

Pellet Manufacturer Perspective: Current Status of Compliance

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QA Overview

- A QA program starts at the front end and continues throughout the entire process:
 - Every raw material supplier is qualified prior to purchase
 - Every load is inspected and tested
 - Automated processes in place to assure Quality
 - All key process metrics are recorded and alarmed if they fall outside limits
 - DAILY management review meeting which focuses on key parameters of past 24 hours
 - Equipment is designed / modified to assure quality. For example, we have modified pellet mills so we cannot make a long pellet.
- Our finished product testing is just a confirmation of quality.

Summary of PFI Fuel Grade Requirements

Table 1 PFI Fuel Grade Requirements			
Residential Commercial Densified Fuel Standards			
Fuel Property	PFI Premium	PFI Standard	PFI Utility
Normative Information, Mandatory			
Bulk Density (Pounds / Cubic Foot)	40.0 - 46.0	38.0 - 46.0	38.0 - 46.0
Diameter, Inches	0.230 - 0.285	0.230 - 0.285	0.230 - 0.285
Diameter, mm	5.84 - 7.25	5.84 - 7.25	5.84 - 7.25
Pellet Durability Index	>= 96.5	>= 95.0	>= 95.0
Fines, % (at the mill gate)	<= 0.50	<= 1.0	<= 1.0
Inorganic Ash, %	<= 1.0	<= 2.0	<= 6.0
Length, % > 1.50 inches	<=1.0	<=1.0	<=1.0
Moisture, %	<= 8.0	<= 10.0	<= 10.0
Chloride, ppm	<= 300	<= 300	<= 300
Heating Value	NA	NA	NA
Informative Only - Not Mandatory			
Ash Fusion	NA	NA	NA

Equipment Used -Pellet Splitter



Bulk Density

- PFI Premium Grade Requirement: 40 – 46 Lbs/Ft.³
- ASTM Standard – ASTM E 873
- Test Methodology:
 - Sample size – minimum 12 pounds
 - Take a $\frac{1}{4}$ cubic foot container, fill and tap 25 times from one inch
 - Record results
- Testing Frequency – Twice / Week

Equipment Used For Bulk Density



Stainless Steel Box



FA200 Analytical balance accurate to 0.0001 g. Holds 200 grams.
Price \$1700.

Pellet Diameter

- PFI Premium Grade Requirement: 0.230 – 0.285”
- Test Methodology –
 - Select five pellets randomly from pellet sample (using splitter)
 - Using an approved caliper, measure all five and calculate and report average and range to 0.001. **We report average not the range**
- Testing Frequency – Twice / Week.

Equipment Used - Pellet Diameter



Approx. \$200. 12" Caliper, accurate to 0.001"

Pellet Durability Index (PDI)

- PFI Premium Grade Requirement: $\geq 96.5\%$
- Test Methodology
 - Secure sample of at least 1,100 grams using pellet splitter and a bag of finished goods. **We use 500 g**
 - Screen over 1/8" wire screen sieve to remove fines
 - Weigh 500 grams (± 10 grams) to nearest 0.1 grams (IW)
 - Tumble at 50 rotations per minute for 500 rotations.
 - Re-screen the tumbled sample, weigh the portion remaining on sieve and record whole pellet sample weight to 0.1 grams
 - Compute Pellet Durability index (WPI / IW)
 - Repeat with a second sample. **We do not do the second test.**
- Testing Frequency – Twice per week following PFI standard. **We use a slightly modified method twice per hour. The fuel comes direct from production not from finished goods.**

Equipment Used for Pellet Durability



Durability Tester. We can do 4 tests at the same time. Rotates at 50 RPM for 5 minutes. Approximate Cost \$1700 - \$2,000.

Fines

- PFI Premium Grade Requirement: $\leq 0.5\%$
- Equipment Used – 1/8” Wire screen sieve
- Test Methodology (there is also an alternate method):
 - Secure a representative sample and reduce to min. 2.5 pounds using a sample splitter
 - Using analytical balance weigh sample and record as “initial sample weight” to 0.1 gram
 - Weigh receiving pan and record to 0.1 gram
 - Attach 1/8” screen to pan and place sample on screen. Several individual screenings may be needed depending on sample size relative to screen size
 - Screen by tilting side to side 10 times
 - Remove screen and weigh and record weight of base pan with the fines to 0.1 grams
 - Calculate and report the % of fines to 0.01% (weight of base pan with fines – weight of base pan / initial sample weight)
- Testing Frequency – Twice per week using finished product. **Energex also tests once per hour from the production line.**

Equipment Used for Fines Testing



Scale – in control room, used hourly



Timer

Sieve Shaker. Each sieve has a progressively smaller mesh screen from large at top to very fine at bottom. Set the timer and it shakes back and forth for predetermined period of time.

Inorganic Ash

- PFI Premium Grade Requirement: $\leq 1.0\%$
- ASTM Standard - ASTM D 1102
- Test Methodology:
 - Select a small sample using pellet splitter
 - Pulverize and place on a 40 mesh screen (0.0165")
 - Select 2 grams randomly and place in crucible
 - Place crucible into muffle furnace for 2 hours and 12 minutes bringing temperature to 600C.
 - Weigh remaining ash
 - Determine and record results
- Testing Frequency – Twice / Week

Equipment Used for Ash Samples



Muffle Furnace – slowly ramps up to 600C. We can do 4 tests at a time. Approximate inside dimensions are 5" X 6" X 6".

Additional Equipment for Ash Testing



4 crucibles shown inside $\frac{1}{2}$ " sealable glass desiccator. The samples are cooled to room temperature and then weighed.

Also, FA 200 analytical scale shown previously.

Also For Ash Testing



Plate Mill. Dial to the right allows for wide range of adjustment. Very fine grind of pellets for ash testing. Also used for moisture testing.



FA200 Analytical scale shown previously. Accurate to 0.0001 grams

Length, % > 1.5"

- PFI Premium Grade Requirement: $\leq 1.0\%$
- Test Methodology :
 - Start with 2.5 pounds randomly selected from sample
 - Hand sort to identify pellets over 1.5", using approved calipers or measuring block
 - Determine and record weight of all pellets over 1.5".
 - Additionally report the longest pellet over 1.5"
 - **We have no pellets over 1.50"**
- Testing Frequency – Twice / Week

Equipment for Measuring Length



Same Caliper as Used for Pellet Diameter

Moisture

- PFI Premium Grade Requirement: $\leq 8.0\%$
- Equipment Used – 3 units, \$3,000 each
- Test Methodology
 - Select a random sample using a splitter (approx 1 handful)
 - Grind to a fine flour
 - Select 4 grams
 - Heat to 175C for 5 minutes
 - Moisture % is determined and recorded.
- Testing Frequency – Twice Per Week from finished goods.
Additionally, we do this twice per hour from the production line.

Equipment for Moisture Testing



To the left scale which is calibrated weekly.
To the right, moisture analyzers. In PA
alone, we have 3 at a cost of \$3,000 each.

Chlorides

- PFI Premium Grade Requirement: ≤ 300 ppm
- ASTM Standard – ASTM E 776, ASTM D 4208 or ASTM D 6721
- Test Methodology – This test is not performed in-house.
- Testing Frequency - Twice Per Week. **Quarterly by Energex**

Heating value and Ash Fusion

- Heat value – ASTM E 711
- Ash Fusion – ASTM D 1857

- Both of these tests are performed by independent labs and are optionally reported.

Calibration and Standardization

- Caliper – Before each test confirm accuracy of caliper by measuring a traceable gauge block that is between 80% and 120% of the anticipated fuel diameter.
- Balances and Scales – Before each test, verify the balance or scale by using a calibration weight that is 50% to 150% of the anticipated fuel sample weight. The scale must be accurate to within 1%.

Summary – One Manufacturer's Perspective

- Strengths
 - Test frequency far in excess of requirements
 - Quality Control Manager at each Plant
 - Expensive high quality equipment
- Opportunities for Improvement
 - Independent lab results are recorded but not compared to in-house results. That will be changed.
 - Chloride testing is well below required but we have never had a chloride problem in 19 years.