



出國報告（出國類別：國際會議）



燃料摻配、排程及線性規劃技術研討



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## 壹、出國目的

此次赴馬來西亞吉隆坡參加 UNI 公司舉辦之燃料摻配及排程技術研討會，由燃料摻配及排程專家 Donald E. Dixon 主講，內容包括燃料摻配系統之規劃、最適化、排程及控制等技術，由於該研討會兩年以上才舉辦一次，機會相當難得，且各大煉廠人員也將與會，共同討論與交流相關技術，俾能增加專業技能對公司有所助益。

## 貳、出國行程

日期	起訖地點	工作紀要
98.05.17	嘉義→桃園國際機場 →吉隆坡	啓程
98.05.18 ~ 98.05.20	吉隆坡	參加 UNI 公司舉辦之燃料摻配、排程及線性規劃技術研討會
98.05.21~ 98.05. 22	吉隆坡	與各煉廠人員討論與交流相關製程技術
98.05.23	吉隆坡→桃園國際機場 →嘉義	返程

## 參、研習內容

此次 UNI 公司舉辦之燃料摻配、排程及線性規劃技術研討會，係由 Donald E. Dixon 先生講授相關課程，與會代表共有 11 人，分別來自馬來西亞 PETRONAS 石油公司、泰國 SPRC 及 PTT 石油公司、阿拉伯聯合大公國 EMIRATES 及孟加拉 EASTERN 石油公司，大多為現場從事生產排程及產品摻配人員，茲將研習重點資訊整理如下：

### 3.1 煉廠產品摻配技術

煉廠生產簡圖如圖一所示，所生產的半成品需經由儲存及摻配以生產符合各國規範的 LPG、汽油、柴油、航空燃油及燃料油等產品，常見的摻配系統架構有四種：

### 3.1.1 Tank -to-Tank Blending

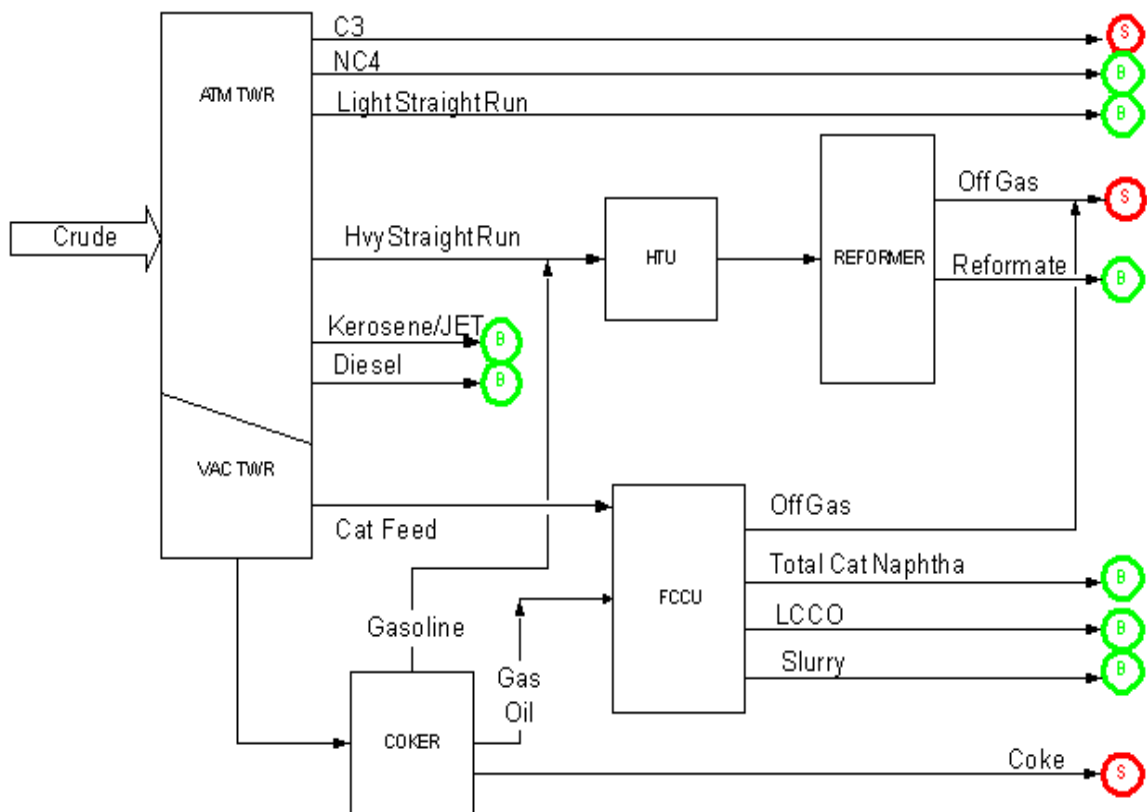
摻配架構如圖二所示，摻配油料進入儲槽後直接摻配為成品油，此方式的優點是所需的設備最少，缺點是很難完全去化低價值的油料，適用於規範較為寬鬆的產品，允許較多的 giveaway。

### 3.1.2 Rundown Blending

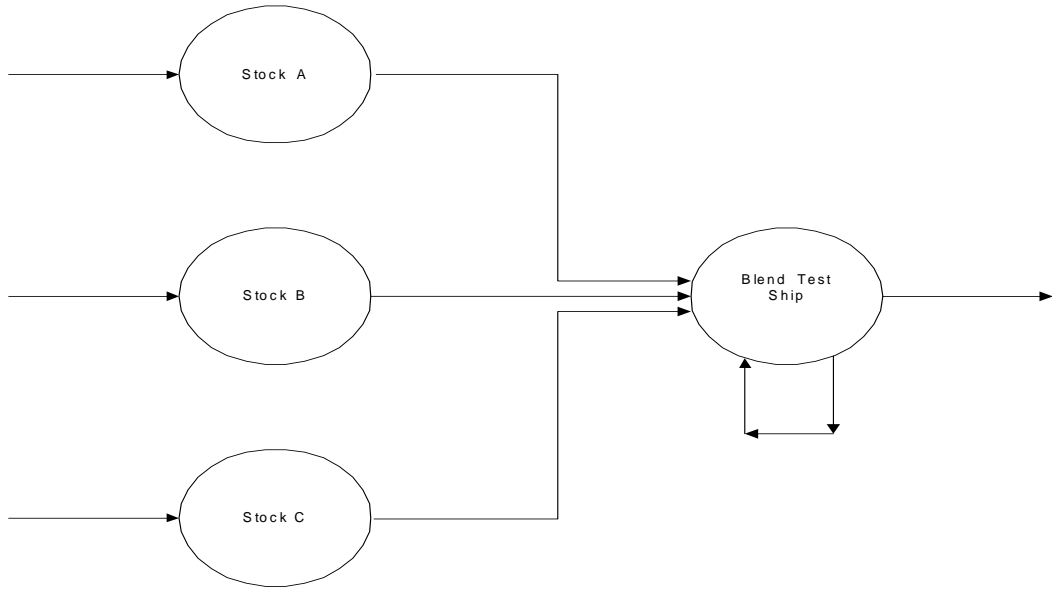
摻配架構如圖三所示，摻配油料的摻配比例由人工計算決定控制閥開度進行摻配，當產品規範 giveaway 較多時，可由油槽內的摻配料進行調整，此方式適用於規範較為寬鬆且易於摻配的產品。

### 3.1.3 In-line Header

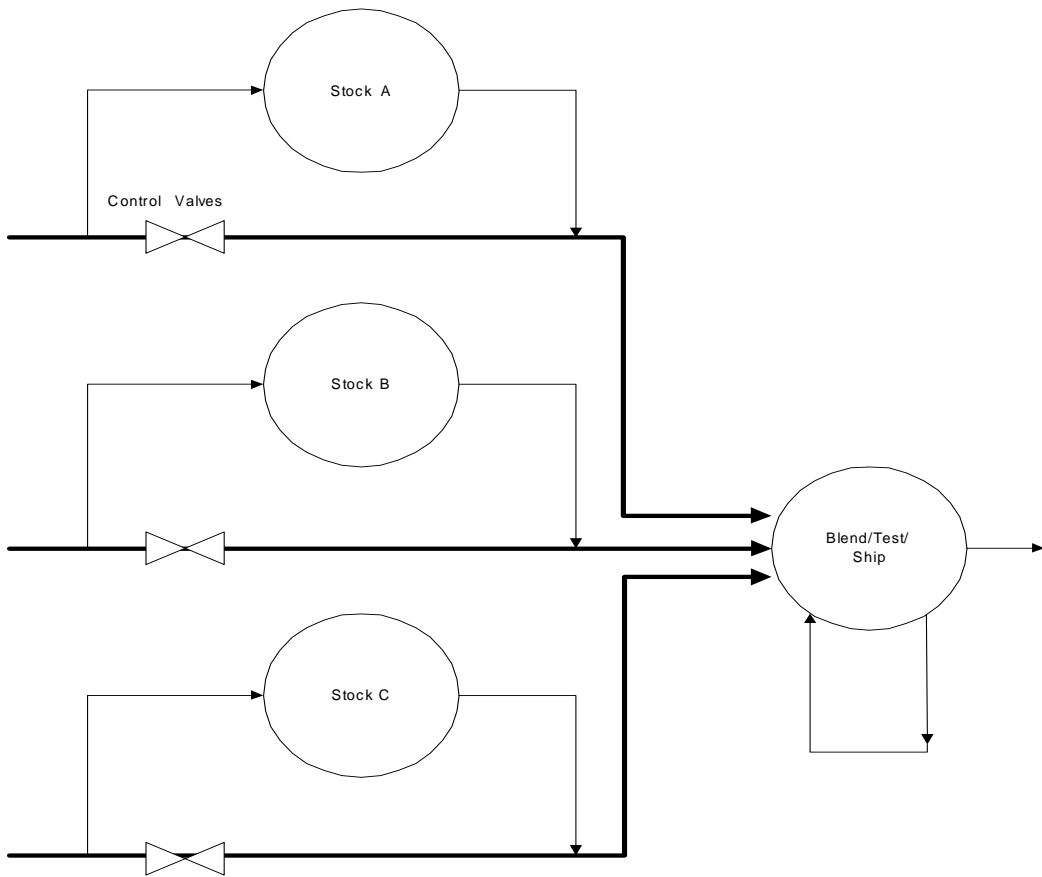
摻配架構如圖四所示，使用自行開發或廠商提供之摻配軟體並配合產品端線上分析儀(如 NIR)的資訊，決定摻配油料的摻配比例並自動調整控制閥開度進行摻配，此方式是較有效率的摻配方式，可降低產品的 giveaway 且容易去化品質較差的油料。



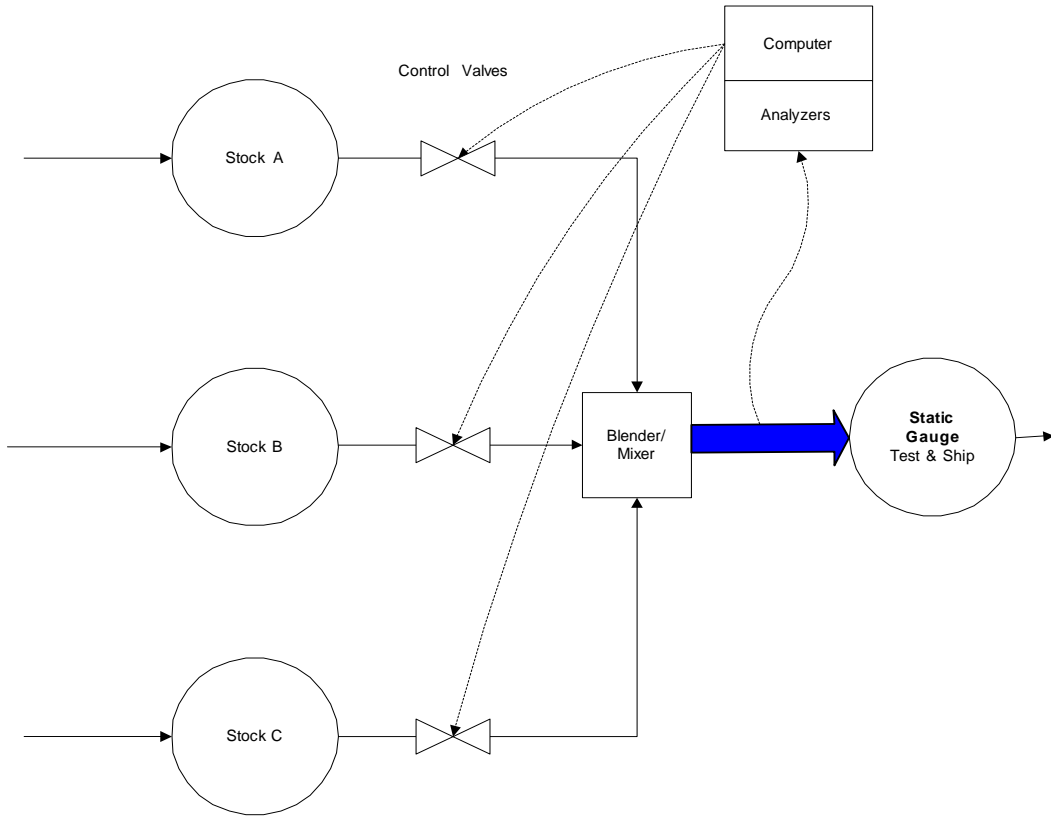
圖一、煉油廠流程簡圖



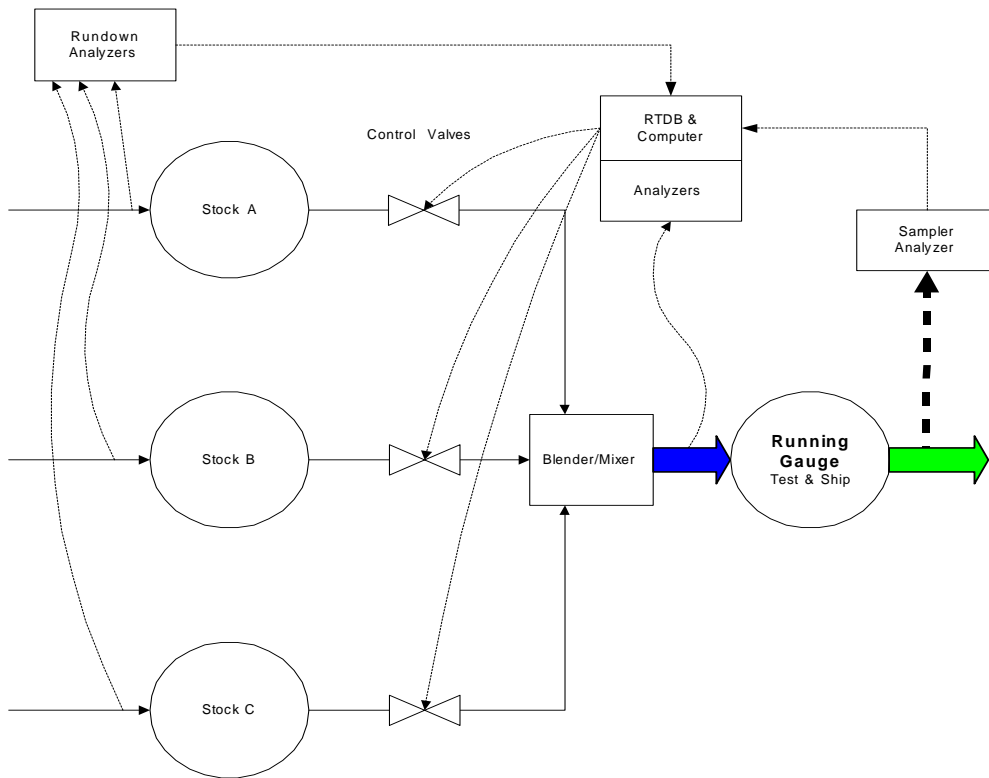
圖二、Tank -to-Tank Blending



圖三、Rundown Blending



圖四、In-Line Header



圖五、In-Line +On-Line

### 3.1.4 In-line+On-Line

摻配架構如圖五所示，使用廠商提供之商用摻配軟體，配合摻配油料及產品端線上分析儀的資訊以及產品端的化驗資訊，決定摻配油料的摻配比例並自動調整控制閥開度進行摻配。此方式是最有效率的摻配方式，產品的 giveaway 可降至最低，產品可直接裝船運送，同時可減少成品槽的使用，增加調度的彈性，但相對的，對軟體、控制系統及分析儀的依賴度很高。

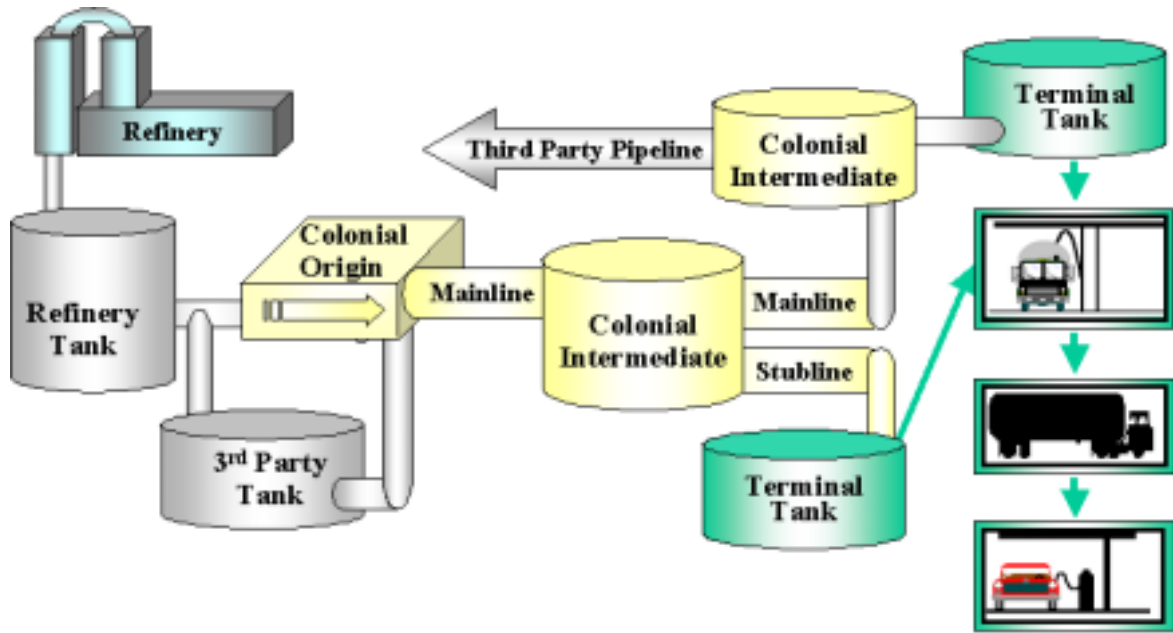
### 3.2 美國 Colonial pipeline 公司油品規範與超低硫柴油運輸研究

美國 Colonial Pipeline 公司擁有 5,519 英哩的長途管線，由休士頓輸送油品至紐約港(參見圖六)，全美國大約有 20%的油品經由 Colonial Pipeline 公司的長途管線運送，此運輸系統由 1963 年操作至今，每天運送超過 220 萬桶的油品，由 30 個煉廠送至它們的終端油庫(參見圖七)。

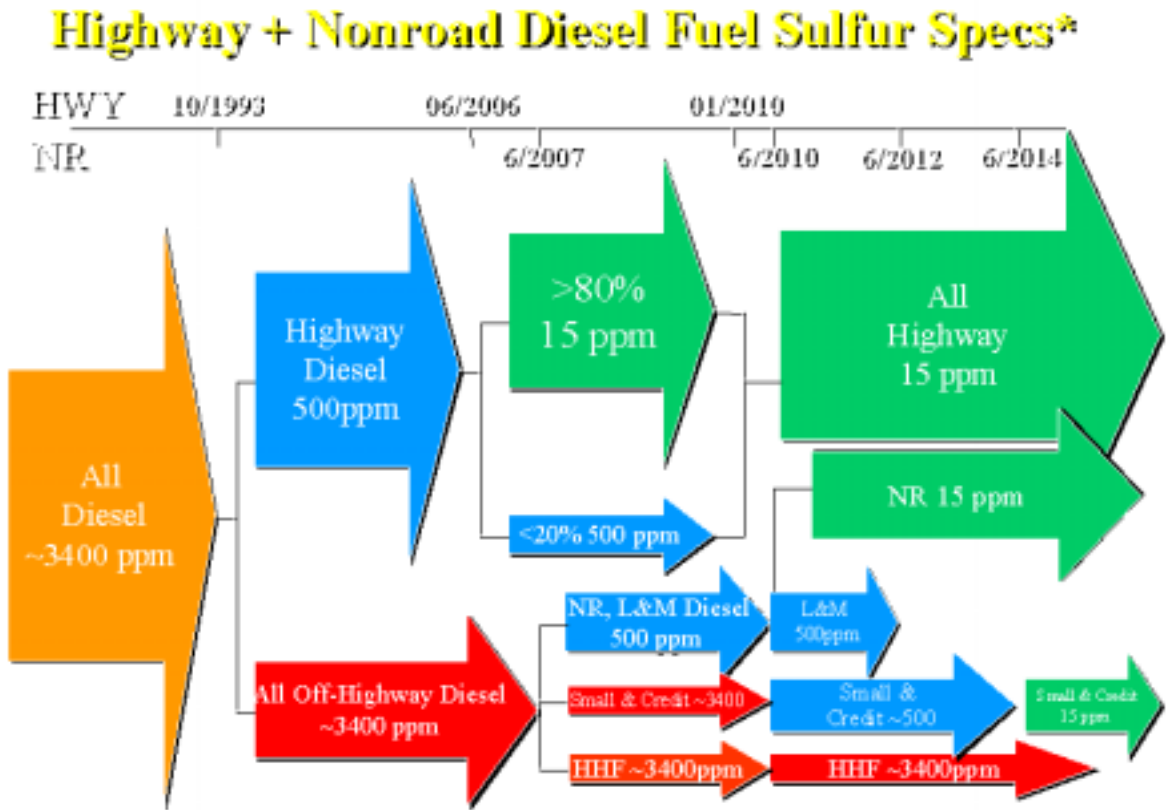
透過 Colonial pipeline 公司輸送的油品繁多，包括汽油、柴油、航空燃油及燃料油等，而每種油品又分為不同等級，如汽油即分為  $RON + MON/2 = 87$ 、93 及 E10 酒



圖六、Colonial Pipeline 公司的長途管線分布圖



圖七、Colonial Pipeline 公司的油品運送系統



圖八、美國未來對車用及非車用柴油(如海運柴油)硫含量管制的規劃時程



精汽油，部分油品規範請參見附錄一，另外附錄一中也包含該公司運送的油品允許的添加劑成分及廠牌，所規範的添加劑用途如 gum inhibitors、metal deactivator、corrosion inhibitors、static dissipater additives、aviation kerosene additives、cloud and pour point depressant additives、cetane improver additives、prohibited additives、lubricity additives 等。

美國對車用及非車用柴油(如海運柴油)硫含量管制的規劃時程如圖八所示，2007年6月至2010年6月約有80%的車用柴油硫含量需低於15 ppmw(ULSD)，2010年6月之後則全部的車用柴油硫含量需低於15 ppmw。2004年 Colonial Pipeline 爲了測試其管線輸送超低硫柴油的能力並蒐集管線運送途中硫含量變化情形，規劃兩批油品的輸送試驗，其結果提供給煉廠作爲超低硫柴油出廠時硫含量管制的參考依據。此兩批油品分別爲爲14萬桶及14.4萬桶的低硫柴油，經由36”的主輸油管由Baton Rouge 運送至如下路線：

#### 第一批油品

Birmingham, AL→Atlanta, GA→Nashville, TN→Macon, GA→Greensboro, NC

#### 第二批油品

Birmingham, AL→Atlanta, GA→Greensboro, NC→Baltimore, MD→New York Harbor

由於該管線有多種油品共管使用，故試驗時係依序切換運輸汽油、高硫柴油、低硫柴油、航空柴油，再運送試驗用超低硫柴油。在整個試驗過程中，共取樣超過1,500個樣品，並評估超低硫柴油遭鄰近運輸油品污染時硫含量的變化情形及運輸過程中運輸管線、閥件、油品滯留區(dead segments)等的硫含量變化情形，此試驗獲得下列結論：

- (1) 透過運輸管線運送至目的地的超低硫柴油硫含量約增加6~8 ppmw。
- (2) 油槽區對硫含量的增加貢獻最大，包括閥件的整合性、輸送主管、油槽管線、油品滯留區(dead segments)皆會增加油品的硫含量，此部份需持續追蹤改善。
- (3) 通常應用 API 變化作爲切換油品的判斷標準是沒效率的，必須以較準確的線上硫份分析儀作爲判斷依據，但硫份分析儀是複雜且不易維護的，此點需進行改進。
- (4) 硫含量之再現性約爲4 ppmw。

(5) 此次試驗約有 8~10 vol%的超低硫油品受到嚴重污染需 downgrade 至其他油品。

### 3.3 線性規劃

線性規劃求解法最早係由線性規劃之父 George Dantzig 研究發展而得，一般線性規劃問題可表示為

$$\begin{aligned} \text{Objective function : } & \max \quad y = c^T x \\ & \text{subject to } Ax \leq b, x \geq 0 \end{aligned}$$

由於一般煉廠的生產規劃問題即是在煉廠生產、管輸、產品規範及供需等限制條件下求解煉廠的最大效益，就單一煉廠而言就可能有數千條限制式，故無法以人工方式求解，因此有許多研究者發展線性規劃求解技術以快速求解，而廠商即應用線性規劃技術發展商用軟體提供煉廠進行生產規劃，如 Haverly Inc.的 GRTMPS 和 Aspentech 公司的 PIMS 等皆為此類軟體。

在此次的研討會中主要介紹如何應用 Simplex Method 求解線性規劃問題。Simplex Method 求解線性規劃問題的步驟如下：

- Step 1.** Express the problem in terms of a set of linear equations giving the Objective Function and Constraints. Add Slacks to get equalities.
- Step 2.** Pick an Initial Feasible Solution. This gives you the Basic Variables (Non Zero Variables). The other variables are zero and are the Non Basic Variables.
- Step 3.** Use Linear Algebra to express the Basic Variables in terms of the Non Basic Variables.
- Step 4.** Substitute these values into the Objective Function to express the Objective Function in terms of the Non basic Variables.
- Step 5.** Inspect the Objective Function and find the term with the largest positive coefficient.
- Step 6.** Inspect the constraint rows and determine which row allows you to bring in the above term by the largest amount. This determines which variables should leave the solution.
- Step 7.** Recalculate the Objective Function. If there are positive coefficients return to Step 5.
- Step 8.** If there are no positive coefficients you have an optimal solution.

以下即以兩個範例來說明 Simplex Method 求解法。

Problem 1 : EXAMPLE OF INVESTMENT MODEL

A man has \$1,000 to invest. He has chosen to invest all of his money in some combination of municipal bonds, preferred stock, and common stock; for each, there are two candidates making a total of 6 activities. The following table shows the yields and the symbols for the amount to be invested in each of the six possible activities.

Type:	Bonds	Bonds	Preferred	Preferred	Common	Common
Yield	3%	3 1/2 %	4%	4 1/2 %	5%	5 1/2 %
Symbol	B1	B2	P1	P2	C1	C2

After consultation with his financial advisers, the investor decided upon the following restrictions on his investment policy: at least \$400 must be invested in bonds; no more than \$350 must be invested in preferred stock; and no more than \$350 should be invested in common stock.

Based on the information given how should he invest his money?

**Using Simplex Method to solve the problem**

**Step 1.**

Define the problem.

Maximize

$$0.03B1 + 0.035B2 + 0.04P1 + 0.045P2 + 0.05C1 + 0.055C2 = Z$$

Subject to:

$$B1 + B2 + P1 + P2 + C1 + C2 = 1000$$

$$B1 + B2 \geq 400$$

$$P1 + P2 \leq 350$$

$$C1 + C2 \leq 350(\text{Com.})$$

Add Slacks to get equalities

$$B1 + 3.5B2 + 4P1 + 4.5P2 + 5C1 + 5.5C2 = 100Z \tag{0}$$

$$B1 + B2 + P1 + P2 + C1 + C2 = 1000 \tag{1}$$

$$B1 + B2 - S1 = 400 \quad (2)$$

$$P1 + P2 + S2 = 350 \quad (3)$$

$$C1 + C2 + S3 = 350 \quad (4)$$

**Step 2.**

Pick any basic solution:  $B2 = 400$ ,  $P1 = 350$ ,  $C2 = 250$ ,  $S3 = 100$

The other variables are zero and are the Non Basic Variables.

**Step 3.**

Rearrange equations to express solution in terms of the non-basic variables:

$$B2 = 400 - B1 + S1 \quad \text{from (2)}$$

$$P1 = 350 - P2 - S2 \quad \text{from (3)}$$

$$P1 + P2 + C1 + C2 + S1 = 600 \quad (1-2)$$

$$C1 + C2 + S1 - S2 = 250 \quad (1-2-3)$$

$$C2 = 250 - C1 - S1 + S2$$

$$S1 - S2 - S3 = -100 \quad (1-2-3-4)$$

$$S3 = 100 + S1 - S2$$

**Step 4.**

Substitute these calculated values in the objective function:

$$100Z = 3B1 + 3.5(400 - B1) + 4(350 - P2 - S2) + 4.5P2 + 5C1 + 5.5(250 - C1 - S1 + S2)$$

Gives:

$$Z = 41.75 - 0.005B1 + 0.005P2 - 0.005C1 - 0.02S1 + 0.015S2$$

$$B2 = 400 - B1 + S1$$

$$P1 = 350 - P2 - S2$$

$$C2 = 250 - C1 - S1 + S2$$

$$S3 = 100 + S1 - S2$$

**Step 5.**

Inspect the Objective Function and find the term with the largest positive coefficient.

Now we find candidates are P2 and S2. S2 is most profitable and should leave the solution.

**Step 6.**

Because S3 limits, so we substitute in the last equation

$$\begin{array}{rcl} S3 = 100 & +S1 & -S2 \\ S2 = 100 & +S1 & -S3 \end{array}$$

**Step 7.**

Recalculate the Objective Function.

$$Z = 43.25 - 0.005B1 + 0.005P2 - 0.005C1 - 0.005S1 - 0.015S3$$

$$\begin{array}{rcl} B2 = 400 & - B1 & +S1 \\ P1 = 250 & - P2 & -S1 +S3 \\ C2 = 350 & - C1 & -S3 \\ S2 = 100 & +S1 & -S3 \end{array}$$

Now the candidate is P2

$$P2 = 250 \quad - P1 \quad -S1 \quad +S3$$

$$Z = 44.50 - 0.005B1 - 0.005P1 - 0.005C1 - 0.01S1 - 0.01S3$$

$$\begin{array}{rcl} B2 = 400 & - B1 & +S1 \\ P2 = 250 & - P1 & -S1 +S3 \\ C2 = 350 & - C1 & -S3 \\ S2 = 100 & +S1 & -S3 \end{array}$$

The solution is optimal.

**Problem 2 : EXAMPLE OF MANUFACTURING MODEL**

A manufacturer can make hex nuts, screws and bolts. Each pound of hex nuts requires four man-hours of labor and one hour of lathe time. Each pound of screws requires two man-hours and one hour of grinder time. Each pound of bolts requires two man-hours of labor, one hour of lathe time and three hours of grinder time. The manufacturer makes \$3 profit on each pound of hex nuts, \$2 on each pound of screws, and \$2.50 on each pound of

bolts; he can sell all he can make of each. How much pounds of each product should he make for maximum profit, and what is the profit?

The manufacturer produces other items, but he has decided that for the hex nuts, screws, and bolts he can allow twelve man-hours, two lathe-hours and four grinder-hours each day.

1. What is the penalty for making Bolts?
2. If you make a pound of bolts, what will the Objective Function be?
3. How would the profit be affected if another man-hour of labor were made available?

### Using Simplex Method to solve the problem

Define the problem

$$\text{Maximize } 3H + 2S + 2.5B = Z$$

Subject to:

$$\text{man-hrs } 4H + 2S + 2B \leq 12$$

$$\text{lathe-hrs } 1H + 1B \leq 2$$

$$\text{grinder-hrs } 1S + 3B \leq 4$$

Add Slacks to get equalities

Maximize

$$3H + 2S + 2.5B = Z$$

Subject to

$$4H + 2S + 2B + sm = 12$$

$$1H + 1B + sl = 2$$

$$1S + 3B + sg = 4$$

Pick any basic solution:  $sm = 400$ ,  $sl = 350$ ,  $sg = 250$ ,

Then  $Z = 0$

The other variables are zero and are the Non Basic Variables.

Rearrange equations to express solution in terms of the non-basic variables and substitute these calculated values in the objective function

$$\begin{aligned}
Z &= 0 + 3H + 2S + 2.5B \\
sm &= 12 - 4H - 2S - 2B \\
sl &= 2 - 1H \quad \quad \quad - 1B \\
sg &= 4 \quad \quad \quad - 1S - 3B
\end{aligned}$$

Iteration 1

$$\begin{aligned}
sl &= 2 - 1H - 1B \\
H &= 2 - 1B - sl \\
sm &= 12 - 4H - 2S - 2B \\
sm &= 12 - 4(2 - B - sl) - 2S - 2B \\
sm &= 4 - 2S + 2B + 4sl \\
sg &= 4 - 1S - 3B \\
Z &= 0 + 3(2 - B - sl) + 2S + 2.5B \\
Z &= 6 + 2S - 0.5B - 3sl
\end{aligned}$$

Solution table

Basis	Activity	sl	Screws	Bolts
Profit =	\$6	-\$3.00	-\$2.00	-\$0.50
sm =	4	+4	-2	+2
Hex nuts =	2	-1		-1
sg =	4		-1	-3

Iteration 2

Basis	Activity	sl	sm	Bolts
Profit =	\$10	+\$1.00	-\$1.00	+\$1.50
Screws =	2	+2	-1/2	+1
Hex nuts =	2	+1		-1
sg =	2	-2	+1/2	-4

### Iteration 3

Basis	Activity	sl	sm	sg
Profit =	\$10.75	+\$0.25	-\$0.8125	-\$0.375
Screws =	2.5	+1.5	-0.375	-0.25
Hex nuts =	1.5	-0.5	-0.125	+0.25
Bolts=	0.5	-0.5	+0.125	-0.25

### Iteration 4

Basis	Activity	Bolts	sm	sg
Profit =	\$11.00	-\$0.50	-\$0.75	-\$0.50
Screws =	4	-3		-1
Hex nuts =	1	+1	-0.25	+0.5
sl =	1	-2	+0.25	-0.5

Ans. 1. 由 Iteration 4 的結果得知，當 Screws= 4 pounds、Hex nuts=1 pounds 時，可獲得的最大的效益為 \$11.00，而當生產 Bolts 時，將降低其獲利。

Ans. 2. 當 Bolts 一定要生產 1 pound 時，根據其限制條件，可解得 Screws= 1 pounds，Hex nuts=1 pounds，最大的效益為 \$7.5。

Ans. 3. 當 man-hour 增加一小時後，根據上述步驟可求出此時的最大效益為 \$11.75。

## 3.4 2007 全球煉廠架構研討

Oil & Gas Journal /Dec.24, 2007 的文獻中探討全球各國的煉油製程單元總煉量，包括 crude、vacuum distillation、coking、thermal operation、catalytic cracking、catalytic reforming、catalytic hydrotreating 及產品產量如 alkylation、pol./Dim、Aromatics、isomerization、lubes、oxygenates、hydrogen、coke、sulfur、asphalt 等，另外亦列出每一國家個別煉廠製程單元煉量及產品產量，是相當值得參考的文獻，茲將部分內容摘錄於附錄二以供參考。



## 肆、研習心得與建議

1. 與會的六家石油公司 (含 CPC) 皆應用 Excel 工作表進行人工排程，其計劃目標的傳達主要應用書面、電話或網路聯繫，此種調度方式主要仰賴調度人員的豐富經驗、應變能力及良好的資訊整合能力才能兼顧生產與效益。
2. 與會的石油公司中僅馬來西亞 Petronas 石油公司使用商用摻配軟體，該公司使用 Honeywell Blend 軟體進行汽油摻配，據負責人員表示雖對摻配工作有幫助，但其缺點是摻配軟體的維護費用相當昂貴，該公司正考量是否繼續使用此摻配軟體。
3. 與會的石油公司中，推行生質燃料的有 CPC 的 95E3 及 B1、泰國 SPRC 及 PTT 石油公司的 B5 及 95E20，泰國石油公司在運輸生質油品時採共管輸送，共管運輸油品包括 91 汽油、95 汽油、酒精汽油、生質柴油、航燃等，輸送時以 API 作為切油依據，與會代表表示此輸油程序對航燃品質並無不良影響。
4. 過去進行 LP 線性規劃模擬時，因直接使用軟體內附線性規劃求解器，對於某一原油、半成品或成品等的 penalty 如何計算較不清楚，此次研討會介紹如何應用 Simplex Method 求解，使與會人員對線性規劃求解器如何運作有較清楚的認知。
5. Colonial pipeline 公司輸送的油品繁多，包括汽、柴、航、燃等且又有共管輸送問題，故在 15 ppm 超低硫柴油(ULSD)推出前即研究長途運輸對硫含量的影響，其寶貴經驗可作為本公司於民國 100 年 7 月推出硫含量 10 ppm 柴油之參考。
6. 為考量各煉廠之煉製結構不同，蔡銘璋等人[4]曾利用 Nelson[5]所發展之方法計算本公司各煉製工場複雜度(complexity factor)、規模因子(unit factor)、煉油當量(Equivalent Distillation Capacity, EDC)、煉油當量利用率(Utilization of EDC, UEDC)及煉廠總複雜度(Refinery Complexity Rating)，並建立一以 EDC/UEDC 評估煉製成本之計算模式。應用同樣的方法，使用 Oil & Gas Journal 的全球煉油製程單元及產品煉量資訊，可用來評估全球各煉廠煉製成本。
7. 此次研討會所列議題較為廣泛、故部分課程不夠深入，如 LP 線性規劃及排程等，該公司表示日後會針對 LP 線性規劃開設高階課程，相關研究人員可注意此進修機會，惟該公司課程收費昂貴是必須考量的因素。

## 參考文獻

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- [2] *2009 Worldwide Fuel Specifications*, IFQC.
- [3] David Nakamura, *Global Refining Capacity Increases Slightly in 2007-Worldwide Report*, Oil & Gas J., Dec 24., 2007.
- [4] 蔡銘璋等人，以 EDC/UEDC 評估煉製成本之計算模式，PR89049，2000。
- [5] Nelson, W. L., *The Concept of Refinery Complexity*, Oil & Gas J., Sept. 13, 1976.

## Colonial Pipeline Company

### PRODUCT CODES - SUMMARY

Product Groupings	
A	RFG - 87 Octane
D	RFG - 93 Octane
E	RBOB - 87 Octane after blending with 5.7% denatured fuel Ethanol
F	RBOB - 87 Octane after blending with 10% denatured fuel Ethanol
G	RBOB - 93 Octane after blending with 5.7% denatured fuel Ethanol
H	RBOB - 93 Octane after blending with 10% denatured fuel Ethanol
L	Gasoline Blendstocks
M	Conventional - 87 Octane
S	Atlanta/Birmingham CBOB - 87 Octane after blending with 10% denatured fuel Ethanol
T	Atlanta/Birmingham CBOB - 93 Octane after blending with 10% denatured fuel Ethanol
V	Conventional - 93 Octane
W	Atlanta/Birmingham Conventional - 87 Octane
X	Atlanta/Birmingham Conventional - 93 Octane
51-58	Kerosene
59	Distillate Blendstock - Not Dyed by Colonial
61	Ultra Low Sulfur Diesel
*66	Ultra Low Sulfur Diesel -NRLM (not dyed by Colonial)
70-78	Fuel Oil, Diesel Fuel, Military DFM - Not Dyed by Colonial
79	Distillate Blendstock - Not Dyed by Colonial
80-88	Fuel Oil, Diesel Fuel - Dyed by Colonial
89	Distillate Blendstock - Dyed by Colonial
90-94	Transmix

\*Denotes Change

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## Colonial Pipeline Company

### PRODUCT CODES - GASOLINE

Fungible Product Code	Segregated Product Code	Description
<u>REG - 87 Octane</u>		
A1	1A	Region 1 VOC-controlled, 1.7=<=oxygen wt.%<= 2.7
A2	2A	Region 2 VOC-controlled, 1.7=<=oxygen wt.%<= 2.7
A3	3A	11.5 psi RVP, 1.7=<=oxygen wt.%<= 2.7
A4	4A	13.5 psi RVP, 1.7=<=oxygen wt.%<= 2.7
A5	5A	15.0 psi RVP, 1.7=<=oxygen wt.%<= 2.7
<u>REG - 91 Octane</u>		
D1	1D	Region 1 VOC-controlled, 1.7=<=oxygen wt.%<= 2.7
D2	2D	Region 2 VOC-controlled, 1.7=<=oxygen wt.%<= 2.7
D3	3D	11.5 psi RVP, 1.7=<=oxygen wt.%<= 2.7
D4	4D	13.5 psi RVP, 1.7=<=oxygen wt.%<= 2.7
D5	5D	15.0 psi RVP, 1.7=<=oxygen wt.%<= 2.7
<u>RBOB - 87 octane after blending with 5.7% denatured fuel ethanol</u>		
E1	1E	Region 1 VOC controlled RBOB for blending with 5.7% denatured fuel ethanol
E2	2E	Region 2 VOC controlled RBOB for blending with 5.7% denatured fuel ethanol
E3	3E	11.5 psi RVP RBOB for blending with 5.7% denatured fuel ethanol
E4	4E	13.5 psi RVP RBOB for blending with 5.7% denatured fuel ethanol
E5	5E	15.0 psi RVP RBOB for blending with 5.7% denatured fuel ethanol
<u>RBOB - 87 octane after blending with 10% denatured fuel ethanol</u>		
F1	1F	Region 1 VOC controlled RBOB for blending with 10% denatured fuel ethanol
F2	2F	Region 2 VOC controlled RBOB for blending with 10% denatured fuel ethanol
F3	3F	11.5 psi RVP RBOB for blending with 10% denatured fuel ethanol
F4	4F	13.5 psi RVP RBOB for blending with 10% denatured fuel ethanol
F5	5F	15.0 psi RVP RBOB for blending with 10% denatured fuel ethanol
<u>RBOB - 91 octane after blending with 5.7% denatured fuel ethanol</u>		
G1	1G	Region 1 VOC controlled RBOB for blending with 5.7% denatured fuel ethanol
G2	2G	Region 2 VOC controlled RBOB for blending with 5.7% denatured fuel ethanol
G3	3G	11.5 psi RVP RBOB for blending with 5.7% denatured fuel ethanol
G4	4G	13.5 psi RVP RBOB for blending with 5.7% denatured fuel ethanol
G5	5G	15.0 psi RVP RBOB for blending with 5.7% denatured fuel ethanol

**Notes:**

1. Delivery of certain products may be limited by facilities.
2. See product specifications for detailed transfer document information.

\*Denotes Change

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## Colonial Pipeline Company

### PRODUCT CODES - GASOLINE

Fungible Product Codes	Segregated Product Codes	Description
<u>RBOB - 93 octane after blending with 10% denatured fuel ethanol</u>		
H1	1H	Region 1 VOC controlled RBOB for blending with 10% denatured fuel ethanol
H2	2H	Region 2 VOC controlled RBOB for blending with 10% denatured fuel ethanol
H3	3H	11.5 psi RVP RBOB for blending with 10% denatured fuel ethanol
H4	4H	13.5 psi RVP RBOB for blending with 10% denatured fuel ethanol
H5	5H	15.0 psi RVP RBOB for blending with 10% denatured fuel ethanol
<u>Gasoline Blendstocks - Segregated Only</u>		
	1L	Low Octane (Octane R+M/2 <83)
	2L	Regular (83 < Octane R+M/2 <87)
	3L	Mid-grade (87 < Octane R+M/2 <93)
	4L	Premium (Octane R+M/2 >93)
<u>Conventional Gasoline - 87 Octane</u>		
M0	0M	7.0 psi RVP
M1	1M	7.8 psi RVP
M2	2M	9.0 psi RVP
M3	3M	11.5 psi RVP
M4	4M	13.5 psi RVP
M5	5M	15.0 psi RVP
<u>Atlanta/Birmingham CBOB - 87 octane after blending with 10% denatured fuel ethanol</u>		
S0	0S	8.0 psi RVP
S1	1S	8.8 psi RVP
S2	2S	10.0 psi RVP
S3	3S	12.5 psi RVP
S4	4S	14.5 psi RVP
S5	5S	16.0 psi RVP
<u>Atlanta/Birmingham CBOB - 93 octane after blending with 10% denatured fuel ethanol</u>		
T0	0T	8.0 psi RVP
T1	1T	8.8 psi RVP
T2	2T	10.0 psi RVP
T3	3T	12.5 psi RVP
T4	4T	14.5 psi RVP
T5	5T	16.0 psi RVP

**Notes:**

1. Delivery of certain products may be limited by facilities.
2. See product specifications for detailed transfer document information.

\*Denotes Change

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## Colonial Pipeline Company

### PRODUCT CODES - GASOLINE

<u>Fungible Product Codes</u>	<u>Segregated Product Codes</u>	<u>Description</u>
<u>Conventional Gasoline - 93 Octane</u>		
V0	0V	7.0 psi RVP
V1	1V	7.8 psi RVP
V2	2V	9.0 psi RVP
V3	3V	11.5 psi RVP
V4	4V	13.5 psi RVP
V5	5V	15.0 psi RVP
<u>Atlanta/Birmingham Conventional Gasoline - 87 Octane</u>		
W0	0W	6.8 psi RVP
W1	1W	7.8 psi RVP
W2	2W	9.0 psi RVP
W3	3W	11.5 psi RVP
W4	4W	13.5 psi RVP
W5	5W	15.0 psi RVP
<u>Atlanta/Birmingham Conventional Gasoline - 93 Octane</u>		
X0	0X	6.8 psi RVP
X1	1X	7.8 psi RVP
X2	2X	9.0 psi RVP
X3	3X	11.5 psi RVP
X4	4X	13.5 psi RVP
X5	5X	15.0 psi RVP

**Notes:**

1. Delivery of certain products may be limited by facilities.
2. See product specifications for detailed transfer document information.

\*Denotes Change

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## Colonial Pipeline Company

Fungible Product Codes	Segregated Product Codes	PRODUCT CODES - DISTILLATE  Description
51		<u>Ultra Low Sulfur Kerosene</u> Ultra Low Sulfur Kerosene
52		<u>Kerosene</u> Military Jet JP-5
54	53	Aviation Kerosene
55		Aviation Kerosene
56		Aviation Kerosene/K-1
		Bonded Aviation Kerosene
58	57	Aviation Kerosene
		Military Jet JP-8
	59	Distillate Blendstock - Not Dyed by Colonial
61		<u>Ultra Low Sulfur Diesel Fuel - Not Dyed by Colonial</u> Ultra Low Sulfur Diesel Fuel
*66		Ultra Low Sulfur Diesel - NRLM
70		<u>Fuel Oils, Diesel Fuels, Military DEM - Not Dyed by Colonial</u> Dyed Heating Oil - 2000 ppmwt - Intraharbor Only
	71	Undyed, Distillate Fuel for Export Only - 2000 ppmwt sulfur
	72	Low Dyed, Low Sulfur NRLM Diesel Fuel - 500 ppmwt sulfur
	73	Undyed Low Sulfur Diesel Fuel - 500 ppmwt sulfur
74		Undyed Low Sulfur Highway Diesel Fuel - 420 ppmwt sulfur
	75	Low Dyed, High Sulfur NRLM Diesel Fuel - 5000 ppmwt sulfur
76		Undyed NRLM Diesel Fuel - 420 ppmwt sulfur
77		Low Dyed Heating Oil - 2000 ppmwt sulfur
78		Undyed Military Diesel Fuel Marine
	79	Distillate Blendstock - Low Dyed unless waived by Q.A.
80		<u>Fuel Oils, Diesel Fuels, Military DEM - Dyed by Colonial</u> Dyed NRLM Diesel Fuel - 420 ppmwt sulfur
	82	Dyed Low Sulfur NRLM Diesel Fuel - 500 ppmwt sulfur
84		Dyed Low Sulfur Diesel Fuel - 420 ppmwt sulfur
	85	Dyed High Sulfur NRLM Diesel Fuel - 5000 ppmwt sulfur
88		Dyed Heating Oil - 2000 ppmwt sulfur
	89	Distillate Blendstock
90		<u>Transmix - Fungible Only</u> Distillate - Conventional Gasoline
91		Distillate RFG - VOC Controlled
92		Distillate RFG - Non-VOC Controlled
93		Distillate RBOB - VOC Controlled
94		Distillate RBOB - Non-VOC Controlled

**Notes:**

1. Delivery of certain products may be limited by facilities.
2. See product specifications for detailed transfer document information.

\*Denotes Change

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# Colonial Pipeline Company

## PRODUCT SPECIFICATIONS INDEX

3.1.1

### Product Specifications

This section contains specifications for products that are handled on a segregated and fungible (common-stream) basis. A "fungible batch" is defined as a batch of petroleum product meeting carrier's established specifications that may be commingled with other quantities of petroleum product meeting the same specifications. A "segregated batch" is defined as a batch of petroleum product being the property of a single shipper and meeting carrier's established specifications.

Delivery of batches may be limited by facilities.

For gasoline product codes the order of the letter and number designates whether the product is fungible or segregated. Gasoline product codes that begin with a letter are fungible and with a number are segregated.

### Section

3.1	Index
3.2	Additive Requirements/Restrictions
3.3	A grades (1-5) - 87 octane reformulated gasoline
3.4	D grades (1-8) - 93 octane reformulated gasoline
3.5	E grades (1-5) - RBOB 87 octane after blending with 5.7% denatured fuel ethanol
3.6	F grades (1-5) - RBOB 87 octane after blending with 10.0% denatured fuel ethanol
3.7	G grades (1-5) - RBOB 93 octane after blending with 5.7% denatured fuel ethanol
3.8	H grades (1-5) - RBOB 93 octane after blending with 10.0% denatured fuel ethanol
3.9	L grades (1-4) - gasoline blendstocks
3.10	M grades (0-9) - 87 octane non-oxygenated conventional gasoline
3.11	S grades (0-5) - CBOB 87 octane after blending with 10.0% denatured fuel ethanol
3.12	T grades (0-5) - CBOB 93 octane after blending with 10.0% denatured fuel ethanol
3.13	V grades (0-9) - 93 octane non-oxygenated conventional gasoline
3.14	W grades (0-5) - 87 octane non-oxygenated low sulfur conventional gasoline
3.15	X grades (0-5) - 93 octane non-oxygenated low sulfur conventional gasoline

\*Denotes Change

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## Colonial Pipeline Company

### PRODUCT SPECIFICATIONS INDEX

3.1.2

#### Product Specifications

##### Section

3.16	Grade 51 - Fungible Ultra Low Sulfur Kerosene
3.17	Grade 52 - Fungible military JP-5
3.18	Grade 53 - Segregated aviation kerosene
3.19	Grade 54 - Fungible aviation kerosene
3.20	Grade 55 - Fungible aviation kerosene 1-K
3.21	Grade 56 - Fungible bonded aviation kerosene
3.22	Grade 57 - Segregated aviation kerosene - 500 ppmwt sulfur
3.23	Grade 58 - Fungible military JP-8
3.24	Grade 59 - Segregated undyed distillate blendstock
3.25	Grade 61 - Fungible ultra low sulfur diesel fuel
3.26	Grade 63 - Reserved for future use
*3.27	Grade 66 - Fungible Ultra Low Sulfur Diesel - NRLM (not dyed by Colonial) 15 ppmwt sulfur
3.28	Grade 70 - Fungible dyed heating oil - For IntraHarbor movements only
3.29	Grade 71 - Segregated high sulfur distillate fuel for export only - 2000 ppmwt sulfur
3.30	Grade 72 - Segregated Low Dyed, Low Sulfur NRLM Diesel Fuel - 500 ppmwt sulfur
3.31	Grade 73 - Segregated undyed low sulfur diesel fuel - 500 ppmwt sulfur
3.32	Grade 74 - Fungible undyed low sulfur highway diesel fuel - 420 ppmwt sulfur
3.33	Grade 75 - Segregated low dyed high sulfur NRLM diesel fuel - 5000 ppmwt sulfur
3.34	Grade 76 - Fungible undyed NRLM diesel fuel - 420 ppmwt sulfur
3.35	Grade 77 - Fungible low dyed heating oil - 2000 ppmwt sulfur
3.36	Grade 78 - Segregated military marine diesel fuel
3.37	Grade 79 - Segregated distillate blendstock - low dyed unless waived by Q. A.
3.38	Grade 80 - Fungible dyed NRLM diesel fuel - 420 ppmwt sulfur
3.39	Grade 82 - Segregated Dyed Low Sulfur NRLM Diesel Fuel - 500 ppmwt sulfur
3.40	Grade 84 - Fungible dyed low sulfur diesel fuel - 420 ppmwt sulfur
3.41	Grade 85 - Segregated dyed high sulfur NRLM diesel fuel - 5000 ppmwt sulfur
3.42	Grade 86 - Reserved for future use
3.43	Grade 88 - Fungible dyed heating oil - 2000 ppmwt sulfur
3.44	Grade 89 - Segregated distillate blendstock
3.45	Grades 90-95 - Transmix

For complete listing of all product codes, refer to individual product specifications.

## Colonial Pipeline Company

### PRODUCT SPECIFICATIONS ADDITIVE REQUIREMENTS/RESTRICTIONS

3.2 Colonial will permit only the types and concentrations of additives detailed below; all other types and concentrations or additives are prohibited.

#### 3.2.1 Gum Inhibitors and Metal Deactivators

Gasoline shipments may, but are not required to, contain the following:

N, N'di-secondary butyl para-phenylenediamine	N, N'disalicylidene-1, 2 propanediamine
N, N'di (1-ethyl-2-methylpentyl) para-phenylenediamine	2, 6-di-tertiary butyl 4 methyl phenol
N, N'di-isopropyl-para-phenylenediamine	n-Butyl para-aminophenol
N, N'bis-(1, 4-diamethylpentyl)-p-phenylenediamine	2,4,6 - tritertiary butylphenol
Ortho-tertiary butylphenol	2,4-dimethyl-6-tertiary-butylphenol
2,4-di-tertiary butylphenol	2,6-tertiary butylphenol
N,secondary butyl, N phenyl-para-phenylenediamine	Mixed propylated and butylated phenols
Butylated ethyl,methyl and dimethyl phenols	2,4,6 tri-isopropylphenol

#### 3.2.2 Corrosion Inhibitors

All products shipped on Colonial Pipeline, with the exception of all grades of Aviation Kerosine, are required to meet a minimum level of corrosion protection prior to shipment. The concentration of inhibitor dosage will be controlled to meet a minimum rating of B+ (less than 5% of test surface rusted) as determined by NACE Standard TM0172-2001, Test Method-Antirust Properties of Petroleum Products Pipeline Cargoes.

Unleaded gasolines shipped on Colonial Pipeline may contain only the following corrosion inhibitors:

Aqua Process	11CH77
Aflon Chem.	HiTEC 6455
Corexit	5267
Innospec	DCI-4A, DCI-6A, DCI-11, DCI-30.N
Ethyl HiTec	580
Lubrizol	8014, 8017
MidContinental	MCC5001
Mobil	C-605

Nalco	5403, 5405, 5406, EC5624A, EC5626A
SPEC-AID	8Q22, 8Q100, 8Q101, 8Q102, 8Q103, 8Q106, 8Q109, 8Q110,8Q112ULS
Tolad	245, 249, 351, 3232, 3232D, 4410
Unichem	7500, 7501, 7510
UOP	Unicor, Unicor J, Unicor PL.

In addition to the above additives, the following may be used in diesel fuels and fuel oil transported by Colonial:  
Dupont AFA-1, Innospec DMA-4, Nalco 5400-A.

#### \*3.2.3 Static Dissipator Additives (Conductivity Improvers)

Product shipments may, but are not required to, contain static dissipator additive(SDA). The only approved SDA for use on Colonial Pipeline is Innospec Stadis® 450. SDA is prohibited from all aviation kerosine grades (grades 51, 53, 54, 55, 56, 57, and 59). The origin maximum concentration of Stadis® 450 is 0.75 mg/l, and the origin maximum conductivity allowed is 250 pS/m at 21°C(70°F) by ASTM D2624.

#### 3.2.4 Aviation Kerosene Additives

Product may only contain antioxidants and metal deactivators specified and within the concentration noted in *Table 2: Detailed Requirements for Additives in Aviation Turbine Fuels* of latest ASTM D-1655 with advance approval from Colonial prior to shipment. Use of these additives is expected to be short term at reasonable treat levels. All other additives are prohibited. Use of these additives must be clearly indicated on Certificate of Analysis. Colonial reserves the right to deny shipment of product containing these additives.

#### 3.2.5 Cloud and Pour Point Depressant Additives

Product may only contain ethylene vinyl acetate copolymer based cloud and pour point depressant additives only upon advance approval from Colonial prior to shipment. Use of these additives is expected to be short term at reasonable treat levels. Colonial reserves the right to deny shipment of product containing cloud and pour point depressant additives.

\*Denotes Change

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## Colonial Pipeline Company

### PRODUCT SPECIFICATIONS ADDITIVE REQUIREMENTS/RESTRICTIONS

#### 3.2.6 Cetane Improver Additives

Product may only contain 2-ethyl hexyl nitrate or T-butyl peroxide based cetane improver additives only upon advance approval from Colonial prior to shipment. Use of these additives is expected to be short term at reasonable treat levels. Colonial reserves the right to deny shipment of product containing cetane improver additives.

#### 3.2.7 Prohibited Additives

As stated in Section 3.2 above, Colonial only permits certain types and concentrations of additives and all other types and concentrations of additives are prohibited. Prohibited additives include, but are not limited to, the following:

Lubricity additives	Port Fuel Injector(PFI) additives	Biodiesel
Intake Valve Detergent Additives	Additives containing Phosphorus	Marker Solvent Yellow 124

#### 3.2.8 Additive Documentation Requirements

If present, the type and concentration of approved additives must be clearly indicated on Certificate of Analysis. Additive treat rates are acceptable for concentration reporting. Carrier may request review of volume reconciliation data to verify actual treat rates.

## Colonial Pipeline Company

### PRODUCT SPECIFICATIONS

3.3.1

### SPECIFICATIONS FOR 87 OCTANE INDEX REFORMULATED GASOLINE

Replaces Previous Issues of A Grades

#### ALL A GRADE REQUIREMENTS (SEGREGATED AND FUNGIBLE)

Product Property	ASTM Test		Test Results		Note
	Method	Minimum	Maximum		
Benzene (vol%)	D3606		1.30		
Octane	RON	D2699	Report		
	MON	D2700	82		
	(R+M)/2		87		
Aromatics (vol%)	D5769, D5599, GC-OFID (See Note)		50		2
E200 (vol%)	D86	30	70		
E300 (vol%)	D86	70	100		
*Olefins (vol%)	D1319		25		
Sulfur (ppmwt)	D2622		80		7
Oxygen Content, weight %	D5599, GC-OFID (See Note)				1.2
Grades A1,A2,A3,A4,A5,1A,2A,3A,4A,5A		1.7	2.7		
RVP (psi)	D5191				3
<u>Grades</u>					
A3,3A (Non-VOC Controlled)			11.5		
A4,4A (Non-VOC Controlled)			13.5		
A5,5A (Non-VOC Controlled)			15.0		
<u>VOC Controlled Requirements</u> (Grades A1,A2,1A,2A, only)					
RVP (psi)	D5191		Report		3
<u>Emissions Performance Reductions (%)</u>					
Region 1 (Grades A1,1A)		Origin:		-29.0% (cycles 16 through 18)	
				-27.0%	
		Delivery:		-25.0%	
Region 2 (Grades A2,2A)		Origin:		-27.4% (cycles 16 through 18)	
				-25.4%	
		Delivery:		-23.4%	
<u>Color</u>					
Corrosion (Cu) 3 hrs @122°F (50°C)	D130			Undyed	
Corrosion (Ag) 3 hrs @122°F (50°C)	D4814-04b Annex A.1			1	
Doctor test	D4952			Negative (sweet)	5
or					
Mercaptan sulfur, wt.%	D3227			0.002	
Existent Gum mg/100 ml	D381			4	
Gravity °API at 60°F	D287,D1298, D4052		Report		

\*Denotes Chance

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A Grade Page 1 of 2

## Colonial Pipeline Company

### PRODUCT SPECIFICATIONS

#### 3.3.2 SPECIFICATIONS FOR 87 OCTANE INDEX REFORMULATED GASOLINE

Cancel Previous Issues of A Grades

#### FUNGIBLE ONLY REQUIREMENTS:

Product Property	ASTM Test Method	Test Results		Note			
		Minimum	Maximum				
Oxidation stability-minutes	D525	240					
Phosphorous, gm/gal	D3231		0.004				
Nace Corrosion	TM0172-2001	B+	(Origin)				
<u>Volatility</u>							
Driveability Index	D4914		See Chart				
Distillation, °C (°F) @ %Evap.	D86						
*Vapor/Liquid Ratio (V/L), °C (°F) @ 20	D5188 (See Note 6)			6			
		10 vol%	50 vol%	90 vol%	End Pt.	V/L	
Grades	Drivesability Index	Max	Min	Max	Max	Min	
A1,A2	1250	70(158)	77(170)	121(250)	190(374)	221(430)	56(133)
A3	1230	60(140)	77(170)	116(240)	185(365)	221(430)	51(124)
A4	1220	55(131)	77(170)	113(235)	185(365)	221(430)	47(116)
A5	1200	50(122)	77(170)	110(230)	185(365)	221(430)	41(105)

NOTES (Apply to Fungible and Segregated):

Heavy Metals are not allowed to be present.

Additive requirements/restrictions - refer to section 3.2.

This is a base gasoline, not for sale to the ultimate consumer.

Any gasoline exhibiting an offensive odor and/or poses a personal health hazard will not be accepted for shipment.

Any gasoline containing more than 0.50 wt. % of dicyclopentadiene will not be accepted for shipment.

The referee method will be based on a gas chromatograph test.

For Helena and Birmingham Delivery Only of A1 and 1A Grades: Due to possible commingling with Birmingham conventional gasoline, the product may not meet the requirements for reformulated gasoline and must not be used in any reformulated gasoline covered area.

Delivery test results may vary by the smaller of ASTM reproducibility for a given test or any test tolerance as allowed by state or EPA regulations at the point of delivery.

1. Non-hydrocarbon blending components are to be reported on the certified laboratory report by type and percent (by volume). This product is required to contain aliphatic ether(s). The use of any other non-hydrocarbons, such as alcohols, as blending components is prohibited.

2. Refer to test methods published in 40 CFR Chapter 1, Part 80.46. Alternative aromatics and oxygenates test methods, ASTM D1319 and ASTM D 4815, may be used according to federal and state regulations.

3. For products blended to meet EPA or state imposed summer VOC requirements, tests must be performed in accordance with the procedures described in 40 CFR, Part 80.

4. Emissions reductions must be calculated using EPA guidelines.

5. Mercaptan Sulfur waived if fuel is negative by Doctor test.

6. Computer and Linear methods may be used to determine V/L value. D5188 will be the referee method method.

7. Refer to 40 CFR Part 80.195 (d)(2). Alternative sulfur test methods, ASTM D 5453 and D 7039, may be used according to federal and state regulations.

\*Denotes Change

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A Grade Page 2 of 2

## Colonial Pipeline Company

### PRODUCT SPECIFICATIONS

#### 3.4.1 SPECIFICATIONS FOR 93 OCTANE INDEX REFORMULATED GASOLINE

1 Cancels Previous Issues of D Grades

#### ALL D GRADE REQUIREMENTS (SEGREGATED AND FUNGIBLE)

Product Property	ASTM Test		Test Results		Note
	Method	Minimum	Maximum		
Benzene (vol%)	D3606		1.30		
Octane	RON	D2699	Report		
	MON	D2700	Report		
(R+M)/2			93.0		
Aromatics (vol%)	D5769, D5599, GC-OFID (See Note)		50		2
E200 (vol%)	D86	30	70		
E300 (vol%)	D86	70	100		
*Olefins (vol%)	D1319		25		
Sulfur (ppmw)	D2622		80		7
Oxygen Content, weight %	D5599, GC-OFID (See Note)				1,2
Grades D1,D2,D3,D4,D5,1D,2D,3D,4D,5D		1.7	2.7		
RVP (psi)	D5191				3
<u>Grades</u>					
D3,3D (Non-VOC Controlled)			11.5		
D4,4D (Non-VOC Controlled)			13.5		
D5,5D (Non-VOC Controlled)			15.0		
<u>VOC Controlled Requirements</u>					
(Grades D1,D2,1D,2D only)					
RVP (psi)	D5191		Report		3
<u>Emissions Performance Reductions (%)</u>					
Region 1 (Grades D1,1D)		Origin:		-29.0% (cycles 15 through 17)	
		Delivery:		-27.0%	
Region 2 (Grades D2,2D)		Origin:		-27.4% (cycles 15 through 17)	
		Delivery:		-23.4%	
<u>Color</u>					
Corrosion (Cu) 3 hrs @122°F (50°C)	D130		1		
Corrosion (Ag) 3 hrs @122°F (50°C)	D4814-04b Annex A1		1		
Doctor test	D4952		Negative (sweet)		5
or					
Mercaptan sulfur, wt. %	D3227		0.002		
Existent Gum mg/100 ml	D381		4		
Gravity *API at 60°F	D287,D1298, D4052	Report			

\*Denotes Change

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D Grade Page 1 of 2

## Colonial Pipeline Company

### PRODUCT SPECIFICATIONS

3.4.2

### SPECIFICATIONS FOR 93 OCTANE INDEX REFORMULATED GASOLINE

Cancels Previous Issues of D Grades

#### FUNGIBLE ONLY REQUIREMENTS:

Product Property	ASTM Test		Test Results		Note		
	Method	Minimum	Maximum				
Oxidation stability-minutes	D525	240					
Phosphorous, gms/gal	D3231		0.004				
Nace Corrosion	TM0172-2001	B+	(Origin)				
<u>Volatility:</u> Driveability Index	D4814			See Chart			
Distillation, °C (°F) @ %Evap.	D86						
*Vapor/Liquid Ratio (V/L), °C (°F) @ 20	D5188 (See Note 6)				6		
	Driveability Index	10 vol% Max	50 vol% Min	Max	90 vol% Max	End Pt. Max	V/L Min
D1,D2	1250	70(158)	77(170)	121(250)	190(374)	221(430)	56(133)
D3,6D	1230	60(140)	77(170)	116(240)	185(365)	221(430)	51(124)
D4,7D	1220	55(131)	77(170)	113(235)	185(365)	221(430)	47(116)
D5,8D	1200	50(122)	77(170)	110(230)	185(365)	221(430)	41(105)

NOTES (Apply to Fungible and Segregated):

Heavy Metals are not allowed to be present.

Additive requirements/restrictions - refer to section 3.2.

This is a base gasoline, not for sale to the ultimate consumer.

Any gasoline exhibiting an offensive odor and/or poses a personal health hazard will not be accepted for shipment.

Any gasoline containing more than 0.50 wt. % of dicyclopentadiene will not be accepted for shipment.

The referee method will be based on a gas chromatograph test.

For Helena and Birmingham Delivery Only of D1 and 1D Grades: Due to possible commingling with Birmingham conventional gasoline, the product may not meet the requirements for reformulated gasoline and must not be used in any reformulated gasoline covered area.

Delivery test results may vary by the smaller of ASTM reproducibility for a given test or any test tolerance as allowed by state or EPA regulations at the point of delivery.

1. Non-hydrocarbon blending components are to be reported on the certified laboratory report by type and percent (by volume). This product is required to contain aliphatic ether(s). The use of any other non-hydrocarbons, such as alcohols, as blending components is prohibited.

2. Refer to test methods published in 40 CFR Chapter 1, Part 80.46. Alternative aromatics and oxygenates test methods, ASTM D1319 and ASTM D 4815, may be used according to federal and state regulations.

3. For products blended to meet EPA or state imposed summer VOC requirements, tests must be performed in accordance with the procedures described in 40 CFR, Part 80.

4. Emissions reductions must be calculated using EPA guidelines.

5. Mercaptan Sulfur waived if fuel is negative by Doctor test.

6. Computer and Linear methods may be used to determine V/L value. D5188 will be the referee method.

7. Refer to 40 CFR Part 80.195 (d)(2). Alternative sulfur test methods, ASTM D 5453 and D 7099, may be used according to federal and state regulations.

\*Denotes Change

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D Grade Page 2 of 2

## Colonial Pipeline Company

### PRODUCT SPECIFICATIONS

3.5.1

### REFORMULATED REGULAR GASOLINE BLENDSTOCK (RBOB) FOR BLENDING WITH 5.7% DENATURED FUEL ETHANOL (92% PURITY) AS DEFINED IN ASTM D4806

Cancel Previous Issues of E grades

**This RBOB may not be combined with any other RBOB except RBOB having the same requirement for oxygenate type and amount.**

**All parameters must be met after blending with denatured fuel ethanol unless noted.**

#### ALL E GRADE REQUIREMENTS (SEGREGATED AND FUNGIBLE)

Product Property	ASTM Test		Test Results		Note
	Method		Minimum	Maximum	
Benzene (vol%)	D3606			1.30	
Octane	RON	D2699	Report		
	MON	D2700	82.0		
	(R-M)/2		87.0		
Oxygen Content, weight %	D5599, GC-OFID(See Note)				1,2,8
Aromatics (vol%)	D5769, D5599, GC-OFID (See Note)		50		2
E200 (vol%)	D86		30	70	
E300 (vol%)	D86		70	100	
*Olefins (vol%)	D1319			25	
Sulfur (ppmwt)	D2622			80	9
Non-VOC Controlled Requirements					
RVP (psi)	D5191				3
<u>Grades</u>					
E3,3E (Non-VOC Controlled)				11.5	
E4,4E (Non-VOC Controlled)				13.5	
E5,5E (Non-VOC Controlled)				15.0	
VOC Controlled Requirements					
(Grades E1, E2, 1E, 2E, only)					
RVP (psi)	D5191			Report	3
Emissions Performance Reductions (%)					
Region 1 (Grades E1, 1E)					
	Origin:			-28.0% (cycles 16 through 18)	
				-27.0%	
	Delivery:			-25.0%	
Region 2 (Grades E2, 2E)					
	Origin:			-26.4% (cycles 16 through 18)	
				-25.4%	
	Delivery:			-23.4%	

\*Denotes Change

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E Grade Page 1 of 3



## Colonial Pipeline Company

### PRODUCT SPECIFICATIONS

3.5.2

### REFORMULATED REGULAR GASOLINE BLENDSTOCK (RBOB) FOR BLENDING WITH 5.7% DENATURED FUEL ETHANOL (92% PURITY) AS DEFINED IN ASTM D4806

Cancels Previous Issues of E grades

#### FUNGIBLE ONLY REQUIREMENTS:

<u>Product Property</u>	<u>ASTM Test Method</u>	<u>Test Results</u>		<u>Note</u>			
		<u>Minimum</u>	<u>Maximum</u>				
Color			Undyed				
Corrosion (Cu) 3 hrs @122°F (50°C)	D130		1				
Corrosion (Ag) 3 hrs @132°F (50°C)	D4814-04b Annex A1		1				
Doctor test	D4952		Negative (sweet)	5			
or							
Mercaptan sulfur, wt %	D3227		0.002				
Existent Gum mg/100 ml	D381		4				
Gravity <sup>1</sup> API at 60°F	D287, D1298, D4052	Report		7			
Oxidation stability-minutes	D525	240					
Phosphorous, gms/gal	D3231		0.004				
Nace Corrosion	TM0172-2001	B+ (Origin)		7			
<u>Volatility:</u>							
Driveability Index	D4814		See Chart				
Distillation, °C (°F) @ %Evap.	D86						
*Vapor/Liquid Ratio (V/L), °C (°F) @ 20	D5188 (See Note 6)			6			
		Driveability	10 vol%	50 vol%	90 vol%	End Pt.	V/L
<u>Grades</u>	<u>Index</u>	<u>Max</u>	<u>Min</u>	<u>Max</u>	<u>Max</u>	<u>Max</u>	<u>Min</u>
E1,E2	1250	70(158)	77(170)	121(250)	190(374)	221(430)	56(133)
E3	1230	60(140)	77(170)	116(240)	185(365)	221(430)	51(124)
E4	1220	55(131)	66(150)	113(235)	185(365)	221(430)	47(116)
E5	1200	50(122)	66(150)	110(230)	185(365)	221(430)	41(105)

#### NOTES (Apply to Fungible and Segregated):

Heavy Metals are not allowed to be present.

Additive requirements/restrictions - refer to section 3.2.

This is a base gasoline, not for sale to the ultimate consumer.

Any gasoline exhibiting an offensive odor and/or poses a personal health hazard will not be accepted for shipment.

Any gasoline containing more than 0.50 wt. % of dicyclopentadiene will not be accepted for shipment.

The referee method will be based on a gas chromatograph test.

Delivery test results may vary by the smaller of ASTM reproducibility for a given test or any test tolerance as allowed by state or EPA regulations at the point of delivery.

1. All E grades may not contain oxygenates, such as ethers and alcohols. The use of non-hydrocarbon

blending components in these grades is prohibited. Origin maximum MTBE .25 vol. %.

Delivery maximum MTBE .50 vol. %.

2. Refer to test methods published in 40 CFR Chapter 1, Part 80.46. Alternative aromatics and oxygenates test methods, ASTM D1319 and ASTM D 4815, may be used according to federal and state regulations.

3. For products blended to meet EPA or state imposed summer VOC requirements, tests must be performed in accordance with the procedures described in 40 CFR, Part 80.

\*Denotes Change

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E Grade Page 2 of 3

## Colonial Pipeline Company

### PRODUCT SPECIFICATIONS

3.5.3

### REFORMULATED REGULAR GASOLINE BLENDSTOCK (RBOB) FOR BLENDING WITH 5.7% DENATURED FUEL ETHANOL (92% PURITY) AS DEFINED IN ASTM D4806

Cancels Previous Issues of E grades

#### NOTES (Apply to Fungible and Segregated):

4. Emissions reductions must be calculated using EPA guidelines.
5. Mercaptan Sulfur waived if fuel is negative by Doctor test.
6. Computer and Linear methods may be used to determine V/L value. D5188 will be the referee method.
7. Specifications must be met before blending of denatured fuel ethanol.
8. Oxygen content must meet a minimum of 1.7 wt.% and a maximum of 4.0 wt.% after blending of denatured fuel ethanol.
9. Refer to 40 CFR Part 80.195 (d)(2). Alternative sulfur test methods, ASTM D 5453 and D 7039, may be used according to federal and state regulations.

\*Denotes Change

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## Colonial Pipeline Company

PRODUCT SPECIFICATIONS

3.16.1

SPECIFICATIONS FOR FUNGIBLE ULTRA LOW SULFUR KEROSENE GRADE 51

**EPA Designation: MVNRLM, Motor vehicle diesel fuel, #1D, 15 ppm sulfur motor vehicle diesel fuel**

Cancel Previous Issues of Grade 51

Product Property	ASTM Test Method	Test Results		Note
		Minimum	Maximum	
<u>General Properties</u>				
Gravity	D287, D1298, D4052	37	51	
Net Heat of combustion BTU/Pound	D3338, D4529, D4809	18,400		
Corrosion 2 hrs. @ 212°F (100°C)	D130		1	
Cetane Number	D613, D6890	40		6
MSEP: Origin	D3948	85		
MSEP: Delivery	D3948	75		
<u>Electrical</u>				
Conductivity, pS/m @ 21°C(70°F)	D2624		Report	
Ash, wt.%	D482		0.01	
Determination of Filtration Time or Volume Total Solids or Particulate	MIL-T-5624P, D5452		Report Report	3
<u>Low Temperature Properties</u>				
Freezing Point, °C	D2386, D5972, D7153, D7154		-40	7
Viscosity, cSt @ 104°F (40°C)	D445	1.3	1.9	
Viscosity, cSt @ -4°F (-20°C)	D445		8.0	
<u>Volatility</u>				
Flash Point, °F	D56, D3828	123		
Distillation, °C(°F)	D86			8
10% recovered			205(400)	
50% recovered		Report		
90% recovered			288(550)	
End Point			300(572)	
Residue, %			1.5	
Loss, %			1.5	
or Simulated Distillation, °C(°F)	D2887			8
10% recovered			185(365)	
50% recovered		Report		
90% recovered			304(579)	
End Point			340(644)	
<u>Stability</u>				
Existent Gum, mg/100 ml	D381, IP540		7.0	
Thermal Stability @ 275°C	D3241			Origin
Pres. drop in mm/Hg			25	
Tube deposit less than code			Code 3	
		No Peacock or Abnormal Color Deposits		

\*Denotes Change

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## Colonial Pipeline Company

### PRODUCT SPECIFICATIONS

3.16.2

### SPECIFICATIONS FOR FUNGIBLY ULTRA LOW SULFUR KEROSENE GRADE 51

Cancels Previous Issues of Grade 51

<u>Product Property</u>	<u>ASTM Test Method</u>	<u>Test Results</u>		<u>Note</u>
		<u>Minimum</u>	<u>Maximum</u>	
<u>Stability (continued)</u>				
Thermal Stability @ 260°C Pres. drop in mm/Hg Tube deposit less than code	D3241		25 Code 3	Delivery
No Peacock or Abnormal Color Deposits				
Carbon Residue: Ramsbottom on 10% bottom	D524		0.15	
<u>Composition Properties</u>				
Total Sulfur, ppmwt	D2622, D5453 D7039, other		10 14	4 Origin Delivery
Aromatics, vol.%	D1319		25	
Mercaptan Sulfur, wt.% OR	D3227		0.003	5
Doctor test	D4952		Negative (sweet)	
Acidity total max, mg KOH/g	D974, D3242		0.1	
<u>Combustion Properties</u>				
Smoke point, mm OR	D1322	25		
Smoke point, mm and Naphthalenes, vol.%	D1322 D1840	18	3.0	

**NOTES:**

1. Product shall be clear and bright and free of suspended matter.
2. Additive requirements/restrictions - refer to section 3.2.
3. At this time, the test limits described in MHI-T-5624P, Appendix A, parts 70.a(1) and 70.b will not be imposed.
4. Origin laboratory certifying sulfur content can qualify the test method used per EPA Performance Based Testing Criteria (see CFR 80.584). The referee test method will be ASTM D5453.
5. Mercaptan Sulfur waived if fuel is negative by Doctor test.
6. Where octane number by test method D613 is not available, test method D4737A can be used as an approximation.
7. The referee method will be D2386
8. Either physical or simulated distillation can be used. The referee test method will be ASTM D 86.

\*Denotes Change

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## Colonial Pipeline Company

3.25.1

**PRODUCT SPECIFICATIONS**  
**SPECIFICATIONS FOR FUNGIBLE ULTRA LOW SULFUR DIESEL FUEL -**  
**GRADE 61**

**EPA Designation: MVNRLM, Motor vehicle diesel fuel, #2D, 15 ppm sulfur motor vehicle diesel fuel**

Replaces Previous Issues of Grade 61

PRODUCT PROPERTY	ASTM Test Method	Test Results		Note
		Minimum	Maximum	
Gravity API	D287, D1298, D4052	30		
Flash Point, °F				
Pensky-Martin	D93	130		
Physical Distillation, °C(°F)	D86			5
50%			Report	
90%		282(540)	338(640)	
End Point			366(690)	
or Simulated Distillation, °C(°F)	D2887			5
50% recovered			Report	
90% recovered		300(572)	356(673)	
End Point			421(790)	
Color ASTM	D1500, D6645		2.5	
Color Visual		Undyed		
Viscosity, cSt: @ 40°C (104°F)	D445	1.9	3.4	
Pour Point	D97, D5949, D5950, D5985			2
Cloud Point	D2500, D5771, D5772, D5773			2
Corrosion, 3 hrs. @ 50°C (122°F)	D130		1	
Total Sulfur, ppmwt	D2622, D5453			
	D7639, other		10	Origin
			14	Delivery
Cetane Number	D613, D6890	40		4
Aromatics (Volume %)	D1319		31.7	
or Aromatics by Cetane Index	D976	40		
Ash, wt.%	D482		0.01	
Carbon Residue: Ramsbottom on 10% Bottom	D524		0.35	
BS&W, vol.%	D2709			
	or equivalent		< 0.05	
Thermal stability, 90 minutes				
150°C Pad rating, DuPont scale			7	
OR				
Oxidation stability, mg/100 ml	D2274		2.5	
Haze rating @ 25°C (77°F)	D4176			
	Procedure 2		2	
Nace Corrosion Electrical	TM0172-2001	B+ (Origin)		
Conductivity, pS/m @ 21°C (70°F)	D2624		250	

\*Denotes Change

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61 Grade Page 1 of 2

# Colonial Pipeline Company

## PRODUCT SPECIFICATIONS

3.25.2

### SPECIFICATIONS FOR FUNGIBLE ULTRA LOW SULFUR DIESEL FUEL - GRADE 61

Replaces Previous Issues of Grade 61

Delivery test results may vary by the smaller of ASTM reproducibility for a given test or any test tolerance as allowed by state or EPA regulations at the point of delivery.

#### NOTES:

1. Additive requirements/restrictions - refer to section 3.2.

2. This schedule denotes the fluidity of the distillate at the time and place of origin.

Pour Point - August 1st through March 14th

Maximum:  $-18^{\circ}\text{C}$  ( $0^{\circ}\text{F}$ )

Pour Point - March 15th through July 31st

Maximum:  $-12^{\circ}\text{C}$  ( $+10^{\circ}\text{F}$ )

Cloud Point - August 1st through March 14th

Maximum:  $-9^{\circ}\text{C}$  ( $+15^{\circ}\text{F}$ )

Cloud Point - March 15th through July 31st

Maximum:  $-7^{\circ}\text{C}$  ( $+20^{\circ}\text{F}$ )

The referee method will be Pour point D97 and Cloud point D2500

3. Origin laboratory certifying sulfur content must qualify the test method used per EPA Performance Based Testing Criteria (see CFR 80,584). The referee test method will be ASTM D5453.

4. Where cetane number by test method D613 is not available, test method D4737B can be used as an approximation.

5. Either physical or simulated distillation can be used. The referee test method will be ASTM D 86.

\*Denotes Change

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61 Grade Page 2 of

## Colonial Pipeline Company

### PRODUCT SPECIFICATIONS SPECIFICATIONS FOR FUNGIBLE HIGH SULFUR LOW DYED HEATING OIL GRADE 77

3.35.1

**EPA Designation: Heating Oil**

Replaces Previous Issues of Grade 77

<u>PRODUCT PROPERTY</u>	ASTM Test Method	Test Results		Note
		Minimum	Maximum	
Gravity API	D287, D1298, D4052	30		
Flash Point, °F				
Pensky-Martin	D93	130		
Physical Distillation, °C(°F)	D86			6
50%			Report	
90%		282(540)	338(640)	
End Point			366(690)	
or Simulated Distillation, °C(°F)	D2887			6
50% recovered			Report	
90% recovered		300(572)	356(673)	
End Point			421(790)	
Color ASTM	D1500, D6045		2.5	4
Color Visual				
Viscosity, cSt @ 40°C (104°F)	D445	1.9	3.4	
Pour Point	D97, D5949, D5950, D5985			2
Cloud Point	D2500, D5771, D5772, D5773			2
Corrosion, 3 hrs. @ 50°C (122°F)	D130		1	
Total Sulfur, ppmwt	D2622, D5453, D7039, D4294		2000	5
Ash, wt. %	D482		0.01	
Carbon Residue: Ramsbottom				
on 10% Bottom	D524		0.35	
BS&W, vol. %	D2709			
or equivalent			< 0.05	
Thermal stability, 90 minutes				
150°C Pad rating, DuPont scale			7	
OR				
Oxidation stability, mg/100 ml	D2274		2.5	
Haze rating @ 25°C (77°F)	D4176			
Procedure 2			2	
Nace Corrosion	TM0172-2001	B+ (Origin)		
Electrical				
Conductivity, pS/m @ 21°C(70°F)	D2624		250	

Delivery test results may vary by the smaller of ASTM reproducibility for a given test or any test tolerance as allowed by state or EPA regulations at the point of delivery.

\*Denotes Change

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## Colonial Pipeline Company

### PRODUCT SPECIFICATIONS SPECIFICATIONS FOR FUNGIBLE HIGH SULFUR LOW DYED HEATING OIL GRADE 77

3.35.2

Cancels Previous Issues of Grade 77

#### NOTES:

1. Additive requirements/restrictions - refer to section 3.2.

2. This schedule denotes the fluidity of the distillate at the time and place of origin.

Pour Point - August 1st through March 14th

Maximum: -18°C (0°F).

Pour Point - March 15th through July 31st

Maximum: -12°C (+10°F)

Cloud Point - August 1st through March 14th

Maximum: -9°C (+15°F)

Cloud Point - March 15th through July 31st

Maximum: -7°C (+20°F)

The referee method will be Pour point D97 and Cloud point D2500

3. Dye Requirement:

This product must exhibit visual evidence that red dye is present. The maximum allowable concentration, or spectral equivalence, is 0.75 pounds of Solid Red #26 per 1,000 barrels. This product does not meet IRS excise tax requirements for dye.

4. ASTM color measurement before addition of dye

5. Origin laboratory certifying sulfur content can qualify the test method used per EPA Performance Based Testing Criteria (see CFR 80.584). The referee test method will be ASTM D5453.

6. Either physical or simulated distillation can be used. The referee test method will be ASTM D 86.

\*Denotes Change

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# 2007 Worldwide Refining Survey

Leena Kocoungal  
Sanny Bhat

All figures are  
as of January 1, 2008

All figures in barrels per calendar day (b/cd)

## LEGEND

Numbers identify processes in table

### Coking

1. Fluid coking
2. Delayed coking
3. Other

### Thermal cracking

1. Thermal cracking
2. Pyrocracking

### Catalytic cracking

1. Fluid
2. Other

### Catalytic reforming

1. Semi-regenerative
2. Cyclic
3. Other

### Catalytic hydrotreating

1. Treatment of oil-refiner feeds
2. Other refinery feed treatment
3. Alkylation feed treatment
4. Other refinery feed treatment
5. Other refinery feed treatment
6. Other refinery feed treatment
7. Other refinery feed treatment
8. Other refinery feed treatment
9. Other refinery feed treatment
10. Other refinery feed treatment
11. Other refinery feed treatment
12. Other refinery feed treatment
13. Other

### Alkylation

1. Sulfuric acid
2. Hydrofluoric acid

### Hydrogenation

1. Hydrogenation
2. Hydrogenation
3. Hydrogenation
4. Hydrogenation

### Isomerization

1. C<sub>6</sub> feed
2. C<sub>7</sub> feed
3. C<sub>8</sub> and C<sub>9</sub> feed

### Hydrogen

1. Hydrogen
2. Hydrogen
3. Hydrogen
4. Hydrogen

### Hydrogen

1. Hydrogen
2. Hydrogen
3. Hydrogen
4. Hydrogen
5. Hydrogen
6. Hydrogen
7. Other

## NOTES

- Previously listed as Wilmar Energy Corp.
- Previously listed as Nantex Refining Co.
- Previously listed as Nantex Refining Co.
- Previously listed as Singapore Petroleum Co. Ltd.
- Previously listed as Shell International Refining Co.
- Previously listed as BP PLC

### Capacity additions

Capacity additions in barrels per calendar day (b/cd) is the maximum number of barrels of input that can be processed during a 24-hour period, after making allowances for the following: (a) Time and effort to be processed; (b) Types and grades of products to be produced; (c) Environmental constraints associated with refinery operations; (d) Scheduled downtime due to mechanical problems, repairs, and shutdowns. Capacity increased in barrels per calendar day (b/cd) is the amount of additional capacity that is added to the refinery's capacity to process feedstocks and produce products. It is the sum of capacity additions and the amount of capacity that is removed from the refinery's capacity to process feedstocks and produce products. It is the sum of capacity additions and the amount of capacity that is removed from the refinery's capacity to process feedstocks and produce products.

### Hydrogen

Hydrogen use was presented here separate from generation or upgrading in 2007.

### Catalytic reforming

1. Semi-regenerative reforming is characterized by structure of the reforming unit at specified locations, or at the operator's discretion, for its catalytic reforming.
2. Cyclic regenerative reforming is characterized by structure or catalyst regeneration of catalyst beds, in any one of several locations that can be selected and returned to the reforming operation. This is accomplished without changing feed rate or output.
3. Continuous regenerative reforming is characterized by the addition of a catalyst to the reforming unit.
4. Other catalytic reforming (catalytic) is replaced by fresh catalyst and recycled catalyst.

- Previously listed as Shellref.
- Previously listed as Selenia Refining Co.
- Previously listed as Exxonref.
- Previously listed as Total SA.

## REFINERY REMOVALS

Name	Location	Country	Crude Prod	Restart	Closed operations
Petro-Canada Products Ltd.	Calgary	Canada	\$3,000		



WORLDWIDE OPERATING Company and refinery location	Crude distillation			Thermal cracking operations			Catalytic cracking operations			Catalytic reforming			Catalytic reforming/hydrocracking			Catalytic reforming/hydrocracking			Ethylene production			Production capacity, bbl/d		
	Crude distillation	Thermal cracking operations	Coking operations	Thermal cracking operations	Catalytic cracking operations	Catalytic cracking operations	Catalytic reforming	Catalytic reforming	Catalytic reforming/hydrocracking	Catalytic reforming/hydrocracking	Hydrogen (MMbbl/d)	Hydrogen (MMbbl/d)	Hydrogen (MMbbl/d)	Hydrogen (MMbbl/d)	Hydrogen (MMbbl/d)	Hydrogen (MMbbl/d)	Hydrogen (MMbbl/d)	Hydrogen (MMbbl/d)	Hydrogen (MMbbl/d)	Hydrogen (MMbbl/d)	Hydrogen (MMbbl/d)	Hydrogen (MMbbl/d)	Hydrogen (MMbbl/d)	
<b>ALBANIA</b>																								
Albpetrol-Erbas	12000	4500	712000				3300																	
Albpetrol-Fier	8300	6000																						
<b>Total</b>	<b>20300</b>	<b>10500</b>	<b>12000</b>				<b>3300</b>																	
<b>ALGERIA</b>																								
Inefic SPA-Alger	20000						15000																	
Nahac SPA-Oran	20000	8447					11000																	
Nahac SPA-Nassirouat	30000						14000																	
Nahac SPA-Souk	20000	8447					10000																	
<b>Total</b>	<b>100000</b>	<b>16894</b>					<b>50000</b>																	
<b>ANGOLA</b>																								
Fru Petros de Angola-Luanda	30000	2300					1500																	
<b>Total</b>	<b>30000</b>	<b>2300</b>					<b>1500</b>																	
<b>ARGENTINA</b>																								
Desoladora Argentina de Petros SA-Dos Sud	4000	1500																						
Desoladora Argentina de Petros SA-Lomas de Zamora	8000	1300																						
Excofina Refining & Supply Company	20000	40000	340000				70000																	
Petrolero Bauriac SA-Rio de la Plata	20000	10000					10000																	
Refineria SA-Campo Duran	10000	5000					10000																	
<b>Total</b>	<b>52000</b>	<b>54800</b>	<b>340000</b>				<b>100000</b>																	
<b>BAHAMA</b>																								
Bahama Petroleum SA-Nassau	10000	5000					10000																	
<b>Total</b>	<b>10000</b>	<b>5000</b>					<b>10000</b>																	
<b>BRAZIL</b>																								
Refineria de Petros SA-Porto Alegre	10000	5000					10000																	
<b>Total</b>	<b>10000</b>	<b>5000</b>					<b>10000</b>																	
<b>CHINA</b>																								
China National Petroleum Corporation	100000	50000	1000000				50000																	
<b>Total</b>	<b>100000</b>	<b>50000</b>	<b>1000000</b>				<b>50000</b>																	
<b>COLOMBIA</b>																								
Refineria de Petros SA-Barrancabermeja	10000	5000					10000																	
<b>Total</b>	<b>10000</b>	<b>5000</b>					<b>10000</b>																	
<b>DOMINICAN REPUBLIC</b>																								
Refineria de Petros SA-Santiago	10000	5000					10000																	
<b>Total</b>	<b>10000</b>	<b>5000</b>					<b>10000</b>																	
<b>EGYPT</b>																								
Refineria de Petros SA-Egypt	10000	5000					10000																	
<b>Total</b>	<b>10000</b>	<b>5000</b>					<b>10000</b>																	
<b>INDONESIA</b>																								
Refineria de Petros SA-Jakarta	10000	5000					10000																	
<b>Total</b>	<b>10000</b>	<b>5000</b>					<b>10000</b>																	
<b>IRAN</b>																								
Refineria de Petros SA-Tehran	10000	5000					10000																	
<b>Total</b>	<b>10000</b>	<b>5000</b>					<b>10000</b>																	
<b>ITALY</b>																								
Refineria de Petros SA-Rome	10000	5000					10000																	
<b>Total</b>	<b>10000</b>	<b>5000</b>					<b>10000</b>																	
<b>JAPAN</b>																								
Refineria de Petros SA-Tokyo	10000	5000					10000																	
<b>Total</b>	<b>10000</b>	<b>5000</b>					<b>10000</b>																	
<b>MEXICO</b>																								
Refineria de Petros SA-Mexico	10000	5000					10000																	
<b>Total</b>	<b>10000</b>	<b>5000</b>					<b>10000</b>																	
<b>NET EXPORTS</b>																								
<b>Total</b>	<b>620000</b>	<b>300000</b>	<b>1000000</b>				<b>300000</b>																	