gauge)         kPa           Blowby flow rate         L/min           Coolant-out pressure (gauge)         kPa           Blow to rate         L/min           Coolant for wrate         L/min           Equivalence ratio (λ)         Dimensionless           Ignition timing advance for #1 cylinder         °C           Kasolute throttle position         %           Engine-coolant temperature         °C           Intet-air temperature         °C           Equivalence ratio (λ)         dimensionless           Absolute throttle position         %           Engine-coolant temperature         °C           Intet-air temperature         °C           Accelerator-pedal position         %           Nototic load value         %           Accelerator-pedal position         *           Accelerator-pedal position         *           Accular taske (A) cam		Exhaust temperature	°C
Fuel pressure (gauge)         KPa Power         KW           Monitored         Pre-intercooler air pressure (absolute)         KPa           Ambient temperature         °C           Coolant-in temperature         °C           Coolant flow rate         L/min           Dis-Sump Temperature         °C           Coolant flow rate         L/min           Equivalence ratio (λ)         Dimensionless           Ignition timing advance for #1 cylinder         °           Absolute throttle position         %           Engine-coolant temperature         °C           Intake-manifold pressure (absolute)         KPa           Absolute load value         %           Intake-manifold pressure (absolute)         KPa           Accelerator-pedal position         %           PCM CAN bus channels         Boost pressure - raw value (absolute)         KPa           Actual intake (A) camshaft position actuator duty cycle         %            Actual intake (A) camshaft position         °            Intake (A) camshaft position		Crankcase pressure (gauge)	kPa
Monitored     Power     kW       Pre-intercooler air pressure (absolute)     kPa       Ambient temperature     °C       Coolant-in temperature     °C       Coolant-in temperature     °C       Coolant-in temperature     °C       Oil-Sump Temperature     °C       Coolant flow rate     L/min       Equivalence ratio (λ)     Dimensionless       Ignition timing advance for #1 cylinder     °       Absolute throttle position     %       Engine-coolant temperature     °C       Calant temperature     °C       Inlet-air temperature     °C       Equivalence ratio (λ)     dimensionless       Absolute throttle position     %       Inlet-air temperature     °C       Equivalence ratio (λ)     dimensionless       Absolute throttle position     %       Inlet-air temperature     °C       Equivalence ratio (λ)     dimensionless       Absolute load value     %       PCM CAN bus channels     Boost pressure (absolute)     KPa       Turbocharger wastegate duty cycle     %       Actual intake (A) camshaft position     °       Actual intake (A) camshaft position     °       Intake (A) camshaft position actuator duty cycle     %       Cylinder 1 knock/combustion performance		Fuel pressure (gauge)	kPa
Pre-intercooler air pressure (absolute)       kPa         Ambient temperature       "C         Coolant-in temperature       "C         Coolant-out pressure (gauge)       kPa         Blowby-flow-rate       L/min         Oil-Sump Temperature       "C         Coolant-flow rate       L/min         Equivalence ratio (\lambda)       Dimensionless         Ignition timing advance for #1 cylinder       "C         Absolute throttle position       %         Engine-coolant temperature       "C         Colant-lout pressure (gauge)       kPa         KPa       "C         Bindburget       "C         Coolant-flow rate       L/min         Equivalence ratio (\lambda)       Dimensionless         Bindburget       "C         Bindburget       "C         Equivalence ratio (\lambda)       dimensionless         Absolute load value       %         Intake-manifold pressure (gauge)       kPa         KPa       Accelerator-pead position       %         PCM CAN bus channels       Boost pressure (gauge)       kPa         Actual intake (A) camshaft position actuator duty cycle       %       KPa         Actual intake (A) camshaft position actuator duty cycle       % </td <td>Monitored</td> <td>Power</td> <td>kW</td>	Monitored	Power	kW
Ambient temperature       °C         Coolant-in temperature       °C         Coolant-in temperature       °C         Coolant-in temperature       °C         Blowby flow rate       L/min         Oil-Sump Temperature       °C         Coolant flow rate       L/min         Equivalence ratio (λ)       Dimensionless         Ignition timing advance for #1 cylinder       °         Absolute throttle position       %         Engine-coolant temperature       °C         Inlet-air temperature       °C         Equivalence ratio (λ)       dimensionless         Absolute throttle position       %         Engine-coolant temperature       °C         Equivalence ratio (λ)       dimensionless         Absolute load value       %         Absolute load value       %         Fuel-rail pressure (gauge)       kPa         Accolerator-pedal position       %         Acculerationse raw value (absolute)       kPa         Acculeration temperature       °C         Cultration task (A) camshaft position       °         Acculeration performance       %         Actual intake (A) camshaft position actuator duty cycle       %         Actual intake (A) camshaft		Pre-intercooler air pressure (absolute)	kPa
Coolant-in temperature       °C         Coolant-in temperature       °C         Coolant-out pressure (gauge)       kPa         Blowby-flow rate       L/min         Oil-Sump Temperature       °C         Coolant flow rate       L/min         Equivalence ratio (\lambda)       Dimensionless         Ignition timing advance for #1 cylinder       *         Absolute throttle position       %         Engine-coolant temperature       °C         Inlet-air temperature       °C         Inlet-air temperature       °C         Inlet-air temperature       °C         Inlet-air temperature       °C         Intake-manifold pressure (absolute)       kPa         Accelerator-pedal position       %         Intake-manifold pressure (absolute)       kPa         Accelerator-pedal position       %         Boost pressure - raw value (absolute)       kPa         Accula intake (A) camshaft position       °         Actual intake (A) camshaft position       °         Charge-air-cooler temperature       °C         Charge-air-cooler temperature       °C         Charge-air-cooler temperature       °C         Charge-air-cooler temperature       °C         Cyl		Ambient temperature	°C
Coolant-out pressure (gauge)       kPa         Blowby flow rate       L/min         Oil-Sump Temperature       °C         Coolant flow rate       L/min         Equivalence ratio ( $\lambda$ )       Dimensionless         Ignition timing advance for #1 cylinder       °         Absolute throttle position       %         Engine-coolant temperature       °C         Inlet-air temperature       °C         Inlet-air temperature       °C         Inlet-air temperature       °C         Intake-manifold pressure (absolute)       kPa         Absolute load value       %         Intake-manifold pressure (absolute)       kPa         KPa       Boost pressure (absolute)       kPa         Accelerator-pedal position       %         PCM CAN bus channels       Boost pressure - raw value (absolute)       kPa         Actual intake (A) camshaft position       °       °         Actual exhaust (B) camshaft position       °       °         Actual exhaust (B) camshaft position actuator duty cycle       %       °         Intake (A) camshaft position actuator duty cycle       %       °         Cylinder 1-knock/combustion performance       count       °         Cylinder 2-knock/combustion performance <td></td> <td>Coolant-in temperature</td> <td>°C</td>		Coolant-in temperature	°C
Blowby flow rate Oil-Sump Temperature Coolant flow rate Equivalence ratio (\)       L/min Equivalence Dimensionless         Ignition timing advance for #1 cylinder       °         Absolute throttle position       %         Engine-coolant temperature       °C         Intet-air temperature       °C         Intet-air temperature       °C         Intet-air temperature       °C         Equivalence ratio (\)       dimensionless         Absolute load value       %         Intake-manifold pressure (absolute)       kPa         Accelerator-pedal position       %         PCM CAN bus channels       Boost pressure (absolute)       kPa         Turbocharger wastegate duty cycle       %         Actual intake (A) camshaft position       °         Actual exhaust (B) camshaft position       °         Intake (A) camshaft position actuator duty cycle       %         Exhaust (B) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count		Coolant-out pressure (gauge)	kPa
Oil-Sump Temperature Coolant flow rate       L/min L/min         Equivalence ratio ( $\lambda$ )       Dimensionless         Ignition timing advance for #1 cylinder       °         Absolute throttle position       %         Engine-coolant temperature       °C         Inlet-air temperature       °C         Equivalence ratio ( $\lambda$ )       dimensionless         Absolute Indet-air temperature       °C         Equivalence ratio ( $\lambda$ )       dimensionless         Absolute Indet-air temperature       %         Intake-manifold pressure (absolute)       kPa         Fuel-rail pressure (gauge)       kPa         Accelerator-pedal position       %         Boost pressure - raw value (absolute)       %         Actual intake (A) camshaft position       °         Actual exhaust (B) camshaft position       °         Actual exhaust (B) camshaft position actuator duty cycle       %         Intake (A) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder -1 knock/combustion performance       count         Cylinder -2 knock/combustion performance       count         Cylinder -2 knock/combustion performance       count         Cylinder -2 knock/combustion performance       count		Blowby flow rate	L/min
Coolant flow rate Equivalence ratio (λ)     L/min Dimensionless       Ignition timing advance for #1 cylinder     *       Absolute throttle position     %       Engine-coolant temperature     °C       Inlet-air temperature     °C       Equivalence ratio (λ)     dimensionless       Absolute throttle load value     %       Intake-manifold pressure (gauge)     kPa       Accelerator-pedal position     %       PCM CAN bus channels     Boost pressure - raw value (absolute)     kPa       Turbocharger wastegate duty cycle     %       Actual intake (A) camshaft position     °       Actual intake (A) camshaft position     °       Intake (A) camshaft position     °       Colard intake (A) camshaft position     °       Charge-air-cooler temperature     °C       Charge-air-cooler temperature     °C       Cylinder 1 knock/combustion performance     count       Cylinder 2 knock/combustion performance     count       Cylinder 4 knock/combustion performance     count       Cylinder 4 knock/combustion performance     count		Oil-Sump Temperature	°C
Equivalence ratio ( $\lambda$ )       Dimensionless         Ignition timing advance for #1 cylinder       °         Absolute throttle position       %         Engine-coolant temperature       °C         Inlet-air temperature       °C         Equivalence ratio ( $\lambda$ )       dimensionless         Absolute to load value       %         Intake-manifold pressure (absolute)       kPa         Fuel-rail pressure (gauge)       kPa         Accelerator-pedal position       %         PCM CAN bus channels       Boost pressure - raw value (absolute)       kPa         Accelerator pedal position       %         Actual intake (A) camshaft position       °         Actual intake (A) camshaft position       °         Actual exhaust (B) camshaft position       °         Intake (A) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 3 knock/combustion performance       count         Cylinder 3 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count		Coolant flow rate	L/min
Ignition timing advance for #1 cylinder       °         Absolute throttle position       %         Engine-coolant temperature       °C         Inlet-air temperature       °C         Equivalence ratio (λ)       dimensionless         Absolute load value       %         Intake-manifold pressure (absolute)       kPa         Fuel-rail pressure (gauge)       kPa         Accelerator-pedal position       %         PCM CAN bus channels       Boost pressure - raw value (absolute)       kPa         Turbocharger wastegate duty cycle       %         Actual intake (A) camshaft position       °         Actual exhaust (B) camshaft position       °         Intake (A) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 1 knock/combustion performance       count         Cylinder 3 knock/combustion performance       count         Cylinder 4 knock/combustion performance		Equivalence ratio ( $\lambda$ )	Dimensionless
Absolute throttle position       %         Engine-coolant temperature       °C         Inlet-air temperature       °C         Engine-coolant temperature       °C         Inlet-air temperature       °C         Equivalence ratio (λ)       dimensionless         Absolute load value       %         Intake-manifold pressure (absolute)       kPa         Fuel-rail pressure (gauge)       kPa         Accelerator-pedal position       %         PCM CAN bus channels       Boost pressure - raw value (absolute)       kPa         Turbocharger wastegate duty cycle       %         Actual intake (A) camshaft position       °         Actual exhaust (B) camshaft position       °         Intake (A) camshaft position actuator duty cycle       %         Intake (A) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 3 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count		Ignition timing advance for #1 cylinder	٥
PCM CAN bus channels		Absolute throttle position	%
Inlet-air temperature       °C         Equivalence ratio (λ)       dimensionless         Absolute load value       %         Intake-manifold pressure (absolute)       kPa         Fuel-rail pressure (gauge)       kPa         Accelerator-pedal position       %         Accelerator-pedal position       %         PCM CAN bus channels       Boost pressure - raw value (absolute)       kPa         Turbocharger wastegate duty cycle       %         Actual intake (A) camshaft position       °         Actual intake (A) camshaft position       °         Intake (A) camshaft position actuator duty cycle       %         Intake (A) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 3 knock/combustion performance       count         Cylinder 4 knock/combustion per		Engine-coolant temperature	°C
Equivalence ratio (λ)       dimensionless         Absolute load value       %         Intake-manifold pressure (absolute)       kPa         Fuel-rail pressure (gauge)       kPa         Accelerator-pedal position       %         PCM CAN bus channels       Boost pressure (absolute)       kPa         Accelerator-pedal position       %         Accular intake (A) camshaft position       °         Actual intake (A) camshaft position       °         Actual exhaust (B) camshaft position       °         Intake (A) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count	PCM CAN bus channels	Inlet-air temperature	°C
Absolute load value % Absolute load value % Intake-manifold pressure (absolute) kPa Fuel-rail pressure (gauge) kPa Accelerator-pedal position % Accelerator-pedal position % Accelerator-pedal position % Accelerator-pedal position % Accual intake (A) camshaft position ° Actual intake (A) camshaft position ° Intake (A) camshaft position actuator duty cycle % Exhaust (B) camshaft position actuator duty cycle % Charge-air-cooler temperature °C Cylinder 1 knock/combustion performance count Cylinder 2 knock/combustion performance count Cylinder 4 knock/combustion performance count		Equivalence ratio ()	dimensionless
Accelerator-pedal position       %         PCM CAN bus channels       Boost pressure (gauge)       kPa         Accelerator-pedal position       %         PCM CAN bus channels       Boost pressure - raw value (absolute)       kPa         Accelerator-pedal position       %         Accula intake (A) camshaft position       °         Actual exhaust (B) camshaft position       °         Actual exhaust (B) camshaft position actuator duty cycle       %         Exhaust (B) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count			0/
PCM CAN bus channels       Fuel-rail pressure (gauge)       kPa         Accelerator-pedal position       %         PCM CAN bus channels       Boost pressure - raw value (absolute)       kPa         Turbocharger wastegate duty cycle       %         Actual intake (A) camshaft position       °         Actual exhaust (B) camshaft position       °         Intake (A) camshaft position actuator duty cycle       %         Exhaust (B) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count		Inteke manifold pressure (sheelute)	kBo
PCM CAN bus channels       Boost pressure - raw value (absolute)       kPa         PCM CAN bus channels       Boost pressure - raw value (absolute)       kPa         Turbocharger wastegate duty cycle       %         Actual intake (A) camshaft position       °         Actual exhaust (B) camshaft position       °         Intake (A) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count			KFa kDa
PCM CAN bus channels PCM CAN bus channels		Fuel-rail pressure (gauge)	KPa
PCM CAN bus channels       Boost pressure - raw Value (absolute)       KPa         Turbocharger wastegate duty cycle       %         Actual intake (A) camshaft position       °         Actual exhaust (B) camshaft position       °         Intake (A) camshaft position actuator duty cycle       %         Exhaust (B) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count		Accelerator-pedar position	<del>70</del>
Iurbocharger wastegate duty cycle       %         Actual intake (A) camshaft position       °         Actual exhaust (B) camshaft position       °         Intake (A) camshaft position actuator duty cycle       %         Exhaust (B) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 3 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count		Boost pressure - raw value (absolute)	кРа
Actual intake (A) camshaft position       °         Actual exhaust (B) camshaft position       °         Intake (A) camshaft position actuator duty cycle       %         Exhaust (B) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 3 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count		l urbocharger wastegate duty cycle	%
Actual exhaust (B) camshaft position       °         Intake (A) camshaft position actuator duty cycle       %         Exhaust (B) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 3 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count		Actual intake (A) camshaft position	
Intake (A) camshaft position actuator duty cycle       %         Exhaust (B) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1- knock/combustion performance       count         Cylinder 2- knock/combustion performance       count         Cylinder 3- knock/combustion performance       count         Cylinder 4- knock/combustion performance       count         Cylinder 4- knock/combustion performance       count		Actual exhaust (B) camshaft position	
Exhaust (B) camshaft position actuator duty cycle       %         Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 3 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count		Intake (A) camshaft position actuator duty cycle	%
Charge-air-cooler temperature       °C         Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 3 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count		Exhaust (B) camshaft position actuator duty cycle	%
Cylinder 1 knock/combustion performance       count         Cylinder 2 knock/combustion performance       count         Cylinder 3 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count		Charge-air-cooler temperature	°C
Cylinder 2 knock/combustion performance       count         Cylinder 3 knock/combustion performance       count         Cylinder 4 knock/combustion performance       count		Cylinder 1 knock/combustion performance	count
Cylinder 3 knock/combustion performance count Cylinder 4 knock/combustion performance count		Cylinder 2 knock/combustion performance	count
Cylinder 4 knock/combustion performance count		Cylinder 3 knock/combustion performance	count
		Cylinder 4 knock/combustion performance	count

13.4 In the space provided, note the time, date, test hour, and duration of any shutdown or off-test condition. Start counting downtime at one hour after the end of an iteration of step 6 in the test cycle (Table 9) or any time a test comes down in the middle of an iteration. The maximum allowable downtime is 48 h.

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Quantity, unit	L	U	Over-range	Under-range
Speed, r/min	1730	1770	3941	0
Torque, N·m	264	274	817	0
Coolant out temperature, °C	94.5	95.5	289	0
Oil gallery temperature, °C	94.5	95.5	150	40
Air charge temperature, °C	42.5	43.5	98	0
Inlet air temperature, °C	29.5	30.5	85	0
Fuel temperature, °C	29.5	30.5	1190	0
Back pressure, kPa (absolute)	102	106	323	0
Inlet air pressure, kPa ( <del>absolute</del> gauge)	0.03	0.07	2.2	-2.1
Humidity, g/kg	10.9	11.9	66	0
Coolant pressure, kPa (gauge)	68	72	290	0
Coolant flow rate, L/min	53	57	274	0

#### TABLE A5.2 L and U Limits and Over- and Under-Range Values