G3516C

GAS ENGINE TECHNICAL DATA

CATERPILLAR®

ENGINE SPEED (rpm):	1800	RATING STRATEGY:	STANDARD
COMPRESSION RATIO:	11.3	APPLICATION:	GENSET
AFTERCOOLER TYPE:	SCAC	RATING LEVEL:	STANDBY
AFTERCOOLER - STAGE 2 INLET (°F):	130	FUEL:	NAT GAS
AFTERCOOLER - STAGE 1 INLET (°F):	198	FUEL SYSTEM:	CAT LOW PRESSURE
JACKET WATER OUTLET (°F):	210		WITH AIR FUEL RATIO CONTROL
ASPIRATION:	TA	FUEL PRESSURE RANGE(psig): (See note 1)	0.5-5.0
COOLING SYSTEM:	JW+OC+1AC, 2AC	FUEL METHANE NUMBER:	80
CONTROL SYSTEM:	ADEM3 W/ IM	FUEL LHV (Btu/scf):	905
EXHAUST MANIFOLD:	DRY	ALTITUDE CAPABILITY AT 77°F INLET AIR TEMP. (ft):	6000
COMBUSTION:	LOW EMISSION	POWER FACTOR:	0.8
NOx EMISSION LEVEL (g/bhp-hr NOx):	0.5	VOLTAGE(V):	400-13800

RATING		NOTES	LOAD	100%	75%	50%
GENSET POWER	(WITHOUT FAN)	(2)(3)	ekW	1561	1171	781
GENSET POWER	(WITHOUT FAN)	(2)(3)	kVA	1951	1463	976
ENGINE POWER	(WITHOUT FAN)	(3)	bhp	2175	1642	1109
GENERATOR EFFICIENCY		(2)	%	96.3	95.6	94.4
GENSET EFFICIENCY(@ 1.0 Power Factor)	(ISO 3046/1)	(4)	%	36.4	35.5	32.4
THERMAL EFFICIENCY		(5)	%	49.6	49.8	52.0
TOTAL EFFICIENCY (@ 1.0 Power Factor)		(6)	%	86.0	85.3	84.4

ENGINE DATA						
GENSET FUEL CONSUMPTION	(ISO 3046/1)	(7)	Btu/ekW-hr	9404	9670	10565
GENSET FUEL CONSUMPTION	(NOMINAL)	(7)	Btu/ekW-hr	9633	9906	10822
ENGINE FUEL CONSUMPTION	(NOMINAL)	(7)	Btu/bhp-hr	6914	7062	7618
AIR FLOW (77°F, 14.7 psia)	(WET)	(8)	ft3/min	4620	3640	2600
AIR FLOW	(WET)	(8)	lb/hr	20486	16138	11530
FUEL FLOW (60ºF, 14.7 psia)			scfm	277	214	156
COMPRESSOR OUT PRESSURE			in Hg(abs)	97.7	80.7	62.2
COMPRESSOR OUT TEMPERATURE			°F	424	366	272
AFTERCOOLER AIR OUT TEMPERATURE			°F	138	135	129
INLET MAN. PRESSURE		(9)	in Hg(abs)	84.5	67.0	48.2
INLET MAN. TEMPERATURE	(MEASURED IN PLENUM)	(10)	°F	140	136	135
TIMING		(11)	°BTDC	28	28	28
EXHAUST TEMPERATURE - ENGINE OUTLET		(12)	°F	867	905	930
EXHAUST GAS FLOW (@engine outlet temp, 14.5 psia)	(WET)	(13)	ft3/min	12320	9969	7261
EXHAUST GAS MASS FLOW	(WET)	(13)	lb/hr	21242	16721	11954
MAX INLET RESTRICTION		(14)	in H2O	10.04	10.04	10.04
MAX EXHAUST RESTRICTION		(14)	in H2O	20.07	20.07	20.07

EMISSIONS DATA - ENGINE OUT					
NOx (as NO2)	(15)(16)	g/bhp-hr	0.50	0.50	0.50
CO	(15)(17)	g/bhp-hr	1.94	2.04	2.06
THC (mol. wt. of 15.84)	(15)(17)	g/bhp-hr	5.12	6.12	6.94
NMHC (mol. wt. of 15.84)	(15)(17)	g/bhp-hr	0.77	0.92	1.04
NMNEHC (VOCs) (mol. wt. of 15.84)	(15)(17)(18)	g/bhp-hr	0.51	0.61	0.69
HCHO (Formaldehyde)	(15)(17)	g/bhp-hr	0.52	0.52	0.60
CO2	(15)(17)	g/bhp-hr	439	487	515
EXHAUST OXYGEN	(15)(19)	% DRY	10.2	10.1	10.0
LAMBDA	(15)(19)		1.69	1.73	1.70

ENERGY BALANCE DATA						
LHV INPUT		(20)	Btu/min	250625	193288	140778
HEAT REJECTION TO JACKET WATER (JW)		(21)(29)	Btu/min	35766	26005	24853
HEAT REJECTION TO ATMOSPHERE	(INCLUDES GENERATOR)	(22)	Btu/min	11314	9638	7923
HEAT REJECTION TO LUBE OIL (OC)		(23)(29)	Btu/min	6273	5604	4781
HEAT REJECTION TO EXHAUST (LHV TO 77°F)		(24)(25)	Btu/min	80660	67095	49706
HEAT REJECTION TO EXHAUST (LHV TO 248°F)		(24)	Btu/min	58823	49167	36580
HEAT REJECTION TO A/C - STAGE 1 (1AC)		(26)(29)	Btu/min	18864	10988	3430
HEAT REJECTION TO A/C - STAGE 2 (2AC)		(27)(30)	Btu/min	7011	5414	3735
PUMP POWER		(28)	Btu/min	1964	1964	1964

CONDITIONS AND DEFINITIONS

Engine rating obtained and presented in accordance with ISO 3046/1. (Standard reference conditions of 77°F, 29.60 in Hg barometric pressure.) No overload permitted at rating shown. Consult the altitude deration factor chart for applications that exceed the rated altitude or temperature.

Emission levels are at engine exhaust flange prior to any after treatment. Values are based on engine operating at steady state conditions, adjusted to the specified NOx level at 100% load. Tolerances specified are dependent upon fuel quality. Fuel methane number cannot vary more than ± 3.

For notes information consult page three.

FUEL USAGE GUIDE

CAT METHANE NUMBER	30	35	40	45	50	55	60	65	70	75	80	100
SET POINT TIMING	-	-	-	-	-	22	24	26	27	27	28	28
DERATION FACTOR	0	0	0	0	0	1	1	1	1	1	1	1

ALTITUDE DERATION FACTORS AT RATED SPEED

INLET AIR TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	1	1	0.97	0.94	0.90	0.86	0.83	0.79	0.75	0.70	0.65	0.60	0.55
120	1	1	1	0.98	0.94	0.90	0.86	0.83	0.79	0.75	0.70	0.65	0.59
110	1	1	1	1	0.98	0.94	0.90	0.86	0.83	0.79	0.75	0.69	0.64
100	1	1	1	1	1	0.98	0.94	0.90	0.86	0.82	0.79	0.75	0.68
90	1	1	1	1	1	1	0.96	0.93	0.89	0.85	0.82	0.78	0.74
80	1	1	1	1	1	1	0.99	0.95	0.91	0.87	0.83	0.79	0.75
70	1	1	1	1	1	1	1	0.96	0.92	0.88	0.84	0.80	0.75
60	1	1	1	1	1	1	1	0.96	0.92	0.88	0.84	0.80	0.75
50	1	1	1	1	1	1	1	0.96	0.92	0.88	0.84	0.80	0.75

ALTITUDE (FEET ABOVE SEA LEVEL)

AFTERCOOLER HEAT REJECTION FACTORS (ACHRF)

INLET AIR TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
130	1.28	1.33	1.38	1.43	1.48	1.53	1.58	1.58	1.58	1.58	1.58	1.58	1.58
120	1.22	1.27	1.32	1.37	1.42	1.47	1.52	1.52	1.52	1.52	1.52	1.52	1.52
110	1.17	1.21	1.26	1.31	1.36	1.41	1.46	1.46	1.46	1.46	1.46	1.46	1.46
100	1.11	1.15	1.20	1.25	1.30	1.35	1.40	1.40	1.40	1.40	1.40	1.40	1.40
90	1.05	1.10	1.14	1.19	1.24	1.28	1.33	1.33	1.33	1.33	1.33	1.33	1.33
80	1	1.04	1.08	1.13	1.18	1.22	1.27	1.27	1.27	1.27	1.27	1.27	1.27
70	1	1	1.03	1.07	1.12	1.16	1.21	1.21	1.21	1.21	1.21	1.21	1.21
60	1	1	1	1.01	1.06	1.10	1.15	1.15	1.15	1.15	1.15	1.15	1.15
50	1	1	1	1	1	1.04	1.09	1.09	1.09	1.09	1.09	1.09	1.09

ALTITUDE (FEET ABOVE SEA LEVEL)

FUEL USAGE GUIDE:

This table shows the derate factor and full load set point timing required for a given fuel. Note that deration and set point timing adjustment may be required as the methane number decreases. Methane number is a scale to measure detonation characteristics of various fuels. The methane number of a fuel is determined by using the Caterpillar methane number calculation.

ALTITUDE DERATION FACTORS:

This table shows the deration required for various air inlet temperatures and altitudes. Use this information along with the fuel usage guide chart to help determine actual engine power for your site. The derate factors shown assume a specific air-to-core temperature rise and zero additional air flow restriction on the standard packaged radiator. Refer to TMI Systems Data for fan air flow and air-to-core temperature rise values. Increased fan airflow restriction or a different air-to-core rise value requires a Special Rating Request to determine actual engine power at your site. Additional rating may be available with a larger, custom radiator.

ACTUAL ENGINE RATING:

To determine the actual rating of the engine at site conditions, one must consider separately, limitations due to fuel characteristics and air system limitations. The Fuel Usage Guide deration establishes fuel limitations. The Altitude/Temperature deration factors and RPC (reference the Caterpillar Methane Program) establish air system limitations. RPC comes into play when the Altitude/Temperature deration is less than 1.0 (100%). Under this condition, add the two factors together. When the site conditions do not require an Altitude/Temperature derate (factor is 1.0), it is assumed the turbocharger has sufficient capability to overcome the low fuel relative power, and RPC is ignored. To determine the actual power available, take the lowest rating between 1) and 2).

1) Fuel Usage Guide Deration
2) 1-((1-Altitude/Temperature Deration) + (1-RPC))

AFTERCOOLER HEAT REJECTION FACTORS(ACHRF):

To maintain a constant air inlet manifold temperature, as the inlet air temperature goes up, so must the heat rejection. As altitude increases, the turbocharger must work harder to overcome the lower atmospheric pressure. This increases the amount of heat that must be removed from the inlet air by the aftercooler. Use the aftercooler heat rejection factor (ACHRF) to adjust for inlet air temp and altitude conditions. See notes 29 and 30 for application of this factor in calculating the heat exchanger sizing criteria. Failure to properly account for these factors could result in detonation and cause the engine to shutdown or fail.

INLET AND EXHAUST RESTRICTIONS FOR ALTITUDE CAPABILITY:

The altitude derate chart is based on the maximum inlet and exhaust restrictions provided on page 1. Contact factory for restrictions over the specified values. Heavy Derates for higher restrictions will apply.

NOTES:

1. Fuel pressure range specified is to the engine fuel control valve. Additional fuel train components should be considered in pressure and flow calculations.
2. Generator efficiencies, power factor, and voltage are based on standard generator. [Genset Power (ekW) is calculated as: Engine Power (bkW) x Generator Efficiency], [Genset Power (kVA) is calculated as: Engine Power (bkW) x Generator Efficiency / Power Factor]
3. Rating is with two engine driven water pumps. Tolerance is (+)3, (-)0% of full load.
4. Genset Efficiency published in accordance with ISO 3046/1, based on a 1.0 power factor.
5. Thermal Efficiency is calculated based on energy recovery from the jacket water, lube oil, 1st stage aftercooler, and exhaust to 248ºF with engine operation at ISO 3046/1 Genset Efficiency, and assumes unburned fuel is converted in an oxidation catalyst.
6. Total efficiency is calculated as: Genset Efficiency + Thermal Efficiency. Tolerance is ±10% of full load data.
7. ISO 3046/1 Genset fuel consumption tolerance is (+)5, (-)0% at the specified power factor. Nominal genset and engine fuel consumption tolerance is ± 2.5% of full load data at the specified power factor.
8. Air flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 5 %.
9. Inlet manifold pressure is a nominal value with a tolerance of ± 5 %.
10. Inlet manifold temperature is a nominal value with a tolerance of ± 9°F.
11. Timing indicated is for use with the minimum fuel methane number specified. Consult the appropriate fuel usage guide for timing at other methane numbers.
12. Exhaust temperature is a nominal value with a tolerance of (+)63°F, (-)54°F.
13. Exhaust flow value is on a 'wet' basis. Flow is a nominal value with a tolerance of ± 6 %.
14. Inlet and Exhaust Restrictions are maximum allowed values at the corresponding loads. Increasing restrictions beyond what is specified will result in a significant engine derate.
15. Emissions data is at engine exhaust flange prior to any after treatment.
16. NOx tolerances are ± 18% of specified value.
17. CO, CO2, THC, NMHC, NMNEHC, and HCHO values are "Not to Exceed" levels. THC, NMHC, and NMNEHC do not include aldehydes.
18. VOCs - Volatile organic compounds as defined in US EPA 40 CFR 60, subpart JJJJ
19. Exhaust Oxygen tolerance is ± 0.5; Lambda tolerance is ± 0.05. Lambda and Exhaust Oxygen level are the result of adjusting the engine to operate at the specified NOx level.
20. LHV rate tolerance is ± 2.5%.
21. Heat rejection to jacket water value displayed includes heat to jacket water alone. Value is based on treated water. Tolerance is ± 10% of full load data.
22. Heat rejection to atmosphere based on treated water. Tolerance is ± 50% of full load data.
23. Lube oil heat rate based on treated water. Tolerance is ± 20% of full load data.
24. Exhaust heat rate based on treated water. Tolerance is ± 10% of full load data.
25. Heat rejection to exhaust (LHV to 77°F) value shown includes unburned fuel and is not intended to be used for sizing or recovery calculations.
26. Heat rejection to A/C - Stage 1 based on treated water. Tolerance is ±5% of full load data.
27. Heat rejection to A/C - Stage 2 based on treated water. Tolerance is ±5% of full load data.
28. Pump power includes engine driven jacket water and aftercooler water pumps. Engine brake power includes effects of pump power.
29. Total Jacket Water Circuit heat rejection is calculated as: (JW x 1.1) + (OC x 1.2) + (1AC x 1.05) + [0.92 x (1AC + 2AC) x (ACHRF - 1) x 1.05]. Heat exchanger sizing criterion is maximum circuit heat rejection at site conditions, with applied tolerances. A cooling system safety factor may be multiplied by the total circuit heat rejection to provide additional margin.
30. Total Second Stage Aftercooler Circuit heat rejection is calculated as: (2AC x 1.05) + [(1AC + 2AC) x 0.08 x (ACHRF - 1) x 1.05]. Heat exchanger sizing criterion is maximum circuit heat rejection at site conditions, with applied tolerances. A cooling system safety factor may be multiplied by the total circuit heat rejection to provide additional margin.

FREE FIELD MECHANICAL & EXHAUST NOISE

MECHANICAL: Sound Power (1/3 Octave Frequencies)

Gen Power Without Fan	Percent Load	Engine Power	Overall	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz
ekW	%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
1561	100	2175	116.9	81.0	89.5	93.8	94.0	95.8	96.6	99.4	102.8	103.2	103.7
1171	75	1642	115.1	80.4	89.3	92.7	91.5	94.4	95.2	98.1	102.3	102.7	103.0
781	50	1109	113.6	78.5	86.5	89.3	86.2	91.0	93.2	96.7	102.0	100.7	102.0

MECHANICAL: Sound Power (1/3 Octave Frequencies)

Gen Power Without Fan	Percent Load	Engine Power	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz
ekW	%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
1561	100	2175	106.0	105.9	104.5	103.3	103.9	102.7	102.0	101.8	105.7	110.4	100.0
1171	75	1642	105.5	105.7	103.9	102.6	103.5	102.6	101.8	101.9	107.0	100.4	98.3
781	50	1109	104.7	104.9	103.1	101.8	102.9	101.8	100.9	101.9	98.4	97.3	97.3

EXHAUST: Sound Power (1/3 Octave Frequencies)

Gen Power Without Fan	Percent Load	Engine Power	Overall	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz
ekW	%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
1561	100	2175	123.3	105.3	116.7	113.3	109.5	101.9	101.2	106.0	103.4	97.8	100.6
1171	75	1642	122.1	103.9	116.3	113.3	109.8	101.0	98.5	105.2	101.6	94.9	100.8
781	50	1109	121.4	103.1	116.4	113.4	110.3	100.8	99.9	102.3	98.1	92.7	99.4

EXHAUST: Sound Power (1/3 Octave Frequencies)

Gen Power Without Fan	Percent Load	Engine Power	1 kHz	1.25 kHz	1.6 kHz	2 kHz	2.5 kHz	3.15 kHz	4 kHz	5 kHz	6.3 kHz	8 kHz	10 kHz
ekW	%	bhp	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
1561	100	2175	102.7	105.5	107.5	109.6	110.5	109.9	111.1	112.3	113.5	107.8	111.4
1171	75	1642	100.7	100.1	104.2	107.8	108.1	107.5	108.6	110.1	112.4	110.4	105.9
781	50	1109	99.0	100.2	102.6	105.9	106.3	105.4	106.6	108.9	113.1	105.1	102.4

SOUND PARAMETER DEFINITION:

Sound Power Level Data - DM8702-03

Sound power is defined as the total sound energy emanating from a source irrespective of direction or distance. Sound power level data is presented under two index headings:
Sound power level -- Mechanical
Sound power level -- Exhaust

Mechanical: Sound power level data is calculated in accordance with ISO 3747. The data is recorded with the exhaust sound source isolated.

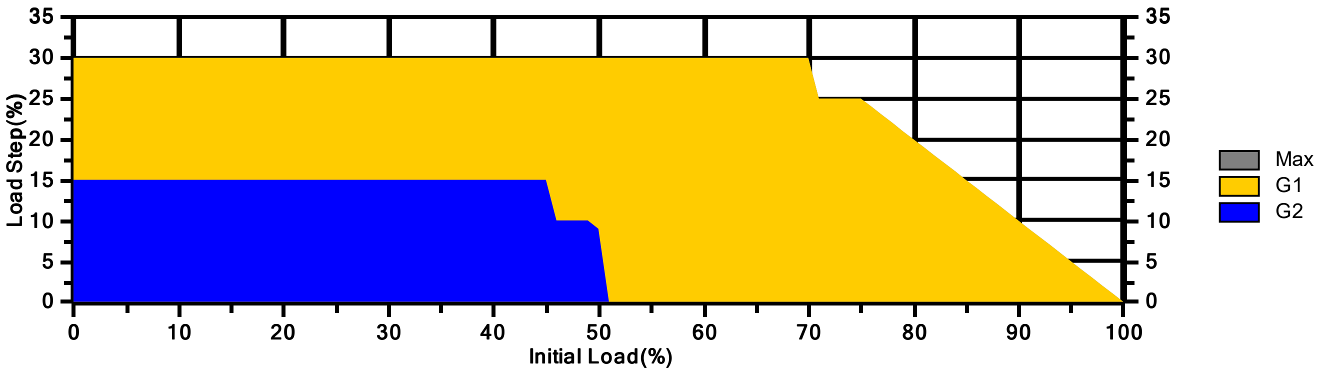
Exhaust: Sound power level data is calculated in accordance with ISO 6798 Annex A. Exhaust data is post-catalyst on gas engine ratings labeled as "Integrated Catalyst".

Measurements made in accordance with ISO 3747 and ISO 6798 for mechanical and exhaust sound level only. Frequency bands outside the displayed ranges are not measured, due to physical test, and environmental conditions that affect the accuracy of the measurement. No cooling system noise is included unless specifically indicated. Sound level data is indicative of noise levels recorded on one engine sample in a survey grade 3 environment.

How an engine is packaged, installed and the site acoustical environment will affect the site specific sound levels. For site specific sound level guarantees, sound data collection needs to be done on-site or under similar conditions.

LEC Hot Test Data

Load Acceptance



Transient Load Acceptance					
Load Step	Frequency Deviation +/- (%)	Voltage Deviation +/- (%)	Recovery Time (sec)	Classification as Defined by ISO 8528 - 5	Notes
30	+1/-10	+2/-19	5.1	G1	1
25	+1/-7	+1/-13	4.6	G1	1
20	+1/-6	+3/-12	4.6	G1	1
15	+2/-4	+1/-8	4.5	G1	1
10	+1/-4	+1/-7	4.4	G1	1
-10	+4/-1	+1/-1	5		
-15	+7/-3	+1/-5	18.3		
-20	+9/-3	+1/-6	21		
-25	+12/-10	+2/-16	20.5		
-30	+12/-9	+4/-16	20.5		
Recovery Specification	+1.75/-1.75	+5/-5			
Steady State Specification	+0.78/-0.78	+0.25/-0.25			

Transient Information

The transient load steps listed above are stated as a percentage of the engine's full rated load as indicated in the appropriate performance technical data sheet. Site ambient conditions, fuel quality, inlet/exhaust restriction and emissions settings will all affect engine response to load change. Engines that are not operating at the standard conditions stated in the Technical data sheet should be set up according to the guidelines included in the technical data; applying timing changes and/or engine derates as needed. Adherence to the engine settings guidelines will allow the engines to retain the transient performance stated in the tables above as a percentage of the site derated power (where appropriate).Fuel supply pressure and stability is critical to transient performance. Proper installation requires that all fuel train components (including filters, shut off valves, and regulators) be sized to ensure adequate fuel be delivered to the engine. The following are fuel pressure requirements to be measured at the engine mounted fuel control valve.

a. Steady State Fuel Pressure Stability +/- .15 psi/sec
b. Transient fuel Pressure Stability +/- .15 psi/sec

Inlet water temperature to the SCAC must be maintained at specified value for all engines. It is important that the external cooling system design is able to maintain the Inlet water temp to the SCAC to within +/- 1 °C during all engine-operating cycles. The SCAC inlet temperature stability criterion is to maintain stable inlet manifold air temperature. The Air Fuel Ratio control system requires up to 180 seconds to converge after a load step has been performed for NOx to return to nominal setting. If the stabilization time is not met between load steps the transient performance listed in the document may not be met. Differences in generator inertia may change the transient response of engine. Engine Governor gains and Voltage regulator settings may need to be tuned for site conditions. Engines must be maintained in accordance to guidelines specified in the Caterpillar Service Manuals applicable to each engine. Wear of components outside of the specified tolerances will affect the transient capability of the engine.Transient performance data is representative of a "Hot" (previously loaded or fully heat soaked) genset.

NOTES

1. The engines specified above have been tested against the voltage deviation, frequency deviation, and recovery time requirements defined in ISO 8528 - 5. At this time the engines stated above will meet class G1 transient performance as defined by ISO 8528 - 5 with exceptions.
2. The engines specified above have been tested against the voltage deviation, frequency deviation, and recovery time requirements defined in ISO 8528 - 5. At this time the engines stated above will meet class G2 transient performance as defined by ISO 8528 - 5 with exceptions.

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