

$$G_s = \frac{12.011 \times HC_{\text{mass}}}{12.011 + 1.008\alpha} + 0.429CO_{\text{mass}} + 0.273CO_{2\text{mass}}$$

Where:

HC_{mass} = mass of hydrocarbon emissions for the mode sampling period [g].

CO_{mass} = mass of carbon monoxide emissions for the mode sampling period [g].

$CO_{2\text{mass}}$ = mass of carbon dioxide emissions for the mode sampling period [g].

α = The atomic hydrogen to carbon ratio of the fuel.

§ 91.427 Catalyst thermal stress resistance evaluation.

(a)(1) The purpose of the evaluation procedure specified in this section is to determine the effect of thermal stress on catalyst conversion efficiency. The thermal stress is imposed on the test catalyst by exposing it to quiescent heated air in an oven. The evaluation of the effect of such stress on catalyst performance is based on the resultant degradation of the efficiency with which the conversions of specific pollutants are promoted. The application of this evaluation procedure involves the several steps that are described in the following paragraphs.

(2) The engine manufacturer need not submit catalyst conversion efficiency data for pollutants that the catalyst being tested was not designed to reduce/oxidize. The engine manufacturer must specify the pollutants that the catalyst will be converting and submit catalyst conversion efficiency data on only those pollutants.

(b) Determination of initial conversion efficiency.

(1) A synthetic exhaust gas mixture having the composition specified in § 91.329 is heated to a temperature of 450 ± 5 °C and passed through the new test catalyst or, optionally, a test catalyst that has been exposed to temperatures less than or equal to 500 °C for less than or equal to two hours, under flow conditions that are representative of anticipated in-use conditions.

(2) The concentration of each pollutant of interest, that is, hydrocarbons, carbon monoxide, or oxides of nitrogen, in the effluent of the catalyst is determined by means of the instrumenta-

tion that is specified for exhaust gas analysis in subpart D of this part.

(3) The conversion efficiency for each pollutant is determined by:

(i) Subtracting the effluent concentration from the initial concentration,

(ii) Dividing this result by the initial concentration,

(iii) Multiplying this result by 100 percent.

(c) Imposition of thermal stress.

(1) The catalyst is placed in an oven that has been pre-heated to 1000 °C and the temperature of the air in the oven is maintained at 1000 ± 10 °C for six hours. Optionally, the catalyst may instead be placed in an oven having a 90% nitrogen/10% water vapor environment that has been pre-heated to at least 850 °C and the temperature of the nitrogen/water vapor environment in the oven is maintained at 850 ± 10 °C for six hours.

(2) The catalyst is removed from the oven and allowed to cool to room temperature.

(d) Determination of final conversion efficiency. The steps listed in paragraph (b) of this section are repeated.

(e) Determination of conversion efficiency degradation.

(1) The final conversion efficiency determined in paragraph (c) of this section is subtracted from the initial conversion efficiency determined in paragraph (b) of this section.

(2) This result is divided by the initial conversion efficiency.

(3) This result is multiplied by 100 percent.

(f) Determination of compliance with degradation limit. The percent degradation determined in paragraph (e) of this section must not be greater than 20 percent.

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**APPENDIX A TO SUBPART E OF PART 91—
TABLES**

**TABLE 2—TEST CYCLE AND WEIGHTING
FACTORS FOR MARINE ENGINES>**

**TABLE 1—PARAMETERS TO BE MEASURED OR
CALCULATED AND RECORDED**

Parameter	Units
Airflow rate (dry), if applicable	g/h
Fuel flow rate	g/h
Engine speed	rpm
Engine torque output	N · m
Power output	kW
Air inlet temperature	°C
Air humidity	mg/kg
Coolant temperature (liquid cooled)	°C
Exhaust mixing chamber surface temperature, if applicable.	°C
Exhaust sample line temperature, if applicable ..	°C
Total accumulated hours of engine operation	h
Barometric pressure	kPa

Mode No.	Engine speed as a percentage of engine rated speed	Engine torque as a percentage of maximum torque at rated speed	Mode weighting factor
1	100	100	0.06
2	80	71.6	0.14
3	60	46.5	0.15
4	40	25	0.25
5	idle	0	0.40

APPENDIX B TO SUBPART E OF PART 91—FIGURES

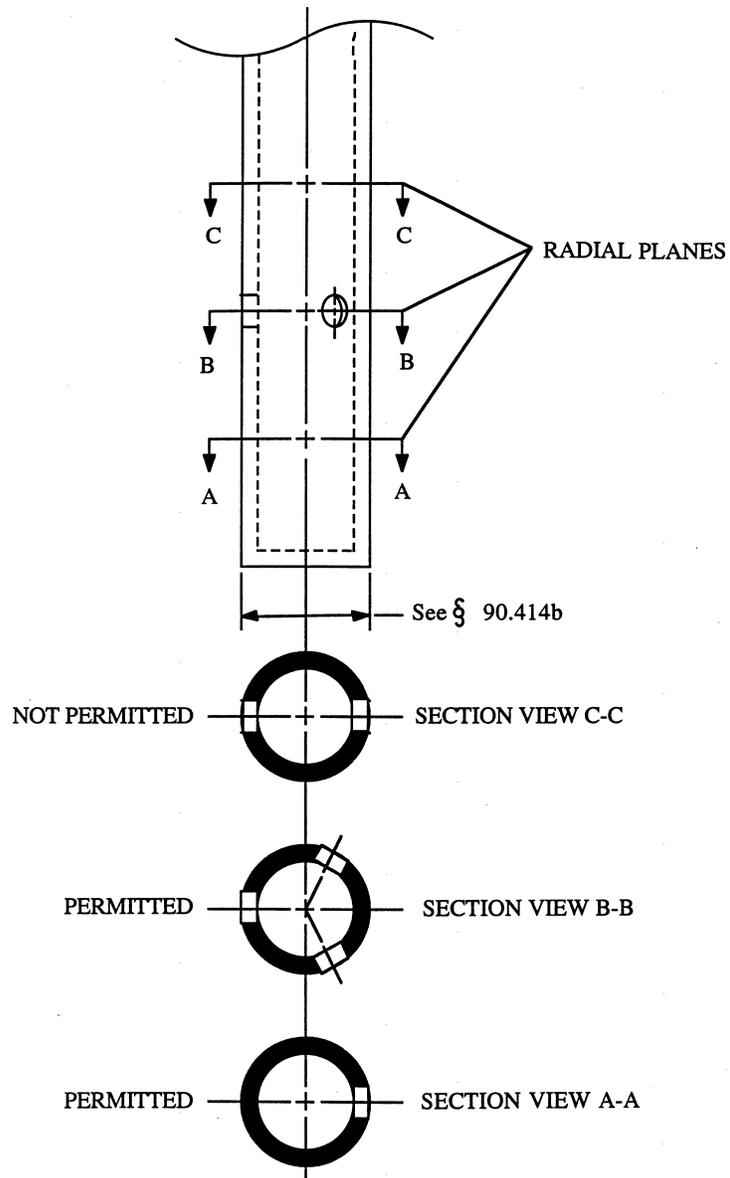
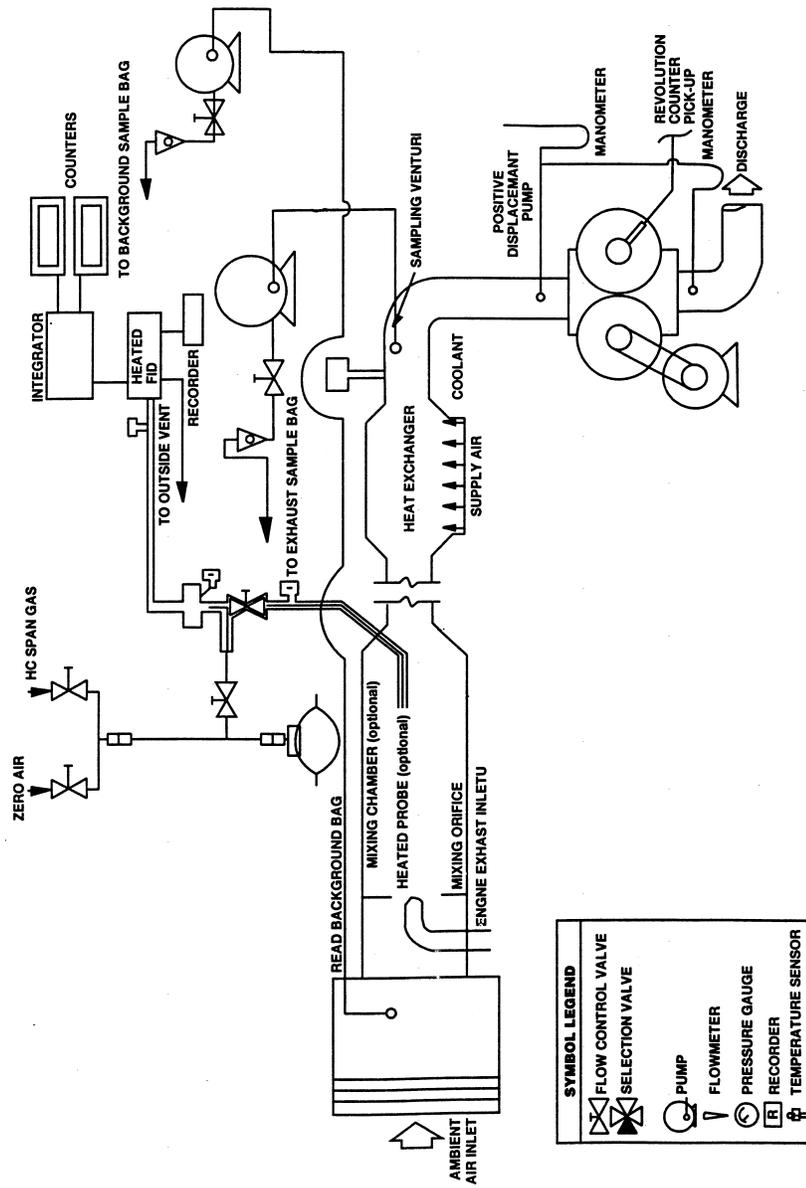


Figure 1.—Sample Probe and Typical Hole Spacings



**Figure 2 — Gaseous Emissions Sampling System (PDP-CVS)
Showing both grab bag sampling and continuous sampling**

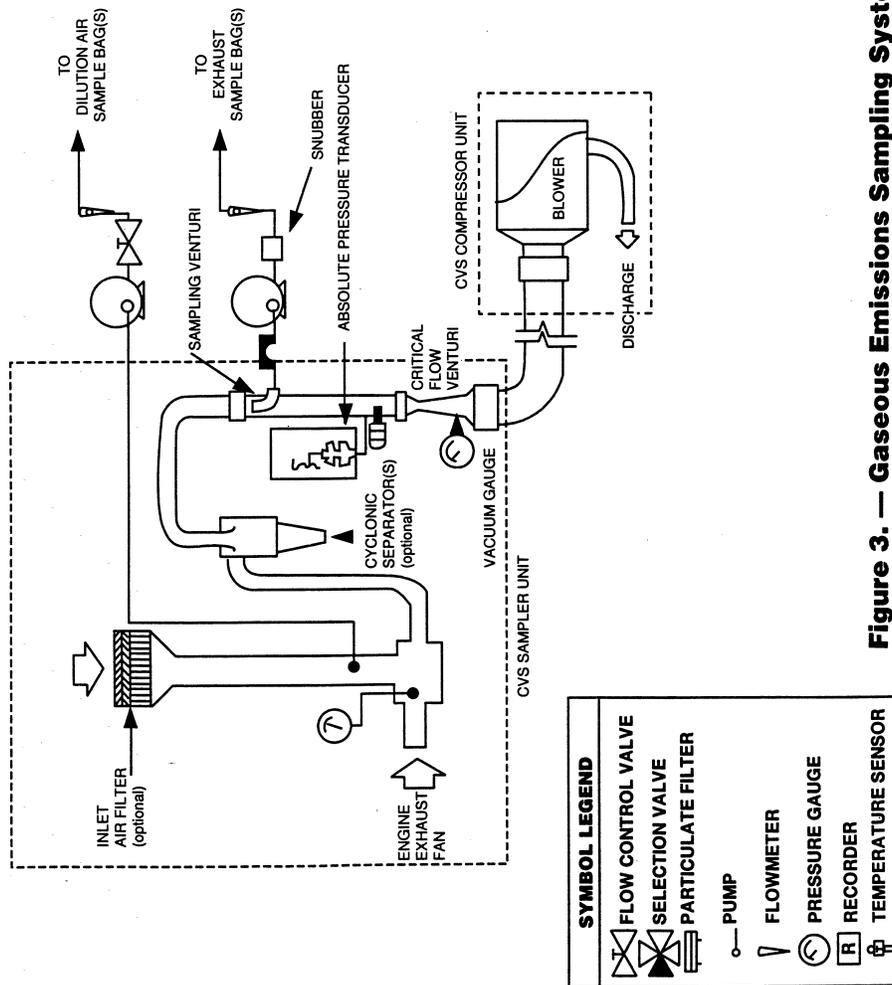


Figure 3. — Gaseous Emissions Sampling System (CVF-CVS)

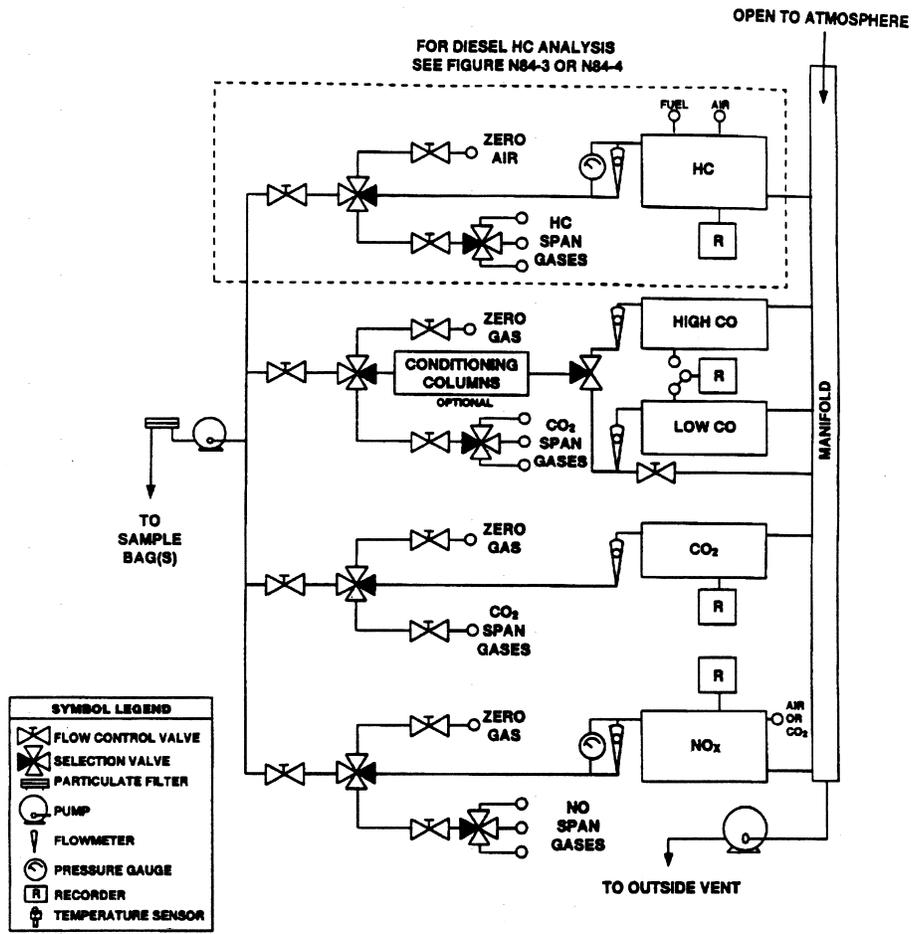


Figure 4. — Exhaust Gas Analytical System

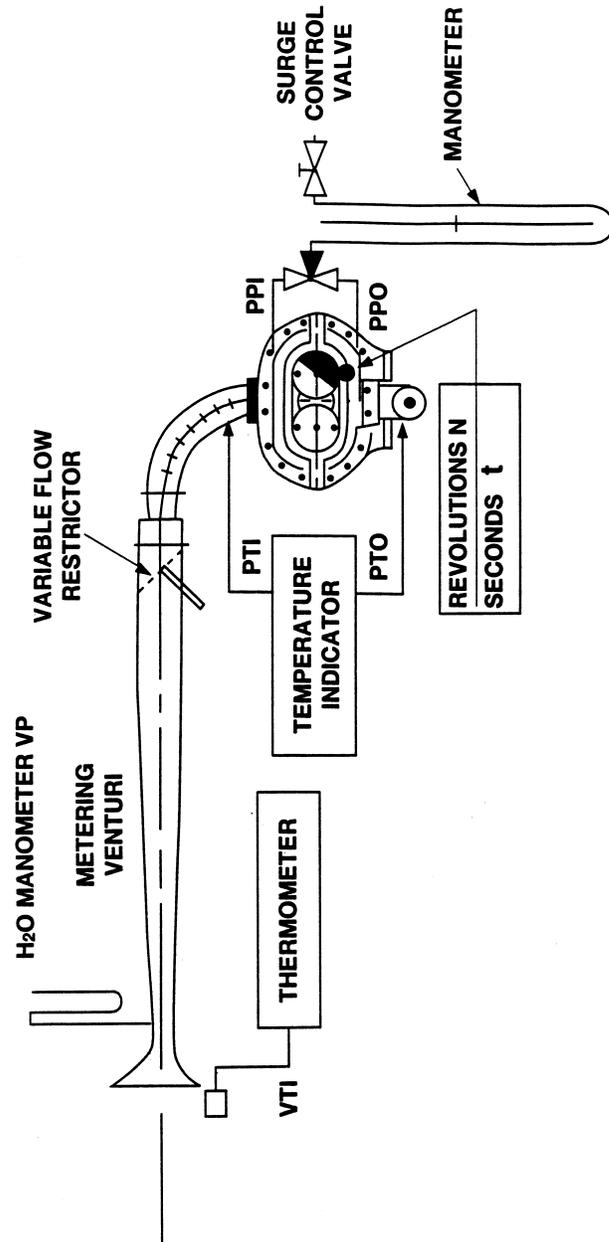


Figure 5. — PDP-CVS Calibration Configuration

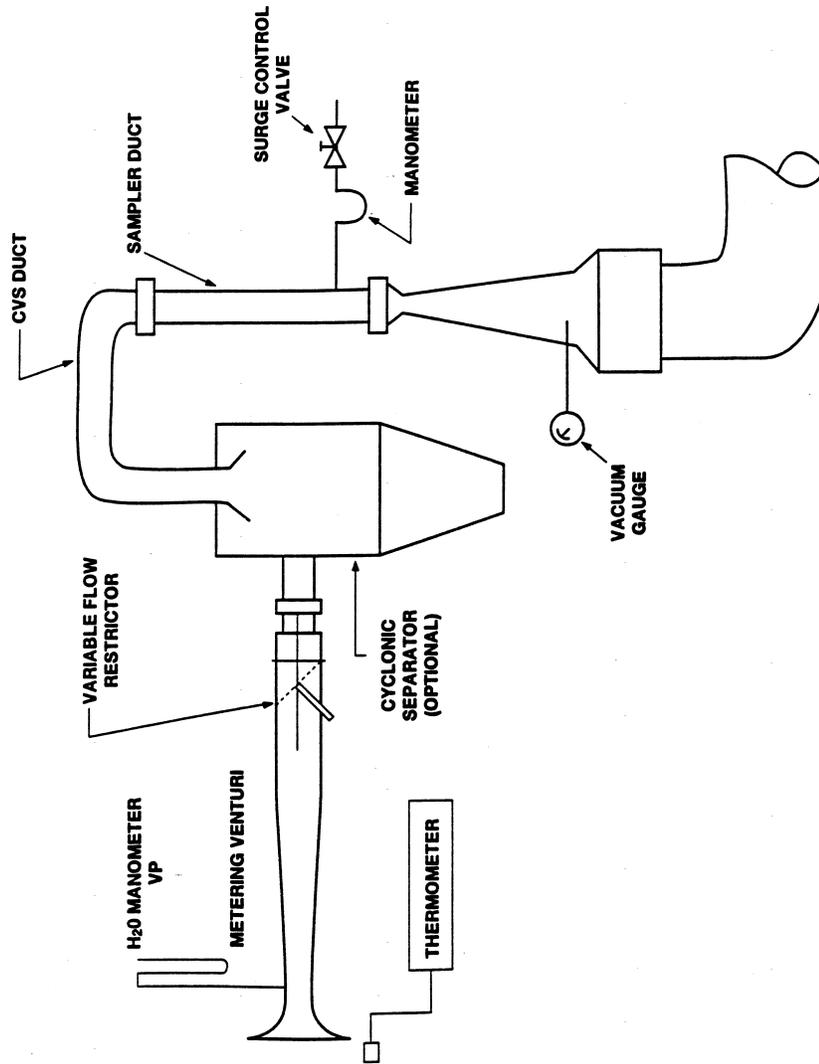


Figure 6. — CFV-CVS Calibration Configuration

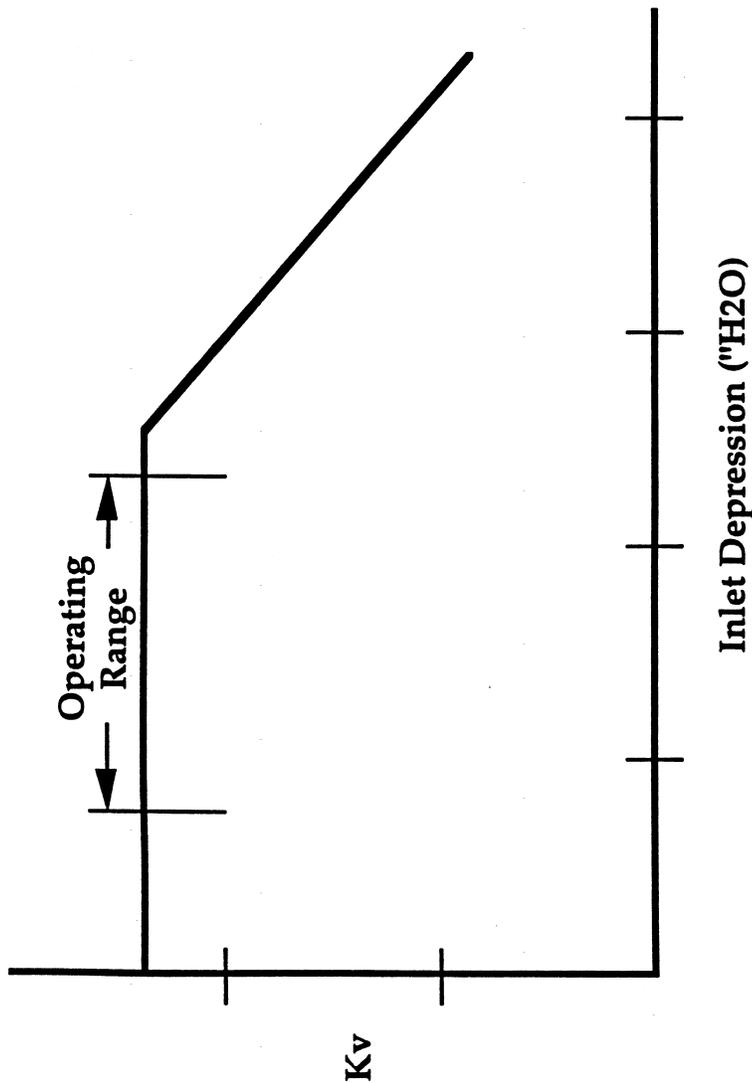


Figure 7.—Sonic Flow Choking

Subpart F—Manufacturer Production Line Testing Program

§91.501 Applicability.

(a) The requirements of this subpart F are applicable to all marine spark-ignition engines subject to the provisions of subpart A of this part 91.

(1) This subpart F applies to marine spark-ignition outboard engines beginning with model year 1999.

(2) This subpart F applies to marine spark-ignition personal watercraft engines beginning with model year 2000.

(b) The Administrator may waive the provisions of this subpart for a manufacturer or a specific engine family, as