

section, filters, and so forth) in the heated portion of the sampling system that has a separate source of power or heating element. Monitor the temperature at that location. If several components are within an oven, then only the surface temperature of the component with the largest thermal mass and the oven temperature need be measured.

(b) If water is removed by condensation, monitor the sample gas temperature or sample dew point either within the water trap or downstream. It may not exceed 7 °C.

§ 90.328 Measurement equipment accuracy/calibration frequency table.

(a) The accuracy of measurements must be such that the maximum tolerances shown in Table 2 in Appendix A of this subpart are not exceeded.

(b) All equipment and analyzers must be calibrated according to the frequencies shown in Table 2 in Appendix A of this subpart.

(c) Prior to initial use and after major repairs, bench check each analyzer (see § 90.323).

(d) Calibrate equipment as specified in § 90.306 and §§ 90.315 through 90.322.

(e) At least monthly, or after any maintenance which could alter calibration, perform the following calibrations and checks.

(1) Leak check the vacuum side of the system (see § 90.324(a)).

(2) Verify that the automatic data collection system (if used) meets the requirements found in Table 2 in Appendix A of this subpart.

(3) Check the fuel flow measurement instrument to insure that the specifications in Table 2 in Appendix A of this subpart are met.

(f) Verify that all NDIR analyzers meet the water rejection ratio and the CO₂ rejection ratio as specified in § 90.325.

(g) Verify that the dynamometer test stand and power output instrumentation meet the specifications in Table 2 in Appendix A of this subpart.

§ 90.329 Catalyst thermal stress test.

(a) *Oven characteristics.* The oven used for thermally stressing the test catalyst must be capable of maintaining a temperature of 500 ± 5 °C and 1000 ± 10 °C.

(b) *Evaluation gas composition.* (1) A synthetic exhaust gas mixture is used for evaluating the effect of thermal stress on catalyst conversion efficiency.

(2) The synthetic exhaust gas mixture must have the following composition:

Constituent	Volume percent	Parts per million
Carbon Monoxide	1	.....
Oxygen	1.3	.....
Carbon Dioxide	3.8	.....
Water Vapor	10	.....
Sulfur dioxide .....	.....	20
Oxides of nitrogen .....	.....	280
Hydrogen .....	.....	3500
Hydrocarbon* .....	.....	4000
Nitrogen = Balance		

* Propylene/propane ratio = 2/1.

(c) *Phase 2 engines.* The catalyst thermal stress test is not required for engine families certified to the Phase 2 standards.

[60 FR 34598, July 3, 1995, as amended at 64 FR 15243, Mar. 30, 1999]

APPENDIX A TO SUBPART D OF PART 90—TABLES

TABLE 1—SYMBOLS USED IN SUBPART D

Symbol	Term	Unit
CO	Carbon monoxide.	
CO ₂	Carbon dioxide.	
NO	Nitric oxide.	
NO ₂	Nitrogen dioxide.	
NO _x	Oxides of nitrogen.	
O ₂	Oxygen.	
conc	Concentration (ppm by volume)	ppm
f	Engine specific parameter considering atmospheric conditions.	
F _{FCB}	Fuel specific factor for the carbon balance calculation.	
F _{FD}	Fuel specific factor for exhaust flow calculation on dry basis.	
F _{FH}	Fuel specific factor representing the hydrogen to carbon ratio.	

TABLE 1—SYMBOLS USED IN SUBPART D—Continued

Symbol	Term	Unit
F_{FW}	Fuel specific factor for exhaust flow calculation on wet basis.	
G_{AIRW}	Intake air mass flow rate on wet basis	kg/h
G_{AIRD}	Intake air mass flow rate on dry basis	kg/h
G_{EXHW}	Exhaust gas mass flow rate on wet basis	kg/h
G_{FUEL}	Fuel mass flow rate	kg/h
H	Absolute humidity (water content related to dry air)	gr/kg
i	Subscript denoting an individual mode.	
K_H	Humidity correction factor.	
L	Percent torque related to maximum torque for the test mode	percent
mass	Pollutant mass flow	g/h
$n_{d,i}$	Engine speed (average at the i'th mode during the cycle)	1/min
P_a	Dry atmospheric pressure	kPa
P_d	Test ambient saturation vapor pressure at ambient temperature	kPa
P	Gross power output uncorrected	kW
P_{AUX}	Declared total power absorbed by auxiliaries fitted for the test	kW
P_M	Maximum power measured at the test speed under test conditions	kW
P_i	$P_i = P_{M,i} + P_{AUX,i}$	
P_B	Total barometric pressure (average of the pre-test and post-test values)	kPa
R_h	Relative humidity of the ambient air	percent
T	Absolute temperature at air inlet	C
T_{be}	Air temperature after the charge air cooler (if applicable) (average)	C
T_{clout}	Coolant temperature outlet (average)	C
T_{dp}	Absolute dew point temperature	C
$T_{d,i}$	Torque (average at the i'th mode during the cycle)	N-m
T_{SC}	Temperature of the intercooled air	C
T_{ref}	Reference temperature	C
V_{EXHD}	Exhaust gas volume flow rate on dry basis	m ³ /h
V_{AIRW}	Intake air volume flow rate on wet basis	m ³ /h
P_B	Total barometric pressure	kPa
V_{EXHW}	Exhaust gas volume flow rate on wet basis	m ³ /h
WF	Weighing factor.	
WF_E	Effective weighing factor.	

TABLE 2—MEASUREMENT CALIBRATION ACCURACY AND FREQUENCY

No.	Item	Permissible deviation from reading*		Calibration frequency
		Non-idle	Idle	
1 ...	Engine speed	± 2 %	Same	Monthly or within one month prior to the certification test.
2 ...	Torque	± 2 % .....	.....	Monthly or within one month prior to the certification test.
3 ...	Fuel consumption	± 2 %	±5%	Monthly or within one month prior to the certification test.
4 ...	Air consumption	± 2 %	±5%	As required.
5 ...	Coolant temperature	± 2 °C	Same	As required.
6 ...	Lubricant temperature	± 2 °C	Same	As required.
7 ...	Exhaust back pressure	± 5 %	Same	As required.
8 ...	Inlet depression	± 5 %	Same	As required.
9 ...	Exhaust gas temperature	± 15 °C	Same	As required.
10	Air inlet temperature (combustion air) ..	± 2 °C	Same	As required.
11	Atmospheric pressure	± 0.5 %	Same	As required.
12	Humidity (combustion air) (relative)	± 3.0 %	Same	As required.
13	Fuel temperature	± 2 °C	Same	As required.
14	Temperature with regard to dilution system.	± 2 °C	Same	As required.
15	Dilution air humidity	± 3 % absolute	Same	As required.
16	HC analyzer	± 2 %**	Same	Monthly or within one month prior to the certification test.
17	CO analyzer	± 2 %**	Same	Monthly or within one month prior to the certification test.
18	NO _x analyzer	± 2 %**	Same	Monthly or within one month prior to the certification test.
19	NO _x converter check	90 %	Same	Monthly or within one month prior to the certification test.
20	CO ₂ analyzer	± 2 %**	Same	Monthly or within one month prior to the certification test.

* All accuracy requirements pertain to the final recorded value which is inclusive of the data acquisition system.

** If reading is under 100 ppm then the accuracy shall be ± 2 ppm.

TABLE 3—TEST FUEL SPECIFICATIONS

Item	Property	Tolerances	Procedure (ASTM) ¹
Sulfur, ppm max.	339 .....	.....	D 2622-92
Benzene, max. %	1.5 .....	.....	D 3606-92
RVP, psi	8.7	±0.2	D 5191-93a
Octane, R+M/2	87.3	±0.5	D 2699-92 D 2700-92
IBP, °C	32.8	±11.0	D 86-93
10 % point, °C	53.3	±5.5	D 86-93
50 % point, °C	103.3	±5.5	D 86-93
90 % point, °C	165.6	±5.5	D 86-93
End Point, max. °C	212.8 .....	.....	D 86-93
Phosphorus, g/liter, max.	0.02 .....	.....	D 3231-89
Lead, g/liter, max.	0.02 .....	.....	.....
Manganese, g/liter, max.	0.004 .....	.....	.....
Aromatics, %	32.0	±4.0	D 1319-89
Olefins, %	9.2	±4.0	D 1319-89
Saturates, %	Remainder .....	.....	D 1319-89

¹ All ASTM procedures in this table have been incorporated by reference. See § 90.7.

APPENDIX B TO SUBPART D OF PART 90—FIGURES

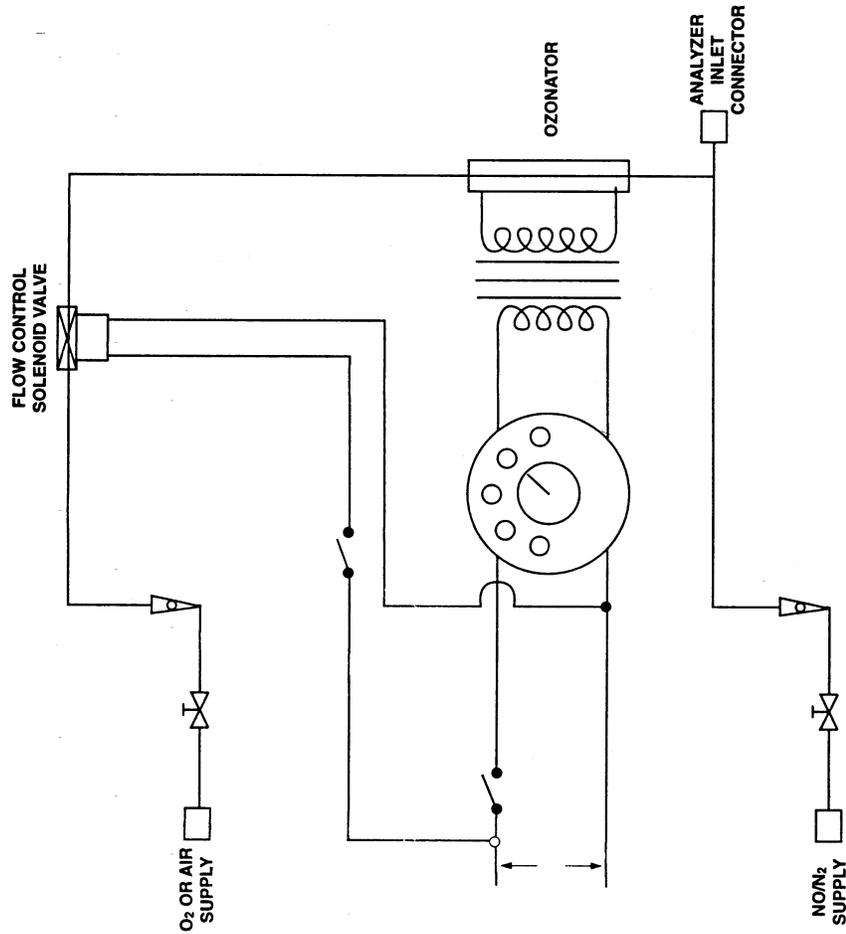
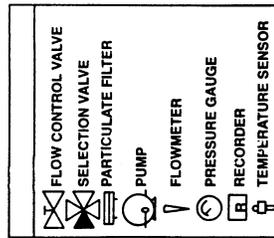


Figure 1. — NOx Converter Efficiency Detector



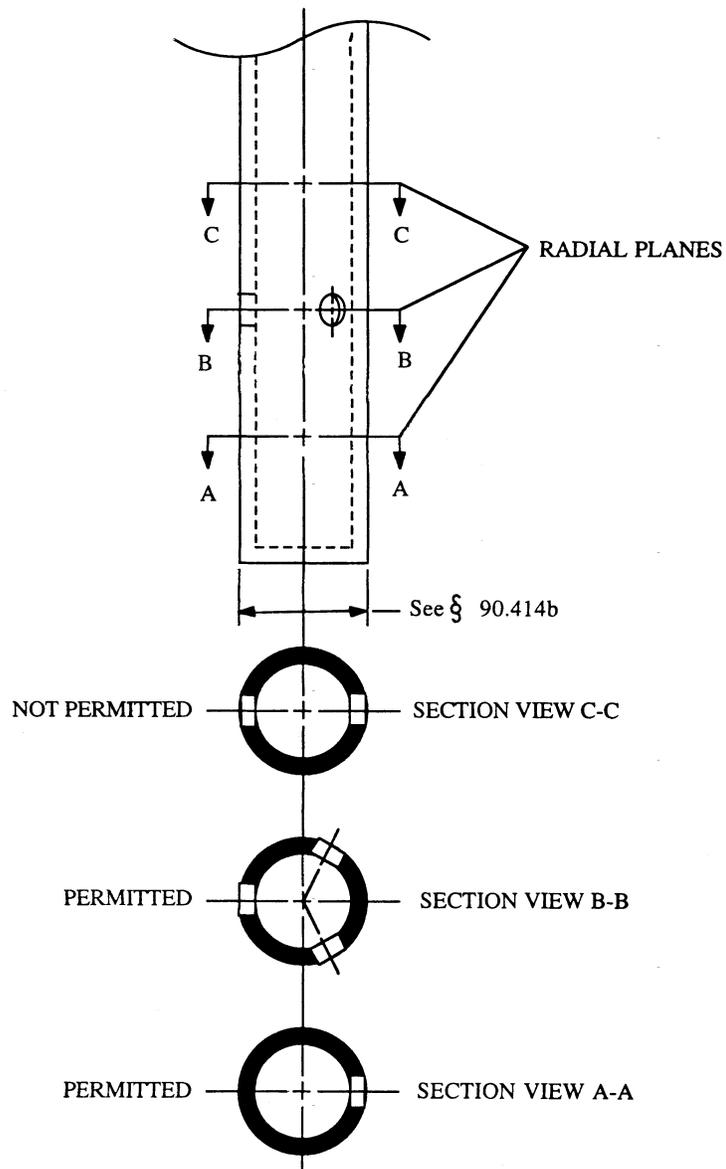


Figure 2.--Sample Probe and Typical Hole Spacings