



Department of Environmental Quality

*To protect, conserve and enhance the quality of Wyoming's
environment for the benefit of current and future generations.*



Matthew H. Mead, Governor

Todd Parfitt, Director

December 5, 2013

RE: WDEQ/AQD 2013 Engine Emissions Testing Summary Report, Weeks 1 Through 8

Dear Wyoming Engine Operator:

The attached report summarizes the results of 8 weeks of Air Quality Division engine emissions testing conducted to date for contract year 2013. For the remainder of contract year 2013 the Division is planning to conduct additional testing during the first quarter of 2014 in the Upper Green River Basin (UGRB) ozone non-attainment area.

The Division is currently reviewing the test results for engines that have failed Air Quality Division or Administrator Directed Reference Method tests. The Division is also working towards making engine emissions training more available to engine operators.

I appreciate the cooperation that the Division is receiving as the engine emissions testing project continues.

Sincerely,

Steven A. Dietrich
Administrator
Air Quality Division



**WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION
MEMORANDUM**

TO: Steve Dietrich, Administrator *SD*
THROUGH: Lori Bocchino, Operating Permits Program Manager *LB*
Cole Anderson, NSR Program Manager *CA*
Fred DiLella, Compliance Program Manager *FD*
District 1 -5 Engineers (Electronic)
FROM: Jon Walker, Air Quality Engineer *JW*
SUBJECT: 2013 Engine Emissions Testing Summary Report, Weeks 1 through 8
DATE: December 2, 2013

Summary

The contract year 2013 engine emissions testing began in May 2013 and will end in April 2014. This report summarizes results from 8 weeks of testing conducted through November 2013. As with previous Air Quality Division (AQD) engine emissions testing, a test firm was contracted by the Division to evaluate the emissions from the selected engines in an as-found condition. During 7 of the test weeks, engine emissions monitoring was conducted using reference method equipment and the procedures from the Wyoming Air Quality Division Portable Analyzer Monitoring Protocol. One week of testing consisted of conducting three 1-hour runs of EPA Reference Methods 1 through 4, 7E, and 10 for NOx and CO. The project flow was consistent with testing conducted since May of 2011.

Test Week 1 - May 2013 Small Engine Emissions Monitoring

During May 2013 the Air Quality Division conducted one week of testing only engines less than 150 hp using the procedures from the Wyoming Air Quality Division Portable Analyzer Monitoring Protocol. These smaller engines had not been the focus of previous AQD engine emissions monitoring and so one week of testing was conducted only to independently evaluate emissions monitoring data from a sample of units in central and southwest Wyoming. The 26 engines that were emissions tested were permitted to 7 operators and were located at 25 minor source facilities. Monitoring test results are shown in the attached table.

Results of May 2013 AQD Small Engine Emissions Monitoring

Note: Preliminary tested levels shown below assume a default BSFC = 9400 Btu/hphr

| Results by Engine Type | 4SRB <150 HP | 2SLB <150 HP | All |
|------------------------|-----------------|-----------------|-----|
| Average HP | 80 | 31 | 74 |
| # Tested | 23 | 3 | 26 |
| # Failed | 14 | 2 | 16 |
| % Failed | 61% | 67% | 62% |

Test Week 3 - July 2013 Reference Method Testing in the Nonattainment Area

During the third week of testing in July 2013 the AQD conducted 4 engine emissions tests in the ozone nonattainment area that consisted of three 1-hour runs of EPA Reference Methods 1 through 4, 7E, and 10 for NOx and CO. This test procedure is the standard for evaluating engine performance for the purpose of determining if the source is operating in compliance with permitted pollutant levels. The four engines tested were permitted to four different operators. Three engines were shown to be operating within permitted levels of NOx and CO, while the fourth engine was shown to be exceeding the permitted CO level on a g/hphr basis. All four engines tested within permitted levels on a lb/hr basis. Emissions testing of a fifth engine was attempted but could not be completed as upon removal of the test port plugs a large volume of very hot exhaust exited the ports. This condition was apparently caused by back pressure in the stack from a downstream spark arrestor. Reference Method 2 requires the AQD's contractor to use a manlift to conduct a stack traverse with a pitot tube to determine flow. Since safety concerns made it impossible to do the traverse necessary to complete the reference method test, a favorable 21-minute monitoring test was completed using the exhaust sampling down tube before leaving the facility.

Test Weeks 2, 4, 5, 6, 7, 8 - June to November Engine Emissions Monitoring

From June to November six additional weeks of engine testing were conducted using reference method equipment and the procedures from the Wyoming Air Quality Division Portable Analyzer Monitoring Protocol. These test weeks focused on engines of all sizes. Monitoring results are summarized below and the results of individual test weeks are shown on the following pages.

Contract Year 2013, Test Weeks 2, 4, 5, 6, 7, 8

Combined Statewide Monitoring Results by Engine Type

Note: Preliminary tested levels shown below assume a default BSFC = 9400 Btu/hphr

| Engine Type | 4SLB 3600 Cats Only | 4SLB Excluding 3600 Cats | 4SRB ≥500 HP | 4SRB <500 HP | 2SLB | All Rich Burn | All Excluding 3600 Cats | All |
|----------------------------------------------------|---------------------------|--------------------------------|-----------------|-----------------|------|---------------------|-------------------------------|-----|
| # Tested | 20 | 47 | 58 | 41 | 4 | 99 | 150 | 170 |
| 1 < g/hphr ≤ 2 x Permitted Level ⁽¹⁾ | 1 | 10 | 9 | 6 | 0 | 15 | 25 | 26 |
| g/hphr > 2 x Permitted Level ⁽²⁾ | 0 | 1 | 9 | 21 | 0 | 30 | 31 | 31 |
| % Failed | 5% | 23% | 31% | 66% | 0% | 45% | 37% | 33% |

(1) Monitoring test results may be indicative of g/hphr exceedance; Corrective action and Protocol portable analyzer testing required.

(2) Monitoring test results may be indicative of lb/hr exceedance; Reference Method testing required.

Contract Year 2013, Test Weeks 2, 4, and 5 Monitoring Results by Engine Type

Note: Preliminary tested levels shown below assume a default BSFC = 9400 Btu/hphr

| Week 2, Wamsutter Area, 11 Operations | | | | | | | | |
|----------------------------------------------------|---------------------------|--------------------------------|-----------------|-----------------|------|---------------------|-------------------------------|------|
| Engine Type/Test Results | 4SLB 3600 Cats Only | 4SLB Excluding 3600 Cats | 4SRB ≥500 HP | 4SRB <500 HP | 2SLB | All Rich Burn | All Excluding 3600 Cats | All |
| Average HP | 2663 | 1365 | 869 | 279 | N/A | 648 | 887 | 1141 |
| # Tested | 4 | 8 | 10 | 6 | 0 | 16 | 24 | 28 |
| 1 < g/hphr ≤ 2 x Permitted Level ⁽¹⁾ | 0 | 3 | 1 | 0 | N/A | 1 | 4 | 4 |
| g/hphr > 2x Permitted Level ⁽²⁾ | 0 | 0 | 2 | 3 | N/A | 5 | 5 | 5 |
| % Failed | 0% | 37% | 30% | 50% | N/A | 37% | 37% | 32% |

| Week 4, Central and Northwest Wyoming, 9 Operations | | | | | | | | |
|------------------------------------------------------------|---------------------------|--------------------------------|-----------------|-----------------|------|---------------------|-------------------------------|------|
| Engine Type/Test Results | 4SLB 3600 Cats Only | 4SLB Excluding 3600 Cats | 4SRB ≥500 HP | 4SRB <500 HP | 2SLB | All Rich Burn | All Excluding 3600 Cats | All |
| Average HP | N/A | 1092 | 1347 | 242 | 533 | 1209 | 1150 | 1150 |
| # Tested | 0 | 3 | 21 | 3 | 2 | 24 | 29 | 29 |
| 1 < g/hphr ≤ 2 x Permitted Level ⁽¹⁾ | N/A | 1 | 3 | 1 | 0 | 4 | 5 | 5 |
| g/hphr > 2x Permitted Level ⁽²⁾ | N/A | 1 | 3 | 0 | 0 | 3 | 4 | 4 |
| % Failed | N/A | 67% | 29% | 33% | 0% | 29% | 31% | 31% |

| Week 5, Northeast Wyoming, 10 Operations | | | | | | | | |
|----------------------------------------------------|---------------------------|--------------------------------|-----------------|-----------------|------|---------------------|-------------------------------|-----|
| Engine Type/Test Results | 4SLB 3600 Cats Only | 4SLB Excluding 3600 Cats | 4SRB ≥500 HP | 4SRB <500 HP | 2SLB | All Rich Burn | All Excluding 3600 Cats | All |
| Average HP | 1775 | 1032 | 1228 | 296 | N/A | 829 | 943 | 992 |
| # Tested | 2 | 18 | 8 | 6 | 0 | 14 | 32 | 34 |
| 1 < g/hphr ≤ 2 x Permitted Level ⁽¹⁾ | 0 | 1 | 2 | 1 | N/A | 3 | 4 | 4 |
| g/hphr > 2x Permitted Level ⁽²⁾ | 0 | 0 | 2 | 2 | N/A | 4 | 4 | 4 |
| % Failed | 0% | 6% | 50% | 50% | N/A | 50% | 25% | 24% |

(1) Monitoring test results may be indicative of g/hphr exceedance; Corrective action and Protocol portable analyzer testing required.

(2) Monitoring test results may be indicative of lb/hr exceedance; Reference Method testing required.

Contract Year 2013, Test Weeks 6, 7, and 8 Monitoring Results by Engine Type

Note: Preliminary tested levels shown below assume a default BSFC = 9400 Btu/hphr

| Week 6, Wamsutter Area, 8 Operations | | | | | | | | |
|----------------------------------------------------|---------------------------|--------------------------------|-----------------|-----------------|------|---------------------|-------------------------------|------|
| Engine Type/Test Results | 4SLB 3600 Cats Only | 4SLB Excluding 3600 Cats | 4SRB ≥500 HP | 4SRB <500 HP | 2SLB | All Rich Burn | All Excluding 3600 Cats | All |
| Average HP | 2094 | 1888 | 1044 | 147 | 636 | 506 | 1260 | 1371 |
| # Tested | 4 | 14 | 4 | 6 | 2 | 10 | 26 | 30 |
| 1 < g/hphr ≤ 2 x Permitted Level ⁽¹⁾ | 1 | 3 | 1 | 0 | 0 | 1 | 4 | 5 |
| g/hphr > 2x Permitted Level ⁽²⁾ | 0 | 0 | 0 | 3 | 0 | 3 | 3 | 3 |
| % Failed | 25% | 21% | 25% | 50% | 0% | 40% | 27% | 27% |

| Week 7, Southwest Wyoming, 7 Operations | | | | | | | | |
|----------------------------------------------------|---------------------------|--------------------------------|-----------------|-----------------|------|---------------------|-------------------------------|-----|
| Engine Type/Test Results | 4SLB 3600 Cats Only | 4SLB Excluding 3600 Cats | 4SRB ≥500 HP | 4SRB <500 HP | 2SLB | All Rich Burn | All Excluding 3600 Cats | All |
| Average HP | 2905 | 1100 | 1172 | 154 | N/A | 561 | 610 | 949 |
| # Tested | 1 | 2 | 8 | 12 | 0 | 20 | 22 | 23 |
| 1 < g/hphr ≤ 2 x Permitted Level ⁽¹⁾ | 0 | 0 | 0 | 2 | 0 | 2 | 2 | 2 |
| g/hphr > 2x Permitted Level ⁽²⁾ | 0 | 0 | 1 | 8 | 0 | 9 | 9 | 9 |
| % Failed | 0% | 0% | 12% | 83% | N/A | 55% | 50% | 48% |

| Week 8, Nonattainment Area, 9 Operations | | | | | | | | |
|----------------------------------------------------|---------------------------|--------------------------------|-----------------|-----------------|------|---------------------|-------------------------------|------|
| Engine Type/Test Results | 4SLB 3600 Cats Only | 4SLB Excluding 3600 Cats | 4SRB ≥500 HP | 4SRB <500 HP | 2SLB | All Rich Burn | All Excluding 3600 Cats | All |
| Average HP | 3277 | 1101 | 847 | 124 | N/A | 461 | 537 | 1485 |
| # Tested | 9 | 2 | 7 | 8 | 0 | 15 | 17 | 26 |
| 1 < g/hphr ≤ 2 x Permitted Level ⁽¹⁾ | 0 | 2 | 2 | 2 | 0 | 4 | 6 | 6 |
| g/hphr > 2x Permitted Level ⁽²⁾ | 0 | 0 | 1 | 5 | 0 | 6 | 6 | 6 |
| % Failed | 0% | 100% | 43% | 87% | N/A | 67% | 71% | 46% |

(1) Monitoring test results may be indicative of g/hphr exceedance; Corrective action and Protocol portable analyzer testing required.

(2) Monitoring test results may be indicative of lb/hr exceedance; Reference Method testing required.

Contract Year 2013, Test Weeks 2, 4, 5, 6, 7, 8
Combined Statewide Monitoring Results by Facility Type

Note: Preliminary tested levels shown below assume a default BSFC = 9400 Btu/hphr

| Test Week | Wyoming Area | Major Facilities, # | | | | % Failed | Minor Facilities, # | | | | % Failed | Total Facilities, # | | | | % Failed |
|-----------|--------------------|---------------------|--------|--------|--------|----------|---------------------|--------|--------|--------|----------|---------------------|--------|--------|--------|----------|
| | | Visited | Tested | Failed | Failed | | Visited | Tested | Failed | Failed | | Visited | Tested | Failed | Failed | |
| 2 | Wamsutter | 3 | 9 | 3 | 33% | 16 | 19 | 6 | 32% | 19 | 28 | 9 | 32% | | | |
| 4 | Central, Northwest | 2 | 6 | 0 | 0% | 14 | 23 | 9 | 39% | 16 | 29 | 9 | 31% | | | |
| 5 | Northeast | 3 | 11 | 3 | 27% | 15 | 23 | 5 | 22% | 18 | 34 | 8 | 24% | | | |
| 6 | Wamsutter | 4 | 9 | 3 | 33% | 13 | 21 | 5 | 24% | 17 | 30 | 8 | 27% | | | |
| 7 | Southwest | 3 | 9 | 1 | 11% | 14 | 14 | 10 | 71% | 17 | 23 | 11 | 48% | | | |
| 8 | Nonattainment | 2 | 9 | 0 | 0% | 16 | 17 | 12 | 71% | 18 | 26 | 12 | 46% | | | |
| Total | | 17 | 53 | 10 | 19% | 88 | 117 | 47 | 40% | 105 | 170 | 57 | 33% | | | |

Discussion

The following observations are noted:

- 1) As has been noted in previous AQD engine emissions testing, many operations produce favorable monitoring test results due to successful engine emissions management practices. Individual operations succeed in different ways depending on the types of engines, applications, staff, etc.
- 2) Poor performing operations have the same general characteristics including inadequate resources (training, time, tools, etc.) devoted to engine maintenance and emissions. A lack of training in identifying and troubleshooting engine emissions problems is prevalent, and training opportunities are not readily available.
- 3) Project test results for any one area, or Statewide, should not be considered as being indicative of the performance of all operations in that area. Operations with good emissions management practices performed well. Noted failures are generally specific to operations with poor emissions management practices. Emissions management practices vary greatly between operations and in different areas.

- 4) Project data summarized for any area may be biased towards poor performing operations which are generally the focus of more time in the field.
- 5) The test Week 1 monitoring results for small engines were similar to that of larger engines. Well-maintained units gave favorable results indicating that permitted emissions levels were reasonable. Any poor performance appeared only to be due to poor maintenance.
- 6) The Division's week conducting three 1-hour runs of EPA Reference Methods 1 through 4, 7E, and 10 for NO_x and CO in the nonattainment area showed that there are many safety concerns associated with using EPA Reference Method 2 to determine stack flow rate for unannounced testing. Besides the use of the manlift, unannounced testing makes it extremely difficult to anticipate all potentially unsafe conditions. Also, many older engines do not have sampling ports that are necessary for the Method 2 stack traverse. Using EPA Reference Method 19 instead of Method 2 would be a much safer method of determining stack flow when conducting unannounced engine testing and could be used to quantify emissions from older engines that do not have test ports in the stack.
- 7) Many small (<100 hp) rich burn engines were tested during contract year 2013. As compared to previous testing, the testing of smaller engines may have yielded significantly worse results for the categories of rich burn engines <500 hp, all rich burn engines, and the combined results for all facility and engine types.
- 8) With the exception of the small engine test week in May of 2013, the Administrator has required an engine operator to conduct Reference Method testing within 14 days for monitoring test results that may be indicative of a mass emissions rate (lb/hr) exceedance for NO_x and/or CO. This testing consists of three (3) 1-hour runs following EPA reference methods 1-4, 7E, 10, 18, 25A, and 320, as applicable. Method 19 was used to determine stack flow for diameters less than 4 inches, or when it was not possible to conduct the Method 2 flow traverse. The engine is required to be tested at the maximum achievable load under normal operating conditions. Several engines have failed these Administrator Directed tests.
- 9) In general, this project has been very well received by the operations visited during contract year 2013. As poor performing operations continue to establish internal emissions monitoring programs to ensure ongoing engine emissions remain within permitted levels, the lack of available training is contributing significantly to any unfavorable results summarized in this report.