CHAPTER FOURTEEN

Pricing Petroleum Products

NETBACK AND FORMULA PRICING FOR CRUDE OIL

The netback pricing of crude oil set a crude oil price on the basis of the product market. Netback and other formula techniques seek to provide reduced market risk and reasonable return to the refiner during extreme market fluctuation, and they make long-term contracts between crude producers and refiners possible.

In the past, violent price fluctuations created huge trading losses for some companies; and this accelerated the shift to netback and other formula pricing as a tactic to minimize risk in place of outright sale at a negotiated price.

There are four basic components of any netback deal: yield of the finished products from refining the crude in question, product prices, timing, processing fees, and transportation cost.

YIELD

The yield is the portion of each refined product that, when combined with refinery fuel and loss, adds up to the whole barrel of crude. A specific spot product price reference point (as monitored by an agreed-on published source) is selected for each portion of yield to determine the total value of crude oil. The processing fees include refining cost, freight, and other elements that are deducted to arrive at a "net" value of the crude "back" at the point of origin (i.e., the netback). The basic method of calculating the netback price follows.

PRODUCT PRICES

Spot prices quotes from any reporting service can be used, although Platts spot price quotes are most popular. The netback price reference is based on the "high," "mean," or "low" point of the price range reported. The choice has a substantial influence on the resulting crude price. In almost all cases, the product pricing base used is that at the intended destination refining center, with few exceptions. For example, an Iranian crude processed in Singapore uses Singapore Market quotes—high, mean or low, as per the terms of the agreement.

TIMING

Typically, the timing component is expressed as a certain number of days (usually between 0 and 60) after bill of lading date. This implies that the prices to be used for calculating the gross product worth are the spot quotes (high, mean, or low) prevailing exactly on the agreed number of days after the crude is loaded. Timing can sometimes create an incentive for the buyer to rush or slow vessel streaming. For example, if prices are falling, the buyer has an incentive to speed up the vessel to process the crude and sell the products at the highest possible prices.

In some netback deals, the product quotes are averaged over a number of days to avoid the chance that the product quote deviates substantially from the prevailing market levels on any single day and unduly distorts the netback prices. The period for averaging may be 5–10 days or more and is agreed to in the netback deal.

The product prices for the indicated time period are multiplied by the yield according to set percentages (on either a weight or volume basis). The total of the calculation gives the overall value or "gross product worth" at the refinery location. The processing fees are then deducted from this total, giving netback or the price of the crude.

PROCESSING FEES

The processing fees consist of the operating cost to the refinery per barrel of the crude processed plus minimum refinery profit. The refining cost include cost of utilities (fuel, electricity, water, etc.), catalysts and chemicals, and personnel incurred in processing one barrel of crude.

Refining costs do not include the amortization and depreciation costs of fixed refinery assets. It is closely related to the refinery bottom-line profit margin. The variation in processing fees are large, ranging from as high as $2 to as low as $0.5 for a simple refinery. The processing fees are usually related to the complexity of the refinery. For a refinery with an extensive conversion facility, the fees may be many times more than for one with only basic crude topping facilities.

TRANSPORTATION COST

For crude transport, it is the cost of chartering an appropriately sized vessel (see Table 14-1) on the spot market for a single voyage. The transport cost is set by Worldscale, a trade association that publishes a flat base rate for voyages between each oil loading and receiving port. Daily tanker market fluctuations are measured in Worldscale "points," which are a percentage of standard flat rate.

For example, the cost of chartering a ship, at Worldscale 35, would be 35% of the flat rate for spot cost of transport to Singapore from the Arabian Gulf:

Flat rate per long ton (VLCC class) = $25.32

Flat rate per barrel = $3.38

Converted at 7.49 bbl/ton of 34 API crude.

Table 14-1
Crude and Product Tanker-Size Classification

CLASS	SHIP, dwt (long tons)
GP	16,000–24,999
MR	25,000–44,999
LR1	45,000–79,999
LR2	80,000–159,999
VLCC	160,000–319,999
ULCC	320,000–OVER

$$\text{Transport cost per barrel at WS 35} = 3.38 \times 35/100 = \$1.183$$

EXAMPLE 14-1

Determine the netback price for light Arabian crude refined in Singapore with its product yield sold in the spot market. Assume April 1998 mean prices. The product yield from this crude (LV%) (LV = Liquid volume %) is presented below;

PRODUCT	PRICES SINGAPORE, MEAN, $	PRODUCT YIELD, VOL%	VALUE OF YIELD, $
NAPHTHA	17.50	14.149	2.48
PREMIUM GASOLINE	25.90	5.557	1.44
JET A-1	22.30	16.140	3.60
DIESEL	22.50	31.687	7.13
FUEL OIL, 3.5% SULFUR	13.4	32.467	4.35
LOSSES	0	0	0
GROSS PRODUCT WORTH			18.99

1. The gross product worth (GPW) of crude is calculated first as shown in table.
2. By subtracting the refining cost, freight, other costs (insurance, loss, financing, duties, etc.), the spot product prices are translated into an equivalent crude oil value at the crude loading port of origin, or the "FOB netback." Therefore,

$$\text{Total Arabian light product (GPW)} = \$18.99$$

$$\text{Less incremental refining fees} = \$1.30$$

$$\text{Less spot freight cost} = \$1.18$$

$$\text{Less insurance, loss, etc.} = \$0.25$$

$$\text{Implied netback of the Arabian light crude} = \$16.26$$

EXAMPLE 14-2

A refinery in the Arabian Gulf sells 40,000 barrels of topped light Arabian crude to a refiner in Singapore for further processing in the Singapore refinery. Establish the FOB price from the Arabian Gulf as per netback principles. Assume a refining cost of $2.10 per barrel.

The dollar per barrel revenue obtained from the topped crude (300°F + cut) is established by multiplying the calculated yield of the product obtained when this feedstock is processed in the Singapore refinery by the market prices prevailing for these products in the month in question.

PRODUCT	YIELD, LV%	Mean of Platts (MOP), $	BARREL COST, $
NAPHTHA	2.0	28.35	0.567
KEROSENE	18.0	33.10	5.958
DIESEL	30.0	28.75	8.625
FUEL OIL	46.0	21.70	9.982
TOTAL	96.0		25.132

From the dollar per barrel revenue just calculated, the actual refining cost and per barrel freight for an Arabian Gulf/Singapore trip in an MR class vessel (Table 14-1) is deducted, to obtain netback price for the topped crude:

$$\text{Sales realization per barrel topped crude in Singapore} = \$25.13$$
$$\text{Less refining cost} = \$2.10$$
$$\text{Less per barrel freight, Singapore/Arabian Gulf} = \$0.75$$
$$\text{Estimated price per barrel topped crude, FOB Arabian Gulf} = \$22.28$$

FORMULA PRICING

Formula pricing techniques do not rely on the product yield value to determine the crude price nor do they secure any margin for the refiner. In formula pricing, the crude price is linked to another crude or group of crudes for which price quotes are regularly available. The usual practice is to select a popular spot crude of comparable quality (API, sulfur, etc.) or a basket of crudes from the same producing area. For example, Mexican crudes sold in U.S. markets at one time were tied to the prices of three U.S. domestic crudes plus an element of residual fuel oil (33% West Texas sour + 33% West Texas intermediate + 33% Alaskan North slope, less 3% fuel). It provided for price determination based on U.S. quotes for 5 days around the bill of lading date.

Formula pricing is inflexible compared to the spot market, to which oil companies are becoming accustomed. The buyers are reluctant to tie themselves to long-term arrangements through complex formulas that offer no advantage, unless the prices are very attractive over long-term contracts, and do not offer secure margins to refiners, as is in the case of netback deals, which will remain popular so long as market volatility persists.

PRICING PETROLEUM PRODUCTS AND INTERMEDIATE STOCKS

For the purpose of economic settlement between the participants, it becomes necessary to estimate the dollar value of the petroleum product and intermediate process stocks inventory in the refinery tanks at a given time. Market quotes for a few finished products, which are regularly traded in bulk, are published regularly and thus easily available. These become the reference prices for computing the prices of other petroleum products or intermediate stocks for which no market price quotes are available.

Product properties produced by a refinery may be quite different from the quality of the reference products for which price quotes are available. For example, a refinery in the Arabian Gulf region may produce 95 octane gasoline. As no price quotes for gasoline are available in the Arabian Gulf market, available gasoline quotes for the Singapore or Mediterranean market may be used as reference. Price adjustments are required, however, for quality variations. Process or intermediate stocks, for the purpose of price determination, are considered a blend of two or more stocks whose price quotes are available.

REFERENCE MARKETS

The appropriate reference market is chosen depending on the location of the refinery where its products are most likely to be sold. Market quotations from the following markets are regularly published by Platt's Oilgram Service or Platt's Marketscan and other reporting services and are used as reference prices for estimating the price of other products:

U.S. Gulf Coast.
Northwestern Europe/Rotterdam (NWE).
Mediterranean.
Arabian Gulf (AG).
Singapore.

To estimate the prices of products and intermediate streams, average quotes over a period of time should be used. The following examples illustrate the mechanism of product pricing from the reference price data.

EXAMPLE 14-3

Determine the prices of motor gasolines, unleaded (RON 91 and 95), for an Arabian Gulf coast location for September 1998 from the following data:

PRODUCT	MARKET	AVERAGE PRICE, $/TON	BARRELS PER TON	SPECIFIC GRAVITY
NAPHTHA	AG	143.55	9.00	0.699
NAPHTHA	NWE	157.23	8.90	0.707
MOGAS REG, 91	NWE	169.34	8.46	0.744
MOGAS PREM, 95	NWE	174.67	8.46	0.755

Price quotations for gasoline grades in the Arabian Gulf Markets are not available as gasolines are not traded in this market.

Gasoline prices for Arabian Gulf locations are, therefore, calculated from NWE quotes as follows:

$$\begin{aligned}\text{MOGAS (RON 91)} &= \text{Arabian Gulf naphtha price} + (\text{NWE,}\\ &\quad \text{regular unleaded price} - \text{NWE naphtha price})\\ &= [143.55 + (169.34 - 157.23)]\\ &= \$155.66/\text{ton}\\ \text{MOGAS (RON 95)} &= \text{Arabian Gulf naphtha price} + (\text{NWE premium}\\ &\quad \text{unleaded price} - \text{NWE naphtha price})\\ &= [143.55 + (174.67 - 157.23)]\\ &= \$160.99/\text{ton}\end{aligned}$$

EXAMPLE 14-4, REFORMATE 96 RON PRICING

Calculate the price of catalytic reformate (RON 96) from the regular and premium gasoline prices for the Arabian Gulf market, calculated in the preceding example.

Reformate 96 prices are estimated on the basis of RON parity with premium and regular gasolines blends:

PRODUCT	RON	vol fraction	SG	wt%	PRICE, $/ton
MOGAS REG	91	−0.2500	0.744	−24.5	155.66
MOGAS PREM	95	1.2500	0.755	124.5	160.99
REFORMATE	96	1.0000	0.758	100.0	162.29

EXAMPLE 14-5, LIGHT CAT NAPHTHA

Calculate the price of light cat naphtha from the FCCU unit, with following properties:

$$\text{RON} = 92.8$$

$$\text{Specific gravity} = 0.788$$

$$\text{Barrels/ton} = 7.985$$

As in the case of reformate, the light cat naphtha prices are estimated on the basis of RON parity with premium and regular gasoline blends as follows:

PRODUCT	RON	vol fraction	SG	wt%	PRICE, $/ton
MOGAS 91	91.0	0.5500	0.744	0.5460	155.66
MOGAS 95	95.0	0.4500	0.755	0.4540	160.98
LIGHT CAT NAPHTHA	92.8	1.0000	0.749	1.0000	158.06

This price is for a product with a specific gravity of 0.749 and it must be corrected for the specific gravity of the required product:

$$\text{The corrected Light Cat Naptha (LCN) price} = 158.06 \times (0.749/0.788)$$
$$= \$150.28/\text{ton}$$

GAS OIL PRICING

Gas oil pricing is done on the basis of cloud point parity; then, correction is applied for specific gravity and sulfur, if required.

EXAMPLE 14-6

Estimate the price of winter grade gas oil (NWE market) with the following properties:

$$\text{Cloud point} = -7°\text{C}$$
$$\text{Specific gravity} = 0.8330$$
$$\text{Sulfur} = 0.19 \text{ wt\%}$$

PRODUCT	CLOUD POINT, °C	CLOUD POINT, °F	CLOUD POINT INDEX[1]	wt fraction	SULFUR	SG	PRICE, $/ton, NWE
KEROSENE	−50	−58	1.15	0.5516	0.10	0.783	155.28
GAS OIL	5	41	38.52	0.4484	0.50	0.845	142.20
NWE GAS OIL	−7	19.4	17.91	1.0000	0.28	0.811	149.42

$$\text{Specific gravity correction} = 149.42 \times (0.811/0.833)$$
$$= \$145.43/\text{ton}$$

Sulfur correction is applied next. This is based on market quotes published on the gas oil sulfur differential ($/% sulfur) for the period in question:

$$\text{Sulfur differential} = 2.4/\text{per percent Sulfur}$$
$$\text{Sulfur correction} = (0.28 - 0.19) \times 2.4$$
$$= 0.22 \ \$/\text{ton}$$
$$\text{Gas oil price} = \$149.42 + 0.22$$
$$\text{NWE with Sulfur correction} = 149.64 \ \$/\text{ton}$$
$$\text{NWE GAS oil price with S.G correction} = 149.64 \times \frac{0.811}{0.833}$$
$$= 145.69 \ \$/\text{ton}$$

PRICING FUEL OILS

Fuel oil pricing is done on viscosity parity basis with a blend of 180 cst, 3.5% sulfur fuel oil and diesel. The prices of these reference fuel oil grades and diesel are available from market quotes.

EXAMPLE 14-7

Estimate the price of 350 cst and 4% sulfur fuel oil on the basis of Arabian Gulf market prices:

Fuel oil sulfur = 4%

Fuel oil viscosity = 380 cst at 50°C.

PRODUCT	VISCOSITY, cst	VISCOSITY BLEND INDEX[2]	wt fraction	SULFUR, wt%	PRICE, $/ton
GAS OIL	2.5	13.55	−0.09	0.50	142.2
FUEL OIL	180	34.93	1.09	3.5	78.01
FUEL OIL	380	36.88	1.00	3.77	72.17

The sulfur differential is based on Mediterranean and Singapore market quotes for a differential between 3.5% and 1.0% sulfur fuel oils:

$$\text{Sulfur differential} = 5.199\ \$/\text{per}\ \%\ \text{sulfur}$$

$$\text{Sulfur correction} = 5.199 \times (4.0 - 3.77) = \$1.18/\text{ton}$$

$$\text{Fuel oil price, after sulfur adjustment} = 72.17 - 1.18 = 70.99\ \$/\text{ton}$$

PRICING VACUUM GAS OILS

Vacuum gas oil (VGO) can be considered a blend of 180 cst, 3.5% fuel oil and diesel to match the viscosity and sulfur of the VGO.

EXAMPLE 14-8

Calculate the price of desulfurized heavy vacuum gas oil (HVGO) from the distillate hydrocracker (bleed stream) with following properties:

$$\text{Viscosity at } 50°\text{C, cst} = 12.7$$
$$\text{Sulfur, wt\%} = 0.15$$

PRODUCT	VISCOSITY, cst	VISCOSITY BLEND INDEX	wt fraction	SULFUR, wt%	PRICE $/ton
GAS OIL	2.5	13.55	0.470	0.50	142.20
FUEL OIL	180	34.93	0.530	3.50	78.01
VACUUM GAS OIL	12.7	24.88	1.000	2.089	108.20

$$\text{Sulfur differential} = \$5.199/\%\ \text{sulfur}$$
$$\text{Sulfur adjustment} = 5.199 \times (2.089 - 0.15)$$
$$= \$10.08/\text{ton}$$
$$\text{Final VGO price} = \$118.28/\text{ton}$$

PRICING CUTTER STOCKS FOR FUEL OILS

A typical pricing basis for cutter stocks is viscosity parity or with a blend of kerosene and diesel.

EXAMPLE 14-9

Calculate the price of cutter stock with 1.22 cst viscosity at 50°C for fuel oil blending on the basis of kerosene and diesel properties that follow:

PRODUCT	VISCOSITY, cst	VISCOSITY BLEND INDEX	wt fraction	SULFUR, wt%	PRICE $/ton
KEROSENE	1.0	3.25	0.750	0.20	155.28
DIESEL	2.5	13.55	0.250	0.50	142.20
CUTTER STOCK	1.22	5.85	1.000	0.28	151.97

The reference prices for diesel and kerosene used here are the market quotes. Here, the price is computed for a cutter viscosity of 1.22 cst.

COST OF ENERGY

Energy is a major cost item in any refinery. Energy may be used in many forms, such as natural or associated gas used as refinery fuel, steam generated in the refinery, distilled and cooling water, and electricity or feed to the hydrogen plant.

The energy cost is usually derived from the cost of heavy fuel oil (380 cst and 3.5% sulfur) as per the Mean of Platts (MOP) published price at any reference time. The calorific value of this grade is around 38 million Btu per ton. The cost of energy-intensive utilities, such as electricity, steam, cooling water, or distilled water, is a function of the energy cost and can be expressed as follows:

UTILITY	UNIT	COST, $/UNIT
ELECTRICITY	kWhr	$A \times E + B$
STEAM	mmBtu	$C \times E + D$
COOLING WATER	m^3	$K \times E + L$
DISTILLED WATER	m^3	$M \times E + N$

m^3 = METER CUBE.

where E is the energy cost per million Btu and A, B, C, D, K, L, and the like are constants.

For example, if the heavy fuel oil price is $76/ton, the corresponding energy cost would be 76/38 or $2.0/million Btu.

The values of the constants can be derived from the refinery's operating data over a period of time.

ASSIGNED CRUDE YIELDS

A refinery may process more than one crude oil at a time. The crude may be received under a netback or similar agreement, in which the refiner pays the crude supplier the gross product worth of the product produced and receives only a processing fee plus a premium. Therefore, it becomes necessary to determine the yield of the products from a crude before the gross product worth of a crude can be determined.

If the refinery is processing only one crude received under netback agreement, the determination of yields from the crude is determined simply from refinery stock balance. However, the refinery may be processing more than one crude at the same time and one of the crudes processed is received under netback arrangement. The determination of the actual yield from the netback crude in the refinery is complicated. To determine the yields, a crude received by refinery under netback or similar arrangement is called an *assigned crude.*

DETERMINATION OF ASSIGNED CRUDE YIELDS

Single-Ownership Refineries

In a single-ownership refinery, the assigned crude yield is determined as follows (the steps are shown in Table 14-2):

1. Two separate LP models are set up for simulating processing of assigned and other crudes processed in the refinery. Only the balancing-grade products, no fixed-grade products, are produced. Also, no drawdown or buildup of process stocks is allowed in the LP. Identical product prices of balancing grade are used to drive the two LP models.
2. The maximum available processing unit capacities to be used in the assigned crude LP model is determined from the "assigned crude ratio" (assigned crude/total refinery crude) and the refinery's maximum available processing unit capacities. For example, if the assigned crude ratio is 0.6 and the total crude unit capacity of the refinery is 100 mbpd, the crude unit capacity to be used in the assigned crude LP model is (100 × 0.6) or 60 mbpd. The remaining CDU capacity (i.e., 40 mbpd) is used in the second LP model, processing the other crude. Downstream processing unit capacities

Table 14-2
Assigned Crude Yields

GRADES	ARAB CRUDE LP PRODUCT	BAHRAIN CRUDE LP PRODUCT	TOTAL LP* PRODUCT	REFINERY PRODUCTION	INITIAL DELTA	DELTA OFFSET	NET DELTA	DELTA CRUDE RATIO	YIELD FROM ARAB CRUDE	% VOL/ VOL YIELD
	(1)	(2)	(3 = 1 + 2)	(4)	(5 = 4 − 3)	(6)	(7 = 5 + 6)	(8)	(9 = 1 + 8)	(10)
I-150	19115	0	19115	3753	−15362	−86	−15447	−12758	6357	0.10%
I-201	77502	0	77502	59656	−17846	−100	−17946	−14822	62681	1.02%
I-210	1042001	197199	1239200	1230148	−9052	−51	−9102	−7517	1034483	16.89%
I-397	300496	52811	353307	534659	181352	−1013	180339	148942	449438	7.34%
I-440	686546	117938	804484	1227704	423220	−2363	420857	347586	1034132	16.89%
I-888	2385691	576836	2962526	2476700	−485826	−2713	−488539	−403485	1982206	32.37%
I-961	1576524	337949	1914473	1844702	−69771	−390	−70161	−57946	1518579	24.80%
TOTAL	6087875	1282732	7370607	7377322	6715	−6715	0	0		99.41%
CRUDE	6124230	1291296	7415526						6124230	

NOTES:

CRUDE	BARRELS
LIGHT ARAB CRUDE	6,124,230
BAHRAIN CRUDE	1,291,296
TOTAL REFINERY CRUDE	7,415,526

ASSIGNED CRUDE RATIO (ARAB) = 0.8259.
COLUMN 7 = (−1)*(*ABSOLUTE VALUE OF COLUMN 6/SUM OF ABSOLUTE VALUES OF DELTAS IN COLUMN 6*)**SUM OF COLUMN.*
COLUMN 8 = COLUMN 6 + COLUMN 7.
COLUMN 9 = COLUMN 8 × *CRUDE RATIO.*
WHERE CRUDE RATIO = ASSIGNED CRUDE/TOTAL REFINERY CRUDE.
SUM OF ABSOLUTE VALUES OF DELTAS 1202429.
*LP = LINEAR PROGRAM.

are similarly split between the two LP models for processing the two crudes.

3. The models are run to determine the balancing grade product yields. The LP optimizes the production of balancing grades on the basis of their prices.
4. The balancing grade production is adjusted to reflect unaccounted losses. The total unaccounted losses are determined as a certain percentage of crude processed. A figure of 0.6% by volume may be used if no refinery data are available. These losses are spread over the balancing grades in the ratio of their production.
5. The revised LP products are adjusted to reflect the actual refinery blending. The adjustment factors (initial deltas) are established by deducting the sum of the revised LP production from the total refinery production (expressed in balancing grades by means of product equivalencies).
6. Ideally, the sum of initial deltas should equal zero, which in practice is not so. The sum of the initial deltas is distributed over all balancing grades in the ratio of their production disregarding their signs; that is, (absolute value of initial delta)/(sum of absolute values of initial deltas). This factor, called the *delta offset*, is deducted from the initial delta to get the net delta.
7. The net deltas established are multiplied by the assigned crude ratio and added to the revised (assigned crude) LP products to determine the overall assigned crude yield.

Joint-Ownership Refineries

In joint-ownership refineries, the assigned crude yield is determined as follows (Table 14-3 shows various steps):

1. An LP model simulating the assigned crude processing is set up containing the actual unit yields, unit capacities, and so forth available for processing the assigned crude. The driving force behind the model is the mean value of Platts (MOP) product prices for the products that prevailed during the month.
2. The maximum available processing unit capacities to be used in the LP model for processing assigned crude are determined from the assigned crude ratio (assigned crude/total refinery crude) and maximum available processing unit capacities. For example, if the assigned crude ratio is 0.6 and the total crude unit capacity of the

Table 14-3
Assigned Crude Yields

GRADES	AOC LP PRODUCT	BOC LP PRODUCT	TOTAL LP PRODUCT FROM L.ARAB	%	LESS 0.6% CRUDE	REVISED LP PROD. YIELD	TOTAL RETROSPECTIVE DOP	TOTAL ALLOCATED PRODUCTION	INITIAL DELTA	%	DELTA OFFSET*	NET DELTA	DELTA* CRUDE RATIO	TOTAL REVISED LP PRODUCTS	LIGHT ARAB CRUDE YIELDS	CRUDE, %
	(1)	(2)	(3 = 1 + 2)	(4)	(5)	(6 = 3 − 5)	(7)	(8)	(9 = 8 − 7)	(10)	(11)	(12 = 9 + 11)	(13)	(6)	(14 = 13 + 6)	(15)
I-150	19230	0	19230	0.31%	115	19115	3161	3753	0	0	0	0	0	19115	19115	0.31%
I-201	0	77970	77970	1.27%	468	77502	316228	59656	−256572	16.59%	−3618	−260190	−214891	77502	−137389	−2.24%
I-210	928560	119730	1048290	17.12%	6289	1042001	976069	1230148	254079	16.43%	−3583	250496	206885	1042001	1248886	20.39%
I-397	194100	108210	302310	4.94%	1814	300496	521905	534659	12754	0.82%	−180	12574	10385	300496	310881	5.08%
I-440	550620	140070	690690	11.28%	4144	686546	825186	1227704	402518	26.02%	−5677	396842	327751	686546	1014297	16.56%
I-888	1921110	478980	2400090	39.19%	14399	2385691	2982594	2476700	−505894	32.71%	−7135	−513029	−423710	2385690	1961980	32.04%
I-961	1315830	270210	1586040	25.90%	9516	1576524	1729774	1844702	114928	7.43%	−1621	113307	93580	1576524	1670104	27.27%
TOTAL	4929450	1195170	6124620	100.00%	36745	6087875	7354917	7377322	21814	100.00%	−21814	0	0	6087874	6087874	99.41%

NOTES:

CRUDE	PARTICIPANT AOC	PARTICIPANT BOC	TOTAL, bbl
LIGHT ARAB	4924230	1200000	6124230
BAHRAIN	1291296		1291296
TOTAL REFINERY	6215526	1200000	7415526

ASSIGNED[1] (LIGHT ARAB) CRUDE RATIO = 0.8259
SUM OF ABSOLUTE TOTAL DELTAS 1546746
ASSIGNED CRUDE RATIO IS THE RATIO OF CRUDE PROCESSED UNDER ASSIGNED CRUDE AGREEMENT TO TOTAL REFINERY CRUDE.
*DELTA OFFSET (COLUMN 11) = SUM OF COLUMN 9 MULTIPLIED WITH (COLUMN 10) AND (−1).

refinery is 100 mbpd, the crude unit capacity to be used in the LP model is (100×0.6) or 60 mbpd. Downstream processing unit capacities are similarly determined.

3. The model is run to determine the balancing-grade production yields. The balancing grade production is adjusted to reflect unaccounted losses. The total unaccounted losses are determined as a certain percentage of crude processed. A figure of 0.6% by volume may be used if no refinery data are available. These losses are spread over the balancing grades in the ratio of their production.
4. The revised LP products are adjusted to reflect the actual refinery blending. The adjustment factors (initial deltas) are established by deducting the balancing grade equivalents of the "retrospective definitive operating program (DOP)"[3] production from the total refinery "allocated production" (expressed in balancing grades).
5. As described earlier, the sum of initial deltas should equal zero, which in practice is not so. The sum of the initial deltas is distributed over all balancing grades in the ratio of their production, disregarding their signs; that is, (absolute value of initial delta)/(sum of absolute values of initial deltas). This factor, called the *delta offset*, is deducted from the initial delta to get the net delta.
6. The net deltas established are multiplied by the assigned crude ratio and added to the revised LP products to determine the overall assigned crude yield.

NOTES

1. For the cloud point index for blending on a weight basis, refer to Table 11-15.
2. Based on weight based viscosity blend index I,

$$I = 23.097 + 33.468 \log_{10} \log_{10}(v + 0.8)$$

where v = viscosity in centistokes (refer to Table 11-13).

3. Refer to Chapter 16, "Product Allocation" for procedures to determine the retrospective DOP and allocated production.