



Engine Performance Data
Cummins Inc.
Columbus, Indiana 47202-3005
www.cummins.com

Industrial
QSK78
FR60451

Advertised power: 3,500 BHP (2,610 kW) @ 1,900 RPM
Maximum power: 3,500 BHP (2,610 kW) @ 1,800 RPM
Peak torque: 10,383 lb-ft (14,078 N-m) @ 1,700 RPM

Configuration
D773004CX03

CPL code
5405

Revision
4-Oct-2019

Compression ratio: **15.3:1**

Bore: **6.69 in (170 mm)**

Fuel system: **Cummins MCRS**

Stroke: **7.48 in (190 mm)**

Emission certification **Non-certified**

Displacement: **4,735 in³ (77.6 L)**

Aspiration: **2-Stg Turbo. Aftercooled and Intercooled**

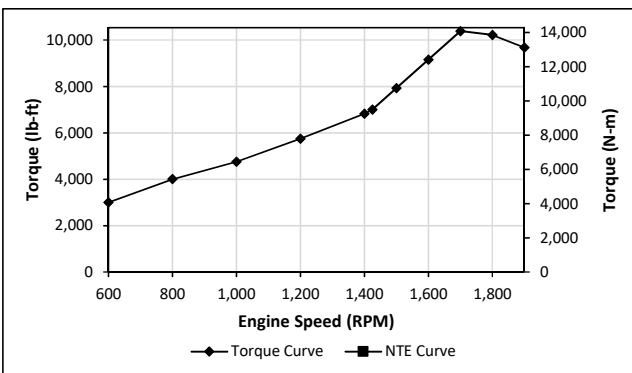
Number of cylinders: **18**

All data is subject to change without notice and based on these operating conditions:

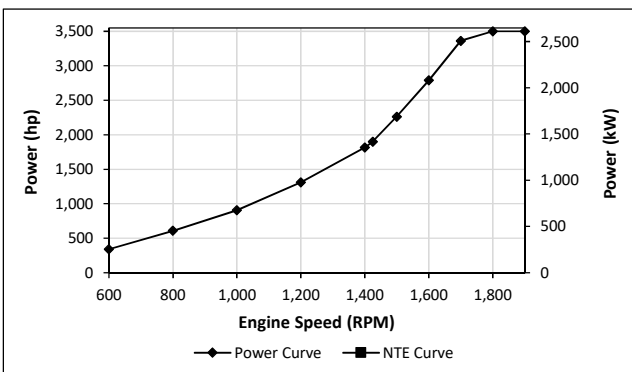
- Inlet air restriction of -15 in-H₂O (-3.7 kPa)
- Exhaust restriction of 1.56 in-Hg (5.3 kPa)
- Relative humidity of 55%

Rating type: Intermittent

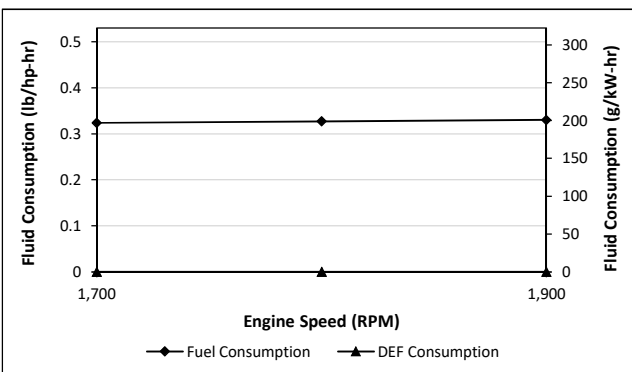
- Excludes parasitic loads associated with alternator, fan and other optional driven components
- Coolant flows and heat rejection data based on a 50/50 mixture of ethylene glycol and water



Torque Output ¹		
RPM	lb-ft	N-m
600	3,000	4,067
800	4,000	5,423
1,000	4,758	6,451
1,200	5,741	7,784
1,400	6,825	9,253
1,425	7,007	9,500
1,500	7,927	10,748
1,600	9,155	12,413
1,700	10,383	14,078
1,800	10,212	13,846
1,900	9,675	13,118



Power Output ¹		
RPM	hp	kW
600	343	256
800	609	454
1,000	906	676
1,200	1,312	978
1,400	1,819	1,356
1,425	1,901	1,418
1,500	2,264	1,688
1,600	2,789	2,080
1,700	3,361	2,506
1,800	3,500	2,610
1,900	3,500	2,610



Fuel Consumption ¹		
RPM	lb/hp-hr	g/kW-hr
1,700	0.324	197
1,800	0.327	199
1,900	0.330	201

STATUS FOR CURVES AND DATA: Production

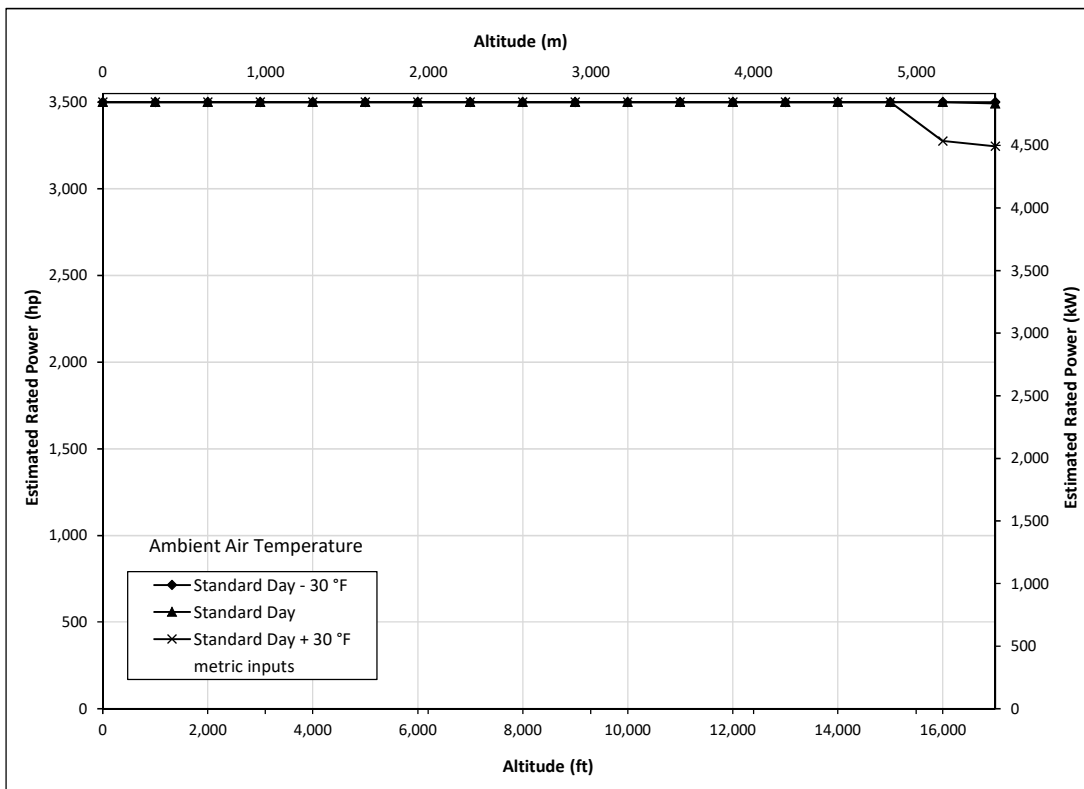
CHIEF ENGINEER: Scott Towsley

Altitude Derate

Altitude before electronic derate at 28 °F (-2 °C) ambient and 1.6 in-Hg (5.3 kPa) exhaust restriction:

16,404 ft 5,000 m

Estimated Rated Power Output vs. Altitude²



Altitude (ft)	Standard Day - 30 °F		Standard Day		Standard Day + 30 °F	
	Temperature (°F)	Est. Power (hp)	Temperature (°F)	Est. Power (hp)	Temperature (°F)	Est. Power (hp)
0	57	3,500	87	3,500	117	3,500
1,000	53	3,500	83	3,500	113	3,500
2,000	50	3,500	80	3,500	110	3,500
3,000	46	3,500	76	3,500	106	3,500
4,000	43	3,500	73	3,500	103	3,500
5,000	39	3,500	69	3,500	99	3,500
6,000	35	3,500	65	3,500	95	3,500
7,000	32	3,500	62	3,500	92	3,500
8,000	28	3,500	58	3,500	88	3,500
9,000	25	3,500	55	3,500	85	3,500
10,000	21	3,500	51	3,500	81	3,500
11,000	18	3,500	48	3,500	78	3,500
12,000	14	3,500	44	3,500	74	3,500
13,000	10	3,500	40	3,500	70	3,500
14,000	7	3,500	37	3,500	67	3,500
15,000	3	3,500	33	3,500	63	3,500
16,000	0	3,500	30	3,500	60	3,275
17,000	-4	3,500	26	3,492	56	3,245

Performance Data

Minimum speed for full load sustained operation	1,800 RPM
Minimum low idle speed	600 RPM
Maximum low idle speed	750 RPM

	Advertised power		Maximum power*	
Engine speed	1,900 RPM		1,800 RPM	
Power output	3,500 hp	2,610 kW	3,500 hp	2,610 kW
Torque output	9,675 lb-ft	13,118 N-m	10,212 lb-ft	13,846 N-m
Motoring torque	1,057 lb-ft	1,433 N-m	1,000 lb-ft	1,356 N-m
Intake manifold pressure	69 in-Hg	234 kPa	73 in-Hg	248 kPa
Turbo comp. outlet pressure	71 in-Hg	239 kPa	75 in-Hg	252 kPa
Turbo comp. outlet temperature	282 °F	138.7 °C	291 °F	144.0 °C
Inlet air flow	7,244 ft ³ /min	3,419 L/s	7,178 ft ³ /min	3,388 L/s
Exhaust gas flow	16,684 ft ³ /min	7,874 L/s	16,586 ft ³ /min	7,828 L/s
Exhaust gas temperature	864 °F	462.2 °C	860 °F	460.3 °C
Heat rejection to ambient air	12,000 BTU/min	211 kW	11,900 BTU/min	209 kW
Heat rejection to exhaust gas	107,500 BTU/min	1,890 kW	105,200 BTU/min	1,849 kW
Heat rejection to LTC coolant	29,200 BTU/min	514 kW	29,300 BTU/min	515 kW
Heat rejection to HTC coolant	55,200 BTU/min	970 kW	54,300 BTU/min	954 kW

*If section is blank, the maximum power data is the same as the advertised power data

Engine Sound Pressure Levels³ (Noise)

Top side	101.0 dBa
Right side	103.9 dBa
Left side	102.9 dBa
Front side	103.9 dBa
Exhaust noise with aftertreatment	101.3 dBa
Exhaust noise out of the turbocharger	107.2 dBa

General Engine Data

Maximum overspeed capability	2,150 RPM	
Mass moment of inertia of rotating components (excluding flywheel)	136 in-lbf-sec ²	15 kg-m ²
Maximum installed engine power angle	6.0 °	
Maximum installed engine tilt angle	6.0 °	

	Approximate Dry Weight		Approximate Wet Weight	
Engine weight (mining market)*	26,506 lb	12,023 kg	27,137 lb	12,309 kg
Engine weight (locomotive market)*	N/A lb	N/A kg	N/A lb	N/A kg
Engine weight (oil and gas market)*	N/A lb	N/A kg	N/A lb	N/A kg

Engine Mounting**Moment of inertia:**

•x-axis (roll)	33,960 in-lbf-sec ²	3,837 kg-m ²
•y-axis (pitch)	94,508 in-lbf-sec ²	10,678 kg-m ²
•z-axis (yaw)	84,489 in-lbf-sec ²	9,546 kg-m ²

Center of gravity:

•from rear face of block	49.20 in	1,250 mm
•from engine centerline to left side of engine (as viewed from rear of engine)	0.20 in	5 mm
•above crankshaft centerline	18.30 in	465 mm

Maximum crankshaft thrust bearing load limit:

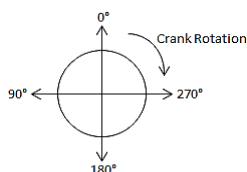
•intermittent load	2,001 lbf	8,900 N
•continuous load	1,000 lbf	4,450 N

Maximum static bending moment at rear face of block

7,634 lb-ft 10,350 N-m

Maximum bending moment available from front of crankshaft:

•0 degrees	3,877 lb-ft	5,257 N-m
•90 degrees	6,724 lb-ft	9,117 N-m
•180 degrees	8,793 lb-ft	11,922 N-m
•270 degrees	5,933 lb-ft	8,044 N-m



Note: maximum torque available from front of crankshaft requires a torsional vibration analysis (TVA). (Reference AEB 24.28)

Intake Air System

Maximum air temperature rise over ambient at turbocharger compressor inlet	5 delta °F	2.8 delta °C
Maximum intake air restriction with:		
•clean filter	15 in-H ₂ O	4 kPa
•dirty filter	25 in-H ₂ O	6 kPa
Minimum air cleaner dirt holding capacity	25 g/cfm	
Maximum intake air bleed for accessories (not including air compressor)	0.0 ft ³ /min	0 L/s
Recommended intake piping size (inner diameter)	5.83 in	148 mm

Exhaust System

Maximum exhaust restriction	2.0 in-Hg	6.8 kPa
Recommended exhaust piping size (inner diameter)	11.78 in	299.212 mm
Maximum downpipe temperature drop	°F	°C
Maximum static bending moment at turbocharger outlet flange	N/A lb-ft	N/A N-m
<i>Note: exhaust manifold or turbocharger blanketing is <u>NOT</u> acceptable</i>		

Lubrication System (reference Service Bulletin #3810340)

Nominal operating oil pressure at:		
•minimum low idle speed	31.2 psi	215.0 kPa
•advertised speed	71.1 psi	490.0 kPa
Minimum oil pressure within 4 seconds of engine first firing at minimum low idle speed (measured at turbocharger oil inlet)	10.2 psi	70.0 kPa
Maximum oil flow to all accessories	10 gpm	37.9 L/min
Maximum oil pressure spike on cold engine	250.0 psi	1,724.0 kPa

Fuel System (reference AEB 24.07 & 24.10)

Fuel compatibility (consult Service Bulletin #3379001 for appropriate use of other fuels)		
Maximum heat rejection to return fuel which occurs at the following conditions:	677 BTU/min	12 kW
•fuel return flow	1,065 lb/hr	483 kg/hr
•fuel return temperature (prior to fuel cooler)	246 °F	119.0 °C
Maximum fuel return flow	1,065 lb/hr	483.0 kg/hr
Maximum fuel supply temperature (measured at on-engine fuel inlet fitting)	158 °F	70.0 °C
Maximum fuel supply pressure (measured at on-engine fuel inlet fitting)	2.9 psi	20.0 kPa
Maximum fuel return restriction (measured at on-engine fuel drain fitting)	10 in-Hg	34.0 kPa
Stage 1 filter(s)		
Maximum fuel supply flow across Stage 1 filter(s)	2,220 lb/hr	1,007.0 kg/hr
Maximum combined fuel supply restriction of Stage 1 assembly & OEM plumbing (measured at on-engine fuel inlet fitting) with:		
•clean Stage 1 fuel filter(s) at maximum fuel supply flow	6 in-Hg	20.0 kPa
•dirty Stage 1 fuel filter(s) at maximum fuel supply flow	10 in-Hg	34.0 kPa
Nominal restriction of clean Stage 1 fuel filter assembly at maximum fuel supply flow	3 in-Hg	10.0 kPa
Maximum fuel inlet pressure measured at Stage 1 inlet	3.0 psi	21.0 kPa
Recommended maximum fuel inlet pressure for Seeing Is Believing® (measured at Stage 1 inlet)	2.1 psi	14.5 kPa
For applications with Stage 2 filters mounted off-engine (measured at maximum fuel supply condition)		
Maximum fuel supply flow across Stage 2 filter(s)	5,553 lb/hr	2,519.0 kg/hr
Maximum fuel supply restriction from low pressure fuel pump outlet to Stage 2 filter head inlet	10 in-Hg	35.0 kPa
Maximum fuel supply restriction from Stage 2 filter head outlet to high pressure fuel pump inlet	10 in-Hg	35.0 kPa
<i>Note: assume 2 in-Hg (7 kPa) for every 33 in (838 mm) above/below fuel pump</i>		

Cooling Systems (reference AEB 24.18 & AEB 24.26)

Cooling system type

2 Pump 2 Loop

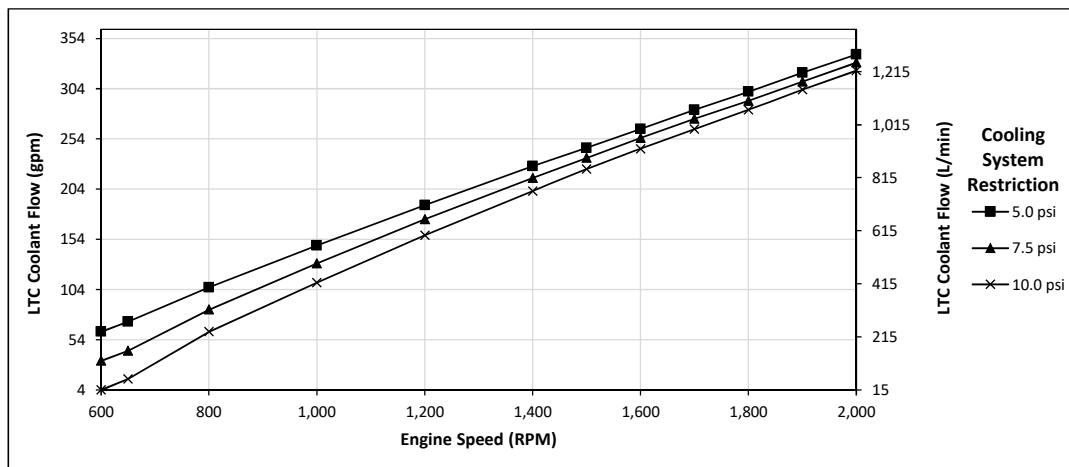
Requirements of both LTC and HTC cooling circuits:

Minimum fill rate	5 gpm	19 L/min
Maximum deaeration time	25.0 min	
Acceptable types of deaeration systems	Positive	
Minimum water pump inlet pressure with fully deaerating cooling system	0 in-Hg	0.0 kPa
Maximum static head of coolant above crankshaft centerline	60 ft	18.3 m
Minimum pressure cap rating at sea level	11.0 psi	76.0 kPa
Maximum pressure cap rating at sea level	15.0 psi	103.4 kPa
Minimum coolant expansion space (% of total cooling system capacity)	6.0 %	
Minimum drawdown (% of total cooling system capacity)	11.0 %	

Low Temperature (Aftercooling) Circuit (LTC)

LTC coolant volume (engine only)	60 quarts	57 L
LTC thermostat opening temperature	115 °F	46.0 °C
LTC thermostat fully open temperature	129 °F	54.0 °C
Maximum LTC water pump inlet temperature at 77 °F (25 °C) ambient air temperature	117 °F	47.2 °C
Maximum external LTC restriction at 1900 RPM	10.2 psi	70.0 kPa

LTC Coolant Flow vs. Engine Speed for Various Cooling System Restrictions (Fully Open Thermostats)



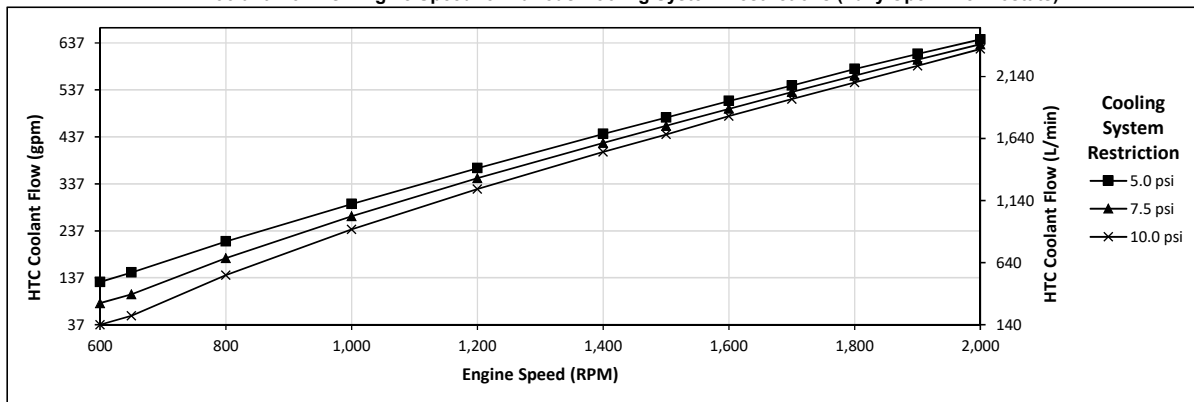
LTC Cooling System Restriction

Engine Speed	5.0 psi (34.5 kPa)		7.5 psi (52 kPa)		10.0 psi (69 kPa)	
RPM	gpm	L/min	gpm	L/min	gpm	L/min
600	62	235	33	125	4	15
650	72	273	43	163	15	57
800	106	401	84	318	62	235
1,000	148	560	130	492	111	420
1,200	188	712	174	659	158	598
1,400	227	859	215	814	202	765
1,500	245	927	235	890	224	848
1,600	264	999	255	965	244	924
1,700	283	1,071	274	1,037	264	999
1,800	301	1,139	292	1,105	283	1,071
1,900	320	1,211	311	1,177	303	1,147
2,000	338	1,280	330	1,249	322	1,219

High Temperature Circuit (HTC) commonly referred to as jacket water

HTC coolant volume (engine only)	175 quarts	166 L
HTC thermostat opening temperature	180 °F	82.0 °C
HTC thermostat fully open temperature	201 °F	94.0 °C
Maximum HTC thermostat outlet temperature at LAT (maximum top tank temperature)	212 °F	100.0 °C
Minimum operating HTC temperature (for continuous cold weather applications)	160 °F	71.0 °C
Maximum external HTC restriction at 1900 RPM	10.0 psi	68.9 kPa
Maximum auxiliary coolant flow at rated speed	67 gpm	256 L/min
Maximum auxiliary coolant flow at minimum low idle	25 gpm	95 L/min

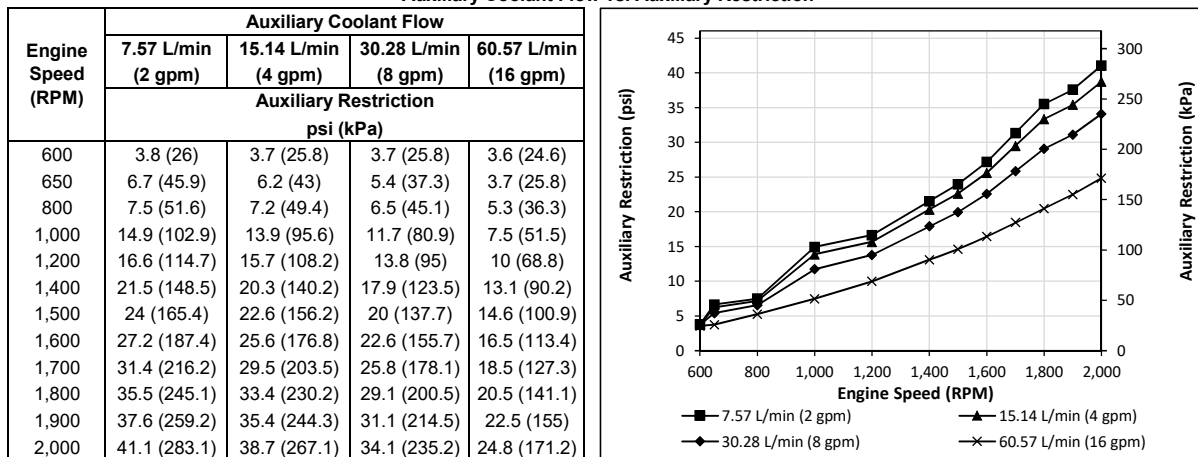
HTC Coolant Flow vs. Engine Speed for Various Cooling System Restrictions (Fully Open Thermostats)



HTC Cooling System Restriction

Engine Speed	5.0 psi (34.5 kPa)		7.5 psi (52 kPa)		10.0 psi (69 kPa)	
	RPM	gpm L/min	gpm L/min	gpm L/min	gpm L/min	gpm L/min
600	128	485	83	314	37	140
650	148	560	102	386	56	212
800	214	810	179	678	143	541
1,000	294	1,113	268	1,015	240	909
1,200	370	1,401	349	1,321	326	1,234
1,400	443	1,677	424	1,605	405	1,533
1,500	478	1,809	460	1,741	442	1,673
1,600	513	1,942	497	1,881	481	1,821
1,700	546	2,067	532	2,014	517	1,957
1,800	581	2,199	567	2,146	553	2,093
1,900	613	2,321	601	2,275	588	2,226
2,000	644	2,438	634	2,400	624	2,362

Auxiliary Coolant Flow vs. Auxiliary Restriction



In order to avoid engine derates, the LTC radiator must limit the aftercooler water inlet temperature to the maximum allowable limit up to the desired Limiting Ambient Temperature (LAT) of the equipment manufacturer. Engine data is provided below for sizing the LTC radiator at the LAT condition. This data is provided under the assumption that the equipment will be operating with the maximum allowable air temperature rise over ambient at the compressor inlet of 5 °F (2.8 °C).

Criteria for sizing LTC radiator at advertised power and LAT

		105 °F LAT (41 °C LAT)		115 °F LAT (46 °C LAT)		125 °F LAT (52 °C LAT)	
Maximum compressor inlet temperature	°F (°C)	110	(43.3)	120	(48.9)	130	(54.4)
LTC aftercooler heat rejection	BTU/min (kW)	33,300	(585)	33,600	(590)	34,800	(612)
Maximum LTC water pump inlet temperature	°F (°C)	142	(61.1)	155	(68.3)	159	(70.6)

Criteria for sizing LTC radiator at maximum power and LAT*

		105 °F LAT (41 °C LAT)		115 °F LAT (46 °C LAT)		125 °F LAT (52 °C LAT)	
Maximum compressor inlet temperature	°F (°C)	110	(43.3)	120	(48.9)	130	(54.4)
LTC aftercooler heat rejection	BTU/min (kW)	34,400	(606)	35,000	(615)	36,400	(640)
Maximum LTC water pump inlet temperature	°F (°C)	139	(59.4)	155	(68.3)	159	(70.5)

*If section is blank, the maximum power data is the same as the advertised power data

Electrical System

System voltage	24 V
Minimum battery capacity for engine only [cold soak at 0 °F (-18 °C) or above]:	
•cold cranking amperes (CCA)	2,700 CCA
•reserve capacity (RC)	640 min
<i>Note: cranking system resistance must be ≤ 0.002 ohms OR must be ≤ 0.004 ohms while meeting the "Alternate Functional Validation Procedure (QSK38 and Larger) - Cranking System" stated in AEB 24.53</i>	

Cranking System (Cold Starting Capability)

Minimum cranking speed	110 RPM	
Maximum parasitic load at 10 °F (-12 °C)	NA lb-ft	NA N-m
Unaided Cold Start		
Minimum ambient temperature	10 °F	-12.0 °C
Cranking torque at minimum unaided cold start temperature	2,680 lb-ft	3,633 N-m
Aided Cold Start		
Minimum ambient temperature with only ether	-25 °F	-31.5 °C
Minimum ambient temperature with only coolant and oil heaters	-25 °F	-31.5 °C

Footnotes

1. Tolerance within +/- 5% for Torque Output, Power Output, and Fuel Consumption
2. The estimated rated power output vs. altitude assumes the air temperature rise over ambient at turbocharger compressor inlet equals the maximum limit of 5 °F (2.8 °C). The power is calculated based on the electronic derate.
3. Free field sound pressure levels measured at 3.28 ft (1 m) and full load governed speed (excludes noise from intake, cooling system and driven components)
4. Engine weight estimate includes 86.3 gal oil pan, 2stg turbocharging, dual 250A alternators, Eliminator oil filter, dual high viscosity dampers, variable viscous clutch fan drive, and SAE #00 flywheel housing and flexplate.

Performance Curves Conditions

Torque, power, fuel data represents gross engine performance capabilities obtained and corrected in accordance with SAE J1995 conditions of:

- inlet air supply pressure (absolute): 14.5 psi (100 kPa)
- inlet air supply temperature: 77 °F (25 °C)
- ASTM D975 Grade No. 2-D S15 diesel

The engine performance data will approximate the values obtained when the observed performance data is corrected to ISO 3046-1, ISO 1585, and ISO 9249 standard reference conditions.

Rating Guidelines

1. Load Ratings

- 1.1 Maximum Rating may be used for intermittent load applications (full throttle operation is cyclically interrupted) where the average load factor does not exceed the continuous rating, and where full throttle operation does not exceed 60 minutes without interruption.
- 1.2 Continuous rating may be used for constant load applications requiring uninterrupted service at full throttle for extended periods of time and for Water Management applications.

2. Speed Ratings

- 2.1 If the application qualifies for the continuous load rating the governor cut-in point shall be set within the limits of the solid line portion of the continuous curve.
- 2.2 If the application qualifies for the maximum load rating the governor cut-in point shall be set within the limits of the solid line portion of the maximum curve.

3. Definitions

- 3.1 Advertised Power - The horsepower for which the fuel rating was developed. This horsepower is stated on the dataplate.
- 3.2 Maximum Power - The maximum horsepower produced by the engine for the specified rating.
- 3.3 Governed Power - The horsepower produced at the engine's highest RPM for the specified rating. Customer specific high speed idle governor breakpoint can not be set lower than this RPM.
- 3.4 Load (Speed) factor - the arithmetic mean of the load (speed) profile of the normal duty cycle, not including prolonged periods of idle
- 3.5 TBD - To be determined
- 3.6 NA - Not available
- 3.7 N/A - Not applicable

4. International Rating Guidelines

These ratings represent gross engine performance capabilities obtained and corrected in accordance with SAE J1995 and the conditions as stated on the front of the curve. The ratings are in conformance with the requirements specified in ISO 3046, BS 5514 and DIN 6271. Although these specific standards have a note excluding road construction, earth moving equipment, agricultural tractors and industrial trucks as applications not covered by the standard, these are included as acceptable applications of these ratings.

The Maximum Rating conforms to ISO 3046 overload power and fuel stop power. The Continuous Rating may be used for continuous service in commercial applications and it conforms to ISO 3046 continuous power.

Reference standards: BS 5514 and DIN 6271 standards are based on ISO 3046.

Datasheet Template Version: 3.0

Change Log

Date	Author	Change Description
6/25/2018	Leigha Curtin	Initial release of datasheet. Data level is Production. Performance content corresponds to Phase 2 calibration release. Maximum heat rejection condition for this rating occurs at SAE (standard) day and the max altitude capability of 5,000 m. The criteria for sizing LTC radiator at this condition are: - Maximum compressor inlet temperature = 31 degF - LTC aftercooler heat rejection = 38020.5 BTU/min - Maximum LTC water pump inlet temperature = 118 degF
11/7/2018	Brian Watkins	Added Maximum downpipe temperature drop
	Brian Watkins	Removed Aftertreatment and DEF verbage and data.
5/7/2019	Phillip Bacon	From recent data sheet review I added back the BSFC values for the FR60451 datasheet. Also to get the correct values to show up in the datasheet template I needed to correct the formula in cells N50 thru N61 due to an incorrect reference. I also noticed that the Altitude Derate comment on the top of Page 2 is rounding different than on page 1 for the exhaust restriction. I will let Brian know and have it corrected.
5/14/2019	Brian Watkins	Maximum exhaust restrictions change from 5.3 kPa to 6.8 kPa
8/29/2019	Brian Watkins	Chief engineer approval to round Heat Rejection values.
9/12/2019	Brian Watkins	Added Noise data