

Environmental Protection Agency

§ 1066.1005

SFTP means the collection of test cycles as given in 1066.801(c)(2).

Standard reference conditions means the following:

(1) *Standard pressure* is 101.325 kPa.

(2) *Standard temperature* is 293.15 K.

Test interval means a period over which a vehicle's emission rates are determined separately. For many standards, compliance with the standard is based on a weighted average of the mass emissions from multiple test intervals. For example, the standard-setting part may specify a complete duty cycle as a cold-start test interval and a hot-start test interval. In cases where multiple test intervals occur over a duty cycle, the standard-setting part may specify additional calculations that weight and combine results to arrive at composite values for comparison against the applicable standards.

Test weight has the meaning given in §§ 1066.410(b) or 1066.805.

UDDS means the test cycle specified in Appendix I, paragraph (a), of 40 CFR part 86.

US06 means the test cycle specified in Appendix I, paragraph (g), of 40 CFR part 86.

Unloaded coastdown means a dynamometer coastdown run with the vehicle wheels removed from the roll surface.

We (us, our) means the Administrator of the Environmental Protection Agency and any authorized representatives.

§ 1066.1005 Symbols, abbreviations, acronyms, and units of measure.

The procedures in this part generally follow either the International System of Units (SI) or the United States customary units, as detailed in NIST Special Publication 811, which we incorporate by reference in § 1066.1010. See 40 CFR 1065.20 for specific provisions related to these conventions. This section summarizes the way we use symbols, units of measure, and other abbreviations.

(a) *Symbols for quantities.* This part uses the following symbols and units of measure for various quantities:

Symbol	Quantity	Unit	Unit symbol	Unit in terms of SI base units
α	atomic hydrogen to carbon ratio.	mole per mole	mol/mol	1
A	area	square meter	m ²	m ²
A	vehicle frictional load	pound force or newton	lbf or N	kg · s ⁻²
A_m	calculated vehicle frictional load.	pound force or newton	lbf or N	kg · s ⁻²
a_0	intercept of least squares regression.			
a_1	slope of least squares regression.			
a	acceleration	feet per second squared or meters per second squared.	ft/s ² or m/s ²	m · s ⁻²
B	vehicle load from drag and rolling resistance.	pound force per mile per hour or newton second per meter.	lbf/mph or N · s/m	kg · s ⁻¹ · m ⁻¹
β	ratio of diameters	meter per meter	m/m	1
β	atomic oxygen to carbon ratio	mole per mole	mol/mol	1
c	conversion factor.			
C	vehicle-specific aerodynamic effects.	pound force per mile per hour squared or newton second squared per meter squared.	lbf/mph ² or N · s ² /m ²	kg · m ⁻²
C_e	number of carbon atoms in a molecule.	C_e	number of carbon atoms in a molecule.	C_e
C_d	discharge coefficient.			
$C_p A$	drag area	meter squared	m ²	m ²
C_f	flow coefficient.			
C_p	heat capacity at constant pressure.	joule per kelvin	J/K	J · K ⁻¹
C_v	heat capacity at constant volume.	joule per kelvin	J/K	J · K ⁻¹
d	diameter	meters	m	m
D	distance	miles or meters	mi or m	m
D	slope correlation	pound force per mile per hour squared or newton second squared per meter squared.	lbf/mph ² or N · s ² /m ²	kg · m ⁻²
DF	dilution factor			1
e	mass weighted emission result	grams/mile	g/mi.	
F	force	pound force or newton	lbf or N	kg · s ⁻²

Symbol	Quantity	Unit	Unit symbol	Unit in terms of SI base units
f	frequency	hertz	Hz	s^{-1}
f_n	angular speed (shaft)	revolutions per minute	r/min	$2 \cdot \pi \cdot 60^{-1} \cdot m \cdot m^{-1} \cdot s^{-1}$
FC	friction compensation error	horsepower or watt	W	$kg \cdot m^2 \cdot s^{-3}$
FR	Road-load force	pound force or newton	lbf or N	$kg \cdot s^{-2}$
g	gravitational acceleration	meters per second squared	m/s^2	$m \cdot s^{-2}$
γ	ratio of specific heats	(joule per kilogram kelvin) per (joule per kilogram kelvin).	$(J/(kg \cdot K))/(J/(kg \cdot K))$	1
H	ambient humidity	grams water vapor per kilogram dry air.	g H ₂ O vapor/kg dry air.	g H ₂ O vapor/kg dry air
Δh	change in height	meters	m	m
I	inertia	pound mass or kilogram	lbm or kg	kg
I	current	ampere	A	A
i	indexing variable.			
IR	inertia work rating.			
K	correction factor			1
K_c	calibration coefficient		$m^4 \cdot s \cdot K^{0.5}/kg$	$m^4 \cdot s \cdot K^{0.5} \cdot kg^{-1}$
μ	viscosity, dynamic	pascal second	Pa · s	$m^{-1} \cdot kg \cdot s^{-1}$
M	molar mass	gram per mole	g/mol	$10^{-3} \cdot kg \cdot mol^{-1}$
M_e	effective mass	kilogram	kg	kg
m	mass	pound mass or kilogram	lbm or kg	kg
N	total number in series.			
n	total number of pulses in a series.			
p	pressure	pascal	Pa	$m^{-1} \cdot kg \cdot s^{-2}$
Δp	differential static pressure	pascal	Pa	$m^{-1} \cdot kg \cdot s^{-2}$
p_d	saturated vapor pressure at ambient dry bulb temperature.	kilopascal	kPa	$m^{-1} \cdot kg \cdot s^{-2}$
PF	penetration fraction.			
Q	flow	cubic feet or cubic meter	ft ³ or m ³	m ³
Q	flow rate	cubic feet per minute or cubic meter per second.	ft ³ /min or m ³ /s	m ³ /s
ρ	mass density	kilogram per cubic meter	kg/m ³	kg · m ⁻³
R	dynamometer roll revolutions ..	revolutions per minute	rpm	$2 \cdot \pi \cdot 60^{-1} \cdot m \cdot m^{-1} \cdot s^{-1}$
r	ratio of pressures	pascal per pascal	Pa/Pa	1
r^2	coefficient of determination.			
$Re^{\#}$	Reynolds number.			
RF	response factor.			
RH	relative humidity.			
S	Sutherland constant	kelvin	K	K
SEE	standard estimate of error.			
SG	specific gravity.			
Δs	distance traveled during measurement interval.	meters	m	m
T	absolute temperature	kelvin	K	K
T	Celsius temperature	degree Celsius	°C	K - 273.15
T	torque (moment of force)	newton meter	N · m	$m^2 \cdot kg \cdot s^{-2}$
t	time	second	s	s
Δt	time interval, period, 1/frequency.	second	s	s
U	voltage	volt	V	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-1}$
v	speed	miles per hour or meters per second.	mph or m/s	$m \cdot s^{-1}$
V	volume	cubic meter	m ³	m ³
VP	volume percent.			
x	concentration of emission over a test interval.	part per million	ppm.	
y	generic variable.			
Z	compressibility factor	Z	compressibility factor	Z

(b) *Symbols for chemical species.* This part uses the following symbols for chemical species and exhaust constituents:

Symbol	Species
CH ₄	methane.
CH ₃ OH	methanol.
CH ₂ O	formaldehyde.
C ₂ H ₄ O	acetaldehyde.
C ₂ H ₅ OH	ethanol.
C ₂ H ₆	ethane.

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Symbol	Species
C ₃ H ₇ OH	propanol.
C ₃ H ₈	propane.
C ₄ H ₁₀	butane.
C ₅ H ₁₂	pentane.
CO	carbon monoxide.
CO ₂	carbon dioxide.
H ₂ O	water.
HC	hydrocarbon.
N ₂	molecular nitrogen.
NMHC	nonmethane hydrocarbon.
NMHCE	nonmethane hydrocarbon equivalent.
NMOG	nonmethane organic gas.
NO	nitric oxide.
NO ₂	nitrogen dioxide.
NO _x	oxides of nitrogen.
N ₂ O	nitrous oxide.
O ₂	molecular oxygen.
OHC	oxygenated hydrocarbon.
PM	particulate matter.
THC	total hydrocarbon.
THCE	total hydrocarbon equivalent.

Subscript	Quantity
i	an individual of a series.
ID	driven inertia.
in	inlet.
int	intake.
init	initial quantity, typically before an emission test.
IT	target inertia.
liq	liquid.
max	the maximum (i.e. peak) value expected at the standard over a test interval; not the maximum of an instrument range.
meas	measured quantity.
mix	dilute exhaust gas mixture.
out	outlet.
PM	particulate matter.
record	record.
ref	reference quantity.
rev	revolution.
roll	dynamometer roll.
s	settling.
s	slip.
s	stabilized.
sat	saturated condition.
SC03	air conditioning driving schedule.
span	span quantity.
sda	secondary dilution air.
std	standard conditions.
T	target.
t	throat.
test	test quantity.
uncor	uncorrected quantity.
w	weighted.
zero	zero quantity.

(c) *Superscripts.* This part uses the following superscripts to define a quantity:

Superscript	Quantity
overbar (such as \bar{y})	arithmetic mean.
overdot (such as \dot{y})	quantity per unit time.

(d) *Subscripts.* This part uses the following subscripts to define a quantity:

Subscript	Quantity
0	reference.
abs	absolute quantity.
AC17	air conditioning 2017 test interval.
act	actual or measured condition.
actint	actual or measured condition over the speed interval.
adj	adjusted.
air	air, dry.
atmos	atmospheric.
b	base.
bkgnd	background.
c	cold.
comp	composite.
cor	corrected.
cs	cold stabilized.
ct	cold transient.
cUDDS	cold-start UDDS.
D	driven.
dew	dewpoint.
dexh	dilute exhaust quantity.
dil	dilute.
e	effective.
emission	emission specie.
error	error.
ETOH	ethanol.
exh	raw exhaust quantity.
exp	expected quantity.
fil	filter.
final	final.
flow	flow measurement device type.
gas	gaseous.
h	hot.
HFET	highway fuel economy test.
hs	hot stabilized.
ht	hot transient.
hUDDS	hot-start UDDS.

(e) *Other acronyms and abbreviations.* This part uses the following additional abbreviations and acronyms:

A/C	air conditioning.
AC17	air conditioning 2017 test interval.
ALVW	adjusted loaded vehicle weight.
ASME	American Society of Mechanical Engineers.
CFR	Code of Federal Regulations.
CFV	critical-flow venturi.
CNG	compressed natural gas.
CVS	constant-volume sampler.
EPA	Environmental Protection Agency.
ETW	equivalent test weight.
EV	electric vehicle.
FID	flame-ionization detector.
FTP	Federal test procedure.
GC	gas chromatograph.
GEM	greenhouse gas emissions model.
GHG	greenhouse gas (including CO ₂ , N ₂ O, and CH ₄).
GPS	global positioning system.
GVWR	gross vehicle weight rating.
HEV	hybrid electric vehicle, including plug-in hybrid electric vehicles.
HFET	highway fuel economy test.
HLDT	heavy light-duty truck.
HPLC	high pressure liquid chromatography.
IBR	incorporated by reference.
LA-92	Los Angeles 1992 driving schedule.
MDPV	medium-duty passenger vehicle.
NIST	National Institute for Standards and Technology.

NMC	nonmethane cutter.	SI	International System of Units.
PDP	positive-displacement pump.	SSV	subsonic venturi.
PHEV	plug-in hybrid electric vehicle.	UDDS	urban dynamometer driving schedule.
PM	particulate matter.	US06	aggressive driving schedule.
RESS	rechargeable energy storage system.	U.S.C.	United States Code.
ppm	parts per million.	WWV	NIST radio station call sign.
SAE	Society of Automotive Engineers.		
SC03	air conditioning driving schedule.		
SEA	selective enforcement audit.		
SFTP	supplemental federal test procedure.		

(f) This part uses the following densities of chemical species:

Symbol	Quantity ^{1 2}	g/m ³	g/ft ³
ρ_{CH4}	density of methane	666.905	18.8847
ρ_{CH3OH}	density of methanol	1332.02	37.7185
ρ_{C2H5OH}	C ₁ -equivalent density of ethanol	957.559	27.1151
ρ_{C2H4O}	C ₁ -equivalent density of acetaldehyde	915.658	25.9285
ρ_{C3H8}	density of propane	611.035	17.3026
ρ_{C3H7OH}	C ₁ -equivalent density of propanol	832.74	23.5806
ρ_{CO}	density of carbon monoxide	1164.41	32.9725
ρ_{CO2}	density of carbon dioxide	1829.53	51.8064
ρ_{HC-gas}	effective density of hydrocarbon—gaseous fuel ³	(see 3)	(see 3)
ρ_{CH2O}	density of formaldehyde	1248.21	35.3455
ρ_{HC-liq}	effective density of hydrocarbon—liquid fuel ⁴	576.816	16.3336
$\rho_{NMHC-gas}$	effective density of nonmethane hydrocarbon—gaseous fuel ³	(see 3)	(see 3)
$\rho_{NMHC-liq}$	effective density of nonmethane hydrocarbon—liquid fuel ⁴	576.816	16.3336
$\rho_{NMHCE-gas}$	effective density of nonmethane equivalent hydrocarbon—gaseous fuel ³	(see 3)	(see 3)
$\rho_{NMHCE-liq}$	effective density of nonmethane equivalent hydrocarbon—liquid fuel ⁴	576.816	16.3336
ρ_{NOx}	effective density of oxides of nitrogen ⁵	1912.5	54.156
ρ_{N2O}	density of nitrous oxide	1829.66	51.8103
$\rho_{THC-liq}$	effective density of total hydrocarbon—liquid fuel ⁴	576.816	16.3336
$\rho_{THCE-liq}$	effective density of total equivalent hydrocarbon—liquid fuel ⁴	576.816	16.3336

¹ Densities are given at 20 °C and 101.325 kPa.
² Densities for all hydrocarbon containing quantities are given in g/m³-carbon atom and g/ft³-carbon atom.
³ The effective density for natural gas fuel and liquefied petroleum gas fuel are defined by an atomic hydrogen-to-carbon ratio, α , of the hydrocarbon components of the test fuel. $\rho_{HC-gas} = 41.57 \cdot (12.011 + (\alpha \cdot 1.008))$.
⁴ The effective density for gasoline and diesel fuel are defined by an atomic hydrogen-to-carbon ratio, α , of 1.85.
⁵ The effective density of NO_x is defined by the molar mass of nitrogen dioxide, NO₂.

(g) Constants. (1) This part uses the following constants for the composition of dry air:

Symbol	Quantity	mol/mol
X_{Ar-air}	amount of argon in dry air	0.00934
$X_{CO2-air}$	amount of carbon dioxide in dry air	0.000375
X_{N2-air}	amount of nitrogen in dry air	0.78084
X_{O2-air}	amount of oxygen in dry air	0.209445

(2) This part uses the following molar masses or effective molar masses of chemical species:

Symbol	Quantity	g/mol (10 ⁻³ · kg · mol ⁻¹)
M_{air}	molar mass of dry air ¹	28.96559
M_{H2O}	molar mass of water	18.01528

¹ See paragraph (g)(1) of this section for the composition of dry air.

(3) This part uses the following molar gas constant for ideal gases:

Symbol	Quantity	J/(mol · K) (m ² · kg · s ⁻² · mol ⁻¹ · K ⁻¹)
R	molar gas constant	8.314472

(h) *Prefixes.* This part uses the following prefixes to define a quantity:

Symbol	Quantity	Value
μ	micro	10 ⁻⁶
m	milli	10 ⁻³
c	centi	10 ⁻²
k	kilo	10 ³
M	mega	10 ⁶
n	nano	10 ⁻⁹

§ 1066.1010 Incorporation by reference.

(a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, a document must be published in the FEDERAL REGISTER and the material must be available to the public. All approved material is available for inspection at U.S. EPA, Air and Radiation Docket and Information Center, 1301 Constitution Ave. NW., Room B102, EPA West Building, Washington, DC 20460, (202) 202-1744, and is available from the sources listed below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.

To enforce any edition other than that specified in this section, a document must be published in the FEDERAL REGISTER and the material must be available to the public.

(b) *SAE International material.* The following standards are available from SAE International, 400 Commonwealth Dr., Warrendale, PA 15096-0001, (877) 606-7323 (U.S. and Canada) or (724) 776-4970 (outside the U.S. and Canada), or <http://www.sae.org>:

(1) SAE J1263, Road Load Measurement and Dynamometer Simulation Using Coastdown Techniques, revised March 2010, IBR approved for §§ 1066.301(b), 1066.305, and 1066.310(b).

(2) SAE J1634, Battery Electric Vehicle Energy Consumption and Range Test Procedure, revised October 2012, IBR approved for § 1066.501(a).

(3) SAE J1711, Recommended Practice for Measuring the Exhaust Emis-

sions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-In Hybrid Vehicles, revised June 2010, IBR approved for § 1066.501(a).

(4) SAE J2263, Road Load Measurement Using Onboard Anemometry and Coastdown Techniques, revised December 2008, IBR approved for §§ 1066.301(b), 1066.305, and 1066.310(b).

(5) SAE J2264, Chassis Dynamometer Simulation of Road Load Using Coastdown Techniques, revised January 2014, IBR approved for § 1066.315.

(6) SAE J2711, Recommended Practice for Measuring Fuel Economy and Emissions of Hybrid-Electric and Conventional Heavy-Duty Vehicles, issued September 2002, IBR approved for § 1066.501(a).

(7) SAE J2951, Drive Quality Evaluation for Chassis Dynamometer Testing, revised January 2014, IBR approved for § 1066.425(j).

(c) National Institute of Standards and Technology material. The following documents are available from National Institute of Standards and Technology, 100 Bureau Drive, Stop 1070, Gaithersburg, MD 20899-1070, (301) 975-6478, or www.nist.gov:

(1) NIST Special Publication 811, 2008 Edition, Guide for the Use of the International System of Units (SI), Physics Laboratory, March 2008, IBR approved for §§ 1066.20(a) and 1066.1005.

(2) [Reserved]

PART 1068—GENERAL COMPLIANCE PROVISIONS FOR HIGHWAY, STATIONARY, AND NONROAD PROGRAMS

Subpart A—Applicability and Miscellaneous Provisions

Sec.

- 1068.1 Does this part apply to me?
- 1068.2 How does this part apply for engines and how does it apply for equipment?
- 1068.5 How must manufacturers apply good engineering judgment?
- 1068.10 What provisions apply to confidential information?
- 1068.15 What general provisions apply for EPA decision-making?
- 1068.20 May EPA enter my facilities for inspections?
- 1068.25 What information must I give to EPA?
- 1068.27 May EPA conduct testing with my production engines/equipment?