

TOPIC: Cylinder Heads
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VHP*

SUBJECT: VHP Valve Adjustment

MODELS AFFECTED: All VHP

This bulletin announces a new method of valve adjustment for VHP engines. This new method allows several valves to be adjusted at one time instead of rotating the crankshaft for each cylinder. All valves can now be adjusted with the crankshaft rotated to two positions. This new method is referred to as the Express Method. The previously used Traditional Method continues to be a viable method and is also outlined in this bulletin.

The following instructions describe the proper procedures to adjust the crankshaft for valve adjustment for the Express Method and the Traditional Method. Reference the appropriate Operation & Maintenance manual for the procedure for setting the valve clearance.

EXPRESS METHOD

NOTICE

Shut down the engine and allow it to cool for at least 1 hour before adjusting the valves.

1. Rotate the crankshaft by barring the engine over in a counterclockwise direction (when facing the flywheel) until the piston of the first cylinder is at top dead center (compression stroke).

To determine when this piston is at top dead center (compression stroke), watch the rocker arms and valves on its mating cylinder (see Figure 1). As the exhaust valves on the mating cylinder are closing, the intake valves begin to open. At this point, the mating cylinder is in valve overlap (all four valves partially open). This means that all four valves on the cylinder to be adjusted are fully closed. Verify the piston position using the timing mark on the flywheel.

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NOTICE

Accurately barring the engine to Engine Position 1 is important. The location of the crankshaft relative to the first cylinder in firing order (No. 1 Right Bank cylinder on Vee engines) top dead center – compression stroke must be within $\pm 5^\circ$.

Under the Express Method, all the valves can be set in one of two engine positions:

Engine Position 1: First cylinder in firing order (No. 1 cylinder on inline engine, No. 1 Right Bank cylinder on Vee engines) top dead center – compression stroke.

Engine Position 2: Engine crankshaft rotated 360° from Engine Position 1.

With this technique, half the valves are set at the first position and half the valves are set at the second position.

NOTE: Not all the valves for a single cylinder are adjusted in each position. Follow Table 1 and instructions to determine when to adjust the intake valves, the exhaust valves, or both the intake and exhaust valves.

NOTICE

Failure to follow the sequence outlined in Table 1 may result in severe mechanical damage.

NOTICE

As 16-cylinder engines built before 1981 had a different firing order, the Express Method cannot be used on these engines. The Traditional Method, following the firing order on the nameplate, is the only acceptable method for positioning the valves for adjustment on 16-cylinder engines built before 1981.

NOTE: On 12- and 16-cylinder engines, right bank and left bank are determined by standing at the flywheel end of the engine, facing the flywheel. The cylinders farthest from the flywheel on the right and left side are the No. 1R and No. 1L cylinders, respectively. On 6-cylinder engines, the cylinder farthest from the flywheel is the No. 1 cylinder; the closest is the No. 6 cylinder.

Table 1: Express Method Valve Settings

6-CYLINDER ENGINE			
FIRING ORDER: 1, 5, 3, 6, 2, 4			
		ENGINE POSITION 1 CYL. NO. 1 TDC COMPRESSION STROKE	ENGINE POSITION 2 CRANKSHAFT ROTATED 360° NO. 1 OVERLAP
CYLINDER	VALVES	SET VALVES	SET VALVES
1	EXHAUST	X	(DO NOT SET)
	INTAKE	X	(DO NOT SET)
2	EXHAUST	(DO NOT SET)	X
	INTAKE	X	(DO NOT SET)
3	EXHAUST	X	(DO NOT SET)
	INTAKE	(DO NOT SET)	X
4	EXHAUST	(DO NOT SET)	X
	INTAKE	X	(DO NOT SET)
5	EXHAUST	X	(DO NOT SET)
	INTAKE	(DO NOT SET)	X
6	EXHAUST	(DO NOT SET)	X
	INTAKE	(DO NOT SET)	X
12-CYLINDER ENGINE			
FIRING ORDER: 1R, 6L, 5R, 2L, 3R, 4L, 6R, 1L, 2R, 5L, 4R, 3L			
		ENGINE POSITION 1 CYL. NO. 1 TDC COMPRESSION STROKE	ENGINE POSITION 2 CRANKSHAFT ROTATED 360° NO. 1 OVERLAP
CYLINDER	VALVES	SET VALVES	SET VALVES
1R	EXHAUST	X	(DO NOT SET)
	INTAKE	X	(DO NOT SET)
2R	EXHAUST	(DO NOT SET)	X
	INTAKE	X	(DO NOT SET)
3R	EXHAUST	X	(DO NOT SET)
	INTAKE	(DO NOT SET)	X
4R	EXHAUST	(DO NOT SET)	X
	INTAKE	X	(DO NOT SET)
5R	EXHAUST	X	(DO NOT SET)
	INTAKE	(DO NOT SET)	X
6R	EXHAUST	(DO NOT SET)	X
	INTAKE	(DO NOT SET)	X
1L	EXHAUST	(DO NOT SET)	X
	INTAKE	(DO NOT SET)	X
2L	EXHAUST	X	(DO NOT SET)
	INTAKE	(DO NOT SET)	X
3L	EXHAUST	X	(DO NOT SET)
	INTAKE	X	(DO NOT SET)
4L	EXHAUST	(DO NOT SET)	X
	INTAKE	(DO NOT SET)	X
5L	EXHAUST	(DO NOT SET)	X
	INTAKE	X	(DO NOT SET)
6L	EXHAUST	X	(DO NOT SET)
	INTAKE	X	(DO NOT SET)

Table 1. Express Method Valve Settings

16-CYLINDER ENGINE			
FIRING ORDER: 1R, 1L, 3R, 3L, 7R, 7L, 5R, 5L, 8R, 8L, 6R, 6L, 2R, 2L, 4R, 4L			
		ENGINE POSITION 1 CYL. NO. 1 TDC COMPRESSION STROKE	ENGINE POSITION 2 CRANKSHAFT ROTATED 360° NO. 1 OVERLAP
CYLINDER	VALVES	SET VALVES	SET VALVES
1R	EXHAUST	X	(DO NOT SET)
	INTAKE	X	(DO NOT SET)
2R	EXHAUST	(DO NOT SET)	X
	INTAKE	X	(DO NOT SET)
3R	EXHAUST	X	(DO NOT SET)
	INTAKE	X	(DO NOT SET)
4R	EXHAUST	(DO NOT SET)	X
	INTAKE	X	(DO NOT SET)
5R	EXHAUST	X	(DO NOT SET)
	INTAKE	(DO NOT SET)	X
6R	EXHAUST	(DO NOT SET)	X
	INTAKE	(DO NOT SET)	X
7R	EXHAUST	X	(DO NOT SET)
	INTAKE	(DO NOT SET)	X
8R	EXHAUST	(DO NOT SET)	X
	INTAKE	(DO NOT SET)	X
1L	EXHAUST	X	(DO NOT SET)
	INTAKE	X	(DO NOT SET)
2L	EXHAUST	(DO NOT SET)	X
	INTAKE	X	(DO NOT SET)
3L	EXHAUST	X	(DO NOT SET)
	INTAKE	(DO NOT SET)	X
4L	EXHAUST	X	(DO NOT SET)
	INTAKE	X	(DO NOT SET)
5L	EXHAUST	(DO NOT SET)	X
	INTAKE	(DO NOT SET)	X
6L	EXHAUST	(DO NOT SET)	X
	INTAKE	X	(DO NOT SET)
7L	EXHAUST	X	(DO NOT SET)
	INTAKE	(DO NOT SET)	X
8L	EXHAUST	(DO NOT SET)	X
	INTAKE	(DO NOT SET)	X

TRADITIONAL METHOD**NOTICE**

Shut the engine down and allow it to cool for at least 1 hour before adjusting the valves.

1. Rotate the crankshaft by barring the engine over in a counterclockwise direction (when facing the flywheel) until the piston of the first cylinder is at top dead center (compression stroke).

DEFINITION OF MATING CYLINDER

To determine when this piston is at top dead center (compression stroke), watch the rocker arms and valves on its mating cylinder (see *Figure 1*). As the exhaust valves on the mating cylinder are closing, the intake valves begin to open. At this point, the mating cylinder is in valve overlap (all four valves partially open). This means that all four valves on the cylinder to be adjusted are fully closed.

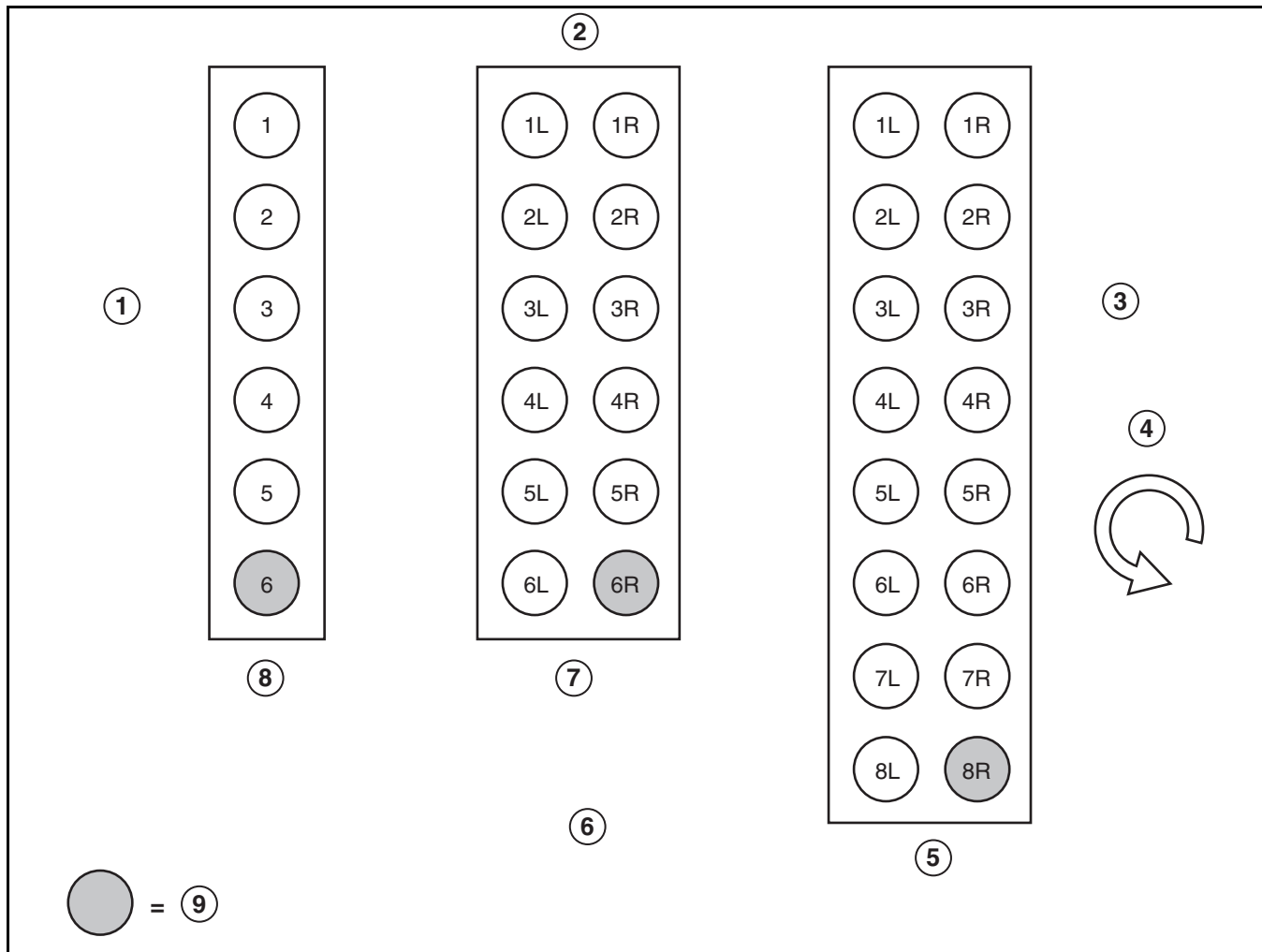


Figure 1: Engine Firing Order and Direction of Rotation – 6-, 12- and 16-Cylinder Engine

- 1 - Left Side
- 2 - Front (Gear Side)
- 3 - Right Side

- 4 - Direction of Flywheel Rotation Counterclockwise
- 5 - Firing Order: 1R, 1L, 3R, 3L, 7R, 7L, 5R, 5L, 8R, 8L, 6R, 6L, 2R, 2L, 4R, 4L
- 6 - Rear (Flywheel Side)

- 7 - Firing Order: 1R, 6L, 5R, 2L, 3R, 4L, 6R, 1L, 2R, 5L, 4R, 3L
- 8 - Firing Order: 1, 5, 3, 6, 2, 4
- 9 - Mating cylinder of the first cylinder in the firing order

NOTE: When the mating cylinder is in valve overlap, the first cylinder in the firing order is at top dead center (compression stroke).

NOTICE

Failure to follow the sequence outlined in Table 2 and Table 3 may result in severe mechanical damage.

NOTE: On 12- and 16-cylinder engines, right bank and left bank are determined by standing at the flywheel end of the engine facing the flywheel. The cylinders farthest from the flywheel on the right and left side are the No. 1R and No. 1L cylinders, respectively. On 6-cylinder

engines, the cylinder farthest from the flywheel is the No. 1 cylinder; the closest is the No. 6 cylinder.

2. Adjust all four valves of the first cylinder while the piston is at top dead center.
3. Continue to rotate the engine in a clockwise direction until the next cylinder in the firing order is at top dead center (60° on a 6-cylinder, 30° on a 12-cylinder and see Table 3 for a 16-cylinder). Repeat steps 1 and 2 for the remaining cylinders.

Table 2: Traditional Method Valve Settings – 6- and 12-Cylinder

6-CYLINDER ENGINE		12-CYLINDER ENGINE	
SET VALVES ON CYLINDER	WHEN VALVES OVERLAP ON MATING CYLINDER	SET VALVES ON CYLINDER	WHEN VALVES OVERLAP ON MATING CYLINDER
COLUMN A	COLUMN B	COLUMN A	COLUMN B
1	6	1R	6R
5	2	6L	1L
3	4	5R	2R
6	1	2L	5L
2	5	3R	4R
4	3	4L	3L
Column A shows the cylinder firing order. Value in column A added to value in column B always equals 7.		6R	1R
		1L	6L
		2R	5R
		5L	2L
		4R	3R
		3L	4L
		Column A shows the cylinder firing order. Value in column A added to value in column B always equals 7.	

Table 3: Traditional Method Valve Settings – 16-Cylinder

SET VALVES ON CYLINDER	WHEN VALVES OVERLAP ON MATING CYLINDER	DEGREES OF ROTATION	DEGREES INCREMENTS
COLUMN A	COLUMN B		
1R	8R	0°	0°
1L	8L	60°	60°
3R	6R	90°	30°
3L	6L	150°	60°
7R	2R	180°	30°
7L	2L	240°	60°
5R	4R	270°	30°
5L	4L	330°	60°
8R	1R	360°	30°
8L	1L	420°	60°
6R	3R	450°	30°
6L	3L	510°	60°
2R	7R	540°	30°
2L	7L	600°	60°
4R	5R	630°	30°
4L	5L	690°	60°
COLUMN A SHOWS THE CYLINDER FIRING ORDER. VALUE IN COLUMN A ADDED TO VALUE IN COLUMN B ALWAYS EQUALS 9.			

TIGHTENING BRIDGE AND ROCKER JAM NUTS

The following final torque values are recommended for tightening the bridge and rocker jam nuts.

- Bridge jam nuts: 50 - 60 ft-lbs (67.7 - 81.3 N·m)
- Rocker jam nuts: 65 - 75 ft-lbs (88.1 - 101.7 N·m)

It is recommended to use a box-end torque adapter or crow's foot with the torque wrench (see Figure 2 for example).



Figure 2: Typical Box-End Torque Adapter

When using a box-end torque adapter or crow's foot on a torque wrench, the set value will need to be modified from the desired output value. This value depends on the length of the torque wrench and the length of the adapter for the specific set of tools used. The link below provides further details:

https://www.engineersedge.com/manufacturing_spec/torque_wrench_1.htm

For example, in the case of rocker jam nuts, if the torque wrench is 26 inches long and the adapter is 2 inches, set the torque wrench between 60 ft-lbs (88 N·m) and 70 ft-lbs (102 N·m) to achieve an output torque between 65 - 75 ft-lbs (88.1 - 101.7 N·m).

It is important that the adapter remain in-line with the body of the torque wrench. If offset to the side, it can change the applied torque.