SAE International®

SURFACE VEHICLE RECOMMENDED PRACTICE

J342 MAR2013

Issued 1968-06
Reaffirmed 2013-03

Superseding J342 JAN1991

Spark Arrester Test Procedure for Large Size Engines

RATIONALE

The procedures described by this standard are still sufficient for testing, and there is no need for revision.

1. Scope—This SAE Recommended Practice establishes equipment and procedures for the evaluation of the effectiveness and other performance characteristics of spark arresters or turbochargers used on the exhaust system of large engines normally used in a railroad locomotive, stationary power plant, and other similar applications. This document does not cover applications requiring flame arresting, exhaust gas cooling, or isolation from explosive gases. Two test methods are presented: a laboratory test using ambient air (cold test) and an engine test using exhaust gases (hot test). The hot test is preferred.

Arresters tested by the provisions of this document can be expected to perform as tested when tilted no more than 45 degrees from their normal position. Test results from a spark arrester or turbocharger evaluated by the hot test can be applied to different engines of similar design, provided the data shows it to be effective in the applicable flow ranges.

Certain design and performance characteristics, which represent current requirements by regulatory agencies for qualification and approval under this document, are listed in Appendix A.

1.1 Purpose—The purpose of this document is to provide a standard method of testing to evaluate spark arresters or turbochargers as spark arresters for use with large compression ignition internal combustion engines.

This document provides a method to evaluate the effectiveness of various spark arresters, but is not intended to establish the performance level required for adequate fire protection (see Appendix A).

2. References

2.1 Applicable Publication—The following publication forms a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J997—Spark Arrester Test Carbon

3. *Procedure*

3.1 Apparatus

3.1.1 COLD TEST—The apparatus shall consist of a suitable blower, air plenum, airflow metering instruments, spark arrester carbon injector device, and a positive trap for collecting the particles. Figure 1 depicts a multi-inlet device. A similar apparatus may be used to test single inlet devices. The apparatus shall be operated to its maximum flow rating as defined in 3.5.1 and determined from Tables 1 and 2 to determine its capability. If the apparatus cannot attain the desired flow level, the data is acceptable, but additional tests at any required higher flows must be obtained on appropriate equipment such as on the actual engine application.

3.1.2 HOT TEST—The apparatus is identical, except that the engine exhaust system is substituted for the blower.

3.2 Test Carbon—All test carbon used shall conform with the provisions of SAE J997. Except as allowed by 3.5.2, each test flow point shall be run using both fine and coarse test carbon.

Total test carbon injected, per Figure 1, shall be 100 g per engine cylinder. Single inlet devices shall have a minimum of 400 g of carbon injected.

3.3 Back Pressure—Back pressure shall be measured during each run at each flow, at the inlet of or in each manifold leg, during both hot and cold tests. A static pressure probe, such as illustrated in Figure 1, shall be used.

3.4 Injection Rate—Test carbon shall be injected into the inlet or each manifold leg as applicable for all flow rates tested at a uniform rate during a period of 15 min ± 5 min.

3.5 Flow Range

3.5.1 COLD TEST—The arrester shall be checked for effectiveness and back pressure at not less than five points between 30 and 100% of the rated flow of the arrester. Rated flow is defined as the calculated flow range for the maximum engine size application as determined per Tables 1 and 2 or stated by the engine manufacturer. Note that maximum engine size application will be limited by maximum allowable back pressure requirements. One point shall be at 100% of rated flow, the remaining points shall be approximately evenly spaced relative to flow with the lowest point at approximately 30% of rated flow.

3.5.2 HOT TEST—The arrester shall be checked for effectiveness and back pressure at all numbered throttle positions. Where eight or more numbered throttle positions are involved, alternating carbon size (fine and coarse) may be used in lieu of testing each throttle position with both carbon sizes. Low effectiveness at any setting with one carbon size warrants further test with the other carbon size.

3.6 Data—For each test point (flow and carbon size), obtain the following data:

a. Weight of carbon injected, gram, to an accuracy of 0.1 g
b. Weight of carbon retained in the trap, gram, to an accuracy of 0.1 g

NOTE—Contents of stack trap should be sieved lightly on No. 30 (600 μm) USA Standard Sieve before calculating effectiveness. Test carbon particles reduced in size so they will pass a No. 30 (600 μm) USA Standard Sieve are considered to be destroyed and, therefore, are discarded.

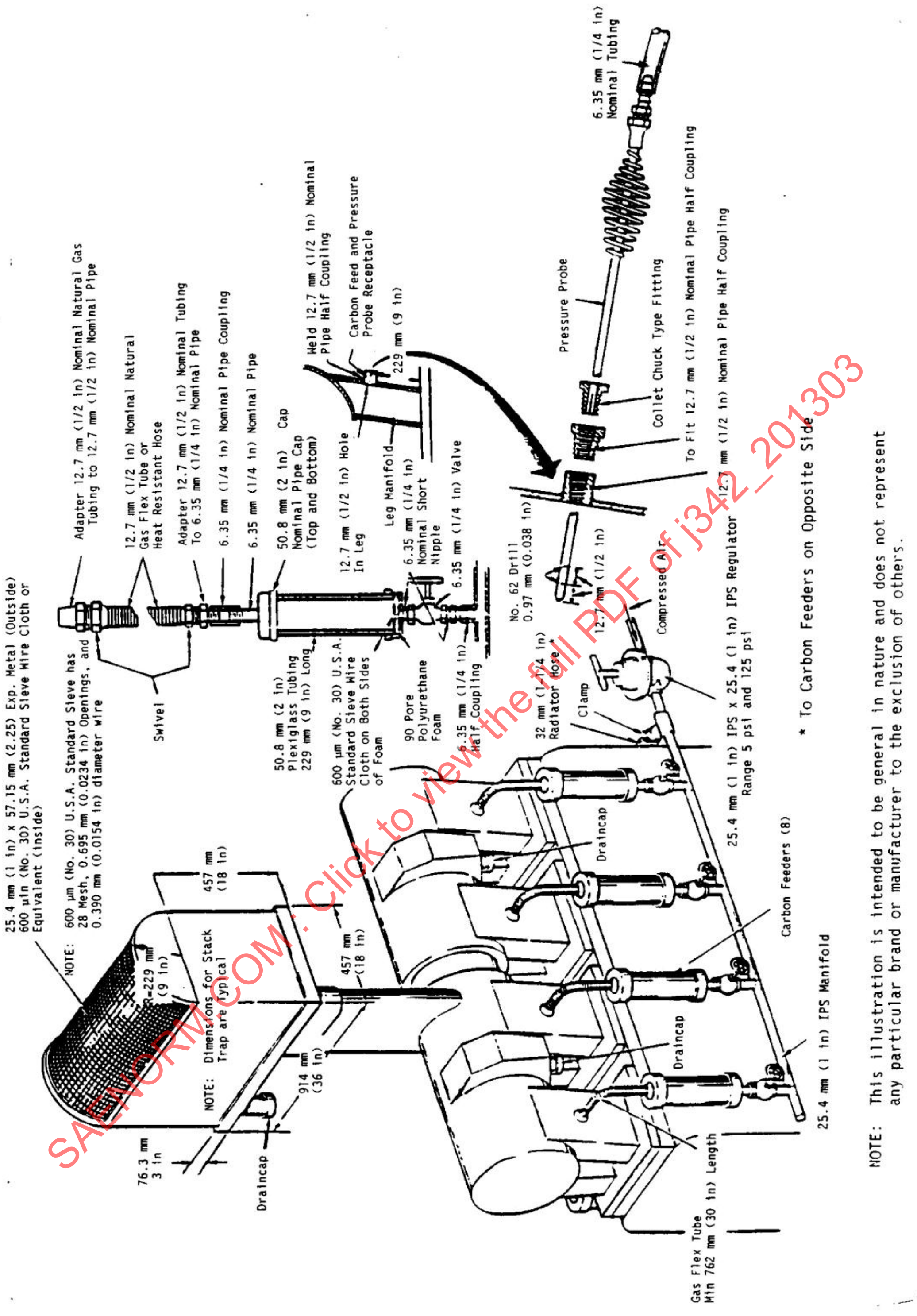
25.4 mm (1 in) x 57.15 mm (2.25) Exp. Metal (Outside) 600 µin (No. 30) U.S.A. Standard Sieve Wire Cloth or Equivalent (Inside)
NOTE: 600 µm (No. 30) U.S.A. Standard Sieve has 28 Mesh, 0.695 mm (0.0234 in) Openings, and 0.390 mm (0.0154 in) diameter wire
Adapter 12.7 mm (1/2 in) Nominal Natural Gas Tubing to 12.7 mm (1/2 in) Nominal Pipe
12.7 mm (1/2 in) Nominal Natural Gas Flex Tube or Heat Resistant Hose
Adapter 12.7 mm (1/2 in) Nominal Tubing To 6.35 mm (1/4 in) Nominal Pipe
6.35 mm (1/4 in) Nominal Pipe Coupling
6.35 mm (1/4 in) Nominal Pipe
50.8 mm (2 in) Nominal Pipe Cap (Top and Bottom)
Cap
Swivel
R=229 mm (9 in)
457 mm (18 in)
457 mm (18 in)
NOTE: Dimensions for Stack Trap are Typical
914 mm (36 in)
76.3 mm 3 in
Draincap
50.8 mm (2 in) Plexiglass Tubing 229 mm (9 in) Long
12.7 mm (1/2 in) Hole In Leg
Weld 12.7 mm (1/2 in) Nominal Pipe Half Coupling
Carbon Feed and Pressure Probe Receptacle
229 mm (9 in)
Leg Manifold
6.35 mm (1/4 in) Nominal Short Nipple
6.35 mm (1/4 in) Valve
600 µm (No. 30) U.S.A. Standard Sieve Wire Cloth on Both Sides of Foam
90 Pore Polyurethane Foam
6.35 mm (1/4 in) Half Coupling
No. 62 Drill 0.97 mm (0.038 in)
32 mm (1-1/4 in) Radiator Hose
Clamp
12.7 mm (1/2 in)
Compressed Air
Pressure Probe
6.35 mm (1/4 in) Nominal Tubing
Collet Chuck Type Fitting
To Fit 12.7 mm (1/2 in) Nominal Pipe Half Coupling
12.7 mm (1/2 in) Nominal Pipe Half Coupling
25.4 mm (1 in) IPS x 25.4 (1 in) IPS Regulator Range 5 psi and 125 psi
* To Carbon Feeders on Opposite Side
Draincap
Draincap
Carbon Feeders (8)
25.4 mm (1 in) IPS Manifold
Gas Flex Tube Min 762 mm (30 in) Length
NOTE: This illustration is intended to be general in nature and does not represent any particular brand or manufacturer to the exclusion of others.

FIGURE 1—

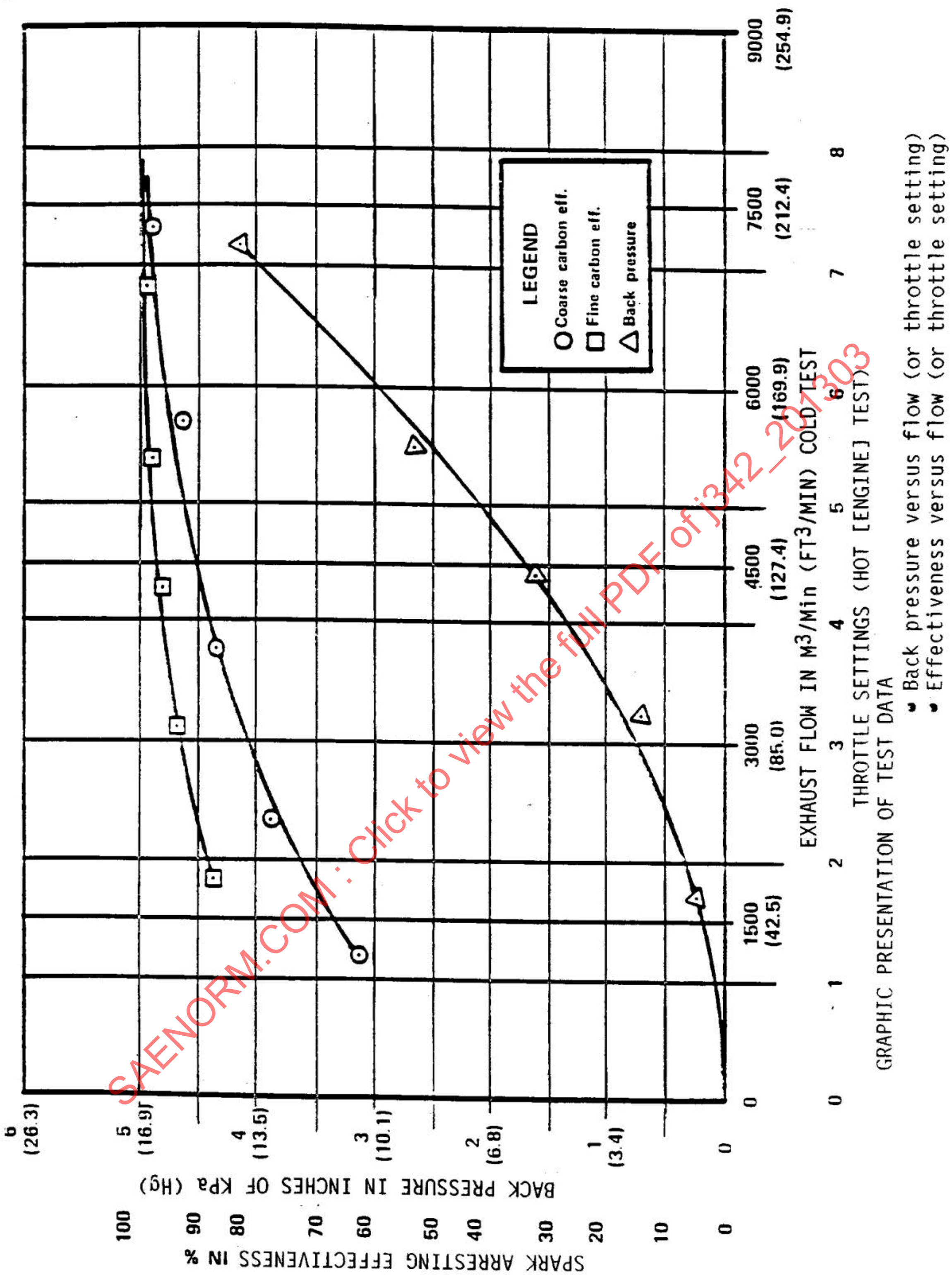
LEGEND
Coarse carbon eff.
Fine carbon eff.
Back pressure
EXHAUST FLOW IN M3/Min (FT3/MIN) COLD TEST
THROTTLE SETTINGS (HOT [ENGINE] TEST)
GRAPHIC PRESENTATION OF TEST DATA
Back pressure versus flow (or throttle setting)
Effectiveness versus flow (or throttle setting)
BACK PRESSURE IN INCHES OF KPa (Hg)
SPARK ARRESTING EFFECTIVENESS IN %
1500 (42.5)
3000 (85.0)
4500 (127.4)
6000 (169.9)
7500 (212.4)
9000 (254.9)
1 (3.4)
2 (6.8)
3 (10.1)
4 (13.5)
5 (16.9)
6 (26.3)

FIGURE 2—

TABLE 1—EXHAUST FLOW IN LITERS PER SECOND AT THE MAXIMUM RATINGS[1] FOR 4-CYCLE DIESEL ENGINES[2]

Engine Displacement (in^3)[3]	Rev Per Min 800	Rev Per Min 1000	Rev Per Min 1200	Rev Per Min 1400	Rev Per Min 1600	Rev Per Min 1800	Rev Per Min 2000	Rev Per Min 2200	Rev Per Min 2400	Rev Per Min 2600	Rev Per Min 2800	Rev Per Min 3000	rpm[4] Differential
1	0	1	1	1	1	1	1	1	1	1	2	2	0
2	1	1	1	2	2	2	2	2	3	3	3	3	0
3	1	2	2	2	3	3	3	4	4	4	5	5	0
4	2	2	3	3	4	4	4	5	5	6	6	7	0
5	2	3	3	4	4	5	6	6	7	7	8	8	1
6	3	3	4	5	5	6	7	7	8	9	9	10	1
7	3	4	5	5	6	7	8	9	9	10	11	12	1
8	4	4	5	6	7	8	9	10	11	12	13	13	1
9	4	5	6	7	8	9	10	11	12	13	14	15	1
10	4	6	7	8	9	10	11	12	13	15	16	17	1
20	9	11	13	16	18	20	22	25	27	29	31	34	2
30	13	17	20	24	27	30	34	37	40	44	47	51	3
40	18	22	27	31	36	40	45	49	54	58	63	67	4
50	22	28	34	39	45	51	56	62	67	73	79	84	6
60	27	34	40	47	54	61	67	74	81	88	94	101	7
70	31	39	47	55	63	71	79	87	94	102	110	118	8
80	36	45	54	63	72	81	90	99	108	117	126	135	9
90	40	51	61	71	81	91	101	111	121	131	142	152	10
100	45	56	67	79	90	101	112	124	135	146	157	169	11
200	90	112	135	157	180	202	225	247	270	292	314	337	22
300	135	168	202	236	270	303	337	371	404	438	472	506	34
400	180	225	270	315	360	404	449	494	539	584	629	674	45
500	224	281	337	393	449	505	562	618	674	732	786	843	56
600	269	337	405	472	539	606	674	742	809	876	944	1011	67
700	314	393	472	550	629	708	786	865	944	1023	1101	1180	79
800	359	449	540	629	719	809	899	989	1079	1169	1258	1348	90
900	404	506	607	708	809	910	1011	1113	1213	1315	1415	1517	101
1000	449	562	674	786	899	1011	1124	1236	1348	1461	1573	1685	112

1. Volumetric effectiveness 80%; exhaust temperatures 900 °F.
2. For 2-cycle engines, multiply value by 3; for 2-cycle supercharged engines, multiply value by 4; for 4-cycle supercharged engines, multiply value by 1.25.
3. 1 cm^3 = 0.061 in^3 (number of cubic centimeters x 0.061 = cubic inches).
4. The "rpm Differential" column gives the difference between rpm columns for interpolation purposes. Entries are to the nearest whole number.

GENERAL: All chart values are proportional, so a flow can be calculated for a 1000 in^3 engine by doubling the flow figure for an identical engine but with 500 in^3 displacement. The same rule applies to rpm. Therefore, a flow rate can be calculated of a 3000 maximum rpm engine by doubling the flow value of an identical engine but with 1500 maximum rpm.

The chart may also be used like an interest table. If the engine has a cubic inch displacement of 438 at 2600 rpm, select readings from 400, 30, and 8 at 2600 rpm. The sum of these is the flow rate. When rpm falls between columns, that is, 1600 to 1800, 1800 to 2000, etc., take the next highest rpm column. To be more exact, interpolate by using the "rpm Differential" value.

EXAMPLE: A 4-cycle diesel engine has a total displacement of 633 in3. If its maximum rpm is 2600, what is the maximum exhaust flow?

SOLUTION: 600 in3 displacement at 2600 rpm = 876; 30 = 44; and 3 = 4; sum = 924.

TABLE 2—EXHAUST FLOW IN CUBIC FEET PER MINUTE AT MAXIMUM RATINGS(1) FOR 4-CYCLE DIESEL ENGINES(2)

Engine Displacement (in^3)(3)	Rev Per Min 800	Rev Per Min 1000	Rev Per Min 1200	Rev Per Min 1400	Rev Per Min 1600	Rev Per Min 1800	Rev Per Min 2000	Rev Per Min 2200	Rev Per Min 2400	Rev Per Min 2600	Rev Per Min 2800	Rev Per Min 3000	rpm(4) Differential
10	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0
20	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.8	0.8	0.9	1.0	0.1
30	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	0.1
40	0.5	0.6	0.8	0.9	1.0	1.2	1.3	1.4	1.6	1.7	1.8	1.9	0.1
50	0.6	0.8	1.0	1.1	1.3	1.5	1.6	1.8	1.9	2.1	2.3	2.4	0.2
60	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	0.2
70	0.9	1.1	1.4	1.6	1.8	2.0	2.3	2.5	2.7	3.0	3.2	3.4	0.2
80	1.0	1.3	1.6	1.8	2.1	2.3	2.6	2.9	3.1	3.4	3.6	3.9	0.3
90	1.2	1.5	1.7	2.0	2.3	2.6	2.9	3.2	3.5	3.8	4.1	4.4	0.3
100	1.3	1.6	1.9	2.2	2.6	2.9	3.2	3.5	3.9	4.2	4.5	4.8	0.3
200	2.6	3.2	3.9	4.5	5.2	5.8	6.5	7.1	7.8	8.4	9.1	9.7	0.7
300	3.8	4.8	5.8	6.8	7.8	8.8	9.8	10.8	11.8	12.8	13.8	14.8	1.0
400	5.2	6.5	7.8	9.1	10.4	11.7	13.0	14.3	15.6	16.9	18.2	19.5	1.3
500	6.5	8.1	9.7	11.3	13.0	14.6	16.2	17.8	19.5	21.1	22.7	24.3	1.6
600	7.8	9.7	11.7	13.6	15.5	17.4	19.3	21.3	23.1	25.0	26.9	28.8	2.0
700	9.0	11.3	13.6	15.9	18.1	20.4	22.7	25.0	27.3	29.5	31.9	34.2	2.3
800	10.3	13.0	15.6	18.2	20.7	23.3	25.9	28.5	31.1	33.7	36.3	38.9	2.6
900	11.7	14.6	17.5	20.4	23.3	26.2	29.2	32.1	35.0	37.9	40.8	43.7	3.0
1000	12.9	16.2	19.4	22.7	26.0	29.3	32.6	35.9	39.2	42.5	45.8	49.1	3.3
2000	25.9	32.4	38.9	45.4	51.8	58.3	64.8	71.4	77.9	84.4	90.9	97.4	6.5
3000	38.8	48.6	58.3	68.0	77.7	87.4	97.1	106.8	116.5	126.2	135.9	145.6	9.7
4000	51.7	64.7	77.7	90.7	103.7	116.7	129.7	142.7	155.7	168.7	181.7	194.7	13.0
5000	64.8	81.0	97.2	113.4	129.6	145.9	162.1	178.4	194.6	210.8	227.0	243.2	16.2
6000	77.6	97.1	116.6	136.1	155.6	175.1	194.6	214.1	233.6	253.1	272.6	292.1	19.5
7000	90.7	113.4	136.0	158.7	181.4	204.2	226.9	249.8	272.5	295.3	318.0	340.8	22.7
8000	103.4	129.4	155.4	181.4	207.4	233.4	259.4	285.4	311.4	337.4	363.4	389.4	26.0
9000	116.1	145.4	174.7	204.0	233.2	262.5	291.8	321.1	350.4	379.7	409.0	438.3	29.3
10 000	129.3	161.9	194.3	226.7	259.3	291.7	324.3	356.8	389.3	421.8	454.3	486.8	32.5
20 000	258.6	323.6	388.6	453.6	518.6	583.6	648.6	713.6	778.6	843.6	908.6	973.6	65.0

1. Volumetric effectiveness 80%; exhaust temperatures 482 °C.
2. For 2-cycle engines, multiply value by 3; for 2-cycle supercharged engines, multiply value by 4; for 4-cycle supercharged engines, multiply value by 2.
3. 1 in^3 = 16.39 cm^3 (number of cubic inches x 16.39 = cubic centimeters).
4. The "rpm Differential" column gives the difference between rpm columns for interpolation purposes. Entries are to the nearest tenth.

GENERAL: All chart values are proportional, so a flow can be calculated for a 1000 cm^3 engine by doubling the flow figure for an identical engine but with 500 cm^3 displacement. The same rule applies to rpm. Therefore, a flow rate can be calculated of a 3000 maximum rpm engine by doubling the flow value of an identical engine but with 1500 maximum rpm.
The chart may also be used like an interest table. If the engine has a cubic inch displacement of 4380 at 2600 rpm, select readings from 400, 30, and 8 at 2600 rpm. The sum of these is the flow rate. When rpm falls between columns, that is, 1600 to 1800, 1800 to 2000, etc., take the next highest rpm column. To be more exact, interpolate by using the "rpm Differential" value.
EXAMPLE: A 4-cycle diesel engine has a total displacement of 6330 cm3. If its maximum rpm is 2600, what is the maximum exhaust flow?

SOLUTION: 6000 cm3 displacement at 2600 rpm = 253.1; 300 = 12.8; and 30 = 1.3; sum = 267.2.