



**TOPIC:** Cylinder  
**NUMBER:** 4-013  
**SUPERSEDES:** NEW  
**DATE:** May 15, 2004

**MODELS APPLICABLE TO:**

- F-1 Research
- F-2 Motor
- F-1/F-2 Combination
- F-4 Supercharge
- F-5 Cetane

**TEST METHOD:**

- D 2699
- D 2700
- D 2699, D 2700
- D 909
- D 613

ROUTE TO: \_\_\_\_\_

RETURN TO: \_\_\_\_\_

**SUBJECT:** Indexing Basic Cylinder Height On CFR F-1/F-2 Rating Units**INTRODUCTION**

The purpose of this CFR Service Bulletin is to inform customers on a "how-to" approach to indexing basic cylinder height on new or rebuilt cylinders. Cylinder height, or the vertical position of the cylinder in the clamping sleeve, determines the compression ratio (C.R.). The C.R. is a key variable for knock testing methods. In this Service Bulletin the user will learn how to index basic cylinder height.

**NOTE:** This bulletin should only be used as an aid in the setting of basic cylinder height. Actual tolerances and specific settings should be always referenced in the most current ASTM book of methods, ASTM Test Methods For Rating Motor, Diesel, And Aviation Fuels (Form 847).

**REQUIRED EQUIPMENT**

The following lists the equipment required to index basic cylinder height:

- Calibrated Compression Gauge Assembly (P/N C110304). All gauge assemblies should be calibrated as a complete unit as described in Section 3.70 of *Form 847, Waukesha CFR F-1 & F-2 Operation & Maintenance Manual*. Faulty gauges can imply false readings and can lead to unnecessary maintenance.
- 7/8 in. socket and wrench for removal of hot detonation pickup and pickup cable assembly
- Open end or adjustable wrench for tightening the compression pressure gauge assembly into the pickup hole
- Current ASTM manual with methods D 2699 and D 2700: *ASTM Test Methods For Rating Motor, Diesel, And Aviation Fuels (Form 847)*

- Allen keys for removal of flex cable from digital counter or wrench for loosening the dial indicator lock nut
- Two pickup gaskets (P/N 111342)

**NOTE THE FOLLOWING****WARNING**

**Do not operate a CFR unit with fuel in any of the carburetor bowls or turn on the ignition switch when the compression pressure gauge is mounted in the cylinder pickup hole. If combustion occurs in the cylinder with the gauge in place, the gauge assembly will be damaged, the flexible hose can sever, and the gauge can be ejected in a manner that can cause serious personal injury or death.**

- When indexing cylinder height, make sure that the fuel is off and that the ignition is off.
- When installing the worm shaft to the cylinder and sleeve make sure it is properly greased and that the backlash of the worm shaft is set correct. With the worm shaft installed you should have approximately 45 degree rotation before the cylinder height changes. The shims installed on the end of the worm shaft will adjust this condition. If the backlash is too tight or not present, you can prematurely wear the worm gear and worm shaft. If the backlash is too loose you can get an inaccurate reading on the digital counter. This happens because the shaft and the numbers on the digital counter move while the backlash is taken up and the cylinder does not move at the same time.

- New and rebuilt cylinders typically rate at the high end of the temperature range. It may be required to raise the mixture temperature or intake air temperature to achieve a fit for use rating.
- Actual tolerances and specific settings should be always referenced in the most current ASTM book of methods, *ASTM Test Methods For Rating Motor, Diesel, And Aviation Fuels (Form 847)*.

## PROCEDURE FOR DIGITAL COUNTER

1. Run unit for one hour on a typical gasoline fuel of which the octane number is known. Adjust the unit to all basic operating and instrument settings required as found in Section 10 "Basic Engine And Instrument Settings And Standard Operating Conditions" of each method in *ASTM Test Methods For Rating Motor, Diesel, And Aviation Fuels (Form 842)*.
2. Continue operation until the F-1 or F-2 unit is at equilibrium and all standard conditions stabilized.
3. Check valve clearances and set to proper value after unit runs for an hour and is at equilibrium with all standard conditions stabilized.
4. Disconnect the flex cable from the digital counter. Do not disconnect the flex cable from the clamping sleeve since this end is keyed. Set both digital counter windows to 930 by rotating the shaft on the back of the digital counter by hand.
5. Adjust the carburetor bowl selector valve between bowls and then turn off ignition switch to unit. Drain all fuel in carburetor bowls.
6. Switch the unit Start/Stop button to "Stop" to shut down the unit completely.

### WARNING

**Do not remove the detonation pickup until the unit has come to a complete stop. Failure to wait until unit stops could result in severe personal injury.**

### WARNING

**Care must be taken when removing the hot detonation pickup from the cylinder. Contact with a hot pickup may cause severe personal injury.**

7. Remove pickup cable and hot detonation pickup.

### WARNING

**Do not operate a CFR unit with fuel in any of the carburetor bowls or turn on the ignition switch when the compression pressure gauge is mounted in the cylinder pickup hole. If combustion occurs in the cylinder with the gauge in place, the gauge assembly will be damaged, the flexible hose can sever, and the gauge can be ejected in a manner that can cause serious personal injury or death.**

**NOTE:** *The adjustment and measurement of compression pressure should be made as quickly as possible so the readings on the gauge represent hot and running engine conditions.*

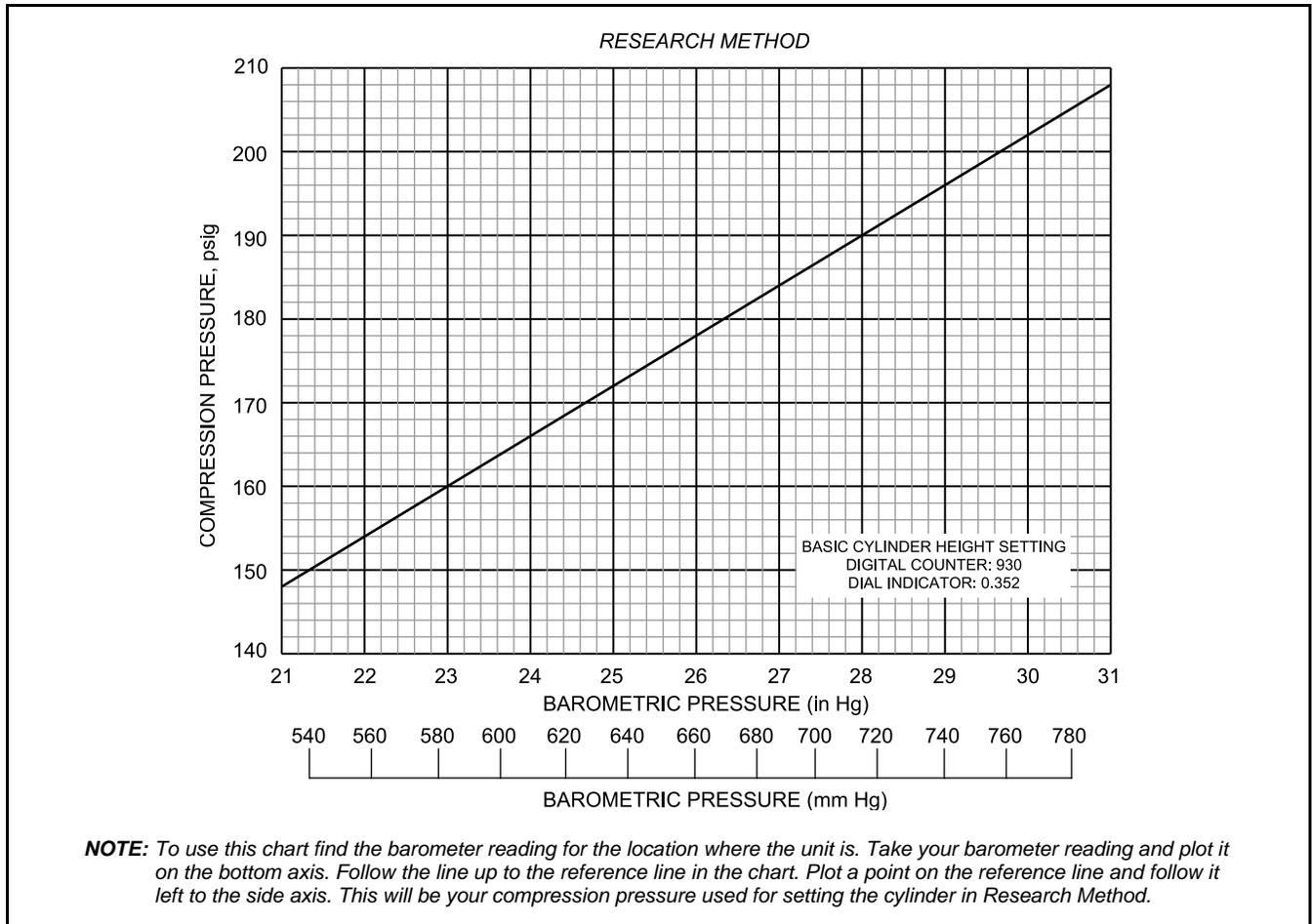
8. Quickly install calibrated compression pressure gauge assembly into pickup hole with a new pickup gasket (P/N 111342) and tighten.
9. Start up unit without fuel and without ignition.
10. In Figure 1 and Figure 2 and in the ASTM manual for both D 2699 and D 2700 methods there are charts for prevailing barometric pressures. For the Research Method there is only one venturi line in the chart for all barometric pressures. For the Motor Method there are three different lines referencing three different venturi sizes.
11. Find your current barometric pressure present in the location where the unit is. Using the barometric pressure, reference the proper chart or each respective method to establish the pressure at a basic cylinder height setting of 930 uncompensated on the digital counter.
12. Raise or lower your compression according to the reading on the gauge to achieve your compression pressure established on the chart.
13. Once your pressure is achieved, slide the flex cable back on to the digital counter assembly and tighten the hex head set screw.
14. Using the barometric pressure reading found in previous steps, use the appropriate table in *ASTM Test Methods For Rating Motor, Diesel, And Aviation Fuels (Form 842)* for D 2699 or D 2700 to compensate the 930 reading in the top window on the digital counter to the correction factor designated in each respective chart.

**NOTE:** *For pressures above 29.92" Hg the correction factor will be subtracted from the 930 reading on the top window. For pressures below 29.92" Hg the correction factor will be added.*

15. It is recommended that the pressure be checked at a high reference octane setting and a low reference octane setting. In this bulletin and in the ASTM manual there are tables for both methods on specifications for checking compression pressures (see Table 1 and Table 2).
16. Raise the compression to check the high reference octane setting for each respective method within the specifications indicated in Table 1 or Table 2.

Then lower the compression to check the low reference octane setting. Note the following:

- If these checks come within tolerance, your cylinder is indexed and ready to rate a TSF fuel.
- If the pressures do not come within tolerances established by the charts, verify that you have the proper venturi size for your altitude, the barometric correction is factored correctly, and the pressure is correct for your basic height of the current barometric pressure.



**Figure 1. Actual Compression Pressure For Setting Basic Cylinder Height Micrometer Or Digital Counter Assembly For Local Observed Barometric Pressure – Research Method**

**Table 1. Specifications For Checking Compression Pressures – Research Method**

Octane Number	93.4	105
Compensated Digital Counter Setting	778	1061
Compensated Dial Indicator Setting, in.	0.460	0.259
Compression Pressure, psi (MPa)	169 ± 2 (1.16 ± 0.01)	241 ± 4 (1.66 ± 0.02)

**Table 2. Specifications For Checking Compression Pressures – Motor Method**

Octane Number	81.1	105
Compensated Digital Counter Setting		
For 9/16" venturi	578	1008
For 19/32" venturi	515	965
For 3/4" venturi	461	912
Compensated Dial Indicator Setting, in.		
For 9/16" venturi	0.602	0.297
For 19/32" venturi	0.647	0.328
For 3/4" venturi	0.685	0.365
Compression Pressure, psi (MPa)	120 ± 2 (0.83 ± 0.01)	194 ± 4 (1.34 ± 0.02)

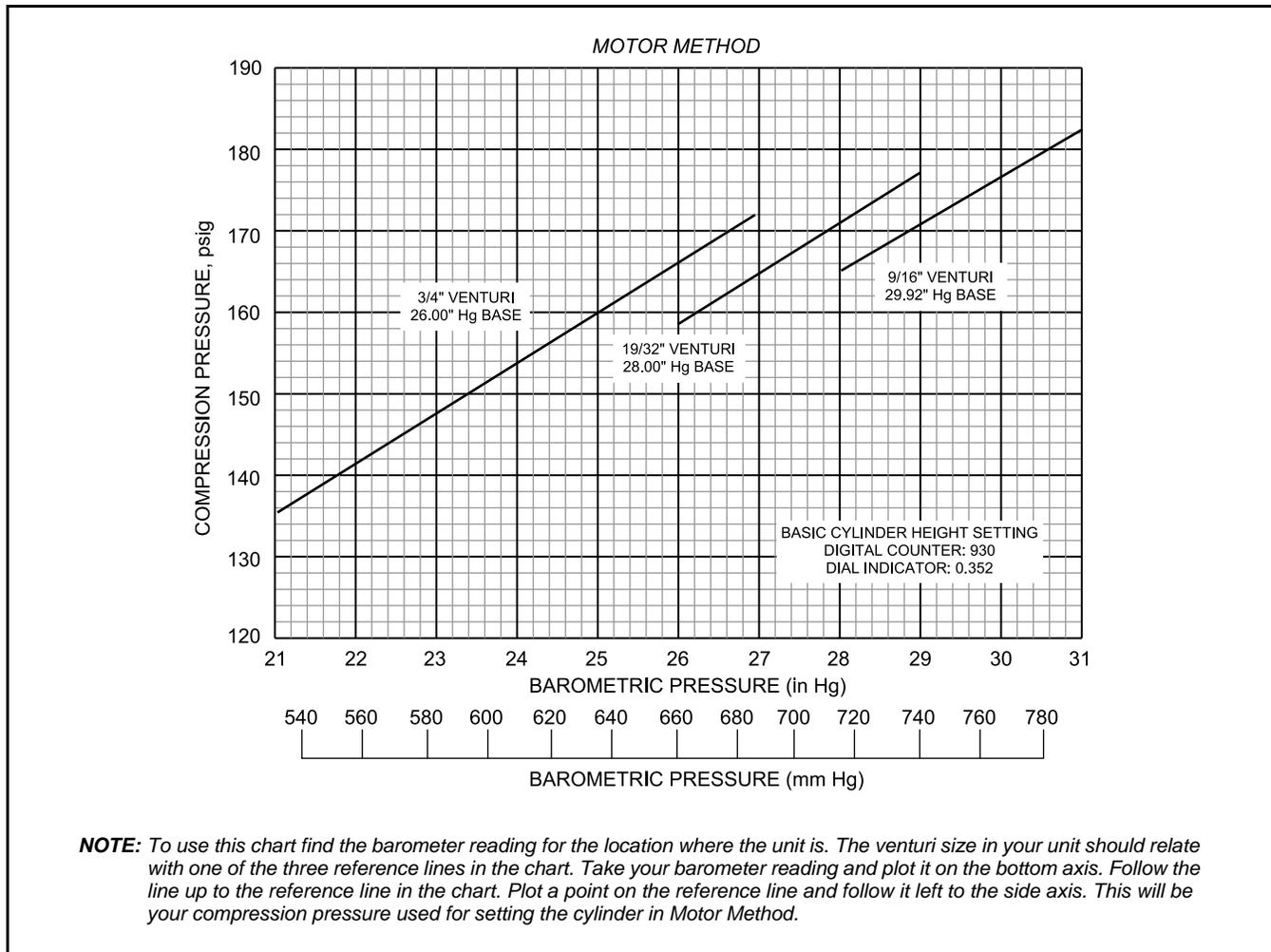


Figure 2. Actual Compression Pressure For Setting Basic Cylinder Height Micrometer Or Digital Counter Assembly For Local Observed Barometric Pressure – Motor Method

**PROCEDURE FOR DIAL INDICATOR METHOD**

1. Run unit for one hour on a typical gasoline fuel of which the octane number is known. Adjust the unit to all basic operating and instrument settings required as found in Section 10 "Basic Engine And Instrument Settings And Standard Operating Conditions" of each method in *ASTM Test Methods For Rating Motor, Diesel, And Aviation Fuels (Form 842)*.
2. Continue operation until the F-1 or F-2 unit is at equilibrium and all standard conditions stabilized.
3. Check valve clearances and set to proper value after unit runs for an hour and is at equilibrium with all standard conditions stabilized.
4. Loosen lock nut and knurled screw on dial indicator bracket.

5. Adjust the carburetor bowl selector valve between bowls and then turn off ignition switch to unit. Drain all fuel in carburetor bowls.
6. Switch the unit Start/Stop button to "Stop" to shut down the unit completely.

**WARNING**

Do not remove the detonation pickup until the unit has come to a complete stop. Failure to wait until unit stops could result in severe personal injury.

**WARNING**

Care must be taken when removing the hot detonation pickup from the cylinder. Contact with a hot pickup may cause severe personal injury.

7. Remove pickup cable and hot detonation pickup.


**WARNING**

Do not operate a CFR unit with fuel in any of the carburetor bowls or turn on the ignition switch when the compression pressure gauge is mounted in the cylinder pickup hole. If combustion occurs in the cylinder with the gauge in place, the gauge assembly will be damaged, the flexible hose can sever, and the gauge can be ejected in a manner that can cause serious personal injury or death.

**NOTE:** The adjustment and measurement of compression pressure should be made as quickly as possible so the readings on the gauge represent hot and running engine conditions.

8. Quickly install calibrated compression pressure gauge assembly into pickup hole with a new pickup gasket (P/N 111342) and tighten.
  9. Start up unit without fuel and without ignition.
  10. In Figure 1 and Figure 2 in this bulletin and in the ASTM manual for both D 2699 and D 2700 methods there are charts for prevailing barometric pressures. For the Research Method there is only one venturi line in the chart for all barometric pressures. For the Motor Method there are three different lines referencing three different venturi sizes.
  11. Find your current barometric pressure present in the location where the unit is. Using the barometric pressure, reference the proper chart or each respective method to establish the pressure at a basic cylinder height setting of 0.352" uncompensated on the dial indicator.
  12. Raise or lower your compression according to the reading on the gauge to achieve your compression pressure established on the chart.
  13. Once your pressure is achieved, set the dial indicator on the cylinder to 0.352". It may be necessary to make small adjustments to the dial indicator once you tighten the lock nut as it may alter the reading.
  14. Using the barometric pressure reading found in previous steps, use the appropriate table in *ASTM Test Methods For Rating Motor, Diesel, And Aviation Fuels (Form 842)* for D 2699 or D 2700 to compensate the 0.352" reading on the dial indicator to the correction factor designated in each respective chart.
- NOTE:** For pressures above 29.92" Hg the correction factor will be added to the 0.352" reading on the dial indicator. For pressures below 29.92" Hg the correction factor will be subtracted.
15. It is recommended that the pressure be checked at a high reference octane setting and a low reference octane setting. In this bulletin and in the ASTM manual there are tables for both methods on specifications for checking compression pressures (see Table 1 and Table 2).
  16. Raise the compression to check the high reference octane setting for each respective method within the specifications indicated in Table 1 and Table 2. Then lower the compression to check the low reference octane setting. Note the following:
    - If these checks come within the tolerance, your cylinder is indexed and ready to rate a TSF fuel.
    - If the pressures do not come within tolerances established by the charts, verify that you have the proper venturi size for your altitude, that your barometric correction is factored correctly, and that your pressure is correct for your basic height of the current barometric pressure. □