BUBBLE POINT AND FORMATION VOLUME FACTOR CORRELATION FOR NIGER-DELTA WELLS

BY

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CERTIFICATION

This is to certify that this project was carried out by AYILEYE DAYO E., in partial fulfillment for the award of Bachelor of Science degree in the department of Petroleum Engineering, University of Ibadan.

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DEDICATION

This work is dedicated to God and to my Late Father, Captain G.A. AYILEYE.

ACKNOWLEDGEMENT

I sincerely appreciate the effort of my Supervisor in setting me in the right path.

A big thank you to my Lecturers, for they all imparted me with knowledge and skills needed to be a sound Petroleum Engineer.

To my mother, thank you for helping me out on those days I could not do it all by myself and you supported me.

To the Akadi family thank you for every effort in my last years in University.

To all my close and important friends, Ife, Basit, Emmanuel and Titi. Thank you.

Lastly to my brothers, I would not replace you all for anything, you made everything worth it.

ABSTRACT

The knowledge of reservoir fluid physical property values constitute an integral part of the data required for comprehensive study of the reservoir and for optimal design of oil recovery and production schemes. The knowledge of bubble point pressures and formation volume factor is as such, very important in reserve estimation and other petroleum engineering calculations such as modeling fluid flow in porous medium or multiphase flow in pipe. When laboratory PVT analysis is not readily available, empirical Pressure-Volume-Temperature (PVT) correlations becomes the best alternative to property estimation. The drawback in PVT correlations is the geologic conditions represented by the data used to develop the correlation, hence the accuracy of a PVT model varies from region to region.

In this study correlations for bubble point pressure and formation volume factor were developed specifically for the Niger-Delta crude oils using non-linear multiple regression and ridge linear regression in python machine learning modules respectively. The developed correlations are as follow

$$\boldsymbol{P_b = a * T^b * RS^c * \gamma_{API}{}^d * \gamma_g{}^e}$$

$$\boldsymbol{Bo = a_1 * RS + a_2 * T + a_3 * \frac{\gamma_{API}}{\gamma_G} + (a_4 * RS^2) + (a_5 * T^2) + \left\{a_6 * \left(\frac{\gamma_{API}}{\gamma_G}\right)^2\right\} + \left(a_7 * \frac{\gamma_{API}}{\gamma_G} * RS\right)) + a_8 * \frac{\gamma_{API}}{\gamma_G} * T) + a_9}$$

With P_b and B_o meaning Bubble Point Pressure and Formation Volume Factor respectively. The correlations were compared to other pre-existing correlations using statistical error metrics and the results obtained shows that the new correlations outperforms pre-existing correlations.

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NOMENCLATURE

P_b – Bubble point pressure (psia)

B_o –Oil Formation Volume Factor (bbl/stb)

R_S – Solution gas –oil ratio (SCF/STB)

γ_{API} – API gravity of oil

γ_g – specific gravity of gas.

T- Reservoir Temperature (R)

f- Function of

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CHAPTER ONE

INTRODUCTION

1.1 OVERVIEW

Solutions to reservoir performance problems at various stages of reservoir life require the knowledge of the physical properties of reservoir fluid at elevated pressure and temperature. The Pressure, Volume, Temperature (PVT) properties for reservoir hydrocarbon mixtures are usually obtained from laboratory analysis on a preserved or a recombined sample of reservoir fluid.

This analysis consists of series of laboratory procedures designed to provide the values of the reservoir fluid properties required in Material balance calculations, well test analysis, reserves estimates, inflow performance calculations and numerical reservoir simulation. Standard reservoir PVT fluid studies are designed to simulate the simultaneous fluid flow of oil and gas from the reservoir to the surface, this is simulated in the laboratory at reservoir temperature.

During this process the bubble point pressure (P_b) is measured, the oil volumes and the amount of gas released are measured and used to determine oil FVF (Bo) and solution GOR as a function of pressure, these properties (P_b, B_o) alongside solution gas-oil ratio (R_s) are important requirements for the planning of oilfield development strategies, evaluate reservoir performance so as to optimize the recovery factor and to design surface facilities.

Over the years, many correlations and empirical models from artificial neural networks, fuzzy logic, genetic programming, were developed to estimate these properties since the laboratory and experimental procedures needed to determine this values are not readily available and it is necessary for the engineer to make an estimate of this crude oil property from the readily available measured producing parameters. Several graphical and mathematical correlations for determining these properties have been proposed during the last four decades.

1.2 BASIC CONCEPTS

Correlation

Mutual relationship between two or more variables which tend to vary when associated. A correlation is an equation or method fit to specific data groups to provide the relationship between dependent and independent variables. Properly defined, the variables cover a wide range of conditions, enabling the correlation to properly represent the physical processes being modeled.

Formation Volume Factor

The oil formation volume factor, Bo, is defined as the ratio of the volume of oil (plus the gas in solution) at the prevailing reservoir temperature and pressure to the volume of oil at standard conditions. Bo is always greater than or equal to unity. The oil formation volume factor can be expressed mathematically as:

$Bo = \frac{(Vo)p,T}{(Vo)sc}$……………equation 1.0

Where Bo = oil formation volume factor, bbl. /STB.

$(Vo)_{p,\,T}$ = volume of oil under reservoir pressure p and temperature T, bbl.

(Vo) sc= volume of oil is measured under standard conditions, STB

A typical oil formation factor curve, as a function of pressure for an under saturated crude oil ($P_i > P_b$), is shown in figure 1. As the pressure is reduced below the initial reservoir pressure P_i, the oil volume increases due to the oil expansion. This behavior results in an increase in the oil formation volume factor and will continue until the bubble-point pressure is reached. At P_b, the oil reaches its maximum expansion and consequently attains a maximum value of Bob for the oil formation volume factor. As the pressure is reduced below P_b, volume of the oil and Bo are decreased as the solution gas is liberated. When the pressure is reduced to atmospheric pressure and the temperature to 60°F, the value of Bo is equal to one.

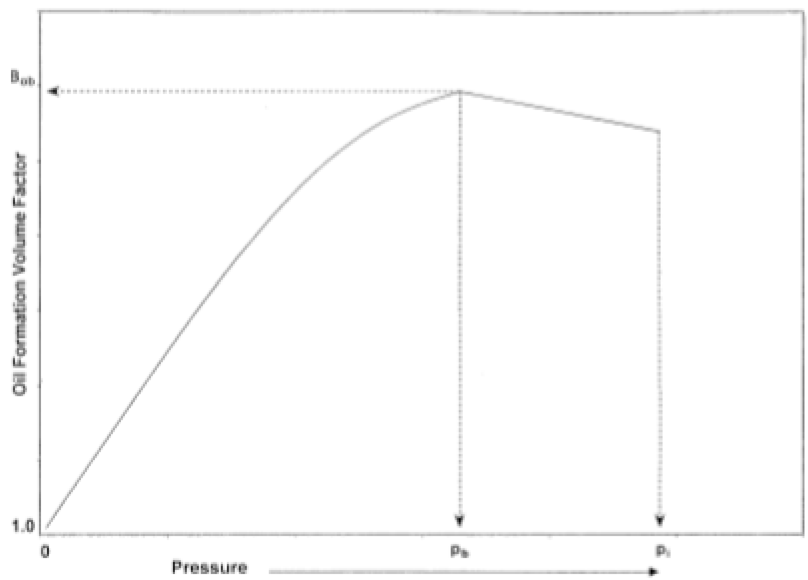

Figure 1

The gas formation volume factor is used to relate the volume of gas, as measured at reservoir conditions, to the volume of the gas as measured at standard conditions, i.e., 60°F and 14.7 psia. This gas property is then defined as the actual volume occupied by a certain amount of gas at a specified pressure and temperature, divided by the volume occupied by the same amount of gas at standard conditions.

In an equation form, the relationship is expressed as $Bg = \frac{V\ p,T}{Vsc}$……….equation 1.1

Where B_g = gas formation volume factor, ft3/scf

$V_{p,T}$ = volume of gas at pressure p and temperature, T, ft3

Vsc = volume of gas at standard conditions, scf.

The oil formation volume factor (FVF) is the ratio of the specific volume of oil at its natural temperature and pressure to the specific volume of the oil at standard conditions (i.e. P = 1 atm and T = 60 ˚F). If B_o is measured in the bubble point condition, it will be the bubble point oil formation volume factor (B_o).

Bubble Point Pressure

The bubble-point pressure "P_b" of a hydrocarbon system is defined as the highest pressure at which a bubble of gas is first liberated from the oil.

In a hydrocarbon system at constant temperature, whether single-component or mixture, the bubble point pressure is the maximum pressure at which the first gas bubbles appear. The state of the system in this condition is called "saturated liquid".

General Characteristics of Niger-Delta Crude Oil

Most of the petroleum production activities in Nigeria occur from the Niger Delta Basin and both crude from offshore and the Niger delta are characterized by very low non-hydrocarbon content. Sulphur content hardly exceeds 0.5%, if at all present, and the nitrogen/carbon dioxide content is usually below 1%. Hence, the Nigerian crude is termed sweet because of the low Sulphur content. Nigeria crudes are light, that is, they have low densities and contain much of the light ends of crude oil assay

1.4 PROPERTY ESTIMATION

The bubble point and the formation volume factors can be estimated experimentally in the laboratory through the constant-composition expansion test and differential liberation tests respectively.

1.5 PROBLEM STATEMENT AND OBJECTIVE OF STUDY

The bubble point pressure and formation volume factor as earlier stated are very important properties in the planning of oilfield development strategies, evaluating reservoir performance so as to optimize the recovery factor and to design surface facilities. The reservoir engineer needs these parameters however they can be only determined after test has been carried out in the laboratory. This project aims to develop a correlation that predicts the Bubble point pressure and formation volume factor of crude oil samples from the physical properties of the crude oil sample.

In fact, the main aim of this project is to provide simple and accurate models for prediction of bubble point pressure (P_b) and bubble point formation volume factor (B_o) solely as functions of simple and quickly accessible live crude oil parameters. The parameters are temperature (T), solution gas-oil ratio (R_s), oil API gravity and gas specific gravity (γ_g).

1.5 JUSTIFICATION OF STUDY

There have been several published formulas and correlation to determine these properties with few of them specifically meant for the Niger-Delta, however this study aims develop a correlation that would be used to predict the Bubble point pressure and Formation volume factor for Niger-Delta crude oil.

CHAPTER TWO

LITERATURE REVIEW

Petroleum reservoir fluid parameters are of great importance in any typical reservoir study. These properties are of great importance in characterizing the various properties of the reservoir.

Traditionally characterizing reservoir fluid demands voluminous PVT data from laboratory experiments, filed experiments and improved PVT analysis carried out on the different fluids. More often the routine laboratory test is extensively conducted to characterize reservoir hydrocarbon fluids. However over the years various correlations have been developed to predict these PVT properties as laboratory tests are usually expensive and sometimes difficult and time-consuming. However, the application of correlations is economically advantageous and increases the speed of works. Furthermore, the other great use of the correlations is to determine oil future specifications and changes taken into great consideration in reservoir simulators.

Pressure-Volume-Temperature (PVT) correlations are hence very important in reservoir engineering. These measurements form the basis for estimating the amount of oil in the reservoir, production capacity and variations in produced gas/oil ratios during the reservoir's production life. PVT relations are also a requirement for calculating the recovery efficiency of a reservoir. (Glaso 1980).

There are several correlations and methodologies developed and proposed so far for prediction bubble-point pressure and formation volume factor. Methods of Standing (1947), Vasquez and Beggs (1980), Glaso (1980), Marhoun (1988) and Petrosky and Farshad (1993). Most of this correlations developed require use of production data such as oil gravity, gas gravity, reservoir temperature, producing GOR. For several years, these correlations were the only source available for estimating PVT properties when experimental data were unavailable. In the last 20 years there has been an increasing interest in developing new correlations for crude oils obtained from various regions in the world.

However in recent years with the advancement in computational speed and power , the relationship to these properties are been determined using various programming language and algorithm Artificial neural network (ANN), generalized regression neural networks (GRN), imperialist competitive algorithm (ICA), particle swarm optimization (PSO), adaptive network-based fuzzy inference system (ANFIS), genetic programing (GP).

In 1942, Katz published a graphical correlation for predicting Bo. Katz used U.S. midcontinent crude to develop his correlations. The graphical correlation uses reservoir temperature, pressure, solution gas/oil ratio (GOR), oil gravity, and gas gravity. The correlations were presented only in graphical form and were hard to use because they required the use of graphs and calculations in combination.

In 1947, Standing published his correlations for P_b and for B_o. The correlations were based on laboratory experiments carried out on 105 samples from 22 different crude oils in California, U.S.A. The correlations treated the P_b and the B_o as a function of the reservoir temperature, GOR, oil gravity, and gas gravity. Standing’s correlations were the first to use these four parameters, which now are commonly used to develop correlations. In fact, these correlations are the most widely used in the oil industry.

Lasater in 1958 presented a new correlation model based on 158 samples from 137 reservoirs in Canada, the U.S., and South America. His correlation was only for P_b. It is based on standard physical chemical equations of solutions. It uses Henry’s law constant and the observation that the bubble point ratio at different temperatures is equal to the absolute temperatures ratio for hydrocarbon systems not close to the critical point. The correlation was presented in graphical form and was used as a lookup chart. An advantage of Lasater's correlation is the wide variety of data sources used to develop the correlation.

In 1972, Cronquist presented a ratio correlation based on 80 data points from 30 Gulf Coast reservoirs. The correlation is useful for the analysis of depletion-drive reservoirs when PVT analysis is not available. The method was presented in graphical form and requires an estimation of average reservoir properties.

In 1976, Vazquez and Beggs published correlations for GOR and Bo. They started categorizing oil mixtures into two categories, above 30ºAPI gravity and below 30ºAPI gravity. They also pointed out the strong dependence on gas gravity and developed a correlation to normalize the gas-gravity measurement to a reference separation pressure of 100 psi. This eliminated its dependence on separation conditions. More than 6,000 data points from 600 laboratory measurements were used in developing the correlations.

Glaso in 1978 developed correlations for P_b, formation volume factor, GOR, and oil viscosity for North Sea hydrocarbon mixtures. The main feature of Glaso's correlations is that they account for paraffinicity by correcting the flash stock-tank-oil gravity to an equivalent corrected value with reservoir temperature and oil viscosity. They also account for the presence of nonhydrocarbons on saturation pressure by using correction factors for the presence of Co_2, N_2, and H_2S in the total surface gases. A total of 45 oil samples, most of which came from the North Sea region, were used in the development of these correlations.

In 1987, Obomanu and Okpobori presented new correlations for predicting GOR and B_o for Nigerian crude oils. They used 503 data points from 100 Nigerian reservoirs in the Niger Delta basin. They used Al-Marhoun's P_b correlation model form and modified Standing's Bo correlation model form. In addition, they developed new correlation coefficients for Nigerian crude oils. The Bo correlation divided the crude oils into two ranges according to oil gravity.

In 1988, Al-Marhoun published new correlations for estimating P_b and B_o for Middle East oils. A total of 160 data sets from 69 Middle Eastern reservoirs were available for the correlation development. Al-Marhoun's correlations were the first to be developed for Middle East reservoirs.

In 1988, Abdul-Majeed and Salman published a Bo correlation based on 420 data sets from unpublished sources. The form of the correlation is Al-Marhoun's B_o correlation with new calculated coefficients. Al-Fattah and Al-Marhoun reported that 259 data sets used by Abdul-Majeed and Salman are from Vazquez's MS thesis. A total of 256 data sets were found as reported by Al-Fattah and Al-Marhoun.

In 1989, Asgapur et al. published a new set of correlations for different geological reservoirs of western Canadian gases and crude oils. Correlations for P_b, GOR at and below the P_b, and B_o at and below the P_b were developed for four geological reservoirs. The new approach of developing correlations for a specific geologic time was justified by the varying behaviors of western Canadian reservoirs. However, little detail was presented concerning the crude oil differences. The new correlations used Al-Marhoun's P_b correlation form and developed a new form for Bo. The new approach resulted in less average error than the Standing, Lasater, and Vazquez and Beggs correlations for all geologic reservoirs studied.

Labedi in 1990 published new correlations for B_o, oil density, and fluid compressibility for African crude oils. Labedi's correlations eliminate the need for gas gravity and total GOR by using the separator pressure and temperature. A total of 97 data sets from Libya, 28 sets from Nigeria, and four from Angola were available for the study. The correlations substitute the gas gravity and total GOR, which are very unlikely to be measured in the field, with separation GOR, temperature, and pressure, as these are reported in field tests.

Dokla and Osman in 1992 published a new set of correlations for estimating P_b and B_o for United Arab Emirates crudes. They used 51 data sets to calculate new coefficients for Al-Marhoun's 1988 Middle East correlations. Al-Yousef and Al-Marhoun pointed out that the Dokla and Osman P_b correlation performance found contradicting physical laws, as the P_b is decreasing with temperature and is insensitive to oil-gravity changes. The data used in calculating the coefficients were insufficient to obtain an empirical correlation.

In 1992, Al-Marhoun published a second correlation for B_o. The correlation was developed with 11,728 experimentally obtained formation volume factors at, above, and below P_b. The data set represents samples from more than 700 reservoirs worldwide, mostly from the Middle East and North America.

In 1992, Farshad et al. produced a new set of correlations for P_b, GOR, and B_o. They used the number of surface-separator stages as a criterion for developing the correlations. The main feature of the new correlation is that it uses separator gas gravity and GOR instead of the totals, and corrects them for separation temperature and pressure. Reservoir samples from 98 Colombian reservoirs were available for the study. The new correlations used Standing's and Glaso's correlation forms and calculated new coefficients for them. The correlations for a single-stage separation process were considered for this study. The proposed correlations based on corrected separator data are more realistic because the stock-tank-gas gravity and GOR are seldom measured in the field.

In 1992, Macary and El-Batanoney presented new correlations for P_b, B_o, and GOR. 90 data sets from 30 independent reservoirs in the Gulf of Suez, Egypt, were used to develop the correlations. The new correlations were tested against other Egyptian data of Saleh et al., and showed improvement over published correlations.

Omar and Todd in 1993, based on work similar to Standing's Bo correlation model, calculated a modified set of correlation coefficients. Omar and Todd also developed a P_b correlation that uses the Bo in addition to oil gravity, gas gravity, GOR, and reservoir temperature. The new correlation was based on 93 data sets from Malaysian oil reservoirs. An estimated Bo from the developed correlation can be used for bubble point prediction if it is not measured.

In 1993, Petrosky and Farshad developed new correlations for Gulf of Mexico crudes. Standing correlations for bubble point pressure, solution gas oil ratio, and oil formation volume factor were taken as a basis for developing the new correlation coefficients. Vazquez & Beggs oil compressibility correlation model was used as a basis for oil compressibility correlation. The approach that Petrosky and Farshad applied to develop the correlations was to give the original correlation model maximum flexibility through nonlinear regression to achieve the best empirical relation the model can achieve through the available data set. The maximum flexibility allows each variable to have a multiplier and exponent. The original model fixes multipliers and exponents of some of the variables to one. Ninety data sets from Gulf of Mexico were used in developing these correlations

In 1994, Kartoatmodjo and Schmidt used a global data bank to develop new correlations for all PVT properties. Standing correlation models were taken as basis for bubble point pressure and solution gas oil ratio correlations. Vazquez & Beggs oil formation volume factor correlation was considered the basis for oil formation volume factor correlation. Data from 740 different crude oil samples gathered from all over the world provided 5392 data sets for the correlation development. These correlations and Al-Marhoun (1992) oil formation volume factor correlation are the only correlations that used global data for development. In addition to the global data gathered for the study, a separate data set collected from literature was used to verify the final results of the correlation models developed and compare them with published correlations. The approach used in the development of the new correlations is similar to Petrosky and Farshad’s approach in providing the maximum flexibility to the base models to reach the best empirical relation for the available data.

In 1997, Almehaideb published a new set of correlations for UAE crudes. He used 62 data sets from UAE reservoirs to develop the new correlations. Correlations developed are for bubble point pressure, oil formation volume factor, oil viscosity, and oil compressibility. The bubble point pressure correlation like Omar and Todd uses the oil formation volume factor as input in addition to oil gravity, gas gravity, solution gas oil ratio, and reservoir temperature. Improvement over published correlations was achieved with these correlations.

2.1 METHODS OF ESTIMATION

From the review of the developed methods, it is quite clear that several methods have been developed to estimate the discussed parameters both mathematically and computationally. However it is only normal that some methods have been accepted globally or regionally as the case may be over some methods.

The most common mathematical correlation for estimating formation volume factor and bubble point pressure are:

i. **STANDING:** standings correlation was developed in 1947 with the use of 106 data points from samples from California oil fields in USA, the samples had a temperature range of 100-256 ºF, API range of 16.5-63.8 and a gas gravity range of 0.59-0.95. The correlating parameters were gas solubility, gas gravity, oil gravity and temperature. The resulting correlation was reported with an average error of 1.17% for the FVF correlation and an average error of 4.8% for the bubble point pressure correlation

The formation volume factor correlation is given as

$$B_0 = 0.972 + 1.472e^{-4}[R_s\left(\frac{\gamma_g}{\gamma}\right)^{0.5} + 1.25T]^{1.175} \text{.......Equation 2.0}$$

The graphical bubble point pressure correlation is given as

$$P_b = 18.2[\left(\frac{R_s}{\gamma_g}\right)^{0.83}(10)^a - 1.4] \text{....... Equation 2.1}$$

$$a = 0.00091(\mathrm{T} - 460) - 0.0125(\mathrm{API}) \text{.......... Equation 2.2}$$

ii. **VASQUEZ AND BEGGS:** the correlation was developed in 1980. The correlation in terms of bubble point was derived from a worldwide sample origin with a temperature range of 75-294 ºF, gas gravity range of 0.511-1.35 , API range of 15.3-59.3 and the use of 6004 data points , the values of B_O ranged from 1.028-2.226. The correlation like Standings was in terms of gas solubility, gas gravity, oil gravity and temperature. The correlation was gotten using linear regression technique.

The formation volume factor correlation is given as:

$$B_0 = 1 + a_1R_S + a_2\left[\left(\frac{\gamma_{api}}{\gamma_g}\right)(T-60)\right] + a_3\left[R_S\left(\frac{\gamma_{api}}{\gamma_g}\right)(T-60)\right] \text{.....equation 2.3}$$

If γ_{api} ≤30 $a_1 = 4.677e^{-4}$, $a_2 = 1.751e^{-5}$, $a_3 = -1.8106e^{-8}$

API >30 $a_1 = 4.67ee^{-4}$, $a_2 = 1.1e^{-5}$, $a_3 = 1.337e^{-9}$.

It is stated in some review papers that the formation volume factor correlation has an absolute average error of 4.7%.

The bubble point pressure correlation is given as

$$P_b = \{\left(\frac{a_1 R_s}{\gamma_g}\right) antilog \left[\frac{-a_3 \gamma_{api}}{460+T}\right]\}^{a_2} \text{....... Equation 2.4}$$

If γ_{api} ≤30 $a_1 = 27.64$, $a_2 = 1.0937$, $a_3 = 11.172$

API >30 $a_1 = 56.06$, $a_2 = 1.187$, $a_3 = 10.393$

iii. GLASO: Glaso correlation of 1980 was based on samples from the North Sea , the data point used was just 41, the samples had a temperature range of 80-280 ºF, API range of 22.3- 48.1 and a gas gravity range of 0.65-1.28. the correlation like Standings was in terms of gas solubility, gas gravity, oil gravity and temperature

The formation volume factor correlation is given

$$B_0 = 1 + 10[a_1 + a_2(\log G) - a_3(\log G)^2] \text{...... Equation 2.5}$$

$$G = R_s(\left(\frac{\gamma_g}{\gamma}\right)^{0.526} + 0.968T \text{........ Equation 2.6}$$

$a_1 = -6.58511$, $a_2 = 2.91329$, $a_3 = 0.27683$, $a_4 = 0.526$, $a_5 = 0.968$.

Sutton and Farshad (1984) concluded that Glaso's correlation offers the best accuracy when compared with the Standing and Vasquez-Beggs correlations. In general, Glaso's correlation under predicts formation volume factor. Standing's expression tends to over predict oil formation volume factors greater than 1.2 bbl. /STB. The Vasquez-Beggs correlation typically over predicts the oil formation volume factor. Glaso reported an average error of -0.43% for the FVF correlation and an average error of 1.28% for the bubble point pressure correlation

The bubble point pressure correlation is given as

$$P_b = antilog[a_1 + a_2(\log G) - a_3(\log G)^2] \ldots\ldots \text{ Equation 2.7}$$

$$G = (\frac{Rs}{\gamma_g})^{a_4} T^{a_5} \gamma_{api}{}^{a_6} \ldots\ldots\ldots \text{ Equation 2.8}$$

a_1 = 1.7669, a_2= 1.7447, a_3 = 0.30218, a_4 = 0.816, a_5 = 0.172, a_6 = –0.989

iv. MARHOUN: Al-Marhoun correlation was published in 1988, the samples had a Middle East origin, he utilized 160 data points the samples had a temperature range of 74-240 ºF, API range of 19.4 - 44.6 and a gas gravity range of 0.75-1.37.

The formation volume factor correlation was published with an author's average error of -0.01.

$$B_0 = a_1 + a_2(T + 460) + a_3 M + a_4 M^2 \ldots\ldots \text{ Equation 2.9}$$

$$M = \left(R_s{}^{a_5} \gamma_g{}^{a_6}\ \gamma_{api}{}^{a_7}\right) \ldots \ldots\ldots \text{ Equation 2.10}$$

a_1 = 0.497069, a_2 = 0.862963e-3, a_3 = 0.182594e-2, a_4 = 0.318099e-5, a_5 =0.74239, a_6=0.323294, a_7 = –1.20204

The bubble point pressure correlation is given as

$$P_b = a_1 R_S{}^{a_2} \gamma_g{}^{a_3}\ \gamma_{api}{}^{a_4} (\mathrm{T} + 460)^{a_5} \ldots\ldots \text{ Equation 2.11}$$

a_1= 5.38088e^{-3}, a_2 = 0.715082, a_3 = –1.877840, a_4 = 3.143700, a_5 = 1.326570

The bubble point pressure correlation was published with an author's average error of -0.03.

v. PETROSKY AND FARSHAD: they proposed a new correlation in 1993, the correlation was based on Standing's 1947 correlation, Petrosky and Farshad new equation was Standing's equation with new calculated constants. Their samples were from Gulf of Mexico wells and they used a total of 90 data points. The samples had a temperature range of 114-288 ºF, API range of 16.3-45.0 and a gas gravity range of 0.58-0.85.

The formation volume factor correlation was published with an author's average error of -0.01.

$$B_0 = 1.0113 + 7.2046e^{-5}[R_s^{0.3738}(\frac{\gamma_g^{0.2914}}{\gamma_{api}^{0.6265}}) + 0.24626T^{0.5371}]^{3.0936} \text{...... Equation 2.12}$$

The bubble point pressure correlation is given as;

$$P_b = a_1 \ [(\frac{R_S^{a_2}}{\gamma_g^{a_3}})\ 10^X - a_4\ ] \text{......... Equation 2.13}$$

$$X = a_5 T^{a_6} - a_7 \gamma_{api}^{a_8} \text{...... Equation 2.14}$$

a_1 = 112.727, a_2=0.5774, a_3 = 0.8439, a_4 = 12.340, a_5 = 4.561e^{-5}, a_6=1.3911, a_7 = 7.916e^{-4}, a_8 = 1.5410.

The correlation was published with an average error of 0.17%

It is worth noting that this method gained global acceptability based on some premise such as the amount of data points, the generality of the data and their fundamentality in the derivation of other "improved" correlations. Majority of the mathematical models mentioned above have basis on one of the listed correlations, the new derivations can be changed term or refining the original (Standings or Marhoun etc.) correlation for a specific geographic location.

2.2 THE CONCEPT OF REGRESSION

Regression analysis is a set of statistical processes for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables (or 'predictors'). More specifically, regression analysis helps one understand how the typical value of the dependent variable (or 'criterion variable') changes when any one of the independent variables is varied, while the other independent variables are held fixed. Regression analysis is widely used for prediction and forecasting, where its use has substantial overlap with the field of machine learning. Regression analysis is also used to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships. In restricted circumstances, regression analysis can be used to infer causal relationships between the independent and dependent variables. However this can lead to illusions or false relationships, so caution is advisable.

Many techniques for carrying out regression analysis have been developed. Familiar methods such as linear regression and ordinary least squares regression are parametric, in that the regression function is defined in terms of a finite number of unknown parameters that are estimated from the data. Nonparametric regression refers to techniques that allow the regression function to lie in a specified set of functions, which may be infinite-dimensional.

The performance of regression analysis methods in practice depends on the form of the data generating process, and how it relates to the regression approach being used. Since the true form of the data-generating process is generally not known, regression analysis often depends to some extent on making assumptions about this process. These assumptions are sometimes testable if a sufficient quantity of data is available.

Regression models involve the following parameters and variables:

- The **unknown parameters**, denoted as β, which may represent a scalar or a vector.
- The **independent variables** ,**X**
- The **dependent variable Y**

A regression model relates Y to a function of **X** and **β**

$$Y \approx f(X, \beta) \text{………… Equation 2.15}$$

The approximation is usually formalized as $E(Y|X) = f(X, \beta)$. to carry out regression analysis, the form of the function ***f*** must be specified. Sometimes the form of this function is based on knowledge about the relationship **X** between and **Y that** does not rely on the data. If no such knowledge is available, a flexible or convenient form **for *f*** is chosen.

Assume now that the vector of unknown parameters **β** is of length **k.** In order to perform a regression analysis the user must provide information about the dependent variable ***Y***

- If **N** data points of the form (Y, X) are observed, where $N < k$, most classical approaches to regression analysis cannot be performed: since the system of equations defining the regression model is underdetermined, there are not enough data to recover **β**

- If exactly $N = k$ data points are observed, and the function ***f*** is linear, the equations

  $Y = f(X, \beta)$ Can be solved exactly rather than approximately. This reduces to solving a set of N **e**quations with **N** unknowns (the elements of **β**, which has a unique solution as long as the **X** are linearly independent. If **f is** nonlinear, a solution may not exist, or many solutions may exist.

- The most common situation is where $N > k$ data points are observed. In this case, there is enough information in the data to estimate a unique value for **β** that best fits the data in some sense, and the regression model when applied to the data can be viewed as an overdetermined system in **β**.

Classical assumptions for regression analysis include:

- The sample is representative of the population for the inference prediction.
- The error is a random variable with a mean of zero conditional on the explanatory variables.
- The independent variables are measured with no error. (Note: If this is not so, modeling may be done instead using errors-in-variables model techniques).
- The independent variables (predictors) are linearly independent, i.e. it is not possible to express any predictor as a linear combination of the others.
- The errors are uncorrelated, that is, the variance–covariance matrix of the errors is diagonal and each non-zero element is the variance of the error.
- The variance of the error is constant across observations (homoscedasticity). If not, weighted least squares or other methods might instead be used.

CHAPTER 3

METHODOLOGY

3.1 MODEL FORMULATION BASIS

Regression Equation

Assuming ***i*** independent variables and ***n*** number of data points X_1, X_2, X_3... X_{n-1}, X_n, the regression equation will be the form

$y = a + b_1x_1 + b_2x_2 + b_3x_3 \ldots b_kx_n \ldots\ldots\ldots$ Equation 3.0

From the theoretical background of statistics, mathematics and machine learning. The data needed for theoretically determining bubble point and formation volume factor were collected from SPDC and NPDC wells. The data was 534 data points with the following headers

		OWC or ODT		GOC or OUT		PROPERTIES AT RESERVOIR CONDITIONS							PROPERTIES AT SURFACE			
6	NAG/AG	Depth ft_ss	Pressure psi	Depth ft_ss	Pressure psi	PB psi	RSI scf/bbl	Boi v/v	Temp deg.F	SG Oil	Oil Visc cp	Water Visc cp	Oil+ Cs	GOR scf/bbl	Oil 60/60f	Gas air=1
7	NAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	NAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	NAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	NAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	NAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	AG	-	-	-	-	-	-	-	181	-	-	-	-	-	-	-
13	NAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	AG	-	-	-	-	-	-	-	199	-	-	-	-	-	-	-
15	AG	7,539	3,287	7,534	3,285	3,285	377	1.150	154	0.84	3.77	0.41	42.0	356	0.93	0.65
16	NAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	NAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	AG	7,857	3,421	7,839	3,415	3,415	401	1.163	159	0.83	3.25	0.40	39.9	378	0.93	0.65
19	AG	8,113	3,515	8,006	3,477	3,515	407	1.161	161	0.83	2.40	0.39	37.8	378	0.93	0.59
20	AG	8,101	3,513	8,040	3,491	3,491	474	1.183	161	0.82	2.60	0.39	36.6	450	0.93	0.65
21	AG	8,113	3,536	8,056	3,516	3,516	540	1.200	163	0.81	2.20	0.39	34.4	515	0.93	0.65
22	AG	8,323	3,627	8,290	3,615	3,615	525	1.197	162	0.80	1.63	0.39	17.3	500	0.92	0.65
23	AG	8,315	3,624	8,292	3,616	3,616	466	1.188	163	0.81	2.08	0.39	23.6	442	0.92	0.65

Sheet1

Figure 2: representative dataset

The properties at reservoir and surface conditions were stated, the OWC.

3.2 DATA EXPLORATION AND PREPROCESSING.

The first step was to explore the data and understand the relationships that exist between the variables (dependent and independent variables). This was done using Microsoft excel data analysis tool.

From the exploration of the data it was seen that **LOG P_b is linear to n*(logT),** for this data it was such that: **LOG (P_b) = 1.57LOGT.** The dependent parameters were also correlated to the independent parameters to give an indication of the collinearity and level of dependence.

The following results were obtained.

PROPERTY	**BUBBLE POINT**	**FORMATION VOLUME FACTOR**
GAS GRAVITY	**-0.1213116**	**0.601797081**
OIL GRAVITY	**-0.438992721**	**0.365043**
TEMPERATURE	**0.37443338**	**0.368344**
SOLUTION GOR	**0.701797081**	**0.553067**

TABLE 3.0.: TABLE OF VARIABLE CORRELATION

From the underlining studies in bubble point and formation volume factor determination, mathematically the natural logarithm of the terms on which bubble point pressure is dependent on should lead to a relationship that is linear in nature.

Then the data was split into 2 – test and validation datasets.

The data cleaning process began, removing outlier’s values, cells with empty values for any of the important dependent parameters. The values for oil gravity closer to condensate were removed as the typical values of NIGER-DELTA are lower than 45^0 API.

Then I converted the API values to specific gravity from the standard $\frac{\mathbf{141.5}}{\boldsymbol{SG}} - \mathbf{131.5}$

The correlations from theoretical petroleum engineering for bubble point and formation volume factor is usually represented by the form.

$$P_b, B_o = f(R_S, \gamma_O, \gamma_{G,}T) \text{……… Equation 3.1}$$

3.3 FORMULATION OF A LINEAR MODELS FOR FVF AND PB.

I attempted to create a linear relationship between the dependent variables and the independents using linear regression from python data analysis and Microsoft data analysis tool pack.

I arrived at the following equations, the accuracy on both the test and validation datasets for the Bubble point relationship were below 50%, however the basic multiple linear regression was able to arrive at 70.67% accuracy on the test set and 65.6% on the train set. In both regression models

$$\boldsymbol{P_b}, \boldsymbol{B_o} = \boldsymbol{a} * \boldsymbol{R_S} + \boldsymbol{b} * \boldsymbol{\gamma_O} + \boldsymbol{c} * \boldsymbol{\gamma_G} + \boldsymbol{d} * \boldsymbol{T} + \boldsymbol{E} \text{……… Equation 3.2}$$

This results explained the use of a nonlinear correlation for bubble point pressure.

3.4 BUBBLE POINT PRESSURE MODEL FORMULATION

Since the relationship is non-linear. It was required to use a form to model my new correlation, so I attempted using Vasquez and Beggs model , Petrosky and Farshad but the resultant models were a little complicated in terms of factors and the results had low accuracy.

The bubble point correlation I developed was a non-linear equation from the AL-MARHOUN correlation form. 112 were done till a convergence was met and the values that resulted in the best predictions were noted.

The developed correlation for Niger Delta wells is shown below.

$$\boldsymbol{P_b = \ a * T^b * RS^c * \ \gamma_{API}{}^d * \gamma_g{}^e} \text{...... Equation 3.3}$$

The equation was then validated using a test dataset containing the variables needed to predict bubble point.

3.5 FORMATION VOLMUME FACTOR MODEL FORMULATION

From the initial attempt and literature, the best relationship between formation volume factor and the variables is a linear one. This was attempted even using some complex regression models like ridge and lasso regressions, but the results were not a very good correlation.

Taking the Vasquez and Beggs formation volume factor equation, I then arrived at a linear yet polynomic equation from the Vasquez begs model for FVF

$$\boldsymbol{B_o = f(R_S, \frac{\gamma_{API}}{\gamma_G}, T)} \text{....... Equation 3.4}$$

Using **variable transformation** in mathematics to arrive at a model that is linear yet polynomic in form

From $Bo = f(R_S, \frac{\gamma_{API}}{\gamma_G} T)$...... Equation 3.4, the resultant equation becomes:

$$\boldsymbol{B_o = a_1 * RS + a_2 * T + a_3 * \frac{\gamma_{API}}{\gamma_G} + (a_4 * RS^2) + (a_5 * T^2) + \left\{a_6 * \left(\frac{\gamma_{API}}{\gamma_G}\right)^2\right\} +}$$

$$\boldsymbol{\left(a_7 * \frac{\gamma_{API}}{\gamma_G} * RS\right)) + a_8 * \frac{\gamma_{API}}{\gamma_G} * T) + a_9} \text{ .... Equation 3.5}$$

A ridge regression model with a minimal cost and error reduction function was deployed using Machine learning linear model through python coding language.

CHAPTER 4

RESULTS AND DISCUSSIONS.

4.1 RESULTS

From the non-linear regression applied. The bubble point correlation developed is shown below with the following constant:

$$\boldsymbol{P_b = \ a * T^b * RS^c * \ \gamma_{API}{}^d * \gamma_g{}^e} \ \text{……… Equation 4.0}$$

a=1.605996 b= 0.5800622 c= 0.4886207 d= 0.1361732 e= -0.9618594

Extracting coefficients and intercepts from the ridge regression program. The developed model for formation volume factor is shown below

$$\boldsymbol{B_o = a_1 * RS + a_2 * T + a_3 * \frac{\gamma_{API}}{\gamma_G} + (a_4 * RS^2\,) + (a_5 * T^2\,) + \left\{a_6 * \left(\frac{\gamma_{API}}{\gamma_G}\right)^2\right\} + \left(a_7 * \frac{\gamma_{API}}{\gamma_G} * RS\right)) + a_8 * \frac{\gamma_{API}}{\gamma_G} * T) + a_9} \text{……… Equation 4.1}$$

The constants $\mathbf{a_1}$**-**$\mathbf{a_9}$ are shown below.

$\mathbf{a_{1}=}$ **3.49761724*10^{-4}**	$\mathbf{a_{2}=}$**-1.33230512*10^{-2}**	$\mathbf{a_{3}=}$ **-6.33687399*10^{-3}**
$\mathbf{a_{4}=}$ **2.06542823*10^{-8}**	$\mathbf{a_{5}=}$ **4.456517*10^{-5}**	$\mathbf{a_{6}=}$**7.53455717*10^{-5}**
$\mathbf{a_{7}=}$ **8.91459823*10^{-6}**	$\mathbf{a_{8}=}$**-5.32189484*10^{-8}**	$\mathbf{a_{9}=}$ **2.11260127**

To give a measure of how well the new correlation performs. The same properties (Pb and FVF) are predicted using other pre-existing correlation

BUBBLE POINT CORRELATION

MODEL	Absolute average Error	Root Mean Square Error
STANDING	0.472353	13.44794
MARHOUN	0.260883	6.796019
OBOMANU AND OKPOBORI	0.250789	4.56889
NEW MODEL	**0.205064**	**3.960668**

TABLE 4.0: STATISCAL COMAPRISON OF CORRELATIONS FOR BUBBLE POINT PRESSURE PREDICTION.

FORMATION VOLUME FACTOR CORRELATION

MODEL	Absolute Average Error	Root Mean Square Error
VASQUEZ AND BEGGS	6.278241388	0.087333621
STANDING	15.65875556	0.185778806
MARHOUN	11.73533013	0.161601962
OBOMANU AND OKPOBORI	4.56739024	0.076738933
NEW MODEL	**1.623347734**	**0.052243766**

TABLE 4.1: STATISCAL COMAPRISON OF CORRELATIONS FOR FORMATION VOLUME FACTOR PREDICTION.

4.2 DISCUSSION

From the results and comparative analysis, it can be seen that the model developed is best suited for predicting the bubble point and formation volume factor for Niger-Delta crude because of lower values of the used error metrics (Absolute Average Error and Root Mean Square Error) this can be due to the fact that some of these prominent models were either built specifically for region or were generalized like Standings. The model developed is specifically made for Niger Delta Crude oils.

Furthermore for the bubble point correlation a trend analysis was done as suggested by some authors (AL-Marhounm, Al-Yousef) to ensure the model obeyed physical laws. The trend analysis gave the expected results as expected,

1. The bubble point pressure is decreasing function of oil API.
2. The bubble point pressure is an increasing function of temperature.
3. The bubble point pressure is an increasing function of gas gravity.
4. The bubble point pressure is an increasing function of solution GOR.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

The correlations developed in this project work are specifically meant for predicting formation volume factor and bubble point pressure for Niger-delta crude oil. Python, Polymath and Excel data analysis tool pack were used for solving the regression equations arrived at during correlation development. Statistical method were employed to handle the comparison between the predictions of the new model and other pre-existing models with this new correlation outperforming the other ones.

I recommend that more advanced non-linear regression software if available be used to verify the developed Bubble Point Pressure correlation.

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APPENDIX 1: PVT DATA

Pressure psi	PB psi	RSI scf/bbl	Bo v/v	Temp deg.F	SG Oil	GOR scf/bbl	Gas SG
3,287	3,285	377	1.150	154	0.84	356	0.65
3,421	3,415	401	1.163	159	0.83	378	0.65
3,515	3,515	407	1.161	161	0.83	378	0.59
3,513	3,491	474	1.183	161	0.82	450	0.65
3,536	3,516	540	1.200	163	0.81	515	0.65
3,627	3,615	525	1.197	162	0.80	500	0.65
3,624	3,616	466	1.188	163	0.81	442	0.65
3,624	3,616	466	1.188	163	0.81	442	0.65
3,637	3,632	1,323	1.589	169	0.61	453	0.65
3,650	3,642	478	1.192	163	0.80	453	0.65
3,703	3,692	578	1.232	171	0.79	550	0.65
3,686	3,680	503	1.221	171	0.79	476	0.65
4,209	4,201	1,287	1.622	190	0.64	1,248	0.65
4,576	4,560	1,338	1.767	218	0.62	1,290	0.65
4,641	4,596	1,399	1.801	219	0.61	1,350	0.65
4,456	3,442	1,086	1.569	186	0.61	1,050	0.65
4,719	4,713	2,162	2.489	226	0.52	2,105	0.65
4,999	4,998	2,640	2.746	240	0.45	2,952	0.65
4,745	4,740	1,010	1.599	227	0.66	962	0.65
4,852	4,833	1,041	1.554	202	0.67	1,000	0.65
4,953	4,928	1,192	1.710	240	0.62	1,364	0.65
4,008	3,992	1,457	1.909	244	0.49	1,400	0.65
5,043	5,031	1,458	1.822	248	0.59	1,400	0.65
5,034	5,019	1,458	1.822	248	0.59	1,400	0.65
5,071	5,068	1,298	1.772	228	0.61	1,400	0.65
3,475	3,452	566	1.214	164	0.79	600	0.65
3,462	3,447	448	1.176	158	0.81	425	0.65
3,684	3,668	627	1.268	168	0.75	600	0.65
3,647	3,633	579	1.215	149	0.77	558	0.65
2,828	2,824	420	1.200	142	0.93	500	0.65
2,883	2,873	385	1.190	144	0.77	3,000	0.57
3,012	2,853	472	1.230	150	0.90	1,000	0.59
3,012	2,853	472	1.230	150	0.90	450	0.59
3,012	2,853	472	1.230	150	0.90	450	0.59
3,012	3,008	444	1.220	149	0.72	450	0.59
3,012	2,853	472	1.230	150	0.90	450	0.59
3,012	3,008	445	1.220	149	0.72	450	0.59
3,249	3,220	579	1.360	163	0.62	580	0.62
3,609	3,603	914	1.570	178	0.51	950	0.67
3,609	3,603	914	1.570	178	0.51	950	0.67

3,974	3,960	1,253	1.770	196	0.45	8,000	0.85
4,000	3,986	1,292	1.790	197	0.44	1,290	0.85
4,044	4,019	1,307	1.790	198	0.44	1,310	0.85
4,085	4,074	2,026	2.000	200	0.40	2,000	0.75
4,526	4,486	2,730	2.540	219	0.31	4,000	0.65
4,535	3,511	1,218	1.710	224	0.80	3,000	0.79
3,260	3,257	726	1.343	160	0.70	700	0.68
3,751	3,735	2,043	1.970	182	0.61	2,000	0.65
2,062	2,050	256	1.135	149	0.84	256	0.65
2,169	2,155	283	1.149	155	0.83	283	0.65
2,288	1,897	318	1.168	160	0.79	350	0.65
2,592	2,567	478	1.253	178	0.75	478	0.65
3,254	2,937	685	1.378	209	0.67	685	0.65
3,217	3,034	723	1.406	215	0.66	723	0.65
3,515	3,122	735	1.420	220	0.64	735	0.65
3,570	3,205	781	1.447	222	0.63	781	0.65
3,343	3,273	793	1.456	226	0.65	793	0.65
3,358	3,350	741	1.455	210	0.70	740	0.65
2,880	2,857	359	1.137	125	0.89	268	0.65
2,920	2,917	294	1.137	127	0.89	282	0.65
2,910	2,892	359	1.135	126	0.88	283	0.65
3,020	3,015	245	1.130	132	0.88	234	0.65
3,010	2,990	317	1.120	128	0.88	300	0.60
3,100	3,094	311	1.130	136	0.88	296	0.65
3,090	3,066	309	1.130	134	0.88	295	0.65
3,115	3,090	311	1.130	135	0.88	296	0.65
3,115	3,104	311	1.129	136	0.88	296	0.65
3,050	3,028	310	1.133	132	0.88	296	0.65
3,100	3,094	310	1.131	134	0.88	296	0.65
3,140	3,121	328	1.132	137	0.87	313	0.60
3,140	3,073	329	1.130	134	0.87	314	0.60
3,170	3,167	330	1.129	139	0.86	314	0.65
3,170	3,140	329	1.131	138	0.87	313	0.65
3,150	3,112	325	1.131	136	0.87	310	0.65
3,240	3,198	355	1.134	142	0.85	338	0.59
3,240	3,173	386	1.136	137	0.87	334	0.59
3,415	3,043	383	1.149	150	0.82	363	0.65
3,315	3,222	382	1.141	146	0.84	363	0.65
3,305	3,243	381	1.141	145	0.84	363	0.65
3,285	3,255	381	1.140	142	0.84	363	0.60
3,280	3,250	375	1.138	143	0.84	357	0.65
3,390	3,336	378	1.141	143	0.84	360	0.65
3,300	3,284	378	1.141	144	0.84	360	0.65
3,375	3,328	422	1.170	146	0.85	234	0.65
3,500	3,487	505	1.193	154	0.79	483	0.64
3,530	3,517	595	1.236	155	0.76	572	0.65

3,455	3,451	523	1.188	152	0.80	501	0.65
3,530	3,515	526	1.204	155	0.78	503	0.65
3,623	3,612	775	1.280	156	0.75	750	0.65
3,545	3,504	535	1.211	153	0.78	513	0.64
3,565	3,554	615	1.253	157	0.75	591	0.65
3,640	3,622	624	1.258	160	0.75	599	0.61
3,645	3,641	625	1.262	161	0.75	600	0.65
3,710	3,694	663	1.280	163	0.74	637	0.65
3,710	3,705	698	1.281	164	0.74	671	0.60
3,715	3,701	701	1.302	164	0.73	674	0.65
3,780	3,742	701	1.297	165	0.73	674	0.65
3,780	3,742	701	1.297	165	0.73	674	0.65
3,926	3,900	1,036	1.500	167	0.67	1,004	0.79
3,850	3,839	877	1.401	169	0.69	847	0.65
3,835	3,817	832	1.150	169	0.84	423	0.63
3,860	3,851	687	1.303	171	0.73	658	0.65
3,820	3,789	819	1.368	167	0.70	790	0.65
4,000	3,993	1,008	1.479	177	0.66	975	0.65
4,015	4,012	1,008	1.477	178	0.67	975	0.65
3,960	3,741	947	1.440	175	0.68	915	0.65
4,060	4,059	1,001	1.489	181	0.66	967	0.65
4,310	4,306	1,148	1.569	192	0.65	1,109	0.65
4,450	4,438	1,069	1.521	196	0.68	1,030	0.59
4,575	4,570	1,159	1.595	198	0.65	1,118	0.65
4,548	4,537	1,126	1.575	204	0.67	1,084	0.67
4,758	4,711	1,485	1.771	210	0.63	1,438	0.65
4,728	4,723	1,486	1.793	213	0.62	1,438	0.65
3,365	3,342	519	1.172	142	0.82	500	0.65
3,606	3,587	726	1.254	160	0.76	700	0.65
3,723	3,705	727	1.296	165	0.74	700	0.65
3,743	3,739	657	1.279	165	0.74	630	0.65
3,850	3,838	688	1.281	167	0.75	661	0.65
3,710	3,696	596	1.243	163	0.76	570	0.65
3,700	3,695	680	1.260	158	0.75	655	0.65
3,834	3,809	830	1.376	169	0.70	801	0.65
3,710	3,689	686	1.252	159	0.76	661	0.65
3,572	3,566	651	1.311	161	0.72	626	0.65
3,700	3,691	863	1.390	169	0.69	834	0.65
3,700	3,687	623	1.300	163	0.75	850	0.65
2,737	2,710	575	1.330	162	0.78	575	0.65
3,177	3,161	1,003	1.460	154	0.77	1,000	0.65
3,566	3,568	1,397	1.730	194	0.76	1,400	0.65
3,658	3,614	1,799	1.810	173	0.75	1,800	0.65
2,824	2,818	368	1.166	160	0.81	345	0.65
3,074	3,063	455	1.207	166	0.78	430	0.65
3,068	3,066	506	1.218	166	0.78	480	0.58

3,248	3,230	1,032	1.352	173	0.74	1,000	0.58
3,248	3,231	506	1.241	173	0.77	478	0.58
3,245	3,243	465	1.235	175	0.78	437	0.58
3,474	3,465	647	1.329	182	0.73	615	0.58
3,508	3,502	613	1.325	183	0.73	581	0.58
3,824	3,822	1,009	1.569	195	0.64	970	0.61
3,824	3,803	1,035	1.513	184	0.66	1,000	0.61
3,824	3,809	953	1.538	195	0.66	915	0.62
3,824	3,809	953	1.529	195	0.66	915	0.62
3,898	3,886	1,015	1.576	201	0.65	975	0.65
4,155	4,079	1,113	1.650	207	0.63	1,070	0.65
4,264	4,255	1,066	1.667	217	0.63	1,020	0.65
4,261	4,256	1,066	1.667	217	0.63	1,020	0.65
4,296	4,279	1,244	1.657	159	0.63	1,047	0.75
4,278	4,261	1,046	1.679	220	0.63	1,000	0.70
4,278	4,261	1,046	1.679	220	0.63	1,000	0.65
4,734	4,711	795	1.528	221	0.68	750	0.65
4,639	4,621	1,702	2.069	221	0.56	1,650	0.65
4,420	4,409	1,147	1.706	220	0.62	1,100	0.65
4,758	4,751	1,316	1.809	232	0.60	1,264	0.65
4,782	4,777	801	1.671	243	0.59	750	0.65
5,260	5,252	1,471	1.749	264	0.56	1,800	0.65
3,209	3,223	416	1.250	138	0.83	416	0.65
3,321	3,223	420	1.250	140	0.83	420	0.65
3,595	3,571	565	1.250	149	0.81	565	0.65
3,615	2,961	2,309	2.008	162	0.62	2,270	0.65
4,175	4,172	1,035	1.487	179	0.67	1,001	0.65
3,788	2,961	2,309	2.007	162	0.62	2,270	0.65
4,091	4,083	1,274	1.561	180	0.65	1,238	0.65
4,577	4,558	1,349	1.796	220	0.61	1,300	0.65
4,665	4,036	1,479	1.832	223	0.60	1,428	0.65
3,854	2,955	508	1.357	181	0.70	540	0.65
4,103	3,123	518	1.348	182	0.70	550	0.65
4,505	3,060	434	1.264	185	0.75	425	0.65
4,961	3,399	746	1.665	208	0.59	1,022	0.65
3,612	3,600	522	1.253	152	0.74	500	0.65
3,780	3,718	574	1.278	157	0.73	550	0.65
2,719	1,967	266	1.113	140	0.84	250	0.65
2,805	2,793	319	1.135	150	0.86	300	0.65
2,908	2,902	368	1.141	142	0.83	1,059	0.65
2,947	2,397	308	1.125	145	0.83	290	0.65
3,075	2,513	320	1.135	152	0.82	300	0.65
3,099	2,914	360	1.144	150	0.82	340	0.65
3,225	2,951	366	1.152	155	0.82	345	0.65
4,176	3,477	1,034	1.512	178	0.64	1,000	0.65
4,544	4,523	1,642	1.838	191	0.60	1,600	0.65

4,067	4,055	845	1.316	151	0.73	821	0.65
4,192	4,184	1,328	1.455	153	0.70	1,300	0.65
4,845	4,813	2,239	1.825	162	0.56	1,913	0.65
4,851	4,828	2,239	1.825	163	0.61	1,913	0.65
3,588	3,587	653	1.281	152	0.73	630	0.65
4,182	4,169	1,135	1.574	179	0.62	1,100	0.65
4,155	4,145	1,437	1.679	179	0.61	1,400	0.65
4,250	4,231	1,135	1.574	179	0.62	1,100	0.65
4,244	4,216	1,232	1.597	156	0.66	938	0.68
4,244	4,216	1,232	1.597	156	0.66	938	0.68
4,237	4,212	1,034	1.517	179	0.65	1,000	0.65
4,244	4,216	1,232	1.597	156	0.66	938	0.68
3,118	3,108	622	1.283	158	0.73	598	0.65
3,311	3,307	836	1.380	162	0.69	809	0.65
3,360	3,350	836	1.383	163	0.69	809	0.65
3,264	3,125	539	1.262	158	0.74	539	0.71
4,658	4,654	1,157	1.543	191	0.67	1,118	0.71
5,255	5,242	1,564	1.968	237	0.57	968	0.65
2,430	2,405	259	1.125	128	0.89	350	0.58
2,512	2,497	364	1.138	130	0.85	350	0.58
2,643	2,628	308	1.127	135	0.85	293	0.65
2,725	2,715	321	1.127	138	0.85	305	0.65
2,840	2,840	340	1.132	142	0.84	323	0.65
2,865	2,857	343	1.133	143	0.84	326	0.65
5,926	5,926	2,292	1.690	200	0.60	2,292	0.70
5,973	5,973	2,500	2.500	207	0.60	2,500	0.71
6,141	4,965	3,544	3.710	220	0.42	3,544	0.84
3,809	3,800	934	1.458	181	0.68	900	0.65
4,742	4,733	2,345	2.445	207	0.57	2,292	0.65
3,266	3,185	1,201	1.576	155	0.62	959	0.69
3,292	3,287	986	1.576	156	0.64	959	0.69
3,815	3,271	988	1.576	164	0.63	959	0.69
4,964	4,465	4,156	3.730	195	0.63	3,801	0.69
3,156	3,142	120	1.085	142	0.87	116	0.58
3,249	754	84	1.056	144	0.88	79	0.58
3,318	3,312	120	1.087	146	0.87	115	0.58
3,450	3,442	120	1.089	149	0.87	114	0.58
3,518	3,254	738	1.315	147	0.72	646	0.60
3,195	3,159	412	1.298	142	0.72	646	0.60
3,535	2,961	502	1.188	158	0.77	432	0.60
3,195	3,186	464	1.223	143	0.77	530	0.60
3,341	3,317	457	1.164	146	0.81	437	0.60
3,352	3,344	466	1.169	146	0.81	454	0.60
3,970	3,767	739	1.262	137	0.75	714	0.60
3,893	3,890	578	1.236	170	0.78	551	0.60
4,987	4,981	1,199	1.535	180	0.66	1,162	0.60

1,616	1,421	161	1.103	128	0.90	150	0.65
2,736	2,702	345	1.155	129	0.38	288	0.56
2,727	2,704	345	1.151	128	0.38	288	0.56
2,808	2,782	349	1.157	131	0.37	301	0.56
2,819	2,789	343	1.151	132	0.37	312	0.56
2,814	2,806	343	1.148	132	0.37	312	0.56
2,810	2,790	343	1.152	132	0.37	312	0.56
2,941	2,911	317	1.130	129	0.87	304	0.56
3,016	2,954	329	1.133	140	0.38	289	0.56
3,093	2,760	350	1.161	143	0.37	310	0.56
3,161	3,150	357	1.134	141	0.84	340	0.56
3,189	3,009	375	1.176	147	0.36	350	0.56
3,457	3,447	14	0.402	152	1.05	25	0.72
3,143	3,134	14	0.402	138	0.95	24	0.65
2,829	2,821	14	0.402	124	0.86	23	0.59
2,514	2,507	14	0.402	110	0.76	22	0.52
2,200	2,194	14	0.402	97	0.67	21	0.46
1,886	1,880	14	0.402	83	0.57	20	0.39
1,572	1,567	14	0.402	69	0.48	19	0.33
3,211	3,195	97	1.037	140	0.93	51	0.65
3,312	659	74	1.037	141	0.91	52	0.59
3,699	3,656	603	1.275	158	0.76	502	0.65
3,716	3,702	552	1.277	162	0.72	694	0.65
3,786	3,779	648	1.321	164	0.71	550	0.68
2,498	2,483	284	1.120	144	0.85	267	0.65
2,472	2,455	281	1.118	143	0.85	264	0.65
2,514	2,503	287	1.120	144	0.85	270	0.65
2,532	2,517	318	1.127	145	0.85	300	0.65
2,499	2,494	285	1.120	144	0.85	268	0.65
2,905	2,899	345	1.147	156	0.83	324	0.65
2,880	2,874	342	1.145	155	0.83	321	0.65
2,906	2,883	286	1.134	156	0.84	265	0.65
2,954	2,944	366	1.155	157	0.82	344	0.65
3,100	2,677	362	1.167	159	0.80	340	0.65
3,117	3,074	525	1.214	162	0.78	500	0.65
3,280	3,249	429	1.199	157	0.81	396	0.61
3,735	3,704	703	1.316	167	0.72	675	0.65
3,725	3,694	906	1.436	187	0.70	870	0.63
3,725	3,702	699	1.377	186	0.71	666	0.65
3,730	3,706	930	1.364	168	0.71	900	0.65
3,770	3,714	930	1.380	168	0.71	900	0.65
4,054	4,050	1,136	1.583	186	0.63	1,099	0.65
4,363	4,362	2,039	1.777	170	0.66	2,000	0.65
4,399	4,388	1,636	1.620	171	0.67	1,600	0.65
2,840	2,837	439	1.199	149	0.77	420	0.65
2,862	2,876	449	1.201	151	0.77	430	0.57

2,879	2,876	455	1.201	151	0.77	435	0.65
2,827	2,876	455	1.201	151	0.77	435	0.65
2,950	2,947	479	1.214	154	0.77	457	0.65
2,950	2,947	479	1.214	154	0.77	457	0.65
2,975	2,940	479	1.205	153	0.77	457	0.65
2,943	2,940	479	1.205	153	0.77	457	0.65
2,952	2,950	482	1.206	153	0.77	460	0.65
2,956	2,953	482	1.214	154	0.77	460	0.65
3,082	3,078	524	1.213	158	0.77	501	0.65
3,034	3,078	524	1.213	158	0.77	501	0.65
3,081	3,078	548	1.213	158	0.77	524	0.65
3,149	3,095	489	1.214	158	0.77	465	0.60
3,153	3,095	523	1.214	158	0.77	500	0.60
3,153	3,095	494	1.214	158	0.77	470	0.60
3,153	3,095	494	1.214	158	0.77	470	0.60
3,153	3,095	564	1.214	158	0.77	540	0.60
3,228	3,204	544	1.271	162	0.74	390	0.63
3,228	3,204	1,028	1.271	162	0.74	1,000	0.65
3,228	3,204	559	1.271	162	0.74	532	0.65
3,228	3,204	626	1.271	162	0.74	600	0.63
3,228	3,204	555	1.271	162	0.74	530	0.63
3,228	3,204	626	1.271	162	0.74	600	0.63
3,228	3,204	555	1.271	162	0.74	530	0.63
3,228	3,204	555	1.271	162	0.74	530	0.63
3,228	3,204	555	1.271	162	0.74	530	0.63
3,228	3,204	555	1.271	162	0.74	530	0.63
3,228	3,204	555	1.271	162	0.74	530	0.63
3,228	3,204	555	1.271	162	0.74	530	0.63
3,228	3,204	555	1.271	162	0.74	530	0.63
3,300	3,230	828	1.334	163	0.70	800	0.68
3,295	3,230	828	1.334	163	0.70	800	0.65
3,300	3,230	779	1.334	163	0.70	750	0.65
3,262	3,217	828	1.393	164	0.68	800	0.68
3,251	3,230	676	1.334	163	0.70	650	0.68
3,251	3,230	828	1.334	163	0.70	800	0.68
3,251	3,230	828	1.334	163	0.70	800	0.68
3,306	3,230	667	1.334	163	0.70	640	0.65
3,287	3,230	828	1.334	163	0.70	800	0.65
3,347	3,230	828	1.334	163	0.70	800	0.65
3,253	3,230	828	1.334	163	0.70	800	0.65
3,290	3,288	831	1.425	165	0.68	800	0.65
3,282	3,288	759	1.425	165	0.68	732	0.65
3,413	3,373	737	1.452	168	0.65	709	0.65
3,391	3,373	1,837	1.452	168	0.65	1,800	0.65
3,330	3,373	737	1.452	168	0.65	709	0.65
3,410	3,373	737	1.452	168	0.65	709	0.65

3,341	3,373	737	1.452	168	0.65	709	0.65
3,477	3,433	1,535	1.469	171	0.65	1,500	0.65
3,396	3,433	960	1.469	171	0.65	930	0.65
3,442	3,433	960	1.469	171	0.65	930	0.65
3,440	3,433	960	1.469	171	0.65	930	0.65
4,198	4,124	1,262	1.775	195	0.59	1,225	0.65
4,198	4,124	2,648	1.775	195	0.59	2,600	0.60
4,198	4,124	2,043	1.775	195	0.59	2,000	0.65
4,195	4,192	1,439	1.908	198	0.58	1,400	0.65
4,210	4,192	1,443	1.908	198	0.58	1,400	0.65
4,407	4,381	1,847	1.939	204	0.58	1,800	0.68
4,582	4,576	1,583	1.999	211	0.58	1,541	0.65
5,280	5,274	2,457	2.462	235	0.58	2,390	0.65
2,568	2,568	284	1.405	145	0.87	284	0.65
2,707	2,568	299	1.122	145	0.87	284	0.65
2,714	2,714	299	1.405	150	0.87	299	0.65
2,705	2,714	299	1.120	145	0.87	299	0.65
2,800	2,800	277	1.405	153	0.78	277	0.65
2,812	2,800	277	1.116	152	0.78	277	0.65
2,800	2,800	277	1.405	153	0.78	277	0.65
3,075	2,800	490	1.238	162	0.83	490	0.65
3,073	3,073	483	1.337	166	0.77	490	0.65
3,073	3,073	490	1.337	166	0.77	490	0.65
3,073	3,073	533	1.405	162	0.77	533	0.65
3,166	3,153	538	1.236	150	0.75	517	0.65
3,322	3,290	526	1.291	167	0.73	500	0.65
3,490	3,462	830	1.405	171	0.68	800	0.65
3,380	3,361	648	1.337	170	0.71	620	0.65
3,436	3,434	830	1.385	170	0.69	800	0.65
3,625	3,620	1,032	1.497	172	0.64	1,000	0.65
3,531	3,522	1,032	1.497	172	0.64	1,000	0.65
3,699	3,671	1,033	1.511	174	0.64	1,000	0.65
3,767	3,763	1,129	1.549	176	0.63	1,095	0.65
3,780	3,766	1,157	1.565	177	0.63	1,123	0.65
3,903	3,892	1,086	1.583	186	0.63	1,050	0.65
4,079	4,066	930	1.455	170	0.66	900	0.65
4,028	4,023	1,063	1.569	191	0.64	1,025	0.65
4,050	4,043	1,062	1.559	189	0.65	1,025	0.65
4,103	4,099	2,348	2.226	191	0.60	2,300	0.65
5,059	5,050	2,557	2.739	215	0.55	2,500	0.65
3,447	3,442	524	1.205	159	0.78	500	0.65
3,693	3,684	777	1.322	164	0.72	750	0.65
4,450	4,417	1,755	1.751	189	0.62	1,720	0.65
4,490	4,458	1,753	1.751	189	0.62	1,720	0.65
4,490	4,458	1,753	1.751	190	0.62	1,720	0.65
4,490	4,458	1,753	1.751	190	0.62	1,720	0.65

4,610	4,606	1,714	1.877	193	0.60	1,670	0.65
4,795	4,793	1,649	1.845	197	0.61	1,605	0.65
4,955	4,950	1,600	1.816	200	0.62	1,555	0.65
5,135	5,125	1,546	1.695	204	0.63	1,500	0.65
5,445	5,438	1,447	1.721	210	0.64	1,400	0.65
1,133	1,127	123	1.089	131	0.90	111	0.65
1,144	1,139	135	1.093	130	0.90	123	0.65
1,133	1,127	139	1.093	131	0.90	127	0.65
1,379	1,379	166	1.070	134	0.89	153	0.65
1,327	1,317	123	1.090	135	0.88	161	0.65
1,267	1,257	166	1.094	134	0.88	153	0.65
1,368	1,359	113	1.100	135	0.88	166	0.65
1,276	1,273	165	1.093	133	0.88	152	0.65
1,407	1,407	116	1.060	136	0.88	173	0.65
1,303	1,295	175	1.096	134	0.88	162	0.65
1,292	1,289	175	1.098	134	0.89	162	0.65
1,528	1,511	114	1.080	143	0.87	191	0.65
1,424	1,436	188	1.070	139	0.86	190	0.65
1,234	1,233	232	1.110	147	0.86	232	0.65
1,427	1,421	200	1.195	140	0.76	186	0.65
1,718	1,707	240	1.109	141	0.86	224	0.65
1,564	1,545	209	1.103	140	0.85	194	0.65
1,741	1,720	238	1.125	151	0.86	249	0.65
1,866	1,863	267	1.144	147	0.86	267	0.65
1,710	1,697	266	1.117	144	0.85	249	0.65
1,732	1,683	267	1.117	143	0.84	250	0.65
1,900	1,813	240	1.110	165	0.82	187	0.65
1,787	1,776	299	1.130	145	0.83	281	0.65
1,793	1,789	290	1.128	145	0.83	272	0.65
2,084	2,072	321	1.190	163	0.80	202	0.65
1,985	1,960	276	1.180	162	0.79	276	0.65
1,930	1,922	302	1.192	158	0.77	355	0.65
1,953	1,941	340	1.137	149	0.83	321	0.65
2,399	2,393	556	1.259	176	0.74	474	0.65
2,351	2,333	440	1.230	184	0.73	326	0.65
2,423	2,406	553	1.275	166	0.74	523	0.65
2,172	2,164	407	1.256	167	0.73	477	0.65
2,496	2,494	500	1.271	180	0.73	493	0.65
2,473	2,466	338	1.220	177	0.80	338	0.65
3,120	3,110	1,045	1.291	204	0.74	509	0.65
2,610	2,604	674	1.420	183	0.70	545	0.65
3,306	3,267	707	1.380	216	0.60	821	0.65
3,083	2,388	900	1.702	236	0.58	850	0.65
3,038	3,031	1,061	1.549	179	0.62	1,027	0.65
3,223	3,222	903	1.702	247	0.57	850	0.65
3,400	3,391	1,150	1.620	186	0.61	1,113	0.65

3,120	3,113	1,081	1.573	182	0.62	1,046	0.65
3,462	3,293	1,087	1.630	186	0.61	1,055	0.65
3,352	3,289	906	1.657	256	0.57	850	0.65
3,346	3,339	1,130	1.609	188	0.62	1,093	0.65
3,575	3,551	1,116	1.630	186	0.61	1,060	0.65
3,417	3,291	908	1.621	261	0.56	850	0.65
3,698	3,690	1,379	1.711	188	0.60	1,340	0.65
3,430	3,425	1,188	1.640	188	0.61	1,150	0.65
3,593	3,297	912	1.483	275	0.55	850	0.65
3,924	3,918	1,498	1.867	204	0.58	1,453	0.65
3,348	3,332	319	1.133	150	0.85	300	0.65
3,395	3,387	397	1.150	151	0.84	377	0.65
3,531	3,154	421	1.169	154	0.80	400	0.65
3,558	3,513	683	1.341	157	0.73	491	0.69
3,675	3,664	593	1.239	159	0.76	568	0.65
3,785	3,778	775	1.341	166	0.71	747	0.65
4,339	4,335	1,266	1.451	146	0.69	1,240	0.68
2,255	1,618	200	1.107	154	0.87	180	0.65
2,331	2,323	259	1.120	127	0.87	247	0.60
2,411	2,406	291	1.136	157	0.84	270	0.65
2,416	2,414	284	1.123	130	0.86	271	0.63
2,453	2,447	294	1.125	132	0.85	280	0.60
2,487	2,500	321	1.129	162	0.81	420	0.64
2,553	2,550	389	1.192	164	0.78	400	0.65
2,717	2,725	588	1.290	170	0.66	600	0.69
2,702	2,694	573	1.279	138	0.73	555	0.65
3,464	3,385	1,233	1.564	170	0.61	1,200	0.62
2,757	2,748	428	1.265	176	0.75	400	0.62
2,900	2,893	732	1.468	181	0.64	700	0.65
3,281	3,264	1,440	1.735	188	0.60	1,400	0.62
3,300	3,287	1,339	1.696	188	0.60	1,300	0.65
3,121	3,116	495	1.198	141	0.78	477	0.65
3,406	3,374	500	1.202	142	0.78	481	0.65
3,816	3,810	503	1.205	144	0.78	484	0.65
3,994	3,981	570	1.261	145	0.74	550	0.60
4,297	4,241	709	1.310	147	0.72	709	0.60
4,249	4,245	650	1.269	149	0.74	628	0.60
4,285	4,263	769	1.309	151	0.72	746	0.60
4,450	4,448	790	1.340	153	0.71	766	0.60
2,584	2,581	588	1.331	156	0.69	565	0.90
2,165	2,157	295	1.140	130	0.83	282	0.90
2,165	2,157	295	1.140	130	0.83	282	0.90
2,256	2,257	282	1.000	130	0.20	282	0.61
2,254	2,250	502	1.302	132	0.70	487	0.82
2,422	2,390	619	1.343	133	0.61	619	0.73
2,919	2,911	975	1.418	144	0.66	952	0.73

3,337	3,313	1,107	1.668	211	0.73	1,107	0.75
3,989	3,985	1,048	1.559	189	0.64	1,011	0.65
4,062	4,053	855	1.540	194	0.64	818	0.65
4,062	4,052	1,139	1.627	194	0.63	1,100	0.65
4,475	4,439	1,447	1.819	210	0.61	1,400	0.65
4,436	4,421	1,749	2.009	210	0.58	1,700	0.70
4,411	4,388	1,245	1.739	210	0.61	1,200	0.67
4,125	3,505	963	1.613	202	0.64	917	0.72
4,480	4,462	1,244	1.734	208	0.61	1,200	0.65
4,158	3,347	928	1.538	202	0.65	889	0.65
4,721	4,708	1,265	1.754	220	0.62	1,217	0.65
3,393	3,387	545	1.264	163	0.74	520	0.65
3,670	3,665	774	1.360	171	0.71	745	0.65
3,723	3,717	749	1.360	172	0.70	720	0.65
3,787	3,785	821	1.390	174	0.69	790	0.65
3,855	3,845	1,073	1.465	176	0.68	1,040	0.65
3,706	3,695	75	1.075	143	0.88	60	0.60
3,702	3,698	75	1.075	143	0.88	60	0.60
3,773	3,754	430	1.076	144	0.87	1,405	0.60
1,824	1,816	197	1.104	139	0.90	197	0.65
1,862	1,592	197	1.104	150	0.87	197	0.65
1,835	1,828	197	1.104	139	0.90	197	0.65
1,886	1,873	211	1.109	146	0.89	211	0.65
1,899	1,891	211	1.110	147	0.86	211	0.65
1,995	1,721	224	1.116	155	0.85	224	0.65
2,108	2,099	214	1.138	147	0.87	214	0.65
2,141	1,905	259	1.138	147	0.83	259	0.65
2,178	1,905	259	1.138	161	0.83	259	0.65
2,157	2,142	302	1.163	153	0.86	302	0.65
2,197	2,180	302	1.163	153	0.84	302	0.65
2,244	2,014	278	1.152	164	0.82	278	0.65
2,261	2,103	287	1.154	164	0.82	287	0.65
2,232	1,992	276	1.149	163	0.82	276	0.65
2,232	1,992	276	1.149	163	0.82	276	0.65
2,232	1,992	276	1.149	163	0.82	276	0.65
2,416	2,395	276	1.149	153	0.81	276	0.65
2,232	1,992	276	1.149	163	0.82	276	0.65
2,556	2,530	323	1.217	167	0.80	323	0.65
2,256	2,225	323	1.177	155	0.83	323	0.65
2,556	2,150	326	1.177	166	0.81	326	0.65
2,567	1,996	350	1.175	168	0.80	350	0.55
2,554	2,085	350	1.175	167	0.81	350	0.65
2,642	2,636	386	1.239	178	0.77	386	0.55
2,695	2,585	649	1.346	173	0.69	649	0.65
2,960	2,955	448	1.321	190	0.74	448	0.65
3,066	3,057	536	1.368	194	0.72	536	0.60

3,285	3,290	899	1.493	195	0.64	899	0.65
3,415	2,633	750	1.508	197	0.66	750	0.65
3,688	3,679	945	1.674	217	0.62	945	0.63
3,699	2,843	945	1.655	217	0.61	945	0.65
3,739	2,883	945	1.652	219	0.62	945	0.65
3,904	3,893	972	1.680	225	0.62	972	0.65
4,233	4,215	938	1.533	231	0.64	938	0.65
3,651	3,625	490	1.383	170	0.72	450	0.65
3,701	3,671	491	1.382	170	0.67	500	0.65
3,701	3,671	500	1.401	180	0.67	500	0.65
3,613	3,608	441	1.240	184	0.81	410	0.65
3,732	3,441	471	1.246	184	0.79	440	0.65
4,322	4,309	1,136	1.515	184	0.67	1,100	0.66
4,410	4,369	1,137	1.520	185	0.67	1,100	0.65
2,029	2,006	234	1.108	143	0.86	234	0.65
2,023	2,017	234	1.108	143	0.86	234	0.65
2,130	2,112	230	1.130	146	0.92	230	0.60
2,130	2,112	230	1.130	146	0.92	230	0.60
2,130	2,112	230	1.130	146	0.92	230	0.60
2,130	2,112	230	1.130	146	0.92	230	0.65
2,130	2,112	230	1.130	145	0.92	230	0.65
2,226	2,112	230	1.130	147	0.91	230	0.65
2,226	2,112	230	1.130	147	0.91	230	0.65
2,226	2,112	230	1.130	147	0.91	230	0.65
2,226	2,112	230	1.130	147	0.91	230	0.65
2,226	2,112	230	1.130	147	0.91	230	0.61
2,226	2,112	230	1.130	147	0.91	230	0.61
2,260	2,216	282	1.136	154	0.82	282	0.61
2,260	2,169	282	1.146	146	0.91	282	0.61
2,260	2,169	282	1.146	146	0.91	282	0.61
2,260	2,169	282	1.146	150	0.91	282	0.61
2,260	2,169	282	1.146	146	0.91	282	0.61