Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas: Methodology for Source Selection, Evaluation of Control Options and Four Factor Analysis

ADDENDUM FOR RESIDUAL OIL

April, 2011

INTRODUCTION

In July of 2007, the Mid-Atlantic/Northeast Visibility Union (MANE-VU) released a report entitled "Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas: Methodology for Source Selection, Evaluation of Control Options and Four Factor Analysis." The purpose of this report was to analyze the economic and environmental impacts of potential control measures that could be implemented by MANE-VU States to reduce emissions from specific source categories in order to make reasonable progress toward meeting visibility improvement goals.

One such control measure is to reduce the sulfur content of home heating and residual oils. The MANE-VU states have signed a *Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Course of Action Within MANE-VU Toward Assuring Reasonable Progress* that outlines a strategy to reduce the sulfur content of home heating and residual oils. The 2007 "Assessment of Reasonable Progress" report evaluated home heating oil as one of its sectors. Although the use of low sulfur residual oil was identified as an option for reducing SO2 emissions at electricity generating units (EGUs) and industrial, commercial and institutional (ICI) boilers, it was not analyzed as a stand-alone strategy. This addendum is intended to provide that information by analyzing the economic and environmental impacts of reducing sulfur in residual oil, with respect to the four factors listed in the Clean Air Act (Section 169A). The four factors are: cost of compliance, time necessary for compliance, energy and non-air impacts, and remaining useful life of the sources. This document primarily focuses on reducing the sulfur content of No. 6 residual oil. Information on reducing the sulfur content of No. 4 residual oil is presented wherever data were available.

BACKGROUND

Residual oil is also known as No. 6 fuel oil. No. 4 oil, sometimes also called a residual oil, is a blend of No. 6 and No. 2 (distillate or diesel) fuel oils. No. 6 fuel oil is commonly used in electric generating units, industrial, commercial and institutional boilers. No. 4 fuel oil is commonly used in large residential facilities.

The Department of Energy - Energy Information Administration (EIA) provides information on the oil consumption by district (Petroleum Administration for Defense Districts or PADD) and sector. MANE-VU states are located in PADD1A (CT, ME, MA, NH, RI, VT) and PADD 1B (DE, DC, MD, NJ, NY, PA). Figures 1 presents total residual oil consumption by year for the years 2000-2009. Figure 2 presents average residual oil consumption by sector for 2006-2009 PADD1B consumes more residual oil than PADD1A; this is especially true for residual oil used for vessel bunkering. Residual oil used for vessel bunkering is combusted by the vessel in which

it is bunkered. For both districts, there is significant residual oil consumption by the electric power sector (43% of total for PADD1A, 21% of total for PADD1B).

Figure 1: Total Residual Oil Consumption by Year

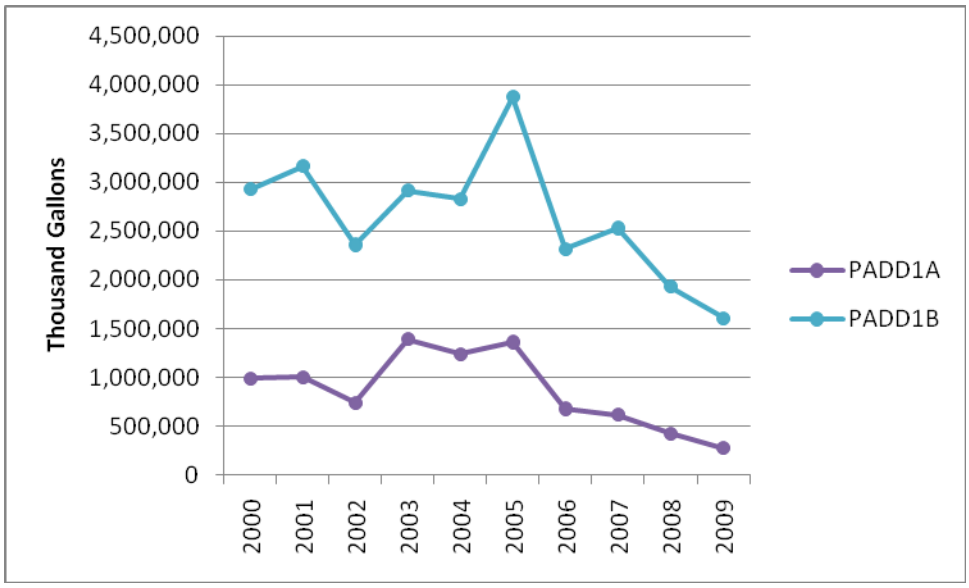
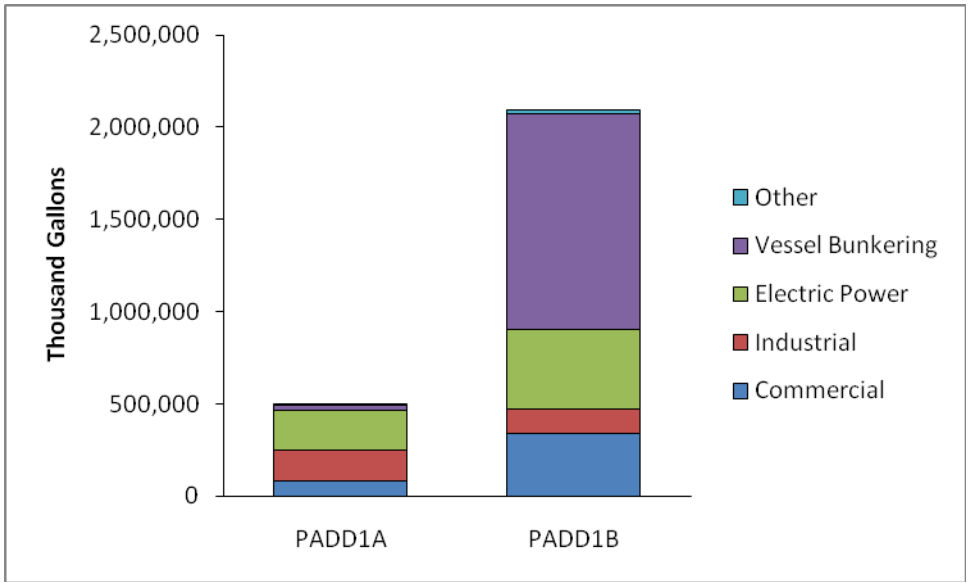


Figure 2: Average Annual Residual Oil Consumption by Sector (2006-2009)*



*The most recent four years available.

Sulfur in Residual Oil

SO_2 emissions are proportional to fuel oil sulfur content. It is uncommon, although not infeasible, to control SO_2 emissions from oil-fired boilers using control devices. Therefore, the

most common and cost-effective method for controlling SO_2 emissions from residual oil in the U.S. is by lowering the amount of sulfur in the fuel.

Currently, the sulfur limits in residual oil in the MANE-VU states vary between 0.3 – 2.8 percent (in this document, all sulfur content percentages refer to percent sulfur by weight). Many states have different fuel sulfur limits for different areas, depending upon population or region; Table 1 presents the range of fuel sulfur limits allowed by each state.

Table 1: MANE-VU State Sulfur Limits for Residual Oil (Percent Sulfur by Weight)*

State	Maximum Sulfur Limit No. 4	Maximum Sulfur Limit No. 6	Data Source
Connecticut	0.48%	0.74%	Wendy Jacobs
Delaware	0.5 – 2.0%	0.5 – 2.0%	Jack Sipple
Maine	0.7%	1.0 - 2.0%	MV 2018 Inventory
Maryland	1.0 – 2.0%	1.0 – 2.0%	Ralph Hall
Massachusetts	0.5 - 2.2%	0.5 - 2.2%	310 CMR 7.05
New Hampshire	1.00%	2.00 – 2.20%	Env-A 1604
New Jersey	0.3 – 2.0%	0.3 – 2.0%	N.J.A.C. 7:27-9
New York	0.30 – 1.50%	0.30 – 1.50%	Mike Jennings
Pennsylvania (Philadelphia)	0.3 – 2.8% (0.3%)	0.5 – 2.8% (0.5%)	25 PA Code 123.22 (3-207(1)(a))
Rhode Island	0.7%	1.0%	MV 2018 Inventory
Vermont	2.0%	2.0%	VT APCR 5-221
Washington, D.C.	0.7%	1.0%	MV 2018 Inventory

* Sulfur limits based on rules in effect as of May 2010.

The MANE-VU states signed a *Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Course of Action Within MANE-VU Toward Assuring Reasonable Progress* which outlines a strategy to reduce the sulfur content of home heating and residual oils. For No. 4 residual oil, sulfur is to be reduced to 0.25 – 0.5% sulfur by weight. For No. 6 residual oil, sulfur is to be reduced to 0.3 – 0.5% sulfur by weight. These limits will apply no later than 2018. It is estimated that this strategy will reduce sulfur dioxide emissions from residual oils by up to 50%.

Several MANE-VU states are in the process of passing or amending regulations to implement the limits in the MANE-VU Statement, including New Jersey and Maine. New Jersey's amendment to N.J.A.C. 7:27-9 was adopted and effective on September 20, 2010, which lowers the sulfur content in 2014 for No. 6 residual oil to 0.3% – 0.5% and for No. 4 residual oil to 0.25%. Maine's legislature passed a bill mandating lower sulfur fuel standards in April, 2010. This bill requires 0.5% sulfur by weight in residual fuel oils by January 1, 2018. The Maine Department of Environmental Protection has been directed to adopt rules allowing equivalent alternative

sulfur reduction strategies for licensed sources. Additional requirements include establishing an advisory committee and conducting a fuel oil supply study in 2014.

Residual Oil Supply

The following table illustrates the average total annual stocks for residual oils of varying sulfur content for the United States and for PADD1 for the years 2006 – 2009 (in thousand barrels ± standard deviation). Also shown is the percentage of U.S. stocks represented by the PADD1. All data were gathered from the EIA web site on February 28, 2011.

Table 1: Average Annual Residual Oil Stocks:
Average ± Standard Deviation for the Years 2006 - 2009

	Residual < 0.31% S	Residual 0.31-1.00% S	Residual > 1.00% S	All Residual (Total)
U.S. (Total)	5,190 ± 1333	12,214 ± 1,635	21,292 ± 928	38,696 ± 2,777
East Coast (PADD1)	3,571 ± 763	6,516 ± 1,594	4,917 ± 454	15,004 ± 2,523
PADD1 Portion of U.S.	70% ± 10%	53% ± 6%	23% ± 1%	39% ± 4%

The information presented in Table 2 indicates that a large amount of lower sulfur residual oil is available on the East Coast and thus, presumably, in the Northeast.

FOUR FACTOR ANALYSIS OF POTENTIAL CONTROL SCENARIOS FOR EMISSIONS FROM HEATING OIL COMBUSTION

Cost of Compliance

Residual oils with varying sulfur contents, including low sulfur content, are currently available in the Northeast fuel oil markets. Many Mid-Atlantic and Northeast states require low sulfur residual oil (e.g., 0.3% - 0.5%) in certain areas, and thus there is an existing market for low sulfur residual oil. In addition, the MARPOL Annex VI fuel sulfur limits specify 1.0% for marine vessels in Emission Control Areas (which includes the U.S. coast) in 2010 and 0.1% in 2015, adding to the market for low sulfur residual oil. EIA provides information on the cost of residual fuel oil by district and by sulfur content. The EIA sulfur categories are ≤ 1.00% and > 1.00% sulfur by weight.

The following table illustrates the recent price differences between ≤ 1.00% and > 1.00% sulfur residual oils for the U.S., PADD 1A (CT, ME, MA, NH, RI, VT) and PADD 1B (DE, DC, MD, NJ, NY, PA). Monthly price averages were averaged to compute annual prices and price differentials in cents per gallon for the years 2006 – 2009. This data was then averaged and is presented in Table 3 below, along with the standard deviations. All data were gathered from the EIA web site on February 28, 2011 and all price comparisons are before taxes.

Table 3: Price Ranges and Price Differentials (Minimum, Average, and Maximum) by Sulfur Content of No. 6 Residual Oil for the Years 2006 - 2009

	No. 6 Residual Price > 1.00%			No. 6 Residual Price ≤ 1.00%			Price Differential		
	Cents per Gallon, excluding taxes								
	Min.	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**
U.S.	117.4	143.8	189.9	132.2	161.2	215.7	13.2	18.8	31.1
PADD1A	118.2	147.1	193.9	127.1	160.7	206.7	8.9	9.9	12.9
PADD1B	117.7	142.9	186.9	136.5	168.7	222.9	19.5	26.2	39.2
NYC Metro	117.9	141.5	186.0	141.4	164.7	202.9	23.5	23.2	16.9

As can be seen in Table 3, the price differential between No. 6 residual oil ≤ 1.00% and > 1.00% sulfur is less than the U.S. average for PADD1A but more than the U.S. average for PADD1B. Lower sulfur No. 6 residual oil ranges from 8.9 to 39.2 cents per gallon more than higher sulfur No. 6 residual oil.

This additional expense, however, is expected to be offset by reduced maintenance costs with the use of lower sulfur No. 6 oil similar to the reductions in maintenance costs that occurs when the sulfur content of No. 2 oil is reduced. Low sulfur oil is cleaner burning and emits less particulate matter than higher sulfur oil; this reduces the rate of fouling of heating units substantially and permits longer time intervals between cleanings. For example, when the existing oil sulfur content for No. 2 distillate oil is 2,000 ppm and 500 ppm sulfur is substituted, the service interval can be extended by a factor of three or more (e.g., cleaning at three year intervals rather than annually) (NESCAUM 2005). The decreased deposits would also enable a more efficient transfer of heat, thereby reducing the fuel usage. Similarly, there are substantial potential cost savings for switching to lower sulfur residual oil.

Under the MANE-VU low sulfur residual oil strategy, refineries would need to bring additional lower sulfur residual oil to market by 2014. However, due to this long lead time and the new MARPOL Annex VI marine vessel regulations that require sulfur content reductions in 2010 and 2015, the cost to produce residual oil that complies should not be too onerous on refineries.

Time Necessary for Compliance

Refiners in the United States are already producing low sulfur residual oil. Existing boilers do not need to be retrofitted or modified to combust lower sulfur residual oil. Consequently, the time necessary for compliance does not hinge on replacing any equipment. Many residual-oil burning facilities, however, have large oil stocks on-site. These stocks may take several years to

be completely depleted and mixing between the old, higher sulfur residual oil stock and new, lower sulfur residual oil is likely to occur. Therefore, compliance may best be monitored by ensuring the purchase and/or sale, rather than the combustion, of lower sulfur residual oil.

Energy and Non-Air Impacts

Reducing the sulfur contents of residual oil has a variety of beneficial consequences for residual oil-fired boilers. Low sulfur residual oil is cleaner burning and emits less particulate matter than higher sulfur oil; this reduces the rate of fouling of heating units substantially and permits longer time intervals between cleanings. The decreased deposits would also enable a more efficient transfer of heat, thereby reducing the fuel usage. Both of these factors result in cost-savings, partially offsetting the higher costs of lower sulfur residual oil described above.

Remaining Useful Life of the Source

Residual oil-fired boilers have finite life times, but they do not need to be replaced to burn lower sulfur fuel. In fact, burning a lower sulfur residual oil may increase their lifespan. Lower sulfur oils cause less corrosion in the heating system because internal condensation produces less sulfuric acid than higher sulfur oil.

REFERENCES

NESCAUM, 2005. *Low Sulfur Heating Oil in the Northeast States: An Overview of Benefits, Costs and Implementation Issues*.

US Energy Information Administration, 2010. Information downloaded from the World Wide Web on February 28, 2011.at: http://tonto.eia.doe.gov/dnav/pet/pet_pri_dist_dcu_R1X_m.htm

APPENDIX

Sales of Residual Fuel Oil by End Use by Area

Data from U.S. Department of Energy, Energy Information Administration website http://tonto.eia.gov/dnav/pet/
Annual Residual Fuel Oil Stocks by Sales Type, by Sulfur
Petroleum Marketing Monthly, February 2011

Total Consumption	06-09 Avg	06-09 StdDev	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
U.S.	9,751,021	1,298,212	13,210,935	13,609,379	10,361,615	11,412,833	11,794,362	13,442,165	10,273,631	10,706,479	8,272,952	6,705,631
PADD1	5,007,307	925,486	7,526,995	8,075,116	6,185,982	7,489,187	7,757,770	9,016,843	5,555,911	5,527,235	3,938,776	2,920,034
PADD1A	570,678	133,312	986,373	1,000,134	738,649	1,390,239	1,238,044	1,361,581	676,210	614,965	420,858	274,660
PADD1B	2,258,283	303,840	2,928,153	3,165,215	2,357,633	2,915,477	2,826,604	3,876,920	2,316,326	2,528,915	1,929,608	1,607,207
OTR Total	**2,828,961**	**421,241**	**3,914,526**	**4,165,349**	**3,096,282**	**4,305,716**	**4,064,648**	**5,238,501**	**2,992,536**	**3,143,880**	**2,350,466**	**1,881,867**

Consumption by Sector - PADD1A	06-09 Avg	06-09 StdDev	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Commercial	124,234	8,664	114,156	86,149	88,501	150,209	192,682	208,830	102,505	88,161	86,915	64,826
Industrial	266,803	65,901	355,553	474,236	319,056	224,662	233,570	251,167	239,005	194,642	109,340	106,980
Electric Power	510,663	52,483	458,707	390,256	277,957	1,013,906	808,988	837,753	286,245	311,508	210,645	51,213
Vessel Bunkering	32,426	17,829	55,436	46,830	51,445	521	2,078	58,373	46,100	18,029	13,022	50,075
Other	2,213	907	2,521	2,663	1,690	941	726	5,458	2,355	2,625	936	1,566
Total	**936,339**	**133,312**	**986,373**	**1,000,134**	**738,649**	**1,390,239**	**1,238,044**	**1,361,581**	**676,210**	**614,965**	**420,858**	**274,660**

Consumption by Sector - PADD1B	06-09 Avg	06-09 StdDev	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Commercial	435,117	40,556	495,051	485,510	433,113	527,840	508,662	439,849	346,426	380,176	299,425	338,089
Industrial	179,127	26,690	226,604	240,402	145,183	181,283	189,255	176,101	173,749	157,892	121,678	71,617
Electric Power	979,374	291,668	880,352	1,304,358	683,071	1,261,743	1,121,164	2,069,711	612,111	715,339	166,514	238,261
Vessel Bunkering	1,118,166	85,473	1,243,375	1,038,444	1,036,387	892,057	968,460	1,152,556	1,156,989	1,247,389	1,327,839	938,273
Other	48,755	7,774	82,771	96,501	59,879	52,554	39,063	38,703	27,051	28,119	14,152	20,967
Total	**2,760,539**	**303,840**	**2,928,153**	**3,165,215**	**2,357,633**	**2,915,477**	**2,826,604**	**3,876,920**	**2,316,326**	**2,528,915**	**1,929,608**	**1,607,207**

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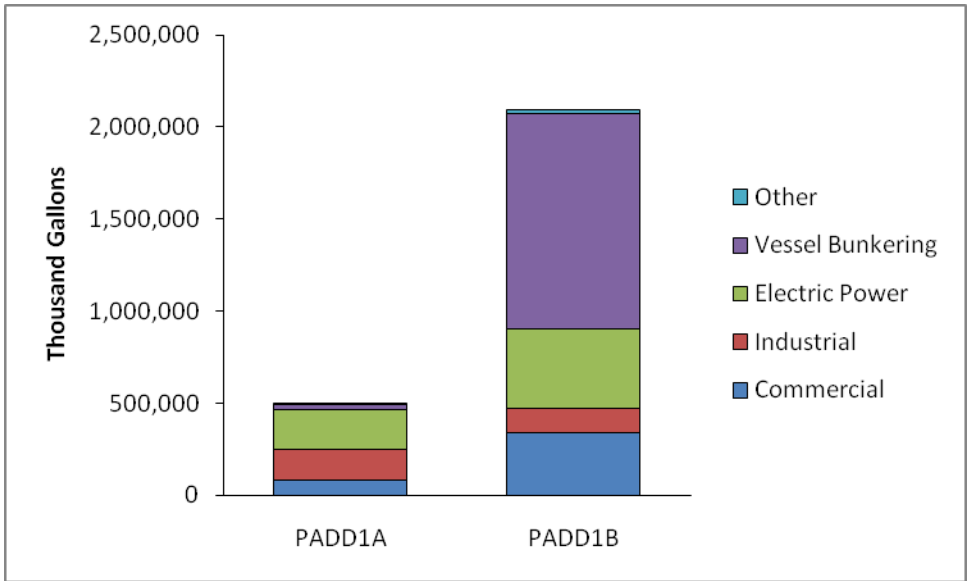
06-09 Avg. Consumption by Sector and Area	PADD1A	PADD1B
Commercial	85,602	341,029
Industrial	162,492	131,234
Electric Power	214,903	433,056
Vessel Bunkering	31,807	1,167,623
Other	1,871	22,572

06-09 Avg. Consumption by Sector as %	PADD1A	PADD1B
Commercial	17%	16%
Industrial	33%	6%
Electric Power	43%	21%
Vessel Bunkering	6%	56%
Other	0%	1%



Fuel Oil Price Comparison Charts DRAFT (02/28/11)
Data from U.S. Department of Energy, Energy Information Administration website
http://tonto.eia.gov/dnav/pet/
Residual Fuel Oil Price by Sales Type, by Sulfur, Sales to End Users
Petroleum Marketing Monthly, February 2011
PADD 1A (New England) = CT, ME, MA, NH, RI & VT

New England PADD 1A Residual Fuel Oil Retail Prices by All Sellers (Cents per Gallon Excluding Taxes)

	Residual >1%S	Residual ≤ 1%S	Differential	% Difference
	(¢/gal)	(¢/gal)	(¢/gal)	
Jan-02	45.6	58.9	13.3	29.2%
Feb-02	47.0	55.3	8.3	17.7%
Mar-02	47.4	57.6	10.2	21.5%
Apr-02	54.5	61.9	7.4	13.6%
May-02	57.1	61.6	4.5	7.9%
Jun-02	57.1	61.2	4.1	7.2%
Jul-02	56.7	63.8	7.1	12.5%
Aug-02	59.5	61.7	2.2	3.7%
Sep-02	63.1	67.7	4.6	7.3%
Oct-02	68.1	70.7	2.6	3.8%
Nov-02	58.6	66.4	7.8	13.3%
Dec-02	63.2	74.0	10.8	17.1%
12 month Average	**56.5**	**63.4**	**6.9**	**12.9%**
Jan-06	117.1	126.5	9.4	8.0%
Feb-06	118.1	131.4	13.3	11.3%
Mar-06	120.7	129.8	9.1	7.5%
Apr-06	124.2	129.6	5.4	4.3%
May-06	125.1	131.1	6	4.8%
Jun-06	121.8	129	7.2	5.9%
Jul-06	120.0	128.2	8.2	6.8%
Aug-06	124.9	138	13.1	10.5%
Sep-06	109.0	120.5	11.5	10.6%
Oct-06	110.4	115.3	4.9	4.4%
Nov-06	112.8	122.3	9.5	8.4%
Dec-06	113.8	123.3	9.5	8.3%
12 month Average	**118.2**	**127.1**	**8.9**	**7.6%**
Jan-07	102.9	120.2	17.3	16.8%
Feb-07	109.8	128	18.2	16.6%
Mar-07	112.5	125.8	13.3	11.8%
Apr-07	118.0	126.6	8.6	7.3%
May-07	127.3	134.7	7.4	5.8%
Jun-07	128.3	140.1	11.8	9.2%
Jul-07	140.9	141.2	0.3	0.2%
Aug-07	140.5	146.4	5.9	4.2%
Sep-07	144.8	149.4	4.6	3.2%
Oct-07	156.9	167.2	10.3	6.6%
Nov-07	177.8	180.0	2.2	1.2%
Dec-07	176.8	185.1	8.34	4.7%
12 month Average	**136.4**	**145.4**	**9.0**	**7.3%**

Jan-08	182.2	197	14.8	8.1%
Feb-08	175.6	185.1	9.5	5.4%
Mar-08	181.5	187.9	6.4	3.5%
Apr-08	193.9	204.2	10.3	5.3%
May-08	213.4	222.8	9.4	4.4%
Jun-08	234.8	257.7	22.9	9.8%
Jul-08	267.7	278.1	10.4	3.9%
Aug-08	244.3	256.0	11.7	4.8%
Sep-08	215.0	232.6	17.6	8.2%
Oct-08	173.5	183.2	9.7	5.6%
Nov-08	131.5	157.5	26	19.8%
Dec-08	112.9	118.6	5.7	5.0%
12 month Average	**193.9**	**206.7**	**12.9**	**7.0%**
Jan-09	116.0	135.4	19.4	16.7%
Feb-09	122.7	128.2	5.5	4.5%
Mar-09	118.1	131.3	13.2	11.2%
Apr-09	119.3	NA		0.0%
May-09	126.0	156.6		
Jun-09	167.7	172.0	4.3	2.6%
Jul-09	NA	167.4		
Aug-09	177.6	177.6	0.0	0.0%
Sep-09	NA	175.1		
Oct-09	173.6	185.0	11.4	6.6%
Nov-09	W	185.4		
Dec-09	W	187.6		
12 month Average	**140.1**	**163.8**	**9.0**	**5.9%**

Conclusion: Assume 7.5 cents per gallon increase in cost for switching from greater than 1% Sulfur Residual Oil to less than 1% Sulfur Residual Oil.

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Fuel Oil Price Comparison Charts DRAFT (02/28/11)

Data from U.S. Department of Energy, Energy Information Administration website http://tonto.eia.gov/dnav/pet/
Residual Fuel Oil Price by Sales Type, by Sulfur, Sales to End
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PADD 1B (Central Atlantic) = DE, DC, MD, NJ, NY & PA

Central Atlantic PADD 1B Residual Fuel Oil Retail Prices by All Sellers (Cents per Gallon Excluding Taxes)

	Residual >1%S	Residual ≤ 1%S	Differential	% Difference
	(¢/gal)	(¢/gal)	(¢/gal)	
Jan-02	40	53.7	13.7	34.3%
Feb-02	40.0	51.7	11.7	29.3%
Mar-02	48.6	55.5	6.9	14.2%
Apr-02	55.3	61.6	6.3	11.4%
May-02	55.7	66.2	10.5	18.9%
Jun-02	55	59.4	4.4	8.0%
Jul-02	54.9	61.3	6.4	11.7%
Aug-02	58.9	66	7.1	12.1%
Sep-02	61.3	66	4.7	7.7%
Oct-02	63.6	70.4	6.8	10.7%
Nov-02	53.3	70.6	17.3	32.5%
Dec-02	57.9	75.7	17.8	30.7%
12 month Average	**53.7**	**63.2**	**9.5**	**18.4%**
Jan-06	117.6	139.8	22.2	18.9%
Feb-06	118.9	140.4	21.5	18.1%
Mar-06	120.2	136.9	16.7	13.9%
Apr-06	122.8	142	19.2	15.6%
May-06	126.1	NA		
Jun-06	124.6	141.9	17.3	13.9%
Jul-06	123.3	144.6	21.3	17.3%
Aug-06	127.1	137.5	10.4	8.2%
Sep-06	113.0	127.5	14.5	12.8%
Oct-06	105.0	129.9	24.9	23.7%
Nov-06	107.1	132.6	25.5	23.8%
Dec-06	106.7	128.3	21.6	20.2%
12 month Average	**117.7**	**136.5**	**19.6**	**16.9%**
Jan-07	98.0	126.6	28.6	29.2%
Feb-07	102.7	129.8	27.1	26.4%
Mar-07	108.1	132.8	24.7	22.8%
Apr-07	116.0	134.6	18.6	16.0%
May-07	130.1	139.6	9.5	7.3%
Jun-07	132.1	143.9	11.8	8.9%
Jul-07	138.0	151.3	13.3	9.6%
Aug-07	141.7	153.3	11.6	8.2%
Sep-07	141.3	157.8	16.5	11.7%
Oct-07	155.9	174.5	18.6	11.9%
Nov-07	182.9	206.4	23.5	12.8%
Dec-07	179.7	210.1	30.4	16.9%
12 month Average	**135.5**	**155.1**	**19.5**	**15.2%**

Jan-08	178.6	215.8	37.2	20.8%
Feb-08	172.3	208.8	36.5	21.2%
Mar-08	183.1	223	39.9	21.8%
Apr-08	186.9	230.4	43.5	23.3%
May-08	203.5	247.1	43.6	21.4%
Jun-08	227.6	286.8	59.2	26.0%
Jul-08	264.2	303.1	38.9	14.7%
Aug-08	247.2	282.5	35.3	14.3%
Sep-08	221.5	NA		
Oct-08	171.7	185.9	14.2	8.3%
Nov-08	100.8	146.5	45.7	45.3%
Dec-08	84.9	122.0	37.1	43.7%
12 month Average	**186.9**	**222.9**	**39.2**	**23.7%**
Jan-09	88.7	122.6	33.9	38.2%
Feb-09	96.5	132.3	35.8	37.1%
Mar-09	94.6	144.2	49.6	52.4%
Apr-09	102.1	NA		
May-09	118.5	142.0	23.5	19.8%
Jun-09	140.3	158.9	18.6	13.3%
Jul-09	140.0	153.1	13.1	9.4%
Aug-09	152.1	172.0	19.9	13.1%
Sep-09	152.1	168.3	16.2	10.7%
Oct-09	156.2	184.9	28.7	18.4%
Nov-09	168.6	194.2	25.6	15.2%
Dec-09	166.8	192.4	25.6	15.3%
12 month Average	**131.4**	**160.4**	**26.4**	**22.1%**

Conclusion: Assume 7.5 cents per gallon increase in cost for switching from greater than 1% Sulfur Residual Oil to less than 1% Sulfur Residual Oil.

Text

Fuel Oil Price Comparison Charts DRAFT (2/28/11)
Data from U.S. Department of Energy, Energy Information Administration website
http://tonto.eia.gov/dnav/pet/

U.S. Residual Fuel Oil Retail Prices by All Sellers (Cents per Gallon Excluding Taxes)

	Residual >1%S	Residual ≤ 1%S	Differential	% Difference
Jan-09	95.1	119.2	24.1	25.3%
Feb-09	97.8	124.3	26.5	27.1%
Mar-09	95.2	121.8	26.6	27.9%
Apr-09	100.7	119.3	18.6	18.5%
May-09	121.0	123.9	2.9	2.4%
Jun-09	143.4	145.7	2.3	1.6%
Jul-09	138.4	149.5	11.1	8.0%
Aug-09	152.2	164.2	12.0	7.9%
Sep-09	151.6	168.4	16.8	11.1%
Oct-09	153.1	173.4	20.3	13.3%
Nov-09	166.0	175.9	9.9	6.0%
Dec-09	165.7	183.5	17.8	10.7%
12 month Average	**131.7**	**147.4**	**15.7**	**13.3%**

Conclusion: Assume 16 cents per gallon increase in cost for switching from greater than 1% Sulfur Residual Oil to less than 1% Sulfur Residual Oil.

PADD1A Residual Fuel Oil Retail Prices by All Sellers (Cents per Gallon Excluding Taxes)

	Residual >1%S	Residual ≤ 1%S	Differential	% Difference
Jan-09	116.0	135.4	19.4	16.7%
Feb-09	122.7	128.2	5.5	4.5%
Mar-09	118.1	131.3	13.2	11.2%
Apr-09	119.3	NA		
May-09	126.0	156.6	30.6	24.3%
Jun-09	167.7	172.0	4.3	2.6%
Jul-09	NA	167.4		
Aug-09	177.6	177.6	0.0	0.0%
Sep-09	NA	175.1		
Oct-09	173.6	185.0	11.4	6.6%
Nov-09	W	185.4		
Dec-09	W	187.6		
12 month Average	**140.1**	**163.8**	**12.1**	**8.2%**

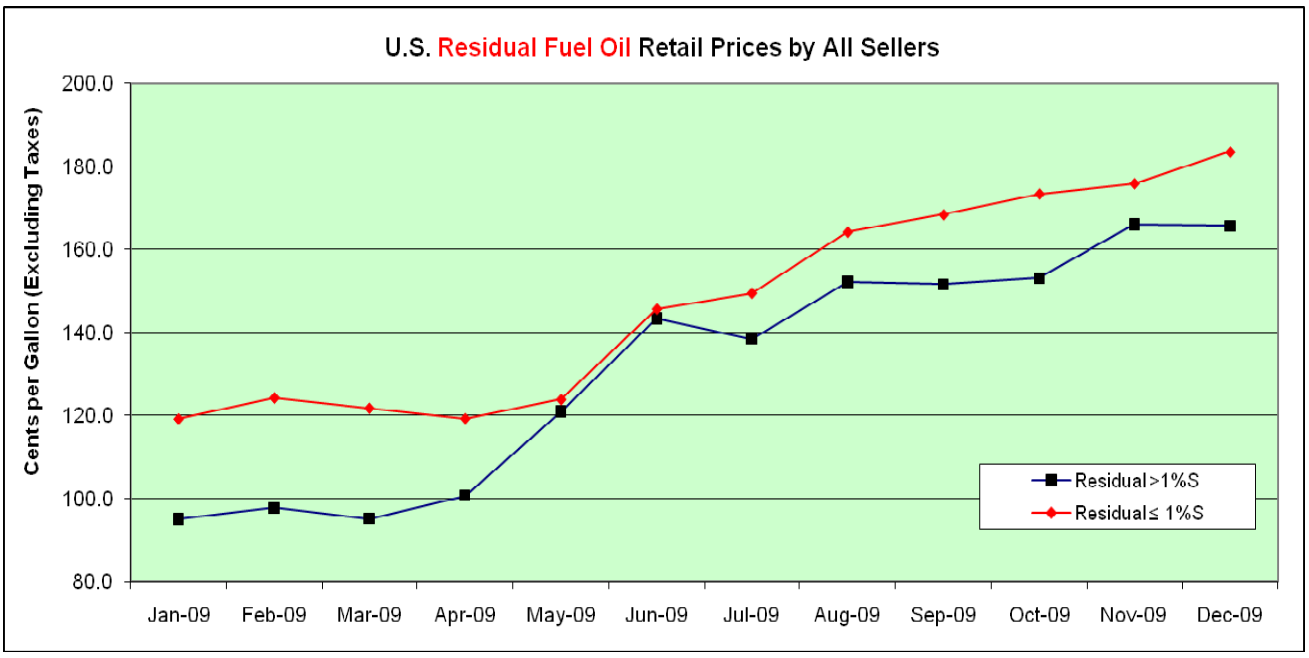
Text

Fuel Oil Price Comparison Charts DRAFT (6/11/08)

Data from U.S. Department of Energy, Energy Information Administration website
http://tonto.eia.gov/dnav/pet/

PADD1B Residual Fuel Oil Retail Prices by All Sellers (Cents per Gallon Excluding Taxes)

	Residual >1%S	Residual ≤ 1%S	Differential	% Difference
Jan-09	88.7	122.6	33.9	38.2%
Feb-09	96.5	132.3	35.8	37.1%
Mar-09	94.6	144.2	49.6	52.4%
Apr-09	102.1	NA		
May-09	118.5	142.0	23.5	19.8%
Jun-09	140.3	158.9	18.6	13.3%
Jul-09	140.0	153.1	13.1	9.4%
Aug-09	152.1	172.0	19.9	13.1%
Sep-09	152.1	168.3	16.2	10.7%
Oct-09	156.2	184.9	28.7	18.4%
Nov-09	168.6	194.2	25.6	15.2%
Dec-09	166.8	192.4	25.6	15.3%
12 month Average	**131.4**	**160.4**	**26.4**	**22.1%**



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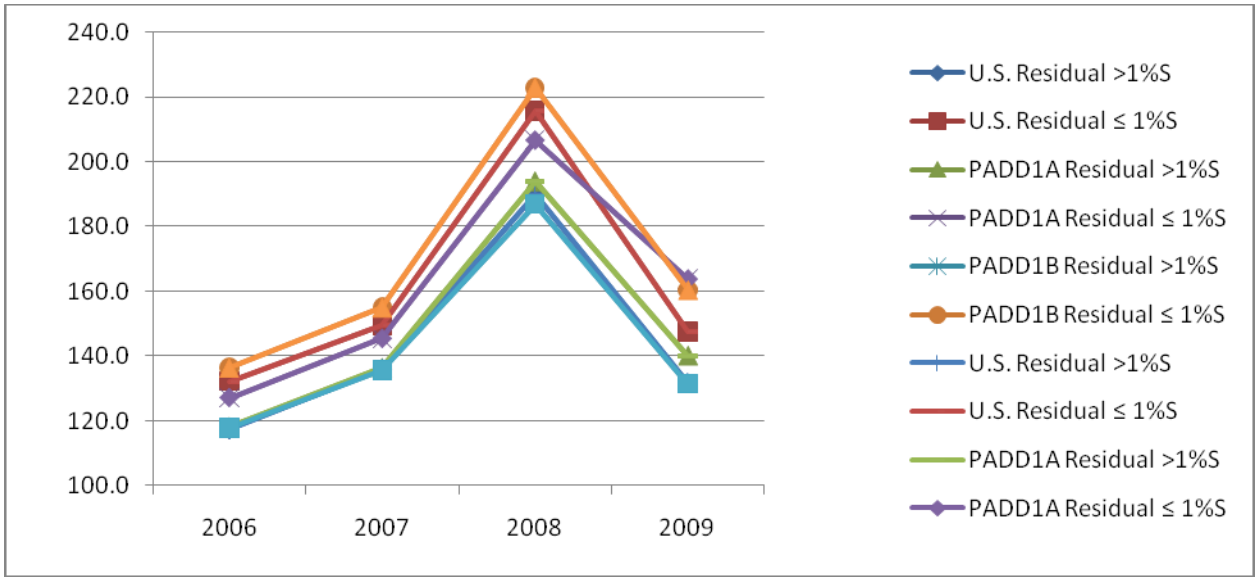
Fuel Oil Price Comparison Charts DRAFT (02/28/11)
Data from U.S. Department of Energy, Energy Information Administration website
http://tonto.eia.gov/dnav/pet/
Residual Fuel Oil Price by Sales Type, by Sulfur, Sales to End Users
Petroleum Marketing Monthly, February 2011

Residual Fuel Oil Retail Prices by All Sellers: Yearly Averages				
(Cents per Gallon Excluding Taxes)				
U.S.				
Year	**U.S. Residual >1%S**	**U.S. Residual ≤ 1%S**	**Differential**	**% Difference**
2006	117.4	132.2	14.7	12.7%
2007	136.1	149.3	13.2	10.2%
2008	189.9	215.7	31.3	19.7%
2009	131.7	147.4	15.7	13.3%
06-09 Avg	143.8	161.2	18.8	14.0%
StdDev	31.8	37.2	8.4	4.0%
PADD1A				
Year	**PADD1A Residual >1%S**	**PADD1A Residual ≤ 1%S**	**Differential**	**% Difference**
2006	118.2	127.1	8.9	7.6%
2007	136.4	145.4	9.0	7.3%
2008	193.9	206.7	12.9	7.0%
2009	140.1	163.8	9.0	5.9%
06-09 Avg	147.1	160.7	9.9	6.9%
StdDev	32.6	34.1	1.9	0.7%
PADD1B				
Year	**PADD1B Residual >1%S**	**PADD1B Residual ≤ 1%S**	**Differential**	**% Difference**
2006	117.7	136.5	19.6	16.9%
2007	135.5	155.1	19.5	15.2%
2008	186.9	222.9	39.2	23.7%
2009	131.4	160.4	26.4	22.1%
06-09 Avg	142.9	168.7	26.2	19.5%
StdDev	30.3	37.5	9.3	4.1%


240.0
220.0
200.0
180.0
160.0
140.0
120.0
100.0
2006
2007
2008
2009
U.S. Residual >1%S
U.S. Residual ≤ 1%S
PADD1A Residual >1%S
PADD1A Residual ≤ 1%S
PADD1B Residual >1%S
PADD1B Residual ≤ 1%S
U.S. Residual >1%S
U.S. Residual ≤ 1%S
PADD1A Residual >1%S
PADD1A Residual ≤ 1%S

Text

Fuel Oil Stocks (05/03/10)

Data from U.S. Department of Energy, Energy Information Administration website http://tonto.eia.gov/dnav/pet/
Annual Residual Fuel Oil Stocks by Sales Type, by Sulfur
Petroleum Marketing Monthly, February 2011

Annual East Coast (PADD 1) - Thousand Barrels	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**06-09 Avg**	**06-08 StdDev**
Residual < 0.31%	3,115	4,009	2,538	3,861	4,128	4,383	4,595	3,604	3,306	2,780	3,835	675
Residual 0.31-1.00%	6,437	9,073	5,742	6,745	7,353	5,871	8,771	6,509	5,465	5,317	6,915	1,690
Residual > 1.00%	4,108	4,675	4,247	5,174	5,539	4,260	5,301	4,560	4,490	5,317	4,784	449
Total	**13,660**	**17,757**	**12,527**	**15,780**	**17,020**	**14,514**	**18,667**	**14,673**	**13,261**	**13,414**	15,534	2,804

Annual U.S. - Thousand Barrels	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**06-09 Avg**	**06-08 StdDev**
Residual < 0.31%	5,268	7,594	4,732	5,182	5,666	5,931	6,381	5,766	5,312	3,302	5,820	537
Residual 0.31-1.00%	12,045	15,146	9,466	13,111	14,467	11,649	14,458	12,226	10,615	11,558	12,433	1,930
Residual > 1.00%	18,880	18,306	16,905	19,255	21,945	19,632	21,474	21,324	20,061	22,308	20,953	776
Total	**36,193**	**41,046**	**31,103**	**37,548**	**42,078**	**37,212**	**42,313**	**39,316**	**35,988**	**37,168**	39,206	3,164

PADD1 as % of U.S.	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**06-09 Avg**	**06-08 StdDev**
Residual < 0.31%	59.1%	52.8%	53.6%	74.5%	72.9%	73.9%	72.0%	62.5%	62.2%	84.2%	66%	6%
Residual 0.31-1.00%	53.4%	59.9%	60.7%	51.4%	50.8%	50.4%	60.7%	53.2%	51.5%	46.0%	55%	5%
Residual > 1.00%	21.8%	25.5%	25.1%	26.9%	25.2%	21.7%	24.7%	21.4%	22.4%	23.8%	23%	2%
Total	37.7%	43.3%	40.3%	42.0%	40.4%	39.0%	44.1%	37.3%	36.8%	36.1%	39%	4%

Pricing by <= 1.00% or > 1.00%