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**An Analysis of Increasing the Size of the
Strategic Petroleum Reserve to One
Billion Barrels**

January 1990

Energy Information Administration
Office of Energy Markets and End Use
U.S. Department of Energy
Washington, D.C. 20585

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Preface

This study was undertaken at the request of the Department of Energy's Office of Energy Emergency Policy and Evaluation to analyze the expansion in the size of the Strategic Petroleum Reserve (SPR) from its currently planned 750 million barrels to 1000 million barrels. This Service Report documents the assumptions, methodology, and results of the analysis.

A cost benefit approach was chosen to complete this analysis. The costs associated with the SPR include the development, operation, and maintenance costs of providing storage in underground salt domes as well as the cost of acquiring the crude oil. Benefits from the SPR result mainly from the reduction in economic damage (during an oil supply disruption) due to its drawdown. The 750 million barrel reserve is assumed to have a maximum drawdown rate of 4.5 million barrels per day while the 1000 million barrel reserve has a maximum drawdown rate of 6.0 million barrels per day.

The assumptions used in this study were developed by the SPR sizing study group, an interagency group consisting of the Departments of Energy, Treasury, Commerce, Defense, State, and Interior, the Council of Economic Advisers, the Office of Management and Budget, Economic Policy Council, National Security Council, the Federal Emergency Management Administration, and the Central Intelligence Agency. This Service Report was prepared by the Energy Information Administration's, Office of Energy Markets and End Use, under the direction of W. Calvin Kilgore. Information on the study can be had by contacting Mark Rodekahr, Director of the International and Contingency Information Division ((202)586-1130), Derriel B. Cato, G. Daniel Butler, Debra Paxson, and Erik Kreil, of the Analysis Branch.

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Contents

Highlights	v
1. Summary	1
Methodology	1
Results	4
2. Overview of Methodology	8
Price Response/Demand Elasticity	8
Economic Benefits	9
Discounting	11
Probability Weighting	11
Incremental Costs	13
Disruption Offsets	13
3. World Oil Market and Price Projections.....	16
4. Price Elasticities	20
5. Economic Benefits and Costs	27
Benefits	27
Cost	28
Salvage Value and Import Costs	30
6. Probability Analysis	37
Mid Probability Case	37
Goodness-of-Fit Test	41
Low and High Probability Ranges	44
Multiple Worst Case Disruptions and Scenarios	44
7. Offsetting Assumptions to Reduce Gross Disruption Size	47
Excess Capacity	47
Foreign Stock Draw/Fuel Switching Assumptions	49
8. Summary Results of Sensitivity Analysis	50
Appendix A: Macroeconomic Impact of an Oil Supply Disruption	56
Appendix B: Detailed Results	69

Contents

(Continued)

Tables

1.	Probabilities of a Disruption	13
2.	SPR Sizing Study - Price Scenarios	19
	Unifier Matrix for the United States	22
4.	Unifier Output at Different Disruption Sizes	25
5.	Comparison of Studies on Crude Oil Price Elasticities	26
6.	SPR Fill Schedule and Costs - 750 MMB	31
7.	SPR Fill Schedule and Costs, Mid Case - 1000 MMB	32
8.	SPR Fill Schedule and Costs, Low Price Case - 1000 MMB	33
9.	SPR Fill Schedule and Costs, High Price Case - 1000 MMB	34
10.	Salvage Value and Increased Import Cost - 750/1000 MMB	35
11.	Salvage Value and Increased Import Cost - 600/750	36
12.	World Oil Supply Disruptions; 1951-1989	39
13.	Weibull Cumulative Probabilities for SPR Sizing Study	40
14.	Disruption Offset Assumptions	48
15.	Summary Results	51

Figures

1.	Incremental Benefits 750 to 1000 MMB SPR	3
2.	Benefit/Cost of Incremental 250 MMB	5
3.	Benefit/Cost of Incremental 150 MMB	6
4.	World Oil Prices/Year 2010	9
5.	Economic Worth of Last 250 MMB - Not Discounted	10
6.	Economic Worth of Last 250 MMB - Discounted	11
7.	Probability of a Disruption - Mid Case	12
8.	Cumulative Gross Benefit 1990-2020	14
9.	World Oil Prices	17
10.	Lag Adjustment	23
11.	DIS Crude Elasticity Curve	24
12.	Loss Due to Disruption	29
13.	Weibull Distribution (Tail Only)	42
14.	Probability of a Disruption - 3 Cases	45
15.	Probability of a Disruption - 15 Years	46
16.	Gross Benefit Versus Discount Rate	52
17.	Gross Benefit Versus Probability	53
18.	15 - Year Probability of a Disruption	54

Highlights

The Department of Energy's Office of Energy Emergency Policy and Evaluation requested that the Energy Information Administration complete an analysis of the proposed expansion in the Strategic Petroleum Reserve (SPR) from its currently planned size of 750 million barrels to 1000 million barrels. Because the SPR contains only 580 million barrels at this point in time, the benefits and costs of increasing the SPR from 600 to 750 million barrels were also estimated. This report documents the assumptions, methodology, and results of the analysis.

A cost benefit approach was chosen to complete this analysis. The costs associated with the SPR include the development, operation, and maintenance costs of providing storage in underground salt domes as well as the cost of acquiring the crude oil. Benefits from the SPR result mainly from the reduction in economic damage due to the drawdown of the reserve if a disruption in oil supply occurs. The 600 million barrel reserve has a maximum drawdown rate of 3.5 million barrels per day, the 750 million barrel reserve has an assumed maximum drawdown rate of 4.5 million barrels per day, and the 1000 million barrel reserve has a maximum drawdown rate of 6.0 million barrels per day.

The mid case results of this analysis indicate that expected discounted benefits are below costs for expansions beyond 600 million barrels. All costs and benefits have been discounted to the present and the benefits have been weighted according to the probability of a disruption of a given size. All costs and benefits are expressed in millions of 1988 dollars:

<u>SPR Size Comparison</u> <u>(million barrels)</u>	<u>Incremental</u> <u>Gross Benefit</u>	<u>Incremental</u> <u>Cost</u>
From 600 to 750	\$940	\$2,000
From 750 to 1000	750	3,370

Several sensitivity cases were also analyzed in order to determine the impact of the various assumptions on the final results. These cases examined variations in:

- the world oil price assumptions,
- the discount rate assumptions,
- the fill rate,
- the length of the disruption,
- the elasticity of demand,
- the probability of a disruption occurring,
- the elasticity of GNP with respect to the price of oil,
- the levels of excess production capacity, foreign stock drawdown.

Individual sensitivities (that is, cases which examined the sensitivity with respect to only one variable) also produced benefits which were below costs. Most of these sensitivities produced benefits that were plus or minus \$200 to \$300 million from the mid case.

Only when several variables were combined in a manner that tended to maximize benefits did the benefits exceed the costs. For

example in the case where low oil price assumptions were combined with low offsets (low excess capacity and low foreign stock draws), for a 9-month disruption did benefits exceed costs.

The costs and benefits calculated in this analysis exclude a number of factors which could be important when considering an expansion of the SPR. Some of these factors include:

- o The national security value of the SPR.
- o The strategic value of the SPR with respect to our allies.
- o The deterrent effect on future oil supply disruptions of a larger SPR.

These issues are addressed separately in the overall SPR size study conducted by the Department of Energy.

1. Summary

The Department of Energy's Office of Energy Emergency Policy and Evaluation requested that the Energy Information Administration (EIA) assist it in completing a study regarding the proposed expansion in the size of the Strategic Petroleum Reserve (SPR) from its current planned size of 750 million barrels (MMB) to 1000 MMB. As of the end of 1989, the SPR held 580 MMB. In addition, an evaluation of the benefits of increasing the SPR from 600 to 750 MMB was also requested. All of the assumptions used in this analysis were provided by the Interagency Working Group established for this study. This report documents the results of this study.

The SPR is designed to reduce the economic cost of a disruption in energy supplies. During a disruption, the shortage of oil on world markets causes world oil prices to increase. This price increase would tend to increase inflation and unemployment and hence reduce economic output or Gross National Product (GNP) from what it otherwise would have been. Past disruptions, like those experienced in 1973/74 and 1979/80, have resulted in significant downturns in economic growth. The current SPR was therefore designed to mitigate some of this economic damage by allowing the Federal Government to sell the oil at the time of a disruption and thus limit the resulting price increase. Therefore, the major benefit of the SPR is its ability to limit price increases and hence limit the damage to the economy.

In this analysis, the benefits of using the SPR are calculated by examining the economic damage caused by various disruption sizes. Alternative SPR sizes are assumed in conjunction with the various disruption sizes, and calculations are made of the reduction in economic damage as a function of the size of the SPR. Over a six month period, a 600 MMB SPR can be drawn down at a rate of 3.5 million barrels per day (MMBD), a 750 MMB SPR at a 4.5 MMBD rate, and a 1000 MMB SPR at a 6.0 MMBD rate. It is this incremental drawdown capability which reduces the price impact of a disruption and therefore determines the level of the benefits.

The remainder of this section will discuss the methodology used, the mid case results, and the many uncertainties associated with the analysis.

Methodology

Benefits are determined by a multistep process which calculates for each SPR system (600, 750, or 1000 million barrel SPR):

- (1) The change in world oil prices for various disruption sizes after accounting for all offsets (excess production capacity, foreign strategic stocks, fuel switching, and drawdown of the SPR).

- (2) Then based on the price change between a base price and the price for each net oil shortfall, calculate the GNP loss foregone and "terms of trade" loss at each disruption size.
- (3) Next, at each disruption size, for each SPR system, the incremental reduction in economic loss from the larger SPR system is calculated as the incremental gross benefit of that SPR system.
- (4) These benefits are then discounted to the present value.
- (5) The discounted benefits are next multiplied by the probability of occurrence of each disruption size and summed across disruption sizes to provide the incremental gross benefits in any given year.
- (6) Next the probability weighted benefits associated with each of the 30 years from 1990 to 2020 are summed to determine the total incremental gross benefit.

The change in the world oil price is a function of the price elasticity of demand discussed in section 2 and the size of the disruption after accounting for all offsets.

Estimates of the GNP loss elasticity and methodology for computing the "terms of trade" benefit were provided by the Department of Treasury, Office of Management and Budget, and Council of Economic Advisers (see Appendix A). After the benefits are calculated according to the procedure outlined above, they are then discounted to the present (using a 10 percent discount rate in the mid-case). The discounted benefits are then weighted by the probability associated with each gross disruption size. The discounted probability weighted benefits are illustrated in Figure 1. The benefits are zero for small disruptions because of the assumption that excess capacity and foreign stocks can be used to offset the impacts of these small disruptions. Benefits are also zero in the early years because the 1000 MMB system contains no additional oil (over a 750 MMB SPR) in these years.

The probability distribution associated with various disruption sizes was developed by using an analysis of data on past disruptions and expert opinion to determine the shape of the distribution (discussed in more detail in Section 6). After the benefits are weighted, they are first summed across all years for each disruption size and then summed across all disruption sizes in order to determine the overall present discounted benefit of increasing the size of the SPR. The benefit can then be compared to the cost of increasing the SPR. In this analysis, benefits accruing because of the possibility of multiple very large disruptions are not incorporated because the probability of such an event is considered insignificant. Furthermore, possible

Figure 1

INCREMENTAL BENEFITS 750 TO 1000 MM BARREL SPR

Thousands of 1988 Dollars

benefits arising from the fact that an increased SPR could have a deterrent value, in other words, decrease the chance of having a disruption at all, were also not considered, because quantifying this value is not possible.

In order to examine the inherent uncertainties involved in this analysis, reasonable ranges of values for the major independent variables were developed. These ranges were then assumed and the impact on the resulting benefits and costs calculated. Variables which have a large impact on the determination of the level of benefits include:

- (1) the size of the price elasticity of demand;
- (2) the size of the elasticity of GNP with respect to price;
- (3) the world oil price case;
- (4) estimates of the size of excess world oil production capacity and size of foreign stock drawdown ability;
- (5) the probability of having a disruption of a certain size;
- (6) the discount rate; and
- (7) the duration of the disruption.

These variables represent the major uncertainties that are explored in this analysis. A detailed discussion of the results of this analysis is contained in Section 8 and Appendix B.

Results

Figure 2 summarizes the results of the analysis for the 1000 MMB SPR for three cases. These cases are: the mid case, which assumes middle values for critical variables; an extreme low case, which assumes a combination of values for all the variables which would tend to decrease the benefit; and an extreme high case in which converse values are assumed.

Almost all of the cases produce benefits that are less than the cost. This result is primarily due to the probability distribution used in the analysis. For example, a disruption in 2005 of greater than about 11.5 MMB must occur before any significant benefits are realized from the additional 250 MMB of SPR oil between a 750 and a 1000 million barrel SPR. The annual probability of such an event occurring in any year is one-half of one percent. Given this low probability, the expected (or probability weighted) benefits of the additional oil are quite low. The 11.5 MMBD figure is the sum of 4.5 MMBD drawdown capability from the reserve of 750 MMB plus mid

Figure 2(a)

(a) Excludes salvage value and incremental imported oil costs.

case excess production capacity of about 4 MMBD and 3 MMBD of foreign stock draw. When variations of the individual uncertainties are examined, there are no cases where the expected benefits exceed the costs on a discounted basis (see Appendix B). The only instances where benefits exceed costs are when combinations of values for individual variables are combined in such a manner as to maximize the benefits (as shown by the extreme case in Figure 2). While most cases would produce negative net benefits, not all cases produce this result. For example the case which combines low world oil prices and low offsets (low excess capacity and low foreign stock draws) for a 9-month disruption produces benefits which exceed costs.

All of the cases presented in this section exclude one noteworthy benefit and one significant cost because there is some debate as to the appropriateness of including them. On the benefit side, the salvage value of the extra 250 MMB at the end of the time period is excluded. The salvage value is the value of the additional SPR oil if it were left unused and sold to the market. For the mid case, when no SPR draw has occurred by 2020, this value is about \$0.5 billion. On the cost side the purchase of the extra 250 MMB could cause world oil prices to increase if production capacity was assumed to be fixed and the increased SPR fill was viewed as an increase in demand. The extra cost to consumers of this increase in all oil import expenditures is estimated to be \$0.97 billion and was not included in the cost analysis.

Figure 3(a)

(a) Excludes salvage value and incremental imported oil costs.

Figure 3 summarizes the results of the analysis for the scenario in which the SPR is increased from 600 MMB to 750 MMB. In this scenario costs are lower because the volume of oil purchased is

lower and the costs of the additional storage capacity is excluded because it was purchased long ago. The incremental benefit (although less than its cost) is greater for the 600/750 MMB increment than the 750/1000 MMB increment because the probability of using this increment is greater and the oil would be available sooner so that the effect of discounting is not as dominant.

2. Overview of Methodology

A cost benefit approach was chosen as the most appropriate method for this analysis. This method was selected because it allows for the clear presentation of all the calculations necessary to determine both costs and benefits, and because it easily lends itself to an examination of the many uncertainties surrounding the analysis. The costs of the 1000 MMB SPR include the cost of purchasing the oil as well as the cost of building and maintaining the extra storage space. These costs are discounted to the present for the purpose of comparing them to the benefits. The benefits consist of the reduction in economic damage due to the use of the additional SPR volume during a disruption. These benefits are discounted to the present and multiplied by the probability of a disruption of any given size occurring. The remainder of this section will discuss these calculations in more detail.

Price Response/Demand Elasticity

During a disruption, economic damage is caused by the resulting increase in crude oil and refined product prices. Since the economy cannot adjust immediately to higher prices, higher inflation and unemployment result in lower real GNP than would have been the case in the absence of a disruption. This damage is proportional to the increase in prices. To determine the benefits of having a 1000 million barrel SPR the difference between two scenarios is considered. The first scenario is the currently planned 750 MMB SPR, which can be drawn down at a rate of 4.5 MMBD. The second scenario is the 1000 MMB SPR, which can be drawn down at a rate of 6.0 MMBD. It is the difference in the resulting price increase between these two scenarios that determines the level of benefits realized from purchasing the larger SPR.

The price increase resulting from disruptions of different sizes is computed from the EIA Disruption Impact Simulator (DIS) model. This model determines the price necessary to clear the market of any excess demand after all offsets to a disruption, such as foreign strategic stocks, excess production capacity, and fuel switching have been considered. Next the price elasticity of demand is utilized or:

$$(1) \quad P_d = P_b * (Q_d/Q_b)^{1/N_c}$$

where P refers to prices, N_c is the crude oil price elasticity of demand, Q refers to the non-OPEC free world demand, b refers to the base or undisrupted case, and d refers to the disrupted case. It is the difference in this change in price for the 750 MMB and the 1000 MMB SPR's that determines the level of benefits. This can be seen more clearly by examining Figure 4 which shows the price increases across selected disruption sizes (after offsets for the use of excess capacity and fuel switching) using the mid case assumptions for all of the other variables. Prices would be much greater than shown here if U.S. and foreign strategic stocks were

not used. The demand elasticities were developed in the "Unification Spreadsheet". The DIS model uses one set of elasticities for the United States and another for the rest of the free world countries. However, the composite world elasticity is generally about -0.1 in the short run. The elasticity is assumed to increase over time as adjustments can be made to higher prices and also to increase as the level of prices increase. The development of these elasticities are discussed in more detail in Section 4.

Figure 4

Economic Benefits

As stated earlier, the economic benefits of the 1000 MMB SPR are calculated as the reduction in economic damage due to the increased SPR drawdown rate. These economic benefits consist of two factors. The first, or the macroeconomic benefit, refers to the change in GNP due to a change in oil price, and is expressed as follows:

$$(2) \quad GNP_d = GNP_b \cdot (P_d/P_b)^e,$$

where GNP refers to the level of Gross National Product, d is the disruption case, b the base or non-disrupted case, and ϵ is the elasticity of GNP with respect to oil prices. This GNP elasticity averaged -0.025 in the mid case and was taken from an analysis completed by the Department of the Treasury, Office of Management and Budget, and Council of Economic Advisers as documented in Appendix A. The second benefit derived from decreases in the terms of trade loss (TTL), refers primarily to the microeconomic loss associated with having to pay more for oil imports after deduction of SPR sale receipts. Hence, with a higher SPR drawdown rate less imports would be needed and a lower TTL would be experienced. This is calculated approximately as:

$$(3) \quad TTL = (P_d - P_b) * (I_d + I_b) / 2 - P_b * SPR$$

where I represents net imports and SPR is the volume of the SPR draw. Again it is important to remember that these benefits are calculated by examining the impact of the two SPR sizes and expressed as the difference between the two cases. Both the macro and micro benefits are added together to estimate the total benefit. Figure 5 shows the level of these benefits across disruption sizes.

Figure 5

Discounting

Discounting is used to compare future streams of costs or benefits. In the mid case, a discount rate of 10 percent is used which represents the official Office of Management and Budget discount rate. Therefore, the discounted benefits (DB) are expressed as follows:

$$(4) \quad DB_t = B_t / (1 + DR)^t$$

where DR refers to the discount rate and t stands for time. Figure 6 illustrates the discounted benefits across a number of disruption sizes.

Figure 6

Probability Weighting

The next step in determining the aggregate benefits involves probability weighting. In any given year there is some chance that there will be a disruption. Since 1950 there have been 13 gross oil supply disruptions which have accounted for more than one percent of consumption at the time. There have been several more

which have accounted for less than one percent but these are not considered to be important enough to warrant the use of a SPR and therefore were not included in the probability analysis. This analysis used a Weibull probability curve (which is a particular form of a probability density function) to characterize the chances of having a disruption. Figure 7 shows the mid case cumulative one year probability function used in this analysis. Note that this distribution is expressed as a function of the percent of WOCA (world outside communist area) consumption. The development of this particular curve is discussed in Section 6. For the mid case probability function, the Table 1 summarizes the chances of having a range of disruptions over a one-year, fifteen-year, and thirty-year period.

Figure 7

Table 1
Probabilities of a Disruption

Disruption Size ^a Percent	1 year	15 year	30 year
0-5	0.926	1.000	1.000
5-10	0.050	0.562	0.798
10-15	0.014	0.202	0.355
15-20	0.005	0.081	0.151
20-25	0.002	0.036	0.069

(a) Percent of consumption

The probabilities within the size classes are then used to weight the benefits. These weighted benefits are shown in Figure 8. The benefits across all disruption sizes are then added together (the area under the curve is computed) to determine the final discounted benefit for all disruption sizes across all years analyzed.

Incremental Costs

On the other side of the analysis, the incremental cost of filling the SPR by the additional 250 MMB and providing the storage for this additional oil had to be determined. The cost of filling the SPR includes the acquisition costs of the oil and capital cost to acquire additional storage capacity of the 1000 MMB system. Acquisition costs are estimated using the alternative world oil price cases and alternative fill rates detailed in Tables 6 through 9. Capital costs were taken from a study^{1/} developed by the Oak Ridge National Laboratories. These costs (C) are summed and discounted (DC) as:

$$(5) \text{ DC} = C / (1 + DR)^t$$

Disruption Offsets

In this part of the analysis a certain volume of oil is assumed to be available during a disruption which can be used to offset the effects of some of the disrupted supplies. This oil comes from one

^{1/}Preliminary Results of The SPR Size Cost Benefit Study, Oak Ridge National Laboratories, November 17, 1988

Figure 8

of three sources which include foreign stocks, excess crude oil production capacity, and fuel switching from oil to gas. Both Japan and West Germany hold or control large quantities of oil which can be used during a disruption. In the mid case between now and 1995 it is assumed that 2 MMBD of these stocks can be drawn down and after 1995 the rate increases to 3 MMBD. At present there is significant excess crude oil capacity throughout the Middle East. Although this excess capacity is projected to decline over time depending on the assumed production capacity utilization and the area of disrupted supplies, there should, in most cases, be some amount of excess capacity available to offset a disruption even in the distant future. The assumptions for this excess capacity are explained in Section 7, Table 14. In addition, during a crisis some oil users will be able to switch to natural gas. In this analysis it is assumed that fuel switching could reduce oil demand by 350 thousand barrels per day from 1995 forward. In this analysis it is assumed that all of the excess capacity, foreign strategic stocks, and fuel switching supplies will be made available at the outset of a disruption. There is however, a range of values for these factors that is considered in the sensitivity analysis. All of these factors can be used to reduce the gross oil disruption and thereby reduce the volume of SPR oil needed during a disruption. These factors (U.S. strategic and Foreign stock

and Foreign stock draws, excess production capacity, and fuel switching) account for the difference between a gross disruption and the actual oil shortage.

3. World Oil Market and Price Projections

The world oil market projections were derived from previously published Department of Energy analyses. The assumptions used in making these projections were as follows:

- o EIA's 1989 International Energy Outlook DOE/EIA-0484(89) oil production, consumption, and price projections were used for 1989-2000.
- o World oil market production and consumption trends from the Department of Energy's Long Range Energy Projections to 2010 DOE/PE-0082 were used for 2001-2020.
- o EIA's Electricity Generation from Natural Gas: Prospects and Implications for the United State SR/EPD/89-01 price projections were used for 2001-2020.

World oil prices, in constant 1988 dollars, are projected to double between 1988 and 2020 under low-price assumptions, and almost triple under the high-price assumptions, as illustrated in Figure 9. In both cases, a substantial part of the increase in prices is projected to occur in the late 1990's as growing demand for oil reduces the current excess in world oil production capacity, and as oil production from sources other than OPEC levels off and begins to decline. Prices continue to rise between 2000 and 2020 as OPEC gains a larger share of the world oil market.

The price cases used in this report are based on the assumption that oil demand can be met primarily from conventional supplies and enhanced oil recovery (EOR) techniques. It is assumed that additional supplies will be forthcoming in sufficient quantities from more costly synthetic fuels to limit further price increases.

Economic and energy trends in the Free World and alternative estimates of world energy resources were considered in formulating these ranges for world oil prices. A number of sensitivity cases were investigated in which several basic assumptions were altered. These sensitivities include varying assumptions for economic growth, energy/GDP ratios, non-OPEC oil supplies, OPEC production capacity, and oil's share of energy consumption. The price effects of these variations in assumptions were first estimated individually and then a combined uncertainty range was derived.

This range of prices does not capture extreme market scenarios such as a supply disruption or an oil price war which could easily cause prices to fall outside of this projected range for at least short periods of time. However, while oil prices in any given year could lie outside this band of uncertainty, it is believed that price fluctuations outside of this band are not sustainable. Prices above this range of uncertainty would discourage demand, encourage the higher cost non-OPEC production, and lead to increased excess oil production capacity in the OPEC countries, with the result that

Figure 9

World Oil Prices (Average Imported RAC)

prices would fall. Prices below this band would have the opposite effect. Given these market pressures, prospects for prices to be sustained outside this band are considered unlikely.

Table 2 summarizes the demand and supply outlook to 2020 under the three price paths. The low price path results in increased demand, lower non-OPEC production, and an increased demand for OPEC production, while higher prices have the opposite effect. The variations in demand and non-OPEC supplies resulting from varying prices were first estimated individually and then a combined uncertainty range for OPEC production was derived.

Prices used in the National Energy Strategy (NES) were not available at the time this analysis was being completed and therefore were not used. However, the NES prices are only marginally lower than those used here.

Table 2
SPR Sizing Study
Price Scenarios
(Million Barrels per Day)

	1990			1995			2000			2005			2010			2015			2020		
	Mid	Low	High	Mid	Low	High	Mid	Low	High	Mid	Low	High	Mid	Low	High	Mid	Low	High	Mid	Low	High
Price(88\$/bbl)	15.00	12.90	18.00	20.60	16.70	24.40	28.00	21.70	35.00	33.40	24.80	42.00	37.20	26.70	47.80	40.00	28.30	51.70	42.50	29.40	55.60
World Demand	51.4	51.8	51.0	54.1	56.0	51.8	54.9	58.4	50.8	57.2	61.7	52.2	60.4	66.1	54.6	64.3	71.1	57.9	68.7	76.7	61.7
OPEC Demand	3.8	3.6	4.0	4.1	3.9	4.3	4.5	4.3	4.7	4.9	4.6	5.2	5.3	5.0	5.6	5.8	5.5	6.2	6.2	5.9	6.5
Production																					
Non-OPEC	27.7	27.1	28.1	24.9	24.2	25.5	24.0	23.1	24.8	23.4	22.3	24.2	22.2	21.0	23.1	20.8	19.6	21.6	19.4	18.2	20.0
OPEC	21.0	21.8	20.4	26.9	29.1	24.6	29.0	33.0	24.9	32.1	37.2	26.9	36.4	42.7	30.3	41.7	48.5	33.9	47.4	55.4	39.5
P.G.	14.0	14.5	13.6	18.0	19.4	16.4	20.2	23.0	17.4	22.8	26.4	19.1	26.0	30.5	21.6	29.8	34.7	24.2	34.0	39.8	28.4
Net CPE	2.4	2.6	2.2	1.9	2.4	1.4	1.5	2.1	0.9	1.5	2.0	0.8	1.6	2.1	0.9	1.6	2.7	2.1	1.6	2.8	1.9
Discrepancy	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
U.S. Balance (inc. territories)																					
Demand	17.7	18.0	17.3	18.1	18.8	17.6	18.9	19.9	18.1	19.2	20.4	18.4	19.6	20.9	18.7	20.0	21.3	19.0	20.3	21.7	19.3
Production	10.0	10.0	10.1	8.6	8.3	9.2	8.4	7.8	9.3	7.8	7.1	8.4	7.1	6.3	7.7	6.4	5.6	7.0	5.7	5.0	6.3
Imports	7.8	8.1	7.3	9.6	10.6	8.5	10.5	12.1	8.8	11.4	13.3	10.0	12.5	14.6	11.0	13.6	15.7	12.0	14.6	16.7	13.0
SPR Fill	0.08	0.08	0.08	0.08	0.08	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Import Bill (\$bill.000)	43	38	48	72	65	76	107	96	112	139	120	153	170	142	192	199	162	226	227	179	264

4. Price Elasticities

The price elasticities used in this analysis were developed by the Unification Spreadsheet (UNIFIER). The Unifier is used to provide consistent crude price elasticities between the EIA's Oil Market Simulation (OMS) and DIS models.

The OMS model is used to make business-as-usual (BAU) forecasts of world crude oil prices, while the DIS model is used for supply disruption analyses of impacts on the U.S. economy, hence the DIS model is only concerned with short-term elasticities of demand. Estimates of crude price elasticities are needed to calculate price impacts at different disruption sizes. The Unifier uses BAU regional crude price elasticities from the OMS model as input to generate crude price elasticities for disrupted scenarios in the DIS model.

Although retail petroleum product price elasticities are commonly used in many models, the OMS and DIS models concentrate on the demand for crude oil instead of petroleum products. For OMS and DIS models, it is necessary to develop crude price elasticities that will consistently capture consumer responsiveness of demand for petroleum products to changes in crude prices. To understand the Unifier's disrupted crude oil price elasticity, the following relationships must be clear:

- o Consumer behavior at the retail level -- petroleum product demand changes versus crude price changes.
- o The nature of the mark-up between crude price and weighted average retail product prices.
- o The role of changing prices on economic growth and demand (feedback effects).
- o The lags in consumer response to changing prices.

The following equation for a crude price elasticity captures a relationship between crude and average retail product prices which reflects the responsiveness of the total petroleum demand changes:

$$(6) \quad N_c = (P_c/P_r) \cdot N_r$$

N_c is the crude price elasticity; P_c and P_r are the crude and retail prices, respectively; and N_r is the retail price elasticity.

The Unifier requires a BAU forecast of petroleum demand and base crude prices with associated crude price elasticities, for five regions. A study of the difference between crude oil prices and the weighted average retail product prices in each region was undertaken to develop the constant retail price mark-ups for each region. It is assumed that these mark-ups, such as taxes, transportation, and other charges, do not usually fluctuate with changes in crude oil prices, so the:

Retail Price = Crude Price + Mark-up.

Constant Retail Price Mark - up
(1988 Dollars Per Barrel)

United States	\$13.57
Canada	\$33.95
Japan	\$52.67
Western Europe	\$44.17
Other ¹	\$19.12

Retail price elasticities are larger (in absolute value) than crude price elasticities because of this assumed constant retail price mark-up. If crude and product price elasticities were assumed to be equal, the implied demand response to a change in crude oil prices would be overestimated.

The crude price elasticity must be smaller than the retail price elasticity in order to reflect the responsiveness of product demand to a change in crude prices. Yet, as the crude oil price increases, the percent change of crude and retail prices approach each other, and the crude price elasticity gets closer to the retail price elasticity.

Also, the retail price elasticity is assumed to increase as prices increase through the incorporation of an economic feedback measure, added in lieu of a separate economic variable in the equation. Economic feedback occurs as crude oil prices increase, and petroleum expenditures become an increasing share of an individual's budget. For example, the U.S. retail price elasticity ranges between -0.19 and -0.25 at crude prices of \$20 to \$75 per barrel respectively. (See Table 3)

The Unifier also assumes the demand response to changes in crude prices will not be immediate, there will be a lag in the full response. A quarterly adjustment is applied so crude price elasticities increase over time, but they increase by a smaller amount every quarter.

Figure 10 exhibits the lag response percent change assumed in the Unifier. During the first quarter, 90 percent of the first year's elasticity is assumed, and by the fourth quarter 110 percent, so that all four quarters average 100 percent. The next year is assumed to experience a 40 percent average increase, while the third year is assumed to experience another 20 percent. (This assumes an annual lagged coefficient of 0.4)

With the above relationships in mind, it is clear why the Unification Spreadsheet was named in that it unifies five regional OMS crude elasticities at a base price to crude elasticities as a function of crude disruptions for the DIS model. Starting with those base price OMS crude elasticities, originally derived from retail petroleum product elasticities from various EIA models, crude elasticities are calculated

¹Other includes less developed countries, excluding OPEC countries, Australia and New Zealand.

Table 3
Unifier Matrix for the United States*

Reference Crude Price	Average Mark-up	Reference Retail Price	Crude Elasticity	Retail Elasticity
\$5.00	\$13.57	\$18.57	-0.0462	-0.1606
\$10.00	\$13.57	\$23.57	-0.0743	-0.1703
\$15.00	\$13.57	\$28.57	-0.0960	-0.1801
\$20.00	\$13.57	\$33.57	-0.1120	-0.1862
\$25.00	\$13.57	\$38.57	-0.1256	-0.1924
\$30.00	\$13.57	\$43.57	-0.1374	-0.1985
\$35.00	\$13.57	\$48.57	-0.1481	-0.2047
\$40.00	\$13.57	\$53.57	-0.1579	-0.2108
\$45.00	\$13.57	\$58.57	-0.1671	-0.2170
\$50.00	\$13.57	\$63.57	-0.1759	-0.2231
\$55.00	\$13.57	\$68.57	-0.1843	-0.2293
\$60.00	\$13.57	\$73.57	-0.1923	-0.2355
\$65.00	\$13.57	\$78.57	-0.2001	-0.2416
\$70.00	\$13.57	\$83.57	-0.2078	-0.2478
\$75.00	\$13.57	\$88.57	-0.2152	-0.2539
\$80.00	\$13.57	\$93.57	-0.2226	-0.2601
\$85.00	\$13.57	\$98.57	-0.2298	-0.2662
\$90.00	\$13.57	\$103.57	-0.2369	-0.2724
\$95.00	\$13.57	\$108.57	-0.2439	-0.2785
\$100.00	\$13.57	\$113.57	-0.2508	-0.2847

These estimates are point elasticities (not average) and include economic feedback.

elasticities from various EIA models, crude elasticities are calculated

Figure 10

Lag Adjustment

by region for any price level.

Figure 11 plots a demand curve generated by the Unifier. If a 10 million barrel per day (MMBD) disruption were specified, the Unifier would indicate a clearing price of about \$70 at an elasticity of -0.155 . This is compared to about \$160 if the elasticity were constant at -0.1 , or almost \$50 if the elasticity were constant at -0.2 .

Table 4 is an example of the elasticity output the Unifier generates for various user-specified disruption sizes. For each disruption size, an annual average world total elasticity is first determined, then annual averages for the United States and rest of the world (Other) are determined as demand weighted averages of the total. Since DIS models quarterly disruptions, quarterly elasticity estimates are made using the lagged adjustment curve. The level of uncertainty surrounding these midpoint elasticity estimates is assumed to be fairly high and is estimated at 25 percent on the high and low sides to create a range of elasticities. The assumption is based on the uncertainties found in

Figure 11

DIS Crude Elasticity Curve

other surveys which range from 25 to 50 percent. (Table 5)

The elasticities generated by the Unifier for the SPR Sizing Study can be found at A1 through AX403 in the elasticity spreadsheet used by the "extended" DIS model in this study.

Table 4
Unifier Output at Different Disruption Sizes
Year 1990

			<u>Quarterly Elasticities</u>			
<u>Base Case* (Base Price = \$15.00)</u>			<u>1st Q</u>	<u>2nd Q</u>	<u>3rd Q</u>	<u>4th Q</u>
Total Avg.	-0.095	Other High	-0.099	-0.111	-0.123	-0.135
Other Avg.	-0.094	Other Low	-0.060	-0.067	-0.074	-0.081
U.S. Avg.	-0.097	U.S. High	-0.103	-0.115	-0.127	-0.139
Demand	47.547	U.S. Low	-0.062	-0.069	-0.076	-0.084
<u>Disruption Size = 5</u>			<u>1st Q</u>	<u>2nd Q</u>	<u>3rd Q</u>	<u>4th Q</u>
Total Avg.	-0.126	Other High	-0.132	-0.148	-0.163	-0.179
Other Avg.	-0.124	Other Low	-0.079	-0.089	-0.098	-0.107
U.S. Avg.	-0.129	U.S. High	-0.137	-0.153	-0.169	-0.185
Demand	42.647	U.S. Low	-0.082	-0.092	-0.101	-0.111
<u>Disruption Size = 10</u>			<u>1st Q</u>	<u>2nd Q</u>	<u>3rd Q</u>	<u>4th Q</u>
Total Avg.	-0.155	Other High	-0.163	-0.182	-0.202	-0.221
Other Avg.	-0.154	Other Low	-0.098	-0.109	-0.121	-0.133
U.S. Avg.	-0.159	U.S. High	-0.169	-0.189	-0.209	-0.229
Demand	37.647	U.S. Low	-0.101	-0.113	-0.125	-0.137
<u>Disruption Size = 15</u>			<u>1st Q</u>	<u>2nd Q</u>	<u>3rd Q</u>	<u>4th Q</u>
Total Avg.	-0.185	Other High	-0.195	-0.218	-0.241	-0.264
Other Avg.	-0.183	Other Low	-0.117	-0.131	-0.144	-0.158
U.S. Avg.	-0.190	U.S. High	-0.202	-0.225	-0.249	-0.273
Demand	32.647	U.S. Low	-0.121	-0.135	-0.149	-0.164
<u>Disruption Size = 20</u>			<u>1st Q</u>	<u>2nd Q</u>	<u>3rd Q</u>	<u>4th Q</u>
Total Avg.	-0.218	Other High	-0.229	-0.256	-0.283	-0.310
Other Avg.	-0.216	Other Low	-0.137	-0.154	-0.170	-0.186
U.S. Avg.	-0.223	U.S. High	-0.237	-0.265	-0.293	-0.321
Demand	27.647	U.S. Low	-0.142	-0.159	-0.176	-0.193

* Note: Crude elasticities differ significantly depending on starting reference/base price and demand levels.

Table 5

Comparison of Studies On Crude Oil Price Elasticities

	<u>OMB^a</u>	<u>Stanford^b</u>	<u>OMS/DIS^c</u>	
Crude Prices	\$35.00	\$15.00	\$35.00	\$15.00
Mean Elasticity	0.160	0.101	0.129	0.097
High Elasticity	0.24	-	0.161	0.121
Low Elasticity	0.08	-	0.096	0.073

^a Survey of Demand Elasticity Studies and Development of a Plausible Range of Estimates for Crude Oil; Office of Management and Budget; 1986

^b Short Run Price Elasticity of Crude Oil Demand; Stanford University; October, 1989

^c Crude Oil Demand Elasticities from the Oil Market Simulation and Disruption Impact Simulator Model

Notes

- 1) The OMB elasticities were averaged from a series of different studies. The time periods of these studies range from 1929 to 1981.
- 2) All analyses assume the crude price elasticity is approximately equal to the product price elasticity multiplied by the ratio of crude to product prices.
- 3) All analyses assume a constant retail price markup.
- 4) Estimates of elasticities listed consider the United States only.

5. Economic Benefits and Costs

The analysis is concerned with incremental benefits and costs of alternative size SPR systems. Due to the greater price reducing potential, larger size systems would lead to lower economic losses during a disruption, or larger incremental benefits and also larger economic costs.

Benefits

The economic benefit of releasing SPR oil stocks is based on the analysis performed by the T2/T3 working group (which consists of the Department of Treasury, Council of Economic Advisers, and Office of Management and Budget). Their analysis, Macroeconomic Impact of an Oil Supply Disruption, November 27, 1989 (See Appendix A), describes two components of the total effect of an oil market disruption on the U.S. economy. The economic benefit of releasing SPR stocks is derived from its limiting effect on potential price increases. Price increases that are not offset by other policy responses have a negative impact on GNP due to adjustment costs imposed on the economy caused primarily by the sluggishness of the labor market and through the net loss in domestic producers' and consumers' surplus (which includes the terms of trade effect). Gains accrue to producers and losses are incurred by consumers. Since the United States is a net importer, the loss exceeds the gain. Further reducing the overall loss during an oil disruption are receipts from the sale of the SPR oil. In addition, the post-2020 salvage value of SPR oil is considered a benefit but is treated separately and not included in the benefit estimates in this analysis.

The GNP impact is estimated using a simple relationship of GNP with respect to oil price changes. That is,

$$(7) \quad \text{GNP}_d = \text{GNP}_b * (P_d/P_b)^e$$

where P_d is the price of oil as a result of the oil disruption reduced by the amount of SPR oil drawn for a given SPR system;

P_b is the price of oil before the disruption for a given SPR system;

e is the elasticity of GNP to oil price changes; and GNP is the quarterly rate (not annual) in constant 1988 dollars.

As described in the T2/T3 working group analysis, this negative impact on GNP is assumed to persist only for the duration of the disruption. The economic feedback parameter (e) is estimated to range between -0.02 and -0.04 with a mid case estimate of -0.025. (These estimates are consistent with a wide range of studies as discussed in the T2/T3 analysis.)

Benefits arising from producers' and consumers' surplus are estimated using price and oil import levels underlying the oil demand functions and range of demand elasticities assumed for the study. Domestic oil production surge due to higher prices is treated separately and included in the excess capacity offset assumptions (Section 7). The calculation of incremental system benefits will not be affected since the domestic oil surge benefit is the same under the alternative systems. The greater the demand elasticity (in absolute value), the less the extent that price will increase and the less will be the loss in consumers' surplus (and, coincidentally, the reduction of GNP). This loss is incurred as long as price is above base case levels even though the disruption may have ended. World oil prices during the hypothetical disruption are calculated as market-clearing prices after offsetting assumptions (such as surge production). Following the end of the disruption, price is assumed to decline at a rate of about 38 percent (of the difference from the base case) per quarter.

Figure 12 illustrates graphically the components used to compute net surplus loss. By area, the calculation:

<u>Area</u>	<u>Component</u>
B+C	Terms-of-Trade Deterioration
+D	Economic Efficiency Loss
-(B+E)	SPR Receipts
<u>C+D-E</u>	Surplus Loss

The model calculates the value of this loss explicitly; however, it can be approximated using the average of pre-and post-shock oil import levels multiplied by the change in price less receipts from the sale of SPR oil using:

$$(8) \quad TTL = (P_a - P_b) * (I_a + I_b) / 2 - P_b * SPR$$

The total loss of the disruption includes both the GNP loss (macro effect) and the net consumers' surplus loss (micro effect). The economic benefit of the alternative systems is the difference in total loss, referred to as gross benefit. Finally the benefits are discounted to present value and weighted by the probability of the occurrence of a given size disruption.

Costs

The cost of filling the SPR includes the acquisition cost of the oil and capital cost to acquire storage capacity. For this study any additional maintenance costs associated with the larger system is assumed to be zero. Further, capital costs for the 750 MMB size is assumed to be zero since this system has already been planned.

Figure 12

Loss Due to Disruption

The incremental capital cost of the 1000 MMB system relative to the 750 MMB system is taken from the Oak Ridge study, footnoted in Section 2.

Tables 6 through 9 contain estimates of incremental capital costs and the developmental schedule for filling the 750 and 1000 MMB systems. The fill schedule varies with the fill rate assumed. For the mid case, a fill rate of 75 thousand barrels per day is assumed. Sensitivities were examined using alternative fill rates of 50 and 100 thousand barrels per day.

These costs (C) are summed and discounted (DC) using:

$$(9) \text{ DC} = C/(1+DR)^t$$

Salvage Value and Import Cost

The salvage value of oil remaining after a partial drawdown of the SPR and the impact on world oil price of filling the SPR are treated separately in the analysis and are never included in either the cost or benefit estimates. Salvage value could be viewed as an economic benefit since it would offset some of the costs of the original oil in the context of a cost-benefit analysis. The impact on world oil prices due to filling the SPR at alternative fill rate assumptions is estimated using the EIA's OMS model. Depending on the fill rate, the impact on world oil price ranges between 10 to 15 cents per barrel. This higher price is applied to total imports (since the costs of all imports would be paid at the higher price) to obtain the incremental costs. Tables 10 and 11 provides the range of estimates for salvage value and costs associated with different fill rates.

Table 6. SPR Fill Schedule and Costs
Post 1989
750 MMB System

Mid Price Case

Year	Fill Rate = 50 MBD				Fill Rate = 75 MBD				Fill Rate = 100 MBD			
	Capital	Year End	SPR Fill	Cumulative	Year End	SPR Fill	Cumulative	Year End	SPR Fill	Cumulative		
	Cost	SPR Level	Cost	Discounted	SPR Level	Cost	Discounted	SPR Level	Cost	Discounted		
	(1988 \$)	(MMB)	(1988 \$)	Cost	(MMB)	(1988 \$)	Cost	(MMB)	(1988 \$)	Cost		
1989		582			582			582				
1990	0	600	274	274	609	411	411	619	548	548		
1991	0	619	283	531	637	424	796	655	566	1062		
1992	0	637	291	771	664	436	1157	692	582	1543		
1993	0	655	312	1006	692	468	1509	728	624	2012		
1994	0	673	345	1241	719	517	1862	750	414	2294		
1995	0	692	376	1475	746	564	2212	750	0	2294		
1996	0	710	412	1707	750	83	2259	750	0	2294		
1997	0	728	443	1935	750	0	2259	750	0	2294		
1998	0	746	475	2156	750	0	2259	750	0	2294		
1999	0	750	99	2198	750	0	2259	750	0	2294		

Low Price Case

Year	Fill Rate = 50 MBD				Fill Rate = 75 MBD				Fill Rate = 100 MBD			
	Capital	Year End	SPR Fill	Cumulative	Year End	SPR Fill	Cumulative	Year End	SPR Fill	Cumulative		
	Cost	SPR Level	Cost	Discounted	SPR Level	Cost	Discounted	SPR Level	Cost	Discounted		
	(1988 \$)	(MMB)	(1988 \$)	Cost	(MMB)	(1988 \$)	Cost	(MMB)	(1988 \$)	Cost		
1989		582			582			582				
1990	0	600	235	235	609	353	353	619	471	471		
1991	0	619	245	458	637	367	687	655	489	915		
1992	0	637	253	666	664	379	1000	692	505	1333		
1993	0	655	270	869	692	405	1304	728	540	1739		
1994	0	673	288	1066	719	433	1599	750	346	1975		
1995	0	692	305	1256	746	457	1883	750	0	1975		
1996	0	710	324	1438	750	65	1920	750	0	1975		
1997	0	728	341	1614	750	0	1920	750	0	1975		
1998	0	746	356	1780	750	0	1920	750	0	1975		
1999	0	750	74	1811	750	0	1920	750	0	1975		

High Price Case

Year	Fill Rate = 50 MBD				Fill Rate = 75 MBD				Fill Rate = 100 MBD			
	Capital	Year End	SPR Fill	Cumulative	Year End	SPR Fill	Cumulative	Year End	SPR Fill	Cumulative		
	Cost	SPR Level	Cost	Discounted	SPR Level	Cost	Discounted	SPR Level	Cost	Discounted		
	(1988 \$)	(MMB)	(1988 \$)	Cost	(MMB)	(1988 \$)	Cost	(MMB)	(1988 \$)	Cost		
1989		582			582			582				
1990	0	600	329	329	609	493	493	619	657	657		
1991	0	619	349	645	637	523	968	655	697	1291		
1992	0	637	370	951	664	554	1426	692	739	1902		
1993	0	655	387	1242	692	580	1862	728	774	2483		
1994	0	673	416	1526	719	624	2289	750	499	2824		
1995	0	692	445	1802	746	668	2703	750	0	2824		
1996	0	710	485	2076	750	97	2758	750	0	2824		
1997	0	728	522	2344	750	0	2758	750	0	2824		
1998	0	746	562	2606	750	0	2758	750	0	2824		
1999	0	750	120	2657	750	0	2758	750	0	2824		

Table 7. SPR Fill Schedule and Costs
Post 1989
1000 MMB System

Mid Price Case												
	Fill Rate = 50 MBD				Fill Rate = 75 MBD				Fill Rate = 100 MBD			
	Capital	Year End	SPR Fill	Cumulative	Year End	SPR Fill	Cumulative	Year End	SPR Fill	Cumulative		
	Cost	SPR Level	Cost	Discounted	SPR Level	Cost	Discounted	SPR Level	Cost	Discounted		
Year	(1988 \$)	(MMB)	(1988 \$)	Cost	(MMB)	(1988 \$)	Cost	(MMB)	(1988 \$)	Cost		
====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====		
1989		582			582			582				
1990	30	600	274	304	609	411	441	619	548	578		
1991	60	619	283	615	637	424	881	655	566	1146		
1992	110	637	291	947	664	436	1333	692	582	1718		
1993	200	655	312	1332	692	468	1834	728	624	2337		
1994	220	673	345	1717	719	517	2338	765	690	2959		
1995	190	692	376	2069	746	564	2806	801	752	3544		
1996	120	710	412	2369	774	618	3223	838	824	4076		
1997	70	728	443	2632	801	665	3600	874	887	4567		
1998	0	746	475	2854	829	712	3932	911	949	5010		
1999	0	765	495	3064	856	742	4247	947	989	5430		
2000	0	783	512	3261	883	769	4543	984	1025	5825		
2001	0	801	535	3449	911	802	4824	1000	475	5991		
2002	0	819	557	3626	938	835	5090	1000	0	5991		
2003	0	838	575	3792	965	862	5340	1000	0	5991		
2004	0	856	593	3949	993	889	5574	1000	0	5991		
2005	0	874	610	4094	1000	236	5631	1000	0	5991		
2006	0	892	624	4230	1000	0	5631	1000	0	5991		
2007	0	911	637	4356	1000	0	5631	1000	0	5991		
2008	0	929	653	4474	1000	0	5631	1000	0	5991		
2009	0	947	664	4582	1000	0	5631	1000	0	5991		
2010	0	965	679	4683	1000	0	5631	1000	0	5991		
2011	0	984	692	4777	1000	0	5631	1000	0	5991		
2012	0	1000	626	4854	1000	0	5631	1000	0	5991		

Table 8. SPR Fill Schedule and Costs
Post 1989
1000 MMB System

Low Price Case											
	Fill Rate = 50 MBD				Fill Rate = 75 MBD				Fill Rate = 100 MBD		
	Capital	Year End	SPR Fill	Cumulative	Year End	SPR Fill	Cumulative	Year End	SPR Fill	Cumulative	
	Cost	SPR Level	Cost	Discounted	SPR Level	Cost	Discounted	SPR Level	Cost	Discounted	
Year	(1988 \$)	(MMB)	(1988 \$)	Cost	(MMB)	(1988 \$)	Cost	(MMB)	(1988 \$)	Cost	
====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	
1989		582			582			582			
1990	30	600	235	265	609	353	383	619	471	501	
1991	60	619	245	542	637	367	771	655	489	1000	
1992	110	637	253	842	664	379	1175	692	505	1508	
1993	200	655	270	1195	692	405	1630	728	540	2064	
1994	220	673	288	1542	719	433	2075	765	577	2609	
1995	190	692	305	1850	746	457	2477	801	610	3105	
1996	120	710	324	2100	774	486	2811	838	648	3539	
1997	70	728	341	2311	801	512	3118	874	683	3925	
1998	0	746	356	2477	829	534	3367	911	712	4257	
1999	0	765	372	2635	856	558	3604	947	745	4573	
2000	0	783	397	2788	883	596	3833	984	794	4879	
2001	0	801	409	2931	911	613	4048	1000	363	5006	
2002	0	819	422	3066	938	632	4250	1000	0	5006	
2003	0	838	433	3191	965	649	4438	1000	0	5006	
2004	0	856	443	3308	993	664	4613	1000	0	5006	
2005	0	874	453	3416	1000	175	4655	1000	0	5006	
2006	0	892	460	3516	1000	0	4655	1000	0	5006	
2007	0	911	465	3608	1000	0	4655	1000	0	5006	
2008	0	929	476	3694	1000	0	4655	1000	0	5006	
2009	0	947	482	3773	1000	0	4655	1000	0	5006	
2010	0	965	487	3845	1000	0	4655	1000	0	5006	
2011	0	984	495	3912	1000	0	4655	1000	0	5006	
2012	0	1000	447	3967	1000	0	4655	1000	0	5006	

Table 9. SPR Fill Schedule and Costs
Post 1989
1000 MMB System

High Price Case											
	Fill Rate = 50 MBD				Fill Rate = 75 MBD				Fill Rate = 100 MBD		
	Capital	Year End	SPR Fill	Cumulative	Year End	SPR Fill	Cumulative	Year End	SPR Fill	Cumulative	
	Cost	SPR Level	Cost	Discounted	SPR Level	Cost	Discounted	SPR Level	Cost	Discounted	
Year	(1988 \$)	(MMB)	(1988 \$)	Cost	(MMB)	(1988 \$)	Cost	(MMB)	(1988 \$)	Cost	
====	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====	
1989		582			582			582			
1990	30	600	329	359	609	493	523	619	657	687	
1991	60	619	349	730	637	523	1053	655	697	1375	
1992	110	637	370	1126	664	554	1602	692	739	2077	
1993	200	655	387	1567	692	580	2188	728	774	2809	
1994	220	673	416	2002	719	624	2765	765	832	3528	
1995	190	692	445	2396	746	668	3297	801	891	4199	
1996	120	710	485	2738	774	727	3776	838	970	4814	
1997	70	728	522	3041	801	783	4213	874	1044	5385	
1998	0	746	562	3304	829	843	4607	911	1124	5910	
1999	0	765	600	3558	856	901	4989	947	1201	6419	
2000	0	783	640	3805	883	961	5359	984	1281	6913	
2001	0	801	668	4039	911	1002	5710	1000	593	7121	
2002	0	819	692	4260	938	1038	6041	1000	0	7121	
2003	0	838	717	4468	965	1076	6352	1000	0	7121	
2004	0	856	743	4663	993	1114	6646	1000	0	7121	
2005	0	874	767	4847	1000	297	6717	1000	0	7121	
2006	0	892	787	5018	1000	0	6717	1000	0	7121	
2007	0	911	808	5178	1000	0	6717	1000	0	7121	
2008	0	929	831	5327	1000	0	6717	1000	0	7121	
2009	0	947	849	5466	1000	0	6717	1000	0	7121	
2010	0	965	872	5596	1000	0	6717	1000	0	7121	
2011	0	984	889	5716	1000	0	6717	1000	0	7121	
2012	0	1000	803	5814	1000	0	6717	1000	0	7121	

Table 10. Salvage Value and Increased Import Cost

750 / 1000 Increment

Discount Rate = 0.08		
	Post-2020 Salvage Value	Increased Import Cost Due To Incremental Fill
Low Price Case	\$ 598.1	\$ 1,175.5
Mid Price Case	\$ 865.0	\$ 1,027.4
High Price Case	\$ 1,131.1	\$ 870.4

Discount Rate = 0.1		
	Post-2020 Salvage Value	Increased Import Cost Due To Incremental Fill
Low Price Case	\$ 344.9	\$ 1,110.5
Mid Price Case	\$ 498.8	\$ 969.8
High Price Case	\$ 652.3	\$ 824.0

Discount Rate = 0.12		
	Post-2020 Salvage Value	Increased Import Cost Due To Incremental Fill
Low Price Case	\$ 200.9	\$ 1,027.1
Mid Price Case	\$ 290.5	\$ 896.6
High Price Case	\$ 379.9	\$ 763.4

Note: Salvage Value and Import Cost are in Millions of 1988
Discounted Dollars.

Table 11. Salvage Value and Increased Import Cost

600 / 750 Increment

Discount Rate = 0.08		
	Post-2020 Salvage Value	Increased Import Cost Due To Incremental Fill
Low Price Case	\$ 338.2	\$ 296.2
Mid Price Case	\$ 489.1	\$ 353.3
High Price Case	\$ 639.5	\$ 341.9

Discount Rate = 0.1		
	Post-2020 Salvage Value	Increased Import Cost Due To Incremental Fill
Low Price Case	\$ 195.0	\$ 371.9
Mid Price Case	\$ 282.0	\$ 414.0
High Price Case	\$ 368.8	\$ 391.6

Discount Rate = 0.12		
	Post-2020 Salvage Value	Increased Import Cost Due To Incremental Fill
Low Price Case	\$ 113.6	\$ 431.5
Mid Price Case	\$ 164.3	\$ 461.2
High Price Case	\$ 214.8	\$ 430.0

Note: Salvage Value and Import Cost are in Millions of 1988 Discounted Dollars.

6. Probability Analysis

Over the last 40 years there have been about 13 oil supply disruptions of greater than 1 percent of consumption. Therefore, in any given year there is some probability of having a disruption. This section describes how the frequency distribution of having a disruption of a specific size was developed. This distribution is critical to the analysis because it is used to develop weights, which are applied to the benefits described in the previous sections.

Several steps are used to develop the probability density function used in the analysis. First the type of function must be chosen. Several functional forms including the polynomial, exponential, and Weibull were examined. Trial fits of several skewed distributions indicated that the range of shapes offered by the Weibull distribution provided the best match to the historical data. This distribution is relatively robust with respect to the process or processes that underlie the data. It requires no particular probability structure and tends to conform to the data rather than to any prior assumptions. It is often chosen to represent data with an unknown degree of skewness where the probability structure of the underlying processes cannot be specified with confidence, e.g., extreme value estimation or life-testing with complex failure modes. It was determined that the Weibull distribution was an appropriate distribution because it was widely used to describe a worst case event which had a low probability of occurring. However, there are some limitations to the use of the Weibull against the 1950 to 1989 gross disruption data primarily in the application of equal weights to all historical events, and in the assumption that a single process generated all the historical events, which was high unlikely.

Mid Probability Case

Two critical parameters of this distribution must be estimated. These are the shape and scale parameters (discussed in more detail below). The values for the parameters were estimated so that:

- The frequency of a gross disruption of 1 percent of consumption or greater was 32.5 percent. This percentage is consistent with historic data (13 in 40 years).
- The probability in any given year of having a "moderate to severe" disruption is 1 percent or less and declines over time. This is based on expert opinion.
- The distribution provided a good fit of actual disruption data over the last 40 years.

The functional form of the Weibull probability density function is:

$$(10) \quad f(x) = c/a \{(x/a)^{c-1}\} * \exp [-(x/a)^c]$$

which gives a standard "at most" cumulative distribution function of the form:

$$(11) \quad F(x) = \Pr [X < x] = 1 - \exp [-(x/a)^c]$$

or an "at least" function of:

$$(12) \quad F(x) = \Pr [X > x] = \exp [-(x/a)^c].$$

The "at least", also known as the survival form of this distribution function was the form focused on in this analysis. That is, the probability that a disruption will be "at least" as large as some critical value is examined. In order to estimate the scale (a) and shape (c) parameters, the function was fitted to the two points mentioned above for the mid probability case.

The first point that the function was forced to pass through was estimated based on the historic frequency of a gross disruption size "at least" equal to or greater than 1 percent of consumption. Based on a study of gross disruptions in oil supply over the last 40 years, there have been 13 occurrences of at least this size (see Table 12).

The second frequency point agreed on by the SPR sizing study group was based on expert opinion, which defined possible "moderate" disruptions over the period from 1995 to 2010. The least severe moderate disruption resulted in a supply loss of 15 percent of forecast consumption. The probability of such a gross disruption of 15 percent or greater was assessed to be 1 percent per year in the mid probability case.

The scale (a) and the shape (c) parameters estimated for the mid case projection are:

$$\begin{array}{l} \text{Mid} \\ a = 0.799050 \\ c = 0.520798 \end{array}$$

Using these a and c values and the Weibull "at least" distribution provides the cumulative probability of a disruption of at least a given percent of consumption occurring in a given year (See Table 13). The "at least" form of the equation is simply one minus the form usually discussed. At the first point used in the estimation, for example, there is a 32.5 percent chance of a disruption of 1 percent or greater. Therefore, a 67.5 percent chance of disruptions less than 1 percent (including 0) exists.

Table 12
World Oil Supply Disruptions
1951-1989
(Million Barrels per Day)

Dates -----	Supply Disruption -----	Gross Shortfall -----	Free World Oil Demand -----	Percent Demand -----
March 1951-October 1954	Iranian Fields Nationalized	0.7	9.9	7.10
November 1956-March 1957	Suez War	2.0	15.8	12.70
December 1966-March 1967	Syrian Transit Fee Dispute	0.7	30.2	2.30
June 1967-August 1967	Six Day War	2.0	31.2	6.40
July 1967-October 1968	Nigerian Civil War	0.5	32.6	1.50
May 1970-January 1971	Libyan Price Controversy	1.3	40.0	3.25
April 1971-August 1971	Algerian-French Nationalization Struggle	0.6	42.1	1.40
March 1973-May 1973	Lebanese Political Conflict	0.5	48.5	1.00
October 1973-March 1974	October Arab-Israeli War	1.6	47.7	3.40
April 1976-May 1976	Civil War in Lebanon	0.3	48.5	0.62
May 1977	Damage at Saudi Oilfield	0.7	48.3	1.40
November 1978-April 1979	Iranian Revolution	3.7	52.8	7.00
October 1980-January 1981	Outbreak of Iran-Iraq War	3.0	50.4	6.00
July 1988-November 1989	UK Piper Alpha Offshore Platform Explosion	0.3	51.3	0.58
December 1988-March 1989	UK Fulmer Floating Storage Vessel Accident	0.2	52.4	0.38
April 1989-June 1989	UK Cormorant Offshore Platform	0.5	49.9	1.00

Table 13

WEIBULL CUMULATIVE PROBABILITIES FOR SPR SIZING STUDY

Disruption Size Percent of Consumption	High Probability		Mid Probability		Low Probability	
	at		at		at	
	least	most	least	most	least	most
0.5	0.4493	0.5507	0.4569	0.5431	0.4690	0.5310
1	0.3250	0.6750	0.3250	0.6750	0.3250	0.6750
1.5	0.2538	0.7462	0.2495	0.7505	0.2427	0.7573
2	0.2062	0.7938	0.1994	0.8006	0.1886	0.8114
2.5	0.1718	0.8282	0.1634	0.8366	0.1504	0.8496
3	0.1457	0.8543	0.1365	0.8635	0.1222	0.8778
3.5	0.1253	0.8747	0.1155	0.8845	0.1008	0.8992
4	0.1088	0.8912	0.0989	0.9011	0.0840	0.9160
4.5	0.0954	0.9046	0.0854	0.9146	0.0708	0.9292
5	0.0842	0.9158	0.0744	0.9256	0.0601	0.9399
5.5	0.0748	0.9252	0.0652	0.9348	0.0514	0.9486
6	0.0668	0.9332	0.0574	0.9426	0.0442	0.9558
6.5	0.0600	0.9400	0.0508	0.9492	0.0382	0.9618
7	0.0540	0.9460	0.0452	0.9548	0.0332	0.9668
7.5	0.0489	0.9511	0.0404	0.9596	0.0289	0.9711
8	0.0443	0.9557	0.0362	0.9638	0.0253	0.9747
8.5	0.0404	0.9596	0.0325	0.9675	0.0223	0.9777
9	0.0368	0.9632	0.0293	0.9707	0.0196	0.9804
9.5	0.0337	0.9663	0.0265	0.9735	0.0174	0.9826
10	0.0309	0.9691	0.0240	0.9760	0.0154	0.9846
10.5	0.0284	0.9716	0.0218	0.9782	0.0137	0.9863
11	0.0262	0.9738	0.0199	0.9801	0.0122	0.9878
11.5	0.0242	0.9758	0.0181	0.9819	0.0109	0.9891
12	0.0223	0.9777	0.0166	0.9834	0.0097	0.9903
12.5	0.0207	0.9793	0.0152	0.9848	0.0087	0.9913
13	0.0192	0.9808	0.0139	0.9861	0.0078	0.9922
13.5	0.0178	0.9822	0.0128	0.9872	0.0071	0.9929
14	0.0166	0.9834	0.0118	0.9882	0.0064	0.9936
14.5	0.0154	0.9846	0.0108	0.9892	0.0058	0.9942
15	0.0144	0.9856	0.0100	0.9900	0.0052	0.9948
15.5	0.0134	0.9866	0.0092	0.9908	0.0047	0.9953
16	0.0126	0.9874	0.0085	0.9915	0.0043	0.9957
16.5	0.0118	0.9882	0.0079	0.9921	0.0039	0.9961
17	0.0110	0.9890	0.0073	0.9927	0.0035	0.9965
17.5	0.0103	0.9897	0.0068	0.9932	0.0032	0.9968
18	0.0097	0.9903	0.0063	0.9937	0.0029	0.9971
18.5	0.0091	0.9909	0.0059	0.9941	0.0027	0.9973
19	0.0086	0.9914	0.0055	0.9945	0.0024	0.9976
19.5	0.0080	0.9920	0.0051	0.9949	0.0022	0.9978
20	0.0076	0.9924	0.0048	0.9952	0.0020	0.9980
20.5	0.0071	0.9929	0.0044	0.9956	0.0019	0.9981
21	0.0067	0.9933	0.0041	0.9959	0.0017	0.9983
21.5	0.0064	0.9936	0.0039	0.9961	0.0016	0.9984
22	0.0060	0.9940	0.0036	0.9964	0.0014	0.9986
22.5	0.0057	0.9943	0.0034	0.9966	0.0013	0.9987
23	0.0054	0.9946	0.0032	0.9968	0.0012	0.9988
PARAMETERS						
Scale	A = 0.787991		A = 0.799050		A = 0.814623	
Shape	C = 0.490336		C = 0.520798		C = 0.569829	

Goodness-of-Fit Test

Figure 13 shows the relationship of this mid probability curve to the historical record, and the uncertainties surrounding that record. These uncertainties arise from two sources:

- o the small number and limited size of historical disruptions; and
- o the possible differences between the historical period and the future period of interest for this study.

The tool chosen to evaluate the historical fit is the Kolmogorov-Smirnov (K-S) statistic. This statistic is designed to measure goodness-of-fit directly from distribution functions. It permits calculation of confidence regions from the actual data, works well with observations that are not evenly spaced, and adapts easily to truncated distributions. (NOTE: all of the data and distributions used in the analysis are truncated on the left -- only disruptions whose gross size exceeds about 1/2 percent of free-world consumption are considered.)

The two "stairstep" functions in Figure 13 are boundaries of the 95 percent confidence region determined from the 40-year empirical distribution function using the K-S statistic. The region is determined by setting the permissible vertical deviation from the empirical (sample) distribution over the range covered by the observations to a value derived from the 0.05 critical point of this statistic. Any curve that fits the data should fall entirely within this region; curves that fit the data well will pass through the middle of the region. The region is also bounded above by the value 1.0 (since all the functions are distribution functions). The vertical dashed line is included in the figure since the K-S, or any other goodness-of-fit statistic, can only be calculated for actual sample points, and thus gives no further information about the extrapolated tail.

The width of the confidence region (indicating large uncertainty) is due to the small number of disruption events that have occurred in the last 40 years, and to the relatively small size of these events compared to those of interest in the future for this SPR study. The absence of extremely large events in this period can be used to set some rough bounds on their probability of occurrence (i.e., the amount of probability in the extrapolated tail) as indicated below. Though free world consumption increased about five-fold during this period, the size distribution has been normalized by expressing the size of the gross disruptions as a percentage of free world consumption at the time the disruption occurred.

The two lower smooth curves in Figure 13 are the Weibull distributions that best fit the data in the first and second half of the historical period. The early (1950-1969) period was

Figure 13

WEIBULL DISTRIBUTION (Tail Only) Fitted to Gross Disruptions for 1950-1989

characterized by U.S. dominance of petroleum production, while the later (1970-1989) period was dominated by OPEC. The lowest curve is the Weibull distribution which is derived by minimizing the K-S statistic without any restriction for the five disruption events that occurred between 1950 and 1969. The middle curve was derived by minimizing the same goodness-of-fit statistic over the ten more recent disruption events that occurred between 1970 and 1989. NOTE: the lowest curve should be used with caution; the two largest disruptions in this period were quite modest by current standards, but were scaled up because of very low consumption at the time they occurred.

The upper curve in Figure 13 was derived by fitting a Weibull distribution to the two points discussed above for the mid probability case. Note that the three curves are similar on the left hand side of the figure. The probabilities of a disruption larger than 1 percent of free world consumption implied by the best-fitting curves (31 percent and 34 percent for curves fitted to the 1950-69 and 1970-89 data points) are very close to the 32.5 percent value, which was based on all 40 years of historic data and used for the mid case. In any case, because of the limited number of observations the K-S statistic suggests that a wide range of distributions (even outside of the high and low probabilities considered in this analysis) could be accepted if one were to rely solely on the data.

To test the uncertainty in the upper point which was used in the mid probability case (gross disruption of 15 percent has a 1 percent chance to occur), distributions bracketing that point were used to calculate the implied probability of hypothetical future events larger than any in the historical record. The set of projected probabilities derived from each curve was compared with the likelihood of such events by a panel of petroleum experts who selected a range of estimated probabilities consistent with their judgement. In this manner, a middle curve bracketed by two sensitivity curves was chosen to fit both the historical record and expert judgment concerning larger, unobserved events. The sensitivity curve with higher tail probabilities is very close to the distribution that provided the best fit to events in the last 20 years. This is consistent with the judgement of experts that the probability of extreme events will decrease slightly in the future.

As larger probabilities for extreme events are considered, the odds that such large disruptions would have been seen during the last 40 years also increases. For the lowest smooth curve in Figure 4 (representing 1950-1969), the odds are about 4 to 1 that an extreme event would have been observed already. For the middle curve in that figure (representing 1970-1989), there is a 50/50 chance that an extreme disruption would have been observed already during the 40 year historical period. In other words, if the 1950-1969 pattern had persisted into the OPEC era, much larger disruptions in recent history should have already been seen.

Low and High Probability Ranges

If 15 percent or greater disruptions have a 1 percent probability of occurring in a year, they have a 13 percent chance of occurrence over the next 15 years. To develop a range at the 15 percent disruption level, it was assumed that over the next 15 years a chance of plus or minus roughly 5 percent on either side of the mid probability case be used to determine the ranges. The range implied by these assumptions was determined to be consistent with the judgement of experts concerning the probability of a future gross disruption in the 15-year period from 1995-2010. The scale and shape parameters for the high and low probability curves are:

<u>Low</u>	<u>High</u>
a = 0.814623	a = 0.787991
c = 0.569829	c = 0.490336

The curves are pictured in Figure 14. Figure 15 shows the probabilities over the next 15 years of gross disruptions occurring which are 10 percent of consumption or greater, 15 percent or greater, and 20 percent or greater for each of the three probability cases. As can be seen, the range of plus or minus 5 percent from the mid probability case results in an 7 to 17 percent chance that a disruption of 15 percent of consumption will occur over a 15-year period.

These probabilities are used to weight (multiply) the benefits at various disruption scenarios analyzed. As a net disruption size is determined, and as it differs by 500 thousand barrels per day, its percent of consumption is calculated and the appropriate probability from Table 13 is then multiplied by the benefits to arrive at probability weighted benefits for that case.

Multiple Worst Case Disruptions and Scenarios

Probabilities used in this analysis are probabilities PER UNIT OF TIME -- they do not rule out any combination of frequencies over multiples of that time unit.

Frequency calculations are done with respect to some threshold -- and give the probability of one or two or three (or more) events in a span of N years. In the 15 year ("mid") example we looked at:

$$\begin{aligned}P(\text{no events} > X) &= .9000 \\P(\text{one or more events} > X) &= .1000\end{aligned}$$

Figure 14

The second probability can be broken down further:

$$\begin{aligned} P(\text{exactly one event} > X) &= .0952 \\ P(\text{exactly two events} > X) &= .0047 \\ P(3 \text{ or more events} > X) &= .0001 \end{aligned}$$

This example can be run out to 30 years as follows:

$$\begin{aligned} P(0 \text{ events} > X) &= .8100 \\ P(1 \text{ event} > X) &= .1713 \\ P(2 \text{ events} > X) &= .0175 \\ P(2+ \text{ events} > X) &= .0012 \end{aligned}$$

Again the single events dominate because the high threshold for incremental benefits forces X into the 1 percent annual probability range. In other words given the distribution adopted in the analysis the probability of having a multiple disruption over 30 years is less than 2 percent.

Figure 15

7. Offsetting Assumptions to Reduce Gross Disruption Size

Excess Production Capacity

A major offset to a disruption is the spare or **excess production capacity** which is forecast to be available outside of the area of the supply disruption. An assessment of the possible "moderate" to "worst" case oil supply disruptions through the year 2010 was provided by experts. Based on these definitions of possible supply disruption scenarios, and on assumptions of OPEC capacity utilization rates, excess capacity estimates were developed.

The **high** and **low** excess capacity assumptions were developed based on recent trends and forecasts of production capacity utilization in OPEC. For both high and low ranges the free world outside of OPEC, or non-OPEC, is assumed to be capable of at least 200,000 barrels per day of excess capacity from 1995 forward, and 500,000 barrels per day in 1990. OPEC, outside of disrupted areas, would provide the remaining excess production capacity forecast (See Table 14). All estimates were rounded to the nearest 500,000 barrels per day.

OPEC excess capacity for the forecast period was based on a review of recent trends (since the time that world petroleum demand has been increasing, as in the forecast period) in the relationship of OPEC production to OPEC capacity, or capacity utilization. The mid case forecast for 1990 to 2020 of OPEC capacity utilization was increased or decreased in each year by 5 percent (as recommended by experts) to arrive at the high and low excess capacity ranges. For the high excess capacity range, OPEC capacity utilization is assumed to be 5 percent lower than in the mid case, lower production results in higher excess capacity. Capacity utilization rates vary from 73 percent in 1990 to 90 percent in 2020 for the high end of the range. Combined with these assumptions of lower OPEC production, in order to get the highest excess capacity range the "moderate disruption" definition was used to determine the producing countries unaffected by the supply disruption.

The low excess capacity range was developed by adding 5 percent to the mid case OPEC capacity utilization estimates. So higher OPEC production (utilization rates of 83 to 100 percent) and a "worst case" disruption definition of countries affected results in the low excess capacity range. In all cases it is assumed that all available excess capacity is brought on line when the disruption begins.

Table 14
Disruption Offset Assumptions
(Million Barrels per Day)

Excess Capacity

	<u>1990</u>	<u>1995</u>	<u>2000</u>	<u>2005</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>
Low	3.5	3	2	1.5	0.5	0.5	0
Mid	5	6	5	4	3	2	1.5
High	6.5	6	5	4.5	4.0	3.5	3.5

Foreign Stock Draws

Low	1	1	2	2	2	2	2
Mid	2	2	3	3	3	3	3
High	2.5	2.5	3.5	3.5	3.5	3.5	3.5

Fuel Switching

0.5	0.35	0.35	0.35	0.35	0.35	0.35	0.35
-----	------	------	------	------	------	------	------

Total Offset Range
(Million Barrels per Day)

	<u>Low</u>	<u>Mid</u>	<u>High</u>
1990	5	7.5	9.5
1995	4.35	8.35	8.85
2000	4.35	8.35	8.85
2005	3.85	7.35	8.35
2010	2.85	6.35	7.85
2015	2.85	5.35	7.35
2020	2.35	4.85	7.35

Foreign Stock Draw/Fuel Switching Assumptions

Foreign governments' stock levels in the future are detailed in Chapter V of the SPR Sizing Study (not this service report) and are based on assumptions about stock building plans of those governments. The stock draw assumptions were decided on by the SPR sizing study group and in the high end of the range the drawdown rates (for 6 month periods) sometimes exceed the amount of stocks forecast to be held or controlled by allied governments. Hence, the drawdown rates are for foreign stocks and may include some commercial stock draws.

In the ongoing Interagency Study "An Energy Evaluation", most of the fuel switching potential from oil to gas is assumed to be in the United States and the assumption of 500 thousand barrels per day, from that study, is used for 1990. The fuel switching potential after 1990 is based on an EIA report "Estimates of Short-Term Petroleum Fuel Switching Capability" May 1989 DOE/EIA 0526. The switching capability for 6 months is currently assumed to be 350 to 620 thousand barrels per day of oil that could be displaced with natural gas. The bottom of that range is assumed in this analysis for 1995 through 2020.

Table 14 also provides a summary or total offset range, used in this analysis to offset a gross disruption. The total offsets are as low as 3 MMBD to as high as over 9.5 MMBD.

8. Summary Results of Sensitivity Analysis

Table 15 summarizes the results of the cost/benefit analysis. Under "Mid" assumptions across all variables, neither the 750 MMB to 1000 MMB increment nor the 600 MMB to 750 MMB increment exhibit a positive net benefit (gross benefit - incremental cost). The cost to benefit ratio for these "mid" cases is approximately 4.5:1 for the 750 MMB to 1000 MMB increment and 2:1 for the 600 MMB to 750 MMB increment.

A series of sensitivity cases was developed that investigated the effect on the gross benefit of varying a single parameter across its assumed range of values. While no single parameter sensitivity case resulted in a positive net benefit posture, it is important to note that certain parameters had a much more pronounced impact on the gross benefit than did others. The following table illustrates this fact for the sensitivity cases associated with the 750 MMB to 1000 MMB increment:

<u>Parameter</u>	<u>Setting</u>	<u>Percentage Increase From Mid Case</u>
Foreign Draw, Excess Capacity	Low	135.4
Disruption Duration	9 Months	97.4
Disruption Probability	High	50.4
Discount Rate	0.08	38.2
Demand Elasticity	Low	36.4
Feedback (GNP) Elasticity	-0.04	19.8
SPR Fill Rate	100 MBD	13.8
World Oil Price	High	6.2

<u>Parameter</u>	<u>Setting</u>	<u>Percentage Decrease From Mid Case</u>
Disruption Probability	Low	53.2
Foreign Draw, Excess Capacity	High	29.8
SPR Fill Rate	50 MBD	26.5
Discount Rate	0.12	25.3
Demand Elasticity	High	19.2
Feedback (GNP) Elasticity	-0.02	6.6
World Oil Price	Low	2.7

These percentages indicate that the incremental 250 MMB would be most beneficial as a measure that significantly reduces the economic loss associated with disruptions of longer duration and as a measure that protects against minimal cooperation from foreign governments in reducing the impacts of a disruption.

The remainder of the sensitivity cases examined the impacts on the gross benefit of combining several of the parameters at their extreme values. If all parameters are combined in a manner that would tend to maximize the gross benefit, it is not surprising that the net benefit is robustly positive. While such a case is academically interesting, the likelihood of such a biased combination of parameters is quite small. Of more interest are the

Table 15. Summary of Results

Mid Cases

=====

Case #	Demand Elasticity	Feedback Elasticity	World Oil Price	Offsets	Probability Curve	Size Comparison	Other	Gross Benefit	Incremental Cost
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
1	Mid	Mid	Mid	Mid	Mid	750/1000	...	0.7461	3.3716
2	Mid	Mid	Mid	Mid	Mid	600/750	...	0.9396	1.9890

Single Parameter Sensitivity Cases

=====

Case #	Demand Elasticity	Feedback Elasticity	World Oil Price	Offsets	Probability Curve	Size Comparison	Other	Gross Benefit	Incremental Cost
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
3	Mid	Low	Mid	Mid	Mid	750/1000	...	0.6966	3.3716
4	Mid	High	Mid	Mid	Mid	750/1000	...	0.8937	3.3716
5	Mid	Mid	Mid	Low	Mid	750/1000	...	1.7564	3.3716
6	Mid	Mid	Mid	High	Mid	750/1000	...	0.5239	3.3716
7	Low	Mid	Mid	Mid	Mid	750/1000	...	1.0176	3.3716
8	High	Mid	Mid	Mid	Mid	750/1000	...	0.6030	3.3716
9	Mid	Mid	Low	Mid	Mid	750/1000	...	0.7260	2.7346
10	Mid	Mid	High	Mid	Mid	750/1000	...	0.7924	3.9587
11	Mid	Mid	Mid	Mid	Low	750/1000	...	0.3493	3.3716
12	Mid	Mid	Mid	Mid	High	750/1000	...	1.1224	3.3716
13	Mid	Mid	Mid	Mid	Mid	600/1000	...	1.6574	5.3606
14	Mid	Mid	Mid	Mid	Mid	750/1000	Fill Rate @ 50 MBD	0.5485	2.6555
15	Mid	Mid	Mid	Mid	Mid	750/1000	Fill Rate @ 100 MBD	0.8494	3.6966
16	Mid	Mid	Mid	Mid	Mid	750/1000	Discount Rate @ 0.08	1.0310	3.9530
17	Mid	Mid	Mid	Mid	Mid	750/1000	Discount Rate @ 0.12	0.5576	2.8957
18	Mid	Mid	Mid	Mid	Mid	750/1000	9 Month Disruption	1.4725	3.3716
19	Mid	Mid	Mid	Mid	Mid	600/750	9 Month Disruption	1.5625	1.9890

Multiple Parameter Sensitivity Cases

=====

Case #	Demand Elasticity	Feedback Elasticity	World Oil Price	Offsets	Probability Curve	Size Comparison	Other	Gross Benefit	Incremental Cost
=====	=====	=====	=====	=====	=====	=====	=====	=====	=====
20	Low	High	Low	Low	High	750/1000	Discount Rate @ 0.08	5.5311	3.1878
21	Low	High	Low	Low	High	600/750	Discount Rate @ 0.08	7.1188	1.7770
22	High	Low	High	High	Low	750/1000	Discount Rate @ 0.12	0.1399	3.3849
23	High	Low	High	High	Low	600/750	Discount Rate @ 0.12	0.1997	2.3157
24	Low	High	Low	Low	High	750/1000	...	3.9665	2.7346
25	Low	High	Low	Low	High	600/750	...	5.5472	1.6879
26	High	Low	High	High	Low	750/1000	...	0.1809	3.9587
27	High	Low	High	High	Low	600/750	...	0.2424	2.4344
28	Low	High	Low	Low	High	750/1000	9 Month Disruption	7.2023	2.7346
29	Mid	Mid	Low	Low	Mid	750/1000	...	1.7120	2.7346
30	Mid	Mid	High	High	Mid	750/1000	...	0.5545	3.9587
31	Mid	Mid	Low	Low	Mid	750/1000	9 Month Disruption	3.3153	2.7346
32	Mid	Mid	Low	Low	Mid	600/750	9 Month Disruption	3.8912	1.6879
33	Mid	Mid	Low	...	Mid	750/1000	Low Excess/Mid Foreign	1.2963	2.7346
34	Mid	Mid	Low	...	Mid	750/1000	Low Excess/Mid Foreign/9 Month	2.7907	2.7346
35	Mid	Mid	Low	...	Mid	600/750	Low Excess/Mid Foreign/9 Month	3.3161	1.6879

Notes: Unless specified, Fill Rate = 75 MBD, Discount Rate = 0.1, and Disruption Duration = 6 Months.

Gross Benefit and Incremental Cost are in Billions of 1988 Discounted Dollars.

Gross Benefit is Probability Weighted.

Gross Benefit excludes Post-2020 Salvage Value of the SPR.

Incremental Cost excludes Increased Import Costs due to SPR Fill.

cases which vary only two or three parameters. For example, if low disruption offsets (low excess production capacity and low drawdown of foreign stocks) are combined with a longer disruption duration (9 months), a positive net benefit is achieved. Detailed results of all cases ("mid" and sensitivity) are presented in Appendix B of this report.

Figure 16

The benefit estimates were highly dependent on the assumptions made about discount rates and probability. The critical importance of these two factors resulted in additional analyses of their impact on these benefit estimates. Figure 16 examines an expanded range for discount rates from zero (no discounting) up to a rate of 12 percent. At the zero rate, gross benefits are somewhat less than \$6 billion compared to the mid case estimate of \$0.75 billion at a discount rate of 10 percent. Due to the shape of the curve, benefits are very sensitive to lower rates whereas higher rates have marginal impacts on gross benefits. Figure 17 examines the impact of varying the mid case probability assumption (of a disruption of "at least" 15 percent of consumption being 0.01) up to the probability level where gross benefits equal incremental costs. This probability for the severe disruption was near 0.044,

over four times the mid case probability assumption. As observed, gross benefits are very sensitive to changes in probability. However, while the change in probability appears to be small, it is a one-year probability. Figure 18 converts the one-year probability into the implied probability that such a severe disruption would occur within 15 years. For instance, the one year probability of .044 implies that a severe disruption has nearly a 50-50 chance of occurring once over the next 15 years.

Figure 17

Figure 18

Appendix A

Macroeconomic Impact of an Oil Supply Disruption

where P is the oil price, e is the elasticity, and 1 refers to the shock case and 0 to the base case. While there is some doubt about whether the response of GNP is log-linear, this seems a reasonable simplification.

To estimate the elasticity, we simulated a two-quarter oil price shock using the Meyer and Associates macro model and the DRI model. We therefore have evidence from two major macro models used by the Troika agencies. We also considered earlier outside results produced by the EMF-7 study and by Michael Darby.

Before presenting the estimates, a word of caution is necessary about the elasticities. The elasticity is defined as the cumulative impact on GNP per percent increase in oil price during the quarters of disruption, expressed as a percent of GNP during a disruption quarter. The response of GNP is therefore assumed to be proportional to the length of the disruption as well as the oil price increase. This formulation greatly facilitates the modeling of supply shocks. The lagged response of GNP (and possibly oil prices) is already taken into account in the elasticity parameter. To count additional cyclical effects after the disruption ends would be double counting.

For a 50 percent price increase sustained for two quarters, the Meyer model simulations give an elasticity of -.017 to -.023, depending on whether oil prices adjust quickly or slowly. In the DRI simulations, the elasticities range from -.031 to -.043 when oil prices adjust quickly or slowly, respectively.

For these two models, the constant elasticity formulation seems to be reasonable. Simulations with 100 percent price increases yielded similar elasticities.

Given the ranges of estimates and based on a review of the Darby and EMF-7 results, our recommendation is that a range of elasticities between -.02 and -.04 be used. Our preferred estimate, however, is -.025.

The total impact of a disruption is the sum of the lost surplus and the cyclical GNP effect. Our detailed analysis follows below.

I. INTRODUCTION

The DOE Request to T3/T2

DOE asked T3/T2 to recommend methods, and where appropriate, parameter values for estimating the economic benefits from a release of SPR oil during an oil supply disruption. Broad outlines of the oil supply disruption scenario were specified by DOE:

1. The oil supply disruption is temporary, lasting less than 1 year, and the short-term nature of the disruption is fully foreseen by economic decisionmakers.
2. Oil prices, after rising during a disruption, return to the reference predisruption oil price path at the end of the supply disruption.
3. We also consider an alternative post-disruption path, which the 1987 Energy Security Study and the DOE Blue Book use. In this scenario, world oil prices do not decline to the base path immediately after the conditions causing the supply disruption are eliminated. Instead, due to lags or gradual decay of cartel discipline, prices return to the base path at a rate of 38 percent of the difference between the disruption price and base case price each quarter.

II. TOTAL EFFECTS OF AN OIL PRICE SHOCK

The effects of an oil price shock due to a supply disruption on the U.S. economy can be decomposed into two broad categories.

1. Cyclical Effects on Gross National Product (GNP):

These are the "temporary," "frictional," or "short-run" costs of adjusting to an oil price shock. Economic agents cannot adjust to a sudden rise in the price of an important input such as oil instantaneously. This is due partly to a downward stickiness in nominal wages which prevents relative wages from quickly readjusting to clear the labor market. Another cause of unemployment during an oil price shock is the imperfect mobility of labor, which prevents needed redistribution of resources between sectors.

2. Losses in Consumers' and Producers' Surpluses:

Attachment 1 illustrates the net loss in consumers' and producers' surpluses, which is area B+C+D under the U.S. oil demand curve. The height of the domestic supply curve can be interpreted as the cost of producing each additional unit of oil. The height of the demand curve can be thought of as the marginal value of each additional unit of oil. At any given quantity, the area between the demand (supply) curve and the market price is the consumers' (producers') surplus accruing to the last additional unit of consumption (output).

The loss to consumers' surplus from the oil price increase is A-B-C+D. However, domestic producers benefit from the higher oil prices, and their producers' surplus increases by area A. Therefore, the net loss to consumers' and producers' surpluses is B-C+D. This area is just the average of pre- and post-shock oil import levels times the increase in prices.

We defer to the SPR study group's findings on the response of world oil prices and domestic oil demand and supply to a supply disruption. However, an estimate of the elasticity of GNP with respect to the world oil price is needed to capture cyclical GNP effects. It seems appropriate to look to simulation models which purport to capture frictional and cyclical aspects of the economy and empirical estimates of short-run effects for some guidance.

III. EVIDENCE CONSIDERED

The proper size of the GNP elasticity ("e") is difficult to determine from the available evidence. Two major outside sources for estimates of the GNP elasticity are the EMF 7 results and a 1981 Darby AER paper. Both estimates have problems.

OUTSIDE SOURCES

EMF 7

Both the EMF 7 and the Darby GNP elasticity values are averages. The EMF 7 result is the average quarterly effect over a 4-year time period. The Darby elasticity is an average annual effect over the period 1957-1976.

The EMF 7 runs simulation experiments with 14 models and considers the average of the 14 individual model results. A permanent 50 percent oil price increase causes an average quarterly decline in GNP of 2.1 percent below its base path. This implies an elasticity of -.042. They find that these results are robust for a range of price variation.

The advantage of using the EMF 7 estimate is that it is an average derived from many well-respected models all using identical disruption scenarios.

The disadvantages of using the EMF 7 estimates are that:

- (1) The scenario used is a permanent 4-year change in oil prices of 50 percent above the base path, which should overstate the total GNP effects compared with the short-lived price increases we were asked to consider. The implications of these results for the temporary disruption case are quite unclear.
- (2) The EMF baseline assumes a current price of oil of \$36 a barrel, which makes the oil share of the economy much larger than it is today (consumption of petroleum and natural gas per dollar of GNP has fallen from a level of 20.9 thousand BTUs per 1982 dollar in 1973 to 12.9 in the second quarter of 1989).
- (3) The total GNP effect includes some of the terms of trade and consumer and producer surplus components.
- (4) The sensitivity of the outcome to important parameters is not discussed.
- (5) Results of our own simulation experiments indicate that the modeling of the oil sector in our economy has changed considerably since the models were run for the EMF7 report. Oil shocks do not seem to be considered as important as they were in the early 1980s. This is probably due to a reconsideration of whether GNP in the 1970s was reacting more to oil price shocks or to price controls.

DARBY

Darby estimates a Lucas-Barro real income equation for the U.S. directly from quarterly historical data covering 1957-1976. The functional form forces the cumulative short-run effect of one period's oil price rise to damp out to zero after four quarters, capturing the temporary nature of adjustment effects. Darby finds a temporary GNP elasticity of $-.021$ (the permanent GNP elasticity also takes on this value) of the current period's real GNP with respect to the current real world oil price. Unfortunately, two of the four distributed lag terms incorporated in the model to capture the short-run effects of an oil price increase are statistically insignificant, and the remaining two are only marginally significant.

There are also problems in interpreting Darby's result for our purpose. His estimate is an average of the reaction to many different oil price shocks under many different circumstances. As he remarks, "the results...are mixed and confounded by price control and decontrol programs which were widespread at nearly the same time as the 1973-74 oil-price change." Price control programs in place during 1971-73 overstated real GNP and understated the GNP deflator. When the controls were relaxed during 1973-75, measured real income fell back to actual real income, generating a spurious decline in real GNP simultaneous with the OPEC oil embargo. In fact, a direct test of the two hypotheses favors the price control argument as an explanation of the oil shock in the United States.

The 1986 T3/T2 study of which GNP elasticity estimate to use selected the Darby estimate despite these problems.

SIMULATION RESULTS

Because of the problems with previous estimates, we used current versions of simulation models used by the Troika agencies to test the effect of a temporary oil shock on GNP. These models are not ideally suited for analyzing the impact of oil price shocks, but they are based on more recent data.

MEYER AND DRI MODELS

The new version of the Laurence H. Meyer and Associates (Meyer) model was used with their September data package. Simulations were also run with the PC version of the DRI quarterly macro model. In the spirit of the EMP 7 study, we did not change the adfactors or exogenous assumptions from those given in the Meyer and DRI packages. No policy accommodations were made for the oil shock.

In both models, refiner's acquisition cost for imported petroleum (NSA, \$/barrel) is exogenous. The historical data are culled from the DOE Weekly Petroleum Status Report. In the Meyer model, changes in this price are transmitted to the implicit price deflator for imports. A dummy for the OPEC oil embargoes which has a negative effect on consumption was not used on the advice of a Meyer vice president. A major drawback of this model is that there is no direct linkage of the oil price to the productive sector via the price of factor inputs, because the producer price index plays only a minor role in the model.

The DRI model treats the energy sector in much greater detail. DRI's energy sector includes four final demand equations, one for each major fuel group, where the level of demand in each sector is a function of energy-using capital stock, disposable personal income, energy prices, and changes in

heating and cooling degree-days. Also included is an equation for total energy use as a function of final energy demands and economic factors affecting industrial and commercial uses of energy. DRI's energy supply sector includes production indexes for natural gas and oil extraction and for mining. Production levels are taken from DRI's energy model, and thus are exogenous to the macro model, but the macro model uses a simulation rule to adjust production levels for changes in real crude oil prices.

In the Meyer model, private nonfarm business output is modeled by a Cobb-Douglas production function with labor and two types of capital as its components. Since energy is not included separately, oil price shocks do not directly affect the path of potential output. Oil price shocks do affect the path of potential GNP in the DRI model, through total factor productivity. DRI treats total factor productivity as a function of total energy demand, which in turn is a function of energy prices.

Exchange rate effects may capture something of a terms of trade effect through their effect on net exports. However it is difficult to discern how much of the change in GNP can be attributed to this effect. The worsening of the trade balance due to oil price shocks was not large for most scenarios. As Hill Huntington points out in a recent unpublished article, macro policy models such as DRI and Meyer take a value-added approach to calculating real GNP, which means that there is no direct terms of trade effect in the elasticities we have calculated.

RESULTS

We focus on two oil price shock scenarios:

- (1) A 50-percent increase in the first two quarters, followed by an immediate return to the base price path.
- (2) A 50-percent increase in the first two quarters, followed by a decline in price of 38.2 percent of the difference between the disruption price and base case price each quarter until the base price path is regained. (The 38.2 percent is the rule of thumb used by DOE and Troika in earlier studies).

We attribute the total GNP effect for all quarters to only those quarters during which the shock itself occurs. Under the 38 percent per annum return rule of thumb we attribute the total GNP effect to the two disruption quarters.

Future GNP effects are discounted at a rate of 10 percent per annum for the calculation of all elasticities.

The results are reported in Attachment 2. At the request of DOE, results for a 100 percent oil price shock are also reported. The GNP elasticities for the 100 percent shock are less than .01

higher than for the 50 percent shock under the Meyer model, but the results from DRI are the same under both scenarios.

Estimated elasticities range from -0.043 for a temporary 50 percent price shock with a 38 percent adjustment rule in the DRI model to -0.017 for a temporary 50 percent price shock with an immediate return to the base price path in the Meyer model. The average GNP elasticity for the two models with an immediate return to the base price path was -.024.

V. CONCLUSIONS

We recommend a two component measure of the total cost of an oil price disruption. The components are a producer and consumer surplus effect which includes the terms of trade effect, and a cyclical GNP effect.

We recommend that a range of elasticities between -.02 and -.04 be tested with the SPR size cost-benefit model. While we are recommending a range, we recommend -.025 as the elasticity for any simulation experiments related to the SPR size study for which a reference case is needed.

Attachments

ATTACHMENT 01

A = gain in producers' surplus to US manufacturers

A-B-C+D = loss in consumers' surplus to US consumers

=> net welfare change = -(B+C+D)

ATTACHMENT #2

GNP ELASTICITIES WITH RESPECT TO WORLD OIL PRICE

MONETARY POLICY: MONEY SUPPLY EXOGENOUS

	TWO QUARTER 50% PRICE RISE	TWO QUARTER 50% PRICE RISE*	TWO QUARTER 100% PRICE RISE	TWO QUARTER 100% PRICE RISE*
MEYER	-0.017	-0.023	-0.023	-0.029
DKI	-0.031	-0.043	-0.030	-0.041

*WITH 38%/QUARTER ADJUSTMENT FACTOR

accommodate short-run supply shocks. The reaction to an oil shock will be less severe since "stop-go" policies, with an accompanying recession, are not expected. For example, when oil prices rose earlier this year, upward pressure on the PPI and CPI was recognized as temporary and did not bring about a significant monetary tightening. Eventually the inflation rate fell as oil prices dropped back. For these reasons, the simulated GNP response is likely to be a bit high.

Appendix B

Detailed Results

Table B1. Case 1 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		=====			=====			=====		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
=====	=====	===	===	=====	===	===	=====	===	===	=====
World Oil Price	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
(1988 \$/B)	10	38.25	38.25	0.00	40.62	37.65	2.97	46.18	38.97	7.21
	15	74.02	74.02	0.00	75.31	70.89	4.42	80.68	70.04	10.64
	20	128.07	128.07	0.00	126.62	120.26	6.37	130.29	115.13	15.15
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	75.9	75.8	0.07	56.9	42.7	14.18	60.9	26.6	34.36
- Not Discounted)	15	173.1	173.1	0.08	168.4	151.2	17.17	184.0	142.0	42.01
	20	260.0	259.9	0.08	273.6	252.2	21.34	305.0	253.0	52.06
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	47.1	47.1	0.04	21.9	16.5	5.47	14.6	6.4	8.23
- Discounted)	15	107.5	107.5	0.05	64.9	58.3	6.62	44.1	34.0	10.06
	20	161.4	161.4	0.05	105.5	97.2	8.23	73.0	60.6	12.46
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			0.0000			0.0186			0.0698
Discounted and	15			0.0001			0.0404			0.1622
Probability Weighted)	20			0.0001			0.0505			0.2039
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		=====			=====			=====		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
=====	=====	===	===	=====	===	===	=====	===	===	=====
World Oil Price	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
(1988 \$/B)	10	49.78	42.41	7.37	52.10	45.18	6.92	54.18	47.62	6.56
	15	82.95	72.36	10.59	83.36	73.71	9.66	83.51	74.59	8.92
	20	129.46	114.70	14.76	126.15	113.04	13.11	122.78	110.92	11.86
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	65.4	27.4	37.91	68.9	29.2	39.74	72.8	31.8	40.95
- Not Discounted)	15	199.5	153.1	46.36	211.2	163.0	48.20	220.9	171.7	49.27
	20	335.4	278.2	57.20	357.8	298.8	58.98	374.7	314.9	59.81
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	9.7	4.1	5.64	6.4	2.7	3.67	4.2	1.8	2.35
- Discounted)	15	29.7	22.8	6.89	19.5	15.0	4.45	12.7	9.8	2.82
	20	49.8	41.3	8.50	33.0	27.6	5.44	21.5	18.0	3.43
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			0.1300			0.1911			0.2471
Discounted and	15			0.3116			0.4604			0.5952
Probability Weighted)	20			0.3920			0.5782			0.7461

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B2. Case 2 - Summary Comparison of 600 MMB System Versus 750 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		600	750	Delta	600	750	Delta	600	750	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	42.09	38.25	3.85	45.39	40.84	4.55	51.01	46.14	4.88
	15	79.97	74.02	5.95	82.51	75.72	6.79	87.76	80.61	7.15
	20	136.98	128.07	8.92	137.13	127.30	9.82	140.35	130.17	10.18
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	91.6	75.8	15.84	78.1	56.9	21.18	84.0	61.0	23.02
	15	192.4	173.1	19.32	194.5	168.5	26.01	212.5	183.9	28.64
	20	284.2	259.9	24.24	306.2	273.7	32.57	340.6	304.7	35.90
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	56.9	47.1	9.84	30.1	21.9	8.17	20.1	14.6	5.51
	15	119.5	107.5	12.00	75.0	65.0	10.03	50.9	44.0	6.86
	20	176.4	161.4	15.05	118.1	105.5	12.56	81.5	72.9	8.59
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0696			0.1491			0.2263
	15			0.1068			0.2522			0.3919
	20			0.1240			0.2997			0.4674
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		600	750	Delta	600	750	Delta	600	750	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
	10	54.49	49.62	4.87	56.59	52.11	4.48	58.42	54.21	4.21
	15	89.66	82.69	6.97	89.59	83.38	6.20	89.25	83.55	5.69
	20	138.77	129.04	9.73	134.60	126.18	8.43	130.41	122.84	7.57
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	90.0	65.3	24.70	94.6	68.9	25.72	99.2	72.8	26.38
	15	229.9	199.3	30.60	242.7	211.3	31.47	252.9	221.0	31.98
	20	373.1	335.0	38.11	396.7	357.9	38.77	413.8	374.8	39.05
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	13.4	9.7	3.67	8.7	6.4	2.37	5.7	4.2	1.51
	15	34.2	29.6	4.55	22.4	19.5	2.90	14.5	12.7	1.83
	20	55.5	49.8	5.66	36.6	33.0	3.58	23.7	21.5	2.24
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.3028			0.3798			0.4463
	15			0.5295			0.6659			0.7879
	20			0.6317			0.7935			0.9396

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B3. Case 3 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	38.25	38.25	0.00	40.62	37.65	2.97	46.18	38.97	7.21
	15	74.02	74.02	0.00	75.31	70.89	4.42	80.68	70.04	10.64
	20	128.07	128.07	0.00	126.62	120.26	6.37	130.29	115.13	15.15
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	67.0	66.9	0.07	50.8	37.9	12.86	55.0	23.7	31.25
	15	155.1	155.0	0.08	152.4	136.3	16.13	167.9	128.4	39.49
	20	234.5	234.5	0.08	249.6	229.1	20.47	280.5	230.5	49.91
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	41.6	41.6	0.04	19.6	14.6	4.96	13.2	5.7	7.48
	15	96.3	96.2	0.05	58.8	52.6	6.22	40.2	30.7	9.45
	20	145.6	145.6	0.05	96.2	88.3	7.89	67.1	55.2	11.95
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0000			0.0168			0.0633
	15			0.0001			0.0372			0.1495
	20			0.0001			0.0468			0.1895
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
	10	49.78	42.41	7.37	52.10	45.18	6.92	54.18	47.62	6.56
	15	82.95	72.36	10.59	83.36	73.71	9.66	83.51	74.59	8.92
	20	129.46	114.70	14.76	126.15	113.04	13.11	122.78	110.92	11.86
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	59.3	24.6	34.64	62.7	26.3	36.37	66.3	28.8	37.49
	15	182.9	139.3	43.65	194.0	148.7	45.35	203.0	156.7	46.30
	20	309.8	255.0	54.86	331.2	274.7	56.49	346.8	289.6	57.19
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	8.8	3.7	5.15	5.8	2.4	3.36	3.8	1.7	2.15
	15	27.2	20.7	6.49	17.9	13.7	4.19	11.6	9.0	2.65
	20	46.1	37.9	8.15	30.6	25.4	5.21	19.9	16.6	3.28
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.1183			0.1744			0.2260
	15			0.2879			0.4263			0.5518
	20			0.3650			0.5392			0.6966

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B4. Case 4 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	38.25	38.25	0.00	40.62	37.65	2.97	46.18	38.97	7.21
	15	74.02	74.02	0.00	75.31	70.89	4.42	80.68	70.04	10.64
	20	128.07	128.07	0.00	126.62	120.26	6.37	130.29	115.13	15.15
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	102.3	102.3	0.07	75.0	56.9	18.10	78.9	35.2	43.65
	15	226.6	226.6	0.08	215.6	195.4	20.21	231.9	182.4	49.45
	20	333.0	334.9	0.08	344.4	320.5	23.88	377.7	319.3	58.33
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	63.5	63.5	0.04	28.9	21.9	6.98	18.9	8.4	10.45
	15	140.7	140.7	0.05	83.1	75.3	7.79	55.5	43.7	11.84
	20	208.0	208.0	0.05	132.8	123.6	9.21	90.4	76.4	13.96
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0000			0.0238			0.0891
	15			0.0001			0.0501			0.2000
	20			0.0001			0.0615			0.2469
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
	10	49.78	42.41	7.37	52.10	45.18	6.92	54.18	47.62	6.56
	15	82.95	72.36	10.59	83.36	73.71	9.66	83.51	74.59	8.92
	20	129.46	114.70	14.76	126.15	113.04	13.11	122.78	110.92	11.86
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	83.6	35.9	47.70	87.7	37.8	49.83	92.3	41.0	51.31
	15	248.9	194.5	54.38	262.5	205.9	56.63	274.4	216.3	58.07
	20	411.0	346.9	64.07	436.9	370.6	66.29	457.6	390.1	67.52
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	12.4	5.3	7.09	8.1	3.5	4.60	5.3	2.3	2.94
	15	37.0	28.9	8.08	24.2	19.0	5.23	15.7	12.4	3.33
	20	61.1	51.6	9.52	40.3	34.2	6.12	26.2	22.4	3.87
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.1651			0.2411			0.3103
	15			0.3821			0.5620			0.7245
	20			0.4724			0.6940			0.8937

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B5. Case 5 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
(1988 \$/B)	10	44.19	44.19	0.00	46.45	43.23	3.22	52.05	44.23	7.82
	15	83.20	83.20	0.00	84.10	79.33	4.77	89.27	77.81	11.46
	20	141.84	141.84	0.00	139.46	132.58	6.89	142.51	126.20	16.32
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	95.9	95.8	0.07	79.5	64.8	14.65	85.6	49.9	35.65
- Not Discounted)	15	191.6	191.5	0.08	190.1	172.2	17.93	208.6	164.7	43.89
	20	275.6	275.5	0.08	293.3	270.9	22.39	328.6	274.1	54.53
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	59.6	59.5	0.05	30.6	25.0	5.65	20.5	11.9	8.53
- Discounted)	15	119.0	118.9	0.05	73.3	66.4	6.91	49.9	39.4	10.51
	20	171.1	171.1	0.05	113.1	104.4	8.63	78.7	65.6	13.05
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0017			0.0037			0.0063
	At Least 15			0.0005			0.0011			0.0018
	At Least 20			0.0001			0.0002			0.0003
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			0.0002			0.0757			0.2768
Discounted and	15			0.0002			0.1243			0.4710
Probability Weighted)	20			0.0003			0.1446			0.5505
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
(1988 \$/B)	10	55.50	47.55	7.95	57.55	50.13	7.42	59.35	52.36	6.99
	15	91.09	79.74	11.35	90.91	80.63	10.29	90.51	81.04	9.46
	20	140.76	124.94	15.81	136.41	122.44	13.97	132.09	119.50	12.58
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	91.9	52.6	39.38	97.0	55.7	41.23	101.9	59.5	42.43
- Not Discounted)	15	226.7	178.3	48.38	240.3	190.1	50.20	251.3	200.1	51.23
	20	362.6	302.7	59.85	387.6	326.0	61.61	406.2	343.9	62.36
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	13.7	7.8	5.85	9.0	5.1	3.81	5.8	3.4	2.43
- Discounted)	15	33.7	26.5	7.19	22.2	17.5	4.63	14.4	11.5	2.94
	20	53.9	45.0	8.90	35.8	30.1	5.69	23.3	19.7	3.57
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0100			0.0146			0.0203
	At Least 15			0.0028			0.0041			0.0057
	At Least 20			0.0005			0.0007			0.0010
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			0.5106			0.7114			0.8633
Discounted and	15			0.8811			1.2315			1.5015
Probability Weighted)	20			1.0303			1.4397			1.7564

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B6. Case 6 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	35.46	35.46	0.00	37.89	35.05	2.84	43.41	36.49	6.92
	15	69.71	69.71	0.00	71.17	66.91	4.26	76.62	66.36	10.25
	20	121.61	121.61	0.00	120.58	114.45	6.13	124.51	109.90	14.61
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	65.7	65.6	0.07	45.5	31.5	13.97	48.6	14.9	33.77
	15	163.8	163.7	0.08	157.4	140.6	16.81	171.7	130.6	41.12
	20	252.0	251.9	0.08	263.5	242.7	20.84	293.1	242.3	50.88
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	40.8	40.8	0.04	17.5	12.1	5.39	11.6	3.6	8.08
	15	101.7	101.6	0.05	60.7	54.2	6.48	41.1	31.3	9.84
	20	156.4	156.4	0.05	101.6	93.6	8.03	70.2	58.0	12.18
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0012			0.0021			0.0033
	At Least 15			0.0004			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0000			0.0133			0.0455
	15			0.0001			0.0345			0.1302
	20			0.0001			0.0442			0.1687
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
	10	47.07	39.98	7.09	49.51	42.83	6.68	51.72	45.37	6.35
	15	79.09	68.86	10.23	79.76	70.41	9.35	80.17	71.51	8.66
	20	124.09	109.83	14.26	121.26	108.55	12.70	118.34	106.82	11.52
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	52.1	14.9	37.23	55.0	15.9	39.04	58.3	18.0	40.26
	15	185.9	140.6	45.39	196.8	149.6	47.23	205.8	157.5	48.33
	20	321.8	265.8	55.94	343.0	285.3	57.73	359.1	300.5	58.59
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	7.7	2.2	5.53	5.1	1.5	3.60	3.3	1.0	2.31
	15	27.6	20.9	6.75	18.2	13.8	4.36	11.8	9.0	2.77
	20	47.8	39.5	8.31	31.7	26.3	5.33	20.6	17.2	3.36
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0048			0.0067			0.0091
	At Least 15			0.0015			0.0021			0.0029
	At Least 20			0.0003			0.0004			0.0006
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0780			0.1069			0.1318
	15			0.2345			0.3263			0.4024
	20			0.3050			0.4249			0.5239

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B7. Case 7 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	47.02	47.02	0.00	45.99	41.49	4.50	51.45	41.03	10.41
	15	113.51	113.51	0.00	104.81	96.50	8.31	108.31	89.70	18.61
	20	236.02	236.02	0.00	209.72	195.41	14.31	205.35	174.16	31.19
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	106.6	106.5	0.07	78.5	58.6	19.95	83.9	36.1	47.72
	15	260.1	260.0	0.08	247.5	219.9	27.58	268.7	203.0	65.76
	20	416.0	415.9	0.10	428.7	389.9	38.77	474.3	383.0	91.31
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	66.2	66.1	0.05	30.3	22.6	7.69	20.1	8.6	11.42
	15	161.5	161.4	0.05	95.4	84.8	10.63	64.3	48.6	15.74
	20	258.3	258.3	0.06	165.3	150.3	14.95	113.5	91.7	21.86
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0001			0.0239			0.0896
	15			0.0001			0.0542			0.2164
	20			0.0001			0.0700			0.2805

Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
	10	54.85	44.35	10.50	56.90	47.05	9.86	58.75	49.46	9.30
	15	108.42	90.46	17.97	106.52	90.38	16.14	104.64	89.98	14.66
	20	196.39	167.27	29.12	185.16	159.91	25.24	175.01	152.79	22.22
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	89.7	37.3	52.46	94.4	39.5	54.84	99.2	42.9	56.38
	15	289.7	218.0	71.67	304.7	231.0	73.68	316.3	241.8	74.49
	20	517.4	418.9	98.48	546.4	446.6	99.77	565.6	466.2	99.35
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	13.3	5.5	7.80	8.7	3.6	5.06	5.7	2.5	3.23
	15	43.1	32.4	10.65	28.1	21.3	6.80	18.1	13.9	4.27
	20	76.9	62.3	14.64	50.4	41.2	9.21	32.4	26.7	5.69
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.1670			0.2451			0.3186
	15			0.4143			0.6105			0.7914
	20			0.5367			0.7882			1.0176

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B8. Case 8 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		=====			=====			=====		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
=====	=====	===	===	=====	===	===	=====	===	===	=====
World Oil Price	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
(1988 \$/B)	10	33.79	33.79	0.00	37.71	35.53	2.18	43.28	37.78	5.50
	15	57.29	57.29	0.00	61.78	58.92	2.86	67.62	60.38	7.24
	20	88.79	88.79	0.00	93.58	89.90	3.68	99.19	89.84	9.35
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	58.8	58.8	0.07	44.5	33.5	11.00	47.8	21.0	26.84
- Not Discounted)	15	130.1	130.0	0.07	127.7	115.3	12.39	140.0	109.2	30.73
	20	189.9	189.9	0.07	201.2	186.8	14.43	225.0	189.1	35.83
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	36.5	36.5	0.04	17.1	12.9	4.24	11.4	5.0	6.42
- Discounted)	15	80.8	80.7	0.05	49.2	44.4	4.78	33.5	26.2	7.36
	20	117.9	117.9	0.05	77.6	72.0	5.56	53.9	45.3	8.58
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			0.0000			0.0155			0.0582
Discounted and	15			0.0001			0.0330			0.1326
Probability Weighted)	20			0.0001			0.0406			0.1642
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		=====			=====			=====		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
=====	=====	===	===	=====	===	===	=====	===	===	=====
World Oil Price	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
(1988 \$/B)	10	46.96	41.29	5.67	49.42	44.09	5.32	51.61	46.55	5.06
	15	70.65	63.30	7.35	71.97	65.22	6.74	72.95	66.66	6.30
	20	100.84	91.48	9.36	100.22	91.81	8.41	99.28	91.55	7.74
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	51.3	21.6	29.68	54.2	23.1	31.16	57.5	25.3	32.15
- Not Discounted)	15	152.1	118.0	34.14	161.7	126.0	35.69	169.8	133.1	36.71
	20	248.1	208.4	39.74	266.0	224.7	41.35	280.3	237.9	42.33
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	7.6	3.2	4.41	5.0	2.1	2.88	3.3	1.5	1.84
- Discounted)	15	22.6	17.5	5.07	14.9	11.6	3.29	9.7	7.6	2.10
	20	36.9	31.0	5.91	24.6	20.7	3.82	16.1	13.6	2.43
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			0.1085			0.1597			0.2055
Discounted and	15			0.2552			0.3778			0.4870
Probability Weighted)	20			0.3164			0.4677			0.6030

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B9. Case 9 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		***	****	*****	***	****	*****	***	****	*****
World Oil Price (1988 \$/B)	0	16.70	16.70	0.00	21.70	21.70	0.00	24.80	24.80	0.00
	10	32.74	32.74	0.00	32.44	29.72	2.71	35.23	29.35	5.88
	15	66.49	66.49	0.00	62.70	58.45	4.25	64.05	55.12	8.93
	20	119.90	119.90	0.00	109.16	102.71	6.45	106.87	93.73	13.15
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	82.3	82.3	0.00	61.0	46.0	14.98	63.8	28.2	35.55
	15	190.1	190.1	0.00	182.8	164.6	18.24	194.6	151.5	43.06
	20	294.9	294.9	0.00	307.7	284.5	23.22	331.9	277.7	54.24
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	51.1	51.1	0.00	23.5	17.7	5.78	15.3	6.8	8.51
	15	118.0	118.0	0.00	70.5	63.5	7.03	46.6	36.3	10.31
	20	183.1	183.1	0.00	118.6	109.7	8.95	79.5	66.5	12.99
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0000			0.0180			0.0696
	15			0.0000			0.0395			0.1610
	20			0.0000			0.0495			0.2022
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		***	****	*****	***	****	*****	***	****	*****
World Oil Price (1988 \$/B)	0	26.70	26.70	0.00	28.30	28.30	0.00	29.40	29.40	0.00
	10	36.62	30.90	5.72	37.67	32.29	5.38	38.23	33.24	4.99
	15	63.26	54.87	8.39	62.26	54.59	7.67	60.73	53.82	6.92
	20	101.66	89.66	12.00	96.80	86.09	10.70	91.54	82.12	9.42
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	66.7	28.5	38.16	69.0	29.7	39.31	71.3	31.5	39.84
	15	204.7	158.7	45.94	211.9	165.0	46.90	217.0	170.1	46.94
	20	351.5	294.2	57.28	364.7	306.9	57.78	372.4	315.4	57.00
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	9.9	4.2	5.67	6.4	2.7	3.63	4.1	1.8	2.28
	15	30.4	23.6	6.83	19.6	15.2	4.33	12.4	9.7	2.69
	20	52.2	43.7	8.51	33.7	28.3	5.33	21.3	18.1	3.27
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0074			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.1299			0.1890			0.2445
	15			0.3074			0.4490			0.5811
	20			0.3855			0.5617			0.7260

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B10. Case 10 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	24.40	24.40	0.00	35.00	35.00	0.00	42.00	42.00	0.00
	10	44.42	44.42	0.00	50.20	46.36	3.84	57.82	48.89	8.93
	15	86.62	86.62	0.00	93.58	87.45	6.13	102.25	88.38	13.87
	20	153.79	153.79	0.00	161.40	151.88	9.52	170.05	149.00	21.04
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	72.5	72.5	0.00	54.1	40.2	13.85	61.1	26.1	34.98
	15	165.5	165.5	0.00	159.6	142.2	17.43	185.8	141.1	44.66
	20	243.4	243.4	0.00	252.1	230.2	21.96	305.2	248.4	56.83
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	45.0	45.0	0.00	20.8	15.5	5.34	14.6	6.2	8.37
	15	102.7	102.7	0.00	61.5	54.8	6.72	44.5	33.8	10.69
	20	151.1	151.1	0.00	97.2	88.7	8.47	73.1	59.5	13.60
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0000			0.0171			0.0685
	15			0.0000			0.0385			0.1635
	20			0.0000			0.0486			0.2074
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	47.80	47.80	0.00	51.70	51.70	0.00	55.60	55.60	0.00
	10	63.68	54.51	9.17	67.14	58.26	8.89	70.55	62.09	8.45
	15	107.11	93.33	13.78	108.42	95.44	12.98	109.17	97.22	11.95
	20	171.40	151.09	20.31	167.93	149.29	18.64	163.21	146.54	16.67
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	66.6	27.5	39.04	71.3	29.6	41.64	76.3	33.0	43.39
	15	205.1	155.1	50.02	221.3	168.2	53.11	234.7	179.9	54.84
	20	344.2	280.4	63.79	376.7	309.2	67.54	401.4	332.2	69.18
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	9.9	4.1	5.80	6.6	2.7	3.84	4.4	1.9	2.49
	15	30.5	23.1	7.43	20.4	15.5	4.90	13.5	10.3	3.14
	20	51.2	41.7	9.48	34.8	28.5	6.23	23.0	19.0	3.96
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.1318			0.1967			0.2546
	15			0.3229			0.4839			0.6258
	20			0.4104			0.6140			0.7924

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B11. Case 11 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	38.25	38.25	0.00	40.62	37.65	2.97	46.18	38.97	7.21
	15	74.02	74.02	0.00	75.31	70.89	4.42	80.68	70.04	10.64
	20	128.07	128.07	0.00	126.62	120.26	6.37	130.29	115.13	15.15
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	75.9	75.8	0.07	56.9	42.7	14.18	60.9	26.6	34.36
	15	173.1	173.1	0.08	168.4	151.2	17.17	184.0	142.0	42.01
	20	260.0	259.9	0.08	273.6	252.2	21.34	305.0	253.0	52.06
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	47.1	47.1	0.04	21.9	16.5	5.47	14.6	6.4	8.23
	15	107.5	107.5	0.05	64.9	58.3	6.62	44.1	34.0	10.06
	20	161.4	161.4	0.05	105.5	97.2	8.23	73.0	60.6	12.46
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0004			0.0008			0.0013
	At Least 15			0.0001			0.0002			0.0003
	At Least 20			0.0000			0.0000			0.0000
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0000			0.0084			0.0330
	15			0.0000			0.0165			0.0694
	20			0.0000			0.0193			0.0818

Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
	10	49.78	42.41	7.37	52.10	45.18	6.92	54.18	47.62	6.56
	15	82.95	72.36	10.59	83.36	73.71	9.66	83.51	74.59	8.92
	20	129.46	114.70	14.76	126.15	113.04	13.11	122.78	110.92	11.86
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	65.4	27.4	37.91	68.9	29.2	39.74	72.8	31.8	40.95
	15	199.5	153.1	46.36	211.2	163.0	48.20	220.9	171.7	49.27
	20	335.4	278.2	57.20	357.8	298.8	58.98	374.7	314.9	59.81
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	9.7	4.1	5.64	6.4	2.7	3.67	4.2	1.8	2.35
	15	29.7	22.8	6.89	19.5	15.0	4.45	12.7	9.8	2.82
	20	49.8	41.3	8.50	33.0	27.6	5.44	21.5	18.0	3.43
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0022			0.0038			0.0060
	At Least 15			0.0005			0.0009			0.0014
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0647			0.1002			0.1353
	15			0.1404			0.2189			0.2960
	20			0.1659			0.2584			0.3493

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B12. Case 12 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	38.25	38.25	0.00	40.62	37.65	2.97	46.18	38.97	7.21
	15	74.02	74.02	0.00	75.31	70.89	4.42	80.68	70.04	10.64
	20	128.07	128.07	0.00	126.62	120.26	6.37	130.29	115.13	15.15
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	75.9	75.8	0.07	56.9	42.7	14.18	60.9	26.6	34.36
	15	173.1	173.1	0.08	168.4	151.2	17.17	184.0	142.0	42.01
	20	260.0	259.9	0.08	273.6	252.2	21.34	305.0	253.0	52.06
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	47.1	47.1	0.04	21.9	16.5	5.47	14.6	6.4	8.23
	15	107.5	107.5	0.05	64.9	58.3	6.62	44.1	34.0	10.06
	20	161.4	161.4	0.05	105.5	97.2	8.23	73.0	60.6	12.46
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0016			0.0030			0.0049
	At Least 15			0.0006			0.0011			0.0018
	At Least 20			0.0001			0.0002			0.0004
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0001			0.0280			0.1028
	15			0.0001			0.0646			0.2529
	20			0.0002			0.0841			0.3309
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
	10	49.78	42.41	7.37	52.10	45.18	6.92	54.18	47.62	6.56
	15	82.95	72.36	10.59	83.36	73.71	9.66	83.51	74.59	8.92
	20	129.46	114.70	14.76	126.15	113.04	13.11	122.78	110.92	11.86
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	65.4	27.4	37.91	68.9	29.2	39.74	72.8	31.8	40.95
	15	199.5	153.1	46.36	211.2	163.0	48.20	220.9	171.7	49.27
	20	335.4	278.2	57.20	357.8	298.8	58.98	374.7	314.9	59.81
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	9.7	4.1	5.64	6.4	2.7	3.67	4.2	1.8	2.35
	15	29.7	22.8	6.89	19.5	15.0	4.45	12.7	9.8	2.82
	20	49.8	41.3	8.50	33.0	27.6	5.44	21.5	18.0	3.43
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0075			0.0113			0.0163
	At Least 15			0.0027			0.0040			0.0058
	At Least 20			0.0006			0.0009			0.0012
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.1869			0.2679			0.3391
	15			0.4732			0.6814			0.8619
	20			0.6194			0.8894			1.1224

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B13. Case 13 - Summary Comparison of 600 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		600	1000	Delta	600	1000	Delta	600	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	42.09	38.25	3.85	45.39	37.65	7.73	51.01	38.97	12.05
	15	79.97	74.02	5.95	82.51	70.89	11.62	87.76	70.04	17.72
	20	136.98	128.07	8.92	137.13	120.26	16.87	140.35	115.13	25.22
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	91.6	75.8	15.84	78.1	42.7	35.43	84.0	26.6	57.40
	15	192.4	173.1	19.32	194.5	151.2	43.32	212.5	142.0	70.53
	20	284.2	259.9	24.24	306.2	252.2	54.02	340.6	253.0	87.66
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	56.9	47.1	9.84	30.1	16.5	13.66	20.1	6.4	13.74
	15	119.5	107.5	12.00	75.0	58.3	16.70	50.9	34.0	16.88
	20	176.4	161.4	15.05	118.1	97.2	20.83	81.5	60.6	20.98
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0696			0.1668			0.2949
	15			0.1068			0.2914			0.5525
	20			0.1240			0.3487			0.6693

Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		600	1000	Delta	600	1000	Delta	600	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
	10	54.49	42.41	12.08	56.59	45.18	11.41	58.42	47.62	10.80
	15	89.66	72.36	17.29	89.59	73.71	15.88	89.25	74.59	14.66
	20	138.77	114.70	24.07	134.60	113.04	21.57	130.41	110.92	19.49
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	90.0	27.4	62.52	94.6	29.2	65.47	99.2	31.8	67.35
	15	229.9	153.1	76.74	242.7	163.0	79.70	252.9	171.7	81.28
	20	373.1	278.2	94.97	396.7	298.8	97.84	413.8	314.9	98.93
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	13.4	4.1	9.29	8.7	2.7	6.04	5.7	1.8	3.86
	15	34.2	22.8	11.41	27.4	15.0	7.36	14.5	9.8	4.66
	20	55.5	41.3	14.12	36.6	27.6	9.03	23.7	18.0	5.67
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.4323			0.5705			0.6855
	15			0.8400			1.1255			1.3621
	20			1.0223			1.3706			1.6574

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B14. Case 14 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	39.70	39.70	0.00	40.62	40.39	0.23	46.18	42.91	3.27
	15	76.27	76.27	0.00	75.31	75.04	0.27	80.68	75.87	4.81
	20	131.43	131.43	0.00	126.62	126.31	0.31	130.29	123.43	6.86
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	81.8	81.8	0.07	56.9	54.9	1.93	60.9	45.6	15.39
	15	180.4	180.3	0.08	168.4	166.0	2.31	184.0	165.0	19.00
	20	269.1	269.0	0.08	273.6	270.6	2.93	305.0	281.3	23.71
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	50.8	50.8	0.04	21.9	21.2	0.74	14.6	10.9	3.68
	15	112.0	112.0	0.05	64.9	64.0	0.89	44.1	39.5	4.55
	20	167.1	167.0	0.05	105.5	104.3	1.13	73.0	67.3	5.68
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0001			0.0020			0.0254
	15			0.0001			0.0034			0.0547
	20			0.0001			0.0041			0.0681
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
	10	49.78	43.87	5.91	52.10	45.18	6.92	54.18	47.62	6.56
	15	82.95	74.46	8.50	83.36	73.71	9.66	83.51	74.59	8.92
	20	129.46	117.61	11.84	126.15	113.04	13.11	122.78	110.92	11.86
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	65.4	35.1	30.24	68.9	29.2	39.74	72.8	31.8	40.95
	15	199.5	162.4	37.06	211.2	163.0	48.20	220.9	171.7	49.27
	20	335.4	289.6	45.79	357.8	298.8	58.98	374.7	314.9	59.81
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	9.7	5.2	4.49	6.4	2.7	3.67	4.2	1.8	2.35
	15	29.7	24.1	5.51	19.5	15.0	4.45	12.7	9.8	2.82
	20	49.8	43.0	6.81	33.0	27.6	5.44	21.5	18.0	3.43
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0710			0.1307			0.1866
	15			0.1599			0.3046			0.4394
	20			0.1995			0.3805			0.5485

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B15. Case 15 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	37.28	36.83	0.45	40.62	35.04	5.58	46.18	38.77	7.41
	15	72.52	71.83	0.70	75.31	66.90	8.41	80.68	69.74	10.94
	20	125.82	124.78	1.04	126.62	114.43	12.19	130.29	114.72	15.57
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	71.9	70.0	1.93	56.9	30.8	26.01	60.9	25.6	35.31
	15	168.3	166.0	2.31	168.4	137.0	31.35	184.0	140.9	43.16
	20	254.0	251.1	2.87	273.6	234.8	38.80	305.0	251.5	53.47
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	44.6	43.4	1.20	21.9	11.9	10.03	14.6	6.1	8.45
	15	104.5	103.1	1.44	64.9	52.8	12.09	44.1	33.7	10.33
	20	157.7	155.9	1.78	105.5	90.5	14.96	73.0	60.2	12.80
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0018			0.0408			0.1014
	15			0.0032			0.0927			0.2434
	20			0.0038			0.1167			0.3074
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
	10	49.78	42.41	7.37	52.10	45.18	6.92	54.18	47.62	6.56
	15	82.95	72.36	10.59	83.36	73.71	9.66	83.51	74.59	8.92
	20	129.46	114.70	14.76	126.15	113.04	13.11	122.78	110.92	11.86
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	65.4	27.4	37.91	68.9	29.2	39.74	72.8	31.8	40.95
	15	199.5	153.1	46.36	211.2	163.0	48.20	220.9	171.7	49.27
	20	335.4	278.2	57.20	357.8	298.8	58.98	374.7	314.9	59.81
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	9.7	4.1	5.64	6.4	2.7	3.67	4.2	1.8	2.35
	15	29.7	22.8	6.89	19.5	15.0	4.45	12.7	9.8	2.82
	20	49.8	41.3	8.50	33.0	27.6	5.44	21.5	18.0	3.43
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.1616			0.2227			0.2787
	15			0.3926			0.5414			0.6762
	20			0.4953			0.6814			0.8494

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B16. Case 16 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	38.25	38.25	0.00	40.62	37.65	2.97	46.18	38.97	7.21
	15	74.02	74.02	0.00	75.31	70.89	4.42	80.68	70.04	10.64
	20	128.07	128.07	0.00	126.62	120.26	6.37	130.29	115.13	15.15
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	75.9	75.8	0.07	56.9	42.7	14.18	60.9	26.6	34.36
	15	173.1	173.1	0.08	168.4	151.2	17.17	184.0	142.0	42.01
	20	260.0	259.9	0.08	273.6	252.2	21.34	305.0	253.0	52.06
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	51.6	51.6	0.05	26.3	19.8	6.57	19.2	8.4	10.83
	15	117.8	117.8	0.05	78.0	70.0	7.95	58.0	44.8	13.24
	20	177.0	176.9	0.06	126.7	116.8	9.88	96.2	79.7	16.41
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0000			0.0215			0.0854
	15			0.0001			0.0467			0.1981
	20			0.0001			0.0583			0.2484
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
	10	49.78	42.41	7.37	52.10	45.18	6.92	54.18	47.62	6.56
	15	82.95	72.36	10.59	83.36	73.71	9.66	83.51	74.59	8.92
	20	129.46	114.70	14.76	126.15	113.04	13.11	122.78	110.92	11.86
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	65.4	27.4	37.91	68.9	29.2	39.74	72.8	31.8	40.95
	15	199.5	153.1	46.36	211.2	163.0	48.20	220.9	171.7	49.27
	20	335.4	278.2	57.20	357.8	298.8	58.98	374.7	314.9	59.81
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	14.0	5.9	8.13	10.1	4.3	5.80	7.2	3.2	4.07
	15	42.8	32.9	9.95	30.8	23.8	7.04	22.0	17.1	4.90
	20	71.9	59.7	12.27	52.2	43.6	8.61	37.2	31.3	5.94
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.1670			0.2564			0.3449
	15			0.3989			0.6150			0.8264
	20			0.4999			0.7689			1.0310

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B17. Case 17 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	38.25	38.25	0.00	40.62	37.65	2.97	46.18	38.97	7.21
	15	74.02	74.02	0.00	75.31	70.89	4.42	80.68	70.04	10.64
	20	128.07	128.07	0.00	126.62	120.26	6.37	130.29	115.13	15.15
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	75.9	75.8	0.07	56.9	42.7	14.18	60.9	26.6	34.36
	15	173.1	173.1	0.08	168.4	151.2	17.17	184.0	142.0	42.01
	20	260.0	259.9	0.08	273.6	252.2	21.34	305.0	253.0	52.06
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	43.1	43.0	0.04	18.3	13.7	4.57	11.1	4.9	6.28
	15	98.2	98.2	0.04	54.2	48.7	5.53	33.6	25.9	7.68
	20	147.5	147.5	0.05	88.1	81.2	6.87	55.7	46.2	9.51
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0000			0.0161			0.0576
	15			0.0001			0.0352			0.1341
	20			0.0001			0.0440			0.1692
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
	10	49.78	42.41	7.37	52.10	45.18	6.92	54.18	47.62	6.56
	15	82.95	72.36	10.59	83.36	73.71	9.66	83.51	74.59	8.92
	20	129.46	114.70	14.76	126.15	113.04	13.11	122.78	110.92	11.86
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	65.4	27.4	37.91	68.9	29.2	39.74	72.8	31.8	40.95
	15	199.5	153.1	46.36	211.2	163.0	48.20	220.9	171.7	49.27
	20	335.4	278.2	57.20	357.8	298.8	58.98	374.7	314.9	59.81
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	6.8	2.8	3.93	4.1	1.7	2.34	2.4	1.1	1.37
	15	20.7	15.9	4.81	12.4	9.6	2.83	7.4	5.7	1.64
	20	34.8	28.8	5.93	21.0	17.6	3.47	12.5	10.5	2.00
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.1028			0.1456			0.1824
	15			0.2472			0.3526			0.4422
	20			0.3125			0.4452			0.5576

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B18. Case 18 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	48.67	48.67	0.00	53.66	51.53	2.13	59.41	53.92	5.50
	15	86.96	86.96	0.00	92.03	89.01	3.02	97.23	89.44	7.80
	20	142.88	142.88	0.00	147.04	142.76	4.28	150.11	139.14	10.96
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	155.8	155.8	0.08	147.5	133.8	13.63	158.9	125.3	33.56
	15	276.8	276.7	0.08	288.0	271.3	16.68	315.7	274.4	41.21
	20	376.4	376.3	0.09	411.9	391.0	20.87	461.6	410.4	51.21
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	96.8	96.7	0.05	56.9	51.6	5.26	38.0	30.0	8.04
	15	171.9	171.8	0.05	111.0	104.6	6.43	75.6	65.7	9.86
	20	233.7	233.7	0.05	158.8	150.8	8.05	110.5	98.3	12.26
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0063			0.0909			0.2595
	15			0.0100			0.1365			0.3847
	20			0.0122			0.1598			0.4438
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.90	40.01	-0.01	42.50	42.52	-0.02
	10	62.63	57.03	5.61	64.33	59.20	5.12	65.65	60.86	4.79
	15	98.65	90.87	7.78	97.94	91.04	6.90	96.90	90.58	6.32
	20	147.86	137.14	10.71	142.90	133.64	9.26	137.85	129.55	8.30
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	170.2	133.3	36.91	179.2	140.8	38.36	186.5	147.2	39.31
	15	342.3	297.3	45.09	362.7	316.4	46.35	378.1	331.0	47.10
	20	509.3	453.6	55.69	545.3	488.5	56.74	571.2	514.1	57.17
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	25.3	19.8	5.49	16.5	13.0	3.54	10.7	8.4	2.25
	15	50.9	44.2	6.70	33.5	29.2	4.28	21.7	19.0	2.70
	20	75.7	67.4	8.28	50.3	45.1	5.24	32.7	29.5	3.28
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.4915			0.7256			0.9037
	15			0.7150			1.0441			1.2983
	20			0.8169			1.1863			1.4725

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B19. Case 19 - Summary Comparison of 600 MMB System Versus 750 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		600	750	Delta	600	750	Delta	600	750	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	20.60	20.60	0.00	28.00	28.15	-0.15	33.40	33.37	0.03
	10	51.44	48.67	2.77	57.19	53.95	3.24	62.95	59.36	3.59
	15	91.03	86.96	4.07	97.11	92.53	4.58	102.19	97.14	5.05
	20	148.67	142.88	5.79	154.16	147.83	6.33	156.91	149.97	6.94
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	170.6	155.8	14.89	167.7	147.6	20.14	180.8	158.8	22.02
	15	294.8	276.7	18.10	312.8	288.2	24.62	342.6	315.4	27.16
	20	398.6	376.3	22.25	442.4	412.0	30.43	494.7	461.2	33.56
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	106.0	96.7	9.25	64.7	56.9	7.76	43.3	38.0	5.27
	15	183.1	171.8	11.24	120.6	111.1	9.49	82.0	75.5	6.50
	20	247.5	233.7	13.82	170.6	158.8	11.73	118.4	110.4	8.03
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0010			0.0019			0.0031
	At Least 15			0.0003			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.1370			0.3306			0.5055
	15			0.1778			0.4417			0.6859
	20			0.1965			0.4928			0.7684
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		600	750	Delta	600	750	Delta	600	750	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	37.20	37.08	0.12	40.00	40.01	-0.01	42.50	42.52	-0.02
	10	66.04	62.43	3.61	67.54	64.34	3.20	68.66	65.68	2.98
	15	103.31	98.33	4.99	102.25	97.97	4.29	100.85	96.95	3.91
	20	154.14	147.38	6.76	148.59	142.93	5.66	142.97	137.92	5.06
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	193.6	170.0	23.52	203.4	179.2	24.23	211.3	186.6	24.75
	15	370.8	342.0	28.84	392.1	362.8	29.32	407.9	378.2	29.69
	20	544.2	508.8	35.39	581.0	545.4	35.64	607.2	571.3	35.83
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	28.8	25.3	3.50	18.8	16.5	2.24	12.1	10.7	1.42
	15	55.1	50.8	4.29	36.2	33.5	2.71	23.4	21.7	1.70
	20	80.9	75.6	5.26	53.6	50.3	3.29	34.8	32.7	2.05
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0050			0.0077			0.0115
	At Least 15			0.0016			0.0024			0.0036
	At Least 20			0.0003			0.0004			0.0007
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.6995			0.8953			1.0429
	15			0.9445			1.2022			1.4026
	20			1.0552			1.3392			1.5625

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B20. Case 20 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	16.70	16.70	0.00	21.70	21.70	0.00	24.80	24.80	0.00
	10	50.42	50.42	0.00	44.93	40.24	4.70	47.05	37.28	9.77
	15	124.75	124.75	0.00	104.54	95.48	9.06	101.56	83.62	17.94
	20	268.52	268.52	0.00	215.00	198.52	16.48	197.91	166.63	31.28
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	195.0	195.0	0.00	154.3	126.6	27.68	159.8	94.8	64.96
	15	409.9	409.9	0.00	387.0	350.7	36.35	406.0	322.5	83.53
	20	641.5	641.5	0.00	650.1	599.0	51.06	689.1	574.4	114.70
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	132.7	132.7	0.00	71.5	58.7	12.82	50.4	29.9	20.48
	15	279.0	279.0	0.00	179.3	162.4	16.84	128.0	101.7	26.33
	20	436.6	436.6	0.00	301.1	277.5	23.65	217.2	181.1	36.16
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0026			0.0055			0.0091
	At Least 15			0.0009			0.0018			0.0030
	At Least 20			0.0002			0.0004			0.0006
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0000			0.2008			0.7719
	15			0.0000			0.3492			1.3756
	20			0.0000			0.4255			1.6773
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	26.70	26.70	0.00	28.30	28.30	0.00	29.40	29.40	0.00
	10	47.57	38.27	9.29	47.79	39.20	8.60	47.56	39.70	7.86
	15	96.37	80.12	16.25	91.64	77.23	14.40	86.74	74.09	12.65
	20	179.01	151.82	27.19	163.13	139.88	23.25	148.38	128.66	19.71
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	165.9	96.7	69.21	170.9	99.9	70.97	175.8	104.0	71.78
	15	422.9	335.1	87.72	434.7	346.2	88.41	443.0	355.4	87.60
	20	719.9	601.7	118.22	738.2	621.6	116.67	747.0	634.1	112.90
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	35.6	20.7	14.85	25.0	14.6	10.36	17.5	10.3	7.13
	15	90.7	71.9	18.82	63.5	50.6	12.91	44.0	35.3	8.71
	20	154.5	129.1	25.36	107.8	90.8	17.04	74.2	63.0	11.22
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0139			0.0199			0.0270
	At Least 15			0.0045			0.0064			0.0087
	At Least 20			0.0009			0.0013			0.0018
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			1.4527			2.0460			2.5441
	15			2.6060			3.6729			4.5717
	20			3.1658			4.4512			5.5311

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B21. Case 21 - Summary Comparison of 600 MMB System Versus 750 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		600	750	Delta	600	750	Delta	600	750	Delta
		600	750	Delta	600	750	Delta	600	750	Delta
World Oil Price (1988 \$/B)	0	16.70	16.70	0.00	21.70	21.70	0.00	24.80	24.80	0.00
	10	57.44	50.42	7.02	52.26	44.93	7.33	53.97	47.05	6.92
	15	138.80	124.75	14.06	118.54	104.54	14.00	114.09	101.56	12.53
	20	294.89	268.52	26.36	240.40	215.00	25.40	219.68	197.91	21.77
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	227.1	195.0	32.09	195.6	154.3	41.29	203.0	159.8	43.25
	15	454.1	409.9	44.14	442.7	387.0	55.71	463.5	406.0	57.52
	20	705.1	641.5	63.62	729.5	650.1	79.39	769.6	689.1	80.51
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	154.6	132.7	21.84	90.6	71.5	19.13	64.0	50.4	13.63
	15	309.0	279.0	30.04	205.1	179.3	25.80	146.1	128.0	18.13
	20	479.9	436.6	43.30	337.9	301.1	36.77	242.6	217.2	25.38
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0026			0.0055			0.0091
	At Least 15			0.0009			0.0018			0.0030
	At Least 20			0.0002			0.0004			0.0006
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.6150			1.4223			2.1780
	15			0.8569			2.1032			3.2556
	20			0.9889			2.4643			3.8158
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		600	750	Delta	600	750	Delta	600	750	Delta
		600	750	Delta	600	750	Delta	600	750	Delta
World Oil Price (1988 \$/B)	0	26.70	26.70	0.00	28.30	28.30	0.00	29.40	29.40	0.00
	10	53.90	47.57	6.33	53.60	47.79	5.80	52.81	47.56	5.25
	15	107.32	96.37	10.95	101.27	91.64	9.63	95.12	86.74	8.38
	20	197.26	179.01	18.25	178.60	163.13	15.48	161.40	148.38	13.02
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	210.5	165.9	44.59	216.4	170.9	45.48	221.5	175.8	45.72
	15	481.1	422.9	58.20	492.8	434.7	58.12	500.0	443.0	57.05
	20	799.7	719.9	79.80	816.1	738.2	77.89	821.5	747.0	74.57
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	45.2	35.6	9.57	31.6	25.0	6.64	22.0	17.5	4.54
	15	103.2	90.7	12.49	72.0	63.5	8.49	49.7	44.0	5.67
	20	171.6	154.5	17.12	119.2	107.8	11.37	81.6	74.2	7.41
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0139			0.0199			0.0270
	At Least 15			0.0045			0.0064			0.0087
	At Least 20			0.0009			0.0013			0.0018
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			2.9135			3.5521			4.0769
	15			4.3610			5.3151			6.1071
	20			5.0995			6.2027			7.1188

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B22. Case 22 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		*****			*****			*****		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
World Oil Price (1988 \$/B)	0	24.40	24.40	0.00	35.00	35.00	0.00	42.00	42.00	0.00
	10	37.12	37.12	0.00	44.22	41.44	2.78	51.63	45.05	6.59
	15	63.97	63.97	0.00	73.36	69.44	3.92	81.97	72.85	9.12
	20	101.76	101.76	0.00	113.96	108.53	5.44	123.56	111.11	12.45
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	42.8	42.8	0.00	30.0	20.5	9.56	34.4	10.0	24.36
	15	104.9	104.9	0.00	102.2	90.6	11.59	120.1	90.1	30.01
	20	155.3	155.3	0.00	163.1	149.0	14.04	198.4	161.7	36.66
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	24.3	24.3	0.00	9.7	6.6	3.08	6.3	1.8	4.45
	15	59.5	59.5	0.00	32.9	29.2	3.73	21.9	16.5	5.48
	20	88.1	88.1	0.00	52.5	48.0	4.52	36.2	29.5	6.70
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0005			0.0009			0.0014
	At Least 15			0.0001			0.0002			0.0003
	At Least 20			0.0000			0.0000			0.0000
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0000			0.0035			0.0131
	15			0.0000			0.0087			0.0348
	20			0.0000			0.0104			0.0423
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		*****			*****			*****		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
World Oil Price (1988 \$/B)	0	47.80	47.80	0.00	51.70	51.70	0.00	55.60	55.60	0.00
	10	57.52	50.70	6.82	61.18	54.54	6.65	64.83	58.48	6.36
	15	87.60	78.38	9.23	90.12	81.31	8.81	92.24	84.00	8.24
	20	127.98	115.65	12.33	128.21	116.65	11.57	127.50	116.93	10.57
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	37.6	10.5	27.37	40.7	11.3	29.33	44.2	13.5	30.68
	15	133.6	99.7	33.87	144.8	108.7	36.18	154.7	117.1	37.61
	20	225.1	183.6	41.47	247.6	203.4	44.23	265.8	220.1	45.73
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	3.9	1.1	2.84	2.4	0.7	1.73	1.5	0.5	1.02
	15	13.8	10.3	3.51	8.5	6.4	2.13	5.2	3.9	1.26
	20	23.3	19.0	4.30	14.6	12.0	2.60	8.9	7.3	1.53
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0021			0.0031			0.0044
	At Least 15			0.0005			0.0007			0.0011
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0234			0.0328			0.0406
	15			0.0649			0.0925			0.1140
	20			0.0794			0.1134			0.1399

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B23. Case 23 - Summary Comparison of 600 MMB System Versus 750 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		600	750	Delta	600	750	Delta	600	750	Delta
		600	750	Delta	600	750	Delta	600	750	Delta
World Oil Price (1988 \$/B)	0	24.40	24.40	0.00	35.00	35.00	0.00	42.00	42.00	0.00
	10	40.14	37.12	3.02	48.37	44.22	4.14	56.00	51.63	4.37
	15	68.24	63.97	4.28	79.18	73.36	5.82	88.00	81.97	6.03
	20	107.80	101.76	6.04	122.06	113.96	8.10	131.84	123.56	8.27
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	53.3	42.8	10.56	44.5	30.0	14.42	51.0	34.4	16.58
	15	117.5	104.9	12.64	119.8	102.2	17.63	140.6	120.1	20.56
	20	170.7	155.3	15.38	184.6	163.1	21.50	223.7	198.4	25.30
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	30.3	24.3	5.99	14.3	9.7	4.64	9.3	6.3	3.03
	15	66.7	59.5	7.17	38.6	32.9	5.69	25.7	21.9	3.76
	20	96.8	88.1	8.73	59.4	52.5	6.92	40.9	36.2	4.62
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0005			0.0009			0.0014
	At Least 15			0.0001			0.0002			0.0003
	At Least 20			0.0000			0.0000			0.0000
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0200			0.0376			0.0546
	15			0.0300			0.0634			0.0956
	20			0.0334			0.0723			0.1097
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		600	750	Delta	600	750	Delta	600	750	Delta
		600	750	Delta	600	750	Delta	600	750	Delta
World Oil Price (1988 \$/B)	0	47.80	47.80	0.00	51.70	51.70	0.00	55.60	55.60	0.00
	10	61.89	57.52	4.38	65.43	61.18	4.25	68.88	64.83	4.04
	15	93.51	87.60	5.91	95.74	90.12	5.62	97.46	92.24	5.22
	20	135.92	127.98	7.94	135.62	128.21	7.40	134.23	127.50	6.73
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	55.9	37.8	18.08	59.9	40.7	19.28	64.3	44.2	20.06
	15	156.0	133.6	22.46	168.7	144.8	23.84	179.3	154.7	24.62
	20	252.7	225.1	27.65	276.9	247.6	29.27	295.8	265.8	30.03
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	5.8	3.9	1.87	3.5	2.4	1.13	2.1	1.5	0.67
	15	16.2	13.8	2.33	9.9	8.5	1.40	6.0	5.2	0.82
	20	26.2	23.3	2.87	16.3	14.6	1.72	9.9	8.9	1.00
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0021			0.0031			0.0044
	At Least 15			0.0005			0.0007			0.0011
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0703			0.0845			0.0945
	15			0.1252			0.1520			0.1724
	20			0.1441			0.1753			0.1997

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B24. Case 24 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	16.70	16.70	0.00	21.70	21.70	0.00	24.80	24.80	0.00
	10	50.42	50.42	0.00	44.93	40.24	4.70	47.05	37.28	9.77
	15	124.75	124.75	0.00	104.54	95.48	9.06	101.56	83.62	17.94
	20	268.52	268.52	0.00	215.00	198.52	16.48	197.91	166.63	31.28
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	195.0	195.0	0.00	154.3	126.6	27.68	159.8	94.8	64.96
	15	409.9	409.9	0.00	387.0	350.7	36.35	406.0	322.5	83.53
	20	641.5	641.5	0.00	650.1	599.0	51.06	689.1	574.4	114.70
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	121.1	121.1	0.00	59.5	48.8	10.67	38.2	22.7	15.55
	15	254.5	254.5	0.00	149.2	135.2	14.02	97.2	77.2	20.00
	20	398.3	398.3	0.00	250.6	231.0	19.69	165.0	137.5	27.46
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0026			0.0055			0.0091
	At Least 15			0.0009			0.0018			0.0030
	At Least 20			0.0002			0.0004			0.0006
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0000			0.1704			0.6201
	15			0.0000			0.2968			1.1070
	20			0.0000			0.3623			1.3525
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	26.70	26.70	0.00	28.30	28.30	0.00	29.40	29.40	0.00
	10	47.57	38.27	9.29	47.79	39.20	8.60	47.56	39.70	7.86
	15	96.37	80.12	16.25	91.64	77.23	14.40	86.74	74.09	12.65
	20	179.01	151.82	27.19	163.13	139.88	23.25	148.38	128.66	19.71
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	165.9	96.7	69.21	170.9	99.9	70.97	175.8	104.0	71.78
	15	422.9	335.1	87.72	434.7	346.2	88.41	443.0	355.4	87.60
	20	719.9	601.7	118.22	738.2	621.6	116.67	747.0	634.1	112.90
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	24.7	14.4	10.29	15.8	9.2	6.55	10.1	6.0	4.11
	15	62.9	49.8	13.04	40.1	32.0	8.16	25.4	20.4	5.02
	20	107.0	89.4	17.57	68.1	57.4	10.77	42.8	36.3	6.47
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0139			0.0199			0.0270
	At Least 15			0.0045			0.0064			0.0087
	At Least 20			0.0009			0.0013			0.0018
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			1.1125			1.5066			1.8107
	15			2.0003			2.7123			3.2664
	20			2.4370			3.2981			3.9665

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B25. Case 25 - Summary Comparison of 600 MMB System Versus 750 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		600	750	Delta	600	750	Delta	600	750	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	16.70	16.70	0.00	21.70	21.70	0.00	24.80	24.80	0.00
	10	57.44	50.42	7.02	52.26	44.93	7.33	53.97	47.05	6.92
	15	138.80	124.75	14.06	118.54	104.54	14.00	114.09	101.56	12.53
	20	294.89	268.52	26.36	240.40	215.00	25.40	219.68	197.91	21.77
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	227.1	195.0	32.09	195.6	154.3	41.29	203.0	159.8	43.25
	15	454.1	409.9	44.14	442.7	387.0	55.71	463.5	406.0	57.52
	20	705.1	641.5	63.62	729.5	650.1	79.39	769.6	689.1	80.51
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	141.0	121.1	19.92	75.4	59.5	15.92	48.6	38.2	10.35
	15	281.9	254.5	27.40	170.7	149.2	21.48	111.0	97.2	13.77
	20	437.8	398.3	39.50	281.3	250.6	30.61	184.2	165.0	19.27
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0026			0.0055			0.0091
	At Least 15			0.0009			0.0018			0.0030
	At Least 20			0.0002			0.0004			0.0006
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.5746			1.2739			1.8746
	15			0.8011			1.8834			2.8026
	20			0.9251			2.2089			3.2901
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		600	750	Delta	600	750	Delta	600	750	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	26.70	26.70	0.00	28.30	28.30	0.00	29.40	29.40	0.00
	10	53.90	47.57	6.33	53.60	47.79	5.80	52.81	47.56	5.25
	15	107.32	96.37	10.95	101.27	91.64	9.63	95.12	86.74	8.38
	20	197.26	179.01	18.25	178.60	163.13	15.48	161.40	148.38	13.02
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	210.5	165.9	44.59	216.4	170.9	45.48	221.5	175.8	45.72
	15	481.1	422.9	58.20	492.8	434.7	58.12	500.0	443.0	57.05
	20	799.7	719.9	79.80	816.1	738.2	77.89	821.5	747.0	74.57
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	31.3	24.7	6.63	20.0	15.8	4.20	12.7	10.1	2.62
	15	71.5	62.9	8.65	45.5	40.1	5.36	28.7	25.4	3.27
	20	118.9	107.0	11.86	75.3	68.1	7.19	47.1	42.8	4.27
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0139			0.0199			0.0270
	At Least 15			0.0045			0.0064			0.0087
	At Least 20			0.0009			0.0013			0.0018
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			2.4100			2.8375			3.1575
	15			3.6110			4.2527			4.7428
	20			4.2322			4.9769			5.5472

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B26. Case 26 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price	0	24.40	24.40	0.00	35.00	35.00	0.00	42.00	42.00	0.00
(1988 \$/B)	10	37.12	37.12	0.00	44.22	41.44	2.78	51.63	45.05	6.59
	15	63.97	63.97	0.00	73.36	69.44	3.92	81.97	72.85	9.12
	20	101.76	101.76	0.00	113.96	108.53	5.44	123.56	111.11	12.45
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	42.8	42.8	0.00	30.0	20.5	9.56	34.4	10.0	24.36
- Not Discounted)	15	104.9	104.9	0.00	102.2	90.6	11.59	120.1	90.1	30.01
	20	155.3	155.3	0.00	163.1	149.0	14.04	198.4	161.7	36.66
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	26.6	26.6	0.00	11.6	7.9	3.68	8.2	2.4	5.83
- Discounted)	15	65.1	65.1	0.00	39.4	34.9	4.47	28.7	21.6	7.18
	20	96.4	96.4	0.00	62.9	57.5	5.41	47.5	38.7	8.77
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0005			0.0009			0.0014
	At Least 15			0.0001			0.0002			0.0003
	At Least 20			0.0000			0.0000			0.0000
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			0.0000			0.0040			0.0156
Discounted and	15			0.0000			0.0098			0.0412
Probability Weighted)	20			0.0000			0.0118			0.0500
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price	0	47.80	47.80	0.00	51.70	51.70	0.00	55.60	55.60	0.00
(1988 \$/B)	10	57.52	50.70	6.82	61.18	54.54	6.65	64.83	58.48	6.36
	15	87.60	78.38	9.23	90.12	81.31	8.81	92.24	84.00	8.24
	20	127.98	115.65	12.33	128.21	116.65	11.57	127.50	116.93	10.57
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	37.8	10.5	27.37	40.7	11.3	29.33	44.2	13.5	30.68
- Not Discounted)	15	133.6	99.7	33.87	144.8	108.7	36.18	154.7	117.1	37.61
	20	225.1	183.6	41.47	247.6	203.4	44.23	265.8	220.1	45.73
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	5.6	1.6	4.07	3.8	1.0	2.71	2.5	0.8	1.76
- Discounted)	15	19.9	14.8	5.03	13.4	10.0	3.34	8.9	6.7	2.16
	20	33.5	27.3	6.16	22.9	18.8	4.08	15.2	12.6	2.62
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0021			0.0031			0.0044
	At Least 15			0.0005			0.0007			0.0011
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			0.0287			0.0415			0.0526
Discounted and	15			0.0796			0.1168			0.1479
Probability Weighted)	20			0.0970			0.1426			0.1809

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B27. Case 27 - Summary Comparison of 600 MMB System Versus 750 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		=====			=====			=====		
		600	750	Delta	600	750	Delta	600	750	Delta
World Oil Price (1988 \$/B)	0	24.40	24.40	0.00	35.00	35.00	0.00	42.00	42.00	0.00
	10	40.14	37.12	3.02	48.37	44.22	4.14	56.00	51.63	4.37
	15	68.24	63.97	4.28	79.18	73.36	5.82	88.00	81.97	6.03
	20	107.80	101.76	6.04	122.06	113.96	8.10	131.84	123.56	8.27
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	53.3	42.8	10.56	44.5	30.0	14.42	51.0	34.4	16.58
	15	117.5	104.9	12.64	119.8	102.2	17.63	140.6	120.1	20.56
	20	170.7	155.3	15.38	184.6	163.1	21.50	223.7	198.4	25.30
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	33.1	26.6	6.56	17.1	11.6	5.56	12.2	8.2	3.97
	15	73.0	65.1	7.85	46.2	39.4	6.80	33.7	28.7	4.92
	20	106.0	96.4	9.55	71.2	62.9	8.29	53.5	47.5	6.06
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0005			0.0009			0.0014
	At Least 15			0.0001			0.0002			0.0003
	At Least 20			0.0000			0.0000			0.0000
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0211			0.0408			0.0612
	15			0.0316			0.0690			0.1073
	20			0.0352			0.0786			0.1229
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		=====			=====			=====		
		600	750	Delta	600	750	Delta	600	750	Delta
World Oil Price (1988 \$/B)	0	47.80	47.80	0.00	51.70	51.70	0.00	55.60	55.60	0.00
	10	61.89	57.52	4.38	65.43	61.18	4.25	68.88	64.83	4.04
	15	93.51	87.60	5.91	95.74	90.12	5.62	97.46	92.24	5.22
	20	135.92	127.98	7.94	135.62	128.21	7.40	134.23	127.50	6.73
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	55.9	37.8	18.08	59.9	40.7	19.28	64.3	44.2	20.06
	15	156.0	133.6	22.46	168.7	144.8	23.84	179.3	154.7	24.62
	20	252.7	225.1	27.65	276.9	247.6	29.27	295.8	265.8	30.03
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	8.3	5.6	2.69	5.5	3.8	1.78	3.7	2.5	1.15
	15	23.2	19.9	3.34	15.6	13.4	2.20	10.3	8.9	1.41
	20	37.6	33.5	4.11	25.6	22.9	2.70	17.0	15.2	1.72
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0021			0.0031			0.0044
	At Least 15			0.0005			0.0007			0.0011
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0811			0.1002			0.1150
	15			0.1446			0.1804			0.2097
	20			0.1662			0.2078			0.2424

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B28. Case 28 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	16.70	16.70	0.00	21.70	21.70	0.00	24.80	24.80	0.00
	10	65.31	65.31	0.00	61.60	57.81	3.80	62.80	54.91	7.89
	15	147.31	147.31	0.00	130.61	123.74	6.86	125.09	111.42	13.66
	20	298.23	298.23	0.00	252.62	240.77	11.85	230.66	207.82	22.84
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	355.2	355.2	0.00	328.9	302.2	26.75	342.6	279.8	62.78
	15	632.4	632.4	0.00	636.4	601.1	35.31	669.8	588.3	81.42
	20	906.8	906.8	0.00	964.6	916.1	48.52	1029.1	918.8	110.29
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	220.6	220.6	0.00	126.8	116.5	10.31	82.0	67.0	15.03
	15	391.6	392.6	0.00	245.4	231.7	13.61	160.3	140.8	19.49
	20	563.1	563.1	0.00	371.9	353.2	18.71	246.4	219.9	26.40
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0026			0.0055			0.0091
	At Least 15			0.0009			0.0018			0.0030
	At Least 20			0.0002			0.0004			0.0006
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0268			0.5409			1.6474
	15			0.0447			0.7688			2.2670
	20			0.0583			0.9073			2.6046
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	26.70	26.70	0.00	28.30	28.30	0.00	29.40	29.40	0.00
	10	61.94	54.58	7.36	60.92	54.23	6.69	59.36	53.34	6.02
	15	116.95	104.73	12.22	109.75	99.04	10.71	102.44	93.14	9.30
	20	206.59	186.91	19.68	186.61	169.93	16.68	168.06	154.03	14.03
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	355.6	289.1	66.47	365.9	298.2	67.74	374.0	305.9	68.12
	15	697.9	613.1	84.73	717.9	633.2	84.72	730.3	647.0	83.34
	20	1079.1	966.3	112.79	1110.2	999.7	110.55	1124.6	1018.3	106.33
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	52.9	43.0	9.88	33.8	27.5	6.25	21.4	17.5	3.90
	15	103.7	91.1	12.60	66.3	58.4	7.82	41.9	37.1	4.78
	20	160.4	143.6	16.77	102.5	92.3	10.20	64.4	58.4	6.09
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0139			0.0199			0.0270
	At Least 15			0.0045			0.0064			0.0087
	At Least 20			0.0009			0.0013			0.0018
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			2.9693			4.0248			4.7754
	15			4.0145			5.4017			6.3918
	20			4.5580			6.1027			7.2023

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B29. Case 29 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price	0	16.70	16.70	0.00	21.70	21.70	0.00	24.80	24.80	0.00
(1988 \$/B)	10	38.24	38.24	0.00	37.45	34.48	2.98	40.08	33.67	6.42
	15	75.37	75.37	0.00	70.51	65.88	4.63	71.35	61.68	9.67
	20	133.80	133.80	0.00	121.00	113.99	7.01	117.61	103.39	14.21
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	104.1	104.1	0.00	85.2	69.7	15.45	89.6	52.8	36.72
- Not Discounted)	15	211.4	211.4	0.00	207.6	188.5	19.12	221.5	176.5	45.04
	20	315.1	315.1	0.00	333.0	308.5	24.46	360.2	303.2	57.00
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	64.6	64.6	0.00	32.8	26.9	5.96	21.4	12.6	8.79
- Discounted)	15	131.3	131.3	0.00	80.0	72.7	7.37	53.0	42.2	10.78
	20	195.7	195.7	0.00	128.4	118.9	9.43	86.2	72.6	13.65
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0017			0.0037			0.0063
	At Least 15			0.0005			0.0011			0.0018
	At Least 20			0.0001			0.0002			0.0003
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			0.0000			0.0734			0.2752
Discounted and	15			0.0000			0.1213			0.4670
Probability Weighted)	20			0.0000			0.1413			0.5455
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price	0	26.70	26.70	0.00	28.30	28.30	0.00	29.40	29.40	0.00
(1988 \$/B)	10	41.17	34.98	6.19	41.92	36.13	5.79	42.17	36.83	5.34
	15	69.88	60.85	9.03	68.29	60.07	8.21	66.16	58.79	7.37
	20	111.13	98.23	12.90	105.19	93.74	11.44	98.92	88.90	10.02
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	93.7	54.3	39.41	97.0	56.5	40.55	99.0	58.9	41.02
- Not Discounted)	15	233.3	185.3	47.95	241.6	192.8	48.83	247.2	198.5	48.73
	20	382.1	322.1	60.05	396.7	336.3	60.41	404.9	345.5	59.42
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	13.9	8.1	5.86	9.0	5.2	3.74	5.7	3.4	2.35
- Discounted)	15	34.7	27.5	7.13	22.3	17.8	4.51	14.2	11.4	2.79
	20	56.8	47.9	8.93	36.6	31.0	5.58	23.2	19.8	3.41
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0100			0.0146			0.0203
	At Least 15			0.0028			0.0041			0.0057
	At Least 20			0.0005			0.0007			0.0010
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			0.5080			0.7016			0.8514
Discounted and	15			0.8693			1.2028			1.4671
Probability Weighted)	20			1.0143			1.4025			1.7120

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B30. Case 30 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	24.40	24.40	0.00	35.00	35.00	0.00	42.00	42.00	0.00
	10	41.23	41.23	0.00	46.89	43.23	3.66	54.37	45.84	8.53
	15	81.43	81.43	0.00	88.29	82.44	5.86	96.90	83.61	13.29
	20	145.57	145.57	0.00	153.19	144.10	9.09	161.92	141.78	20.14
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	62.7	62.7	0.00	43.2	29.6	13.56	48.7	14.5	34.18
	15	156.6	156.6	0.00	149.4	132.4	17.02	173.4	129.8	43.56
	20	236.7	236.7	0.00	243.9	222.5	21.45	293.9	238.4	55.43
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	38.9	38.9	0.00	16.7	11.4	5.23	11.6	3.5	8.18
	15	97.3	97.3	0.00	57.6	51.1	6.56	41.5	31.1	10.43
	20	147.0	147.0	0.00	94.0	85.8	8.27	70.4	57.1	13.27
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0012			0.0021			0.0033
	At Least 15			0.0004			0.0006			0.0010
	At Least 20			0.0001			0.0001			0.0002
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0000			0.0121			0.0443
	15			0.0000			0.0328			0.1308
	20			0.0000			0.0425			0.1713
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	47.80	47.80	0.00	51.70	51.70	0.00	55.60	55.60	0.00
	10	60.24	51.45	8.79	63.82	55.27	8.54	67.37	59.22	8.16
	15	101.95	88.70	13.25	103.57	91.06	12.51	104.69	93.14	11.56
	20	163.78	144.28	19.50	160.96	143.01	17.95	156.96	140.85	16.11
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	53.0	14.9	38.12	56.7	16.0	40.67	61.1	18.7	42.40
	15	191.1	142.3	48.79	206.0	154.2	51.83	218.5	164.9	53.56
	20	330.5	268.3	62.20	361.0	295.2	65.87	384.4	316.9	67.53
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	7.9	2.2	5.67	5.2	1.5	3.75	3.5	1.1	2.43
	15	28.4	21.2	7.25	19.0	14.2	4.78	12.5	9.4	3.07
	20	49.1	39.9	9.25	35.3	27.2	6.08	22.0	18.2	3.87
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0048			0.0067			0.0091
	At Least 15			0.0015			0.0021			0.0029
	At Least 20			0.0003			0.0004			0.0006
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0784			0.1090			0.1346
	15			0.2421			0.3413			0.4213
	20			0.3183			0.4494			0.5545

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B31. Case 31 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	16.70	16.70	0.00	21.70	21.70	0.00	24.80	24.80	0.00
	10	46.38	46.38	0.00	47.42	45.22	2.21	49.75	45.00	4.76
	15	85.20	85.20	0.00	83.20	79.91	3.29	83.32	76.41	6.90
	20	144.25	144.25	0.00	136.19	131.39	4.80	131.63	121.76	9.86
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	186.8	186.8	0.00	178.4	163.7	14.65	188.4	153.5	34.88
	15	321.6	321.6	0.00	334.7	316.5	18.12	358.1	315.2	42.86
	20	442.9	442.9	0.00	486.6	463.8	22.81	529.0	475.3	53.67
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	116.0	116.0	0.00	68.8	63.1	5.65	45.1	36.7	8.35
	15	199.7	199.7	0.00	129.0	122.0	6.99	85.7	75.5	10.26
	20	275.0	275.0	0.00	187.6	178.8	8.79	126.6	113.8	12.85
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0017			0.0037			0.0063
	At Least 15			0.0005			0.0011			0.0018
	At Least 20			0.0001			0.0002			0.0003
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0165			0.2703			0.7785
	15			0.0238			0.3611			1.0239
	20			0.0278			0.4034			1.1293
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	26.70	26.70	0.00	28.30	28.30	0.00	29.40	29.40	0.00
	10	50.16	45.63	4.53	50.27	46.08	4.20	49.78	45.95	3.83
	15	80.72	74.32	6.40	78.11	72.33	5.77	74.90	69.75	5.15
	20	123.51	114.61	8.90	116.16	108.31	7.85	108.46	101.61	6.84
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	197.0	159.8	37.22	203.7	165.6	38.11	208.4	170.0	38.38
	15	377.3	332.0	45.29	391.2	345.3	45.85	399.7	354.2	45.53
	20	563.0	506.8	56.20	586.4	530.2	56.23	599.4	544.3	55.07
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	29.3	23.8	5.53	18.8	15.3	3.52	11.9	9.7	2.20
	15	56.1	49.4	6.73	36.1	31.9	4.23	22.9	20.3	2.61
	20	83.7	75.3	8.35	54.1	48.9	5.19	34.3	31.2	3.16
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0100			0.0146			0.0203
	At Least 15			0.0028			0.0041			0.0057
	At Least 20			0.0005			0.0007			0.0010
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			1.4404			1.9873			2.3628
	15			1.8641			2.5561			3.0401
	20			2.0397			2.7885			3.3153

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B32. Case 32 - Summary Comparison of 600 MMB System Versus 750 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		600	750	Delta	600	750	Delta	600	750	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price	0	16.70	16.70	0.00	21.70	21.70	0.00	24.80	24.80	0.00
(1988 \$/B)	10	49.14	46.38	2.75	50.67	47.42	3.25	52.86	49.75	3.10
	15	89.42	85.20	4.23	88.04	83.20	4.84	87.80	83.32	4.49
	20	150.60	144.25	6.35	143.25	136.19	7.06	138.00	131.63	6.38
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	202.7	186.8	15.95	199.9	178.4	21.54	211.1	188.4	22.74
- Not Discounted)	15	341.5	321.6	19.91	361.5	334.7	26.86	386.2	358.1	28.18
	20	468.2	442.9	25.29	520.6	486.6	33.97	564.4	529.0	35.39
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	125.9	116.0	9.91	77.1	68.8	8.31	50.5	45.1	5.44
- Discounted)	15	212.1	199.7	12.36	139.4	129.0	10.36	92.5	85.7	6.75
	20	290.7	275.0	15.71	200.7	187.6	13.10	135.1	126.6	8.47
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0017			0.0037			0.0063
	At Least 15			0.0005			0.0011			0.0018
	At Least 20			0.0001			0.0002			0.0003
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			0.4316			1.0705			1.6121
Discounted and	15			0.5145			1.3007			1.9754
Probability Weighted)	20			0.5502			1.3980			2.1275
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		600	750	Delta	600	750	Delta	600	750	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price	0	26.70	26.70	0.00	28.30	28.30	0.00	29.40	29.40	0.00
(1988 \$/B)	10	53.03	50.16	2.86	52.91	50.27	2.64	52.18	49.78	2.40
	15	84.74	80.72	4.03	81.73	78.11	3.62	78.12	74.90	3.22
	20	129.09	123.51	5.58	121.07	116.16	4.91	112.72	108.46	4.27
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	220.6	197.0	23.50	227.7	203.7	23.97	232.5	208.4	24.04
- Not Discounted)	15	406.1	377.3	28.81	420.2	391.2	29.03	428.4	399.7	28.70
	20	598.9	563.0	35.83	622.1	586.4	35.68	634.2	599.4	34.79
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	32.8	29.3	3.49	21.0	18.8	2.21	13.3	11.9	1.38
- Discounted)	15	60.4	56.1	4.28	38.8	36.1	2.68	24.6	22.9	1.64
	20	89.0	83.7	5.33	57.4	54.1	3.29	36.3	34.3	1.99
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0100			0.0146			0.0203
	At Least 15			0.0028			0.0041			0.0057
	At Least 20			0.0005			0.0007			0.0010
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			2.1841			2.6568			2.9774
Discounted and	15			2.6634			3.2300			3.6257
Probability Weighted)	20			2.8613			3.4648			3.8912

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B33. Case 33 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	16.70	16.70	0.00	21.70	21.70	0.00	24.80	24.80	0.00
	10	32.74	32.74	0.00	32.44	29.72	2.71	35.23	29.35	5.88
	15	66.49	66.49	0.00	62.70	58.45	4.25	64.05	55.12	8.93
	20	119.90	119.90	0.00	109.16	102.71	6.45	106.87	93.73	13.15
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	82.8	82.8	0.00	61.2	46.2	15.05	64.0	28.4	35.70
	15	191.3	191.3	0.00	183.9	165.5	18.35	195.6	152.3	43.28
	20	297.5	297.5	0.00	310.0	286.6	23.39	334.0	279.4	54.58
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	51.4	51.4	0.00	23.6	17.8	5.80	15.3	6.8	8.55
	15	118.8	118.8	0.00	70.9	63.8	7.07	46.8	36.5	10.36
	20	184.7	184.7	0.00	119.5	110.5	9.02	80.0	66.9	13.07
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0017			0.0037			0.0063
	At Least 15			0.0005			0.0011			0.0018
	At Least 20			0.0001			0.0002			0.0003
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0000			0.0494			0.1597
	15			0.0000			0.0957			0.3423
	20			0.0000			0.1150			0.4168
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	26.70	26.70	0.00	28.30	28.30	0.00	29.40	29.40	0.00
	10	36.62	30.90	5.72	52.91	50.27	2.64	38.23	33.24	4.99
	15	63.26	54.87	8.39	81.73	78.11	3.62	60.73	53.82	6.92
	20	101.66	89.66	12.00	121.07	116.16	4.91	91.54	82.12	9.42
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	66.9	28.6	38.31	227.7	203.7	23.97	71.6	31.6	39.96
	15	205.6	159.4	46.15	420.2	391.2	29.03	217.8	170.7	47.12
	20	353.4	295.8	57.59	622.1	586.4	35.68	374.0	316.8	57.24
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	9.9	4.3	5.69	21.0	18.8	2.21	4.1	1.8	2.29
	15	30.6	23.7	6.86	38.8	36.1	2.68	12.5	9.8	2.70
	20	52.5	44.0	8.56	57.4	54.1	3.29	21.4	18.2	3.28
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0100			0.0146			0.0203
	At Least 15			0.0028			0.0041			0.0057
	At Least 20			0.0005			0.0007			0.0010
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.2837			0.3869			0.4728
	15			0.6280			0.8651			1.0627
	20			0.7656			1.0547			1.2963

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B34. Case 34 - Summary Comparison of 750 MMB System Versus 1000 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	16.70	16.70	0.00	21.70	21.70	0.00	24.80	24.80	0.00
	10	43.09	43.09	0.00	44.32	42.22	2.10	46.80	42.24	4.56
	15	80.13	80.13	0.00	78.57	75.41	3.17	79.04	72.39	6.65
	20	136.64	136.64	0.00	129.45	124.75	4.70	125.55	115.96	9.60
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	172.6	172.6	0.00	162.0	147.6	14.40	170.8	136.5	34.37
	15	309.8	309.8	0.00	319.9	302.1	17.85	341.6	299.4	42.17
	20	435.5	435.5	0.00	474.9	452.2	22.70	514.6	461.5	53.12
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	107.1	107.1	0.00	62.5	56.9	5.55	40.9	32.7	8.23
	15	192.4	192.4	0.00	123.3	116.5	6.88	81.8	71.7	10.10
	20	270.4	270.4	0.00	183.1	174.3	8.75	123.2	110.5	12.72
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0017			0.0037			0.0063
	At Least 15			0.0005			0.0011			0.0018
	At Least 20			0.0001			0.0002			0.0003
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			0.0129			0.2239			0.6171
	15			0.0197			0.3131			0.8565
	20			0.0234			0.3548			0.9595
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		750	1000	Delta	750	1000	Delta	750	1000	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price (1988 \$/B)	0	26.70	26.70	0.00	28.30	28.30	0.00	29.40	29.40	0.00
	10	47.43	43.07	4.36	47.74	43.70	4.05	47.46	43.75	3.71
	15	76.87	70.69	6.18	74.63	69.05	5.59	71.78	66.79	4.99
	20	118.18	109.51	8.66	111.46	103.81	7.65	104.33	97.66	6.67
Disruption Cost (Billions Of 1988 \$ - Not Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	178.5	141.8	36.68	184.4	146.8	37.59	188.6	150.7	37.90
	15	359.3	314.8	44.57	372.2	327.1	45.14	380.1	335.3	44.86
	20	546.3	490.8	55.52	568.1	512.6	55.52	580.1	525.7	54.37
Disruption Cost (Billions Of 1988 \$ - Discounted)	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
	10	26.5	21.1	5.45	17.0	13.6	3.47	10.8	8.6	2.17
	15	53.4	46.8	6.62	34.4	30.2	4.17	21.8	19.2	2.57
	20	81.2	72.9	8.25	52.4	47.3	5.12	33.2	30.1	3.12
Probability Of A Disruption Of:	At Least 0			1.0000			1.0000			1.0000
	At Least 10			0.0100			0.0146			0.0203
	At Least 15			0.0028			0.0041			0.0057
	At Least 20			0.0005			0.0007			0.0010
Cumulative Benefit (Billions Of 1988 \$ Discounted and Probability Weighted)	0			0.0000			0.0000			0.0000
	10			1.1351			1.5627			1.8596
	15			1.5483			2.1176			2.5217
	20			1.7196			2.3443			2.7907

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

Table B35. Case 35 - Summary Comparison of 600 MMB System Versus 750 MMB System

Variable	Net Disruption Size (MMBD)	1995			2000			2005		
		600	750	Delta	600	750	Delta	600	750	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price	0	16.70	16.70	0.00	21.70	21.70	0.00	24.80	24.80	0.00
(1988 \$/B)	10	44.99	42.40	2.59	46.75	43.68	3.07	49.13	46.18	2.95
	15	83.05	79.06	3.99	82.19	77.60	4.59	82.41	78.13	4.28
	20	141.03	135.05	5.99	134.73	128.01	6.72	130.34	124.25	6.09
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	183.8	168.2	15.55	178.4	157.5	20.99	188.2	166.0	22.16
- Not Discounted)	15	323.6	304.3	19.28	340.1	314.1	26.04	362.8	335.5	27.35
	20	452.8	428.3	24.44	500.2	467.2	32.93	541.0	506.7	34.35
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	114.1	104.5	9.66	68.8	60.7	8.09	45.1	39.7	5.31
- Discounted)	15	200.9	189.0	11.97	131.1	121.1	10.04	86.9	80.3	6.55
	20	281.1	266.0	15.18	192.8	180.1	12.70	129.5	121.3	8.22
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0017			0.0037			0.0063
	At Least 15			0.0005			0.0011			0.0018
	At Least 20			0.0001			0.0002			0.0003
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			0.3361			0.8555			1.3262
Discounted and	15			0.4178			1.0894			1.6917
Probability Weighted)	20			0.4528			1.1880			1.8437
Variable	Net Disruption Size (MMBD)	2010			2015			2020		
		600	750	Delta	600	750	Delta	600	750	Delta
		=====	=====	=====	=====	=====	=====	=====	=====	=====
World Oil Price	0	26.70	26.70	0.00	28.30	28.30	0.00	29.40	29.40	0.00
(1988 \$/B)	10	49.58	46.85	2.73	49.74	47.21	2.53	49.28	46.97	2.31
	15	79.90	76.05	3.85	77.37	73.90	3.48	74.22	71.13	3.10
	20	122.38	117.03	5.35	115.17	110.45	4.72	107.56	103.45	4.11
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	196.4	173.5	22.93	202.8	179.3	23.43	207.0	183.5	23.53
- Not Discounted)	15	381.1	353.1	28.01	394.2	366.0	28.27	401.9	373.9	27.99
	20	573.2	538.3	34.81	594.9	560.2	34.71	606.3	572.4	33.90
Disruption Cost	0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
(Billions Of 1988 \$	10	29.2	25.8	3.41	18.7	16.6	2.16	11.9	10.5	1.35
- Discounted)	15	56.7	52.5	4.16	36.4	33.8	2.61	23.0	21.4	1.60
	20	85.2	80.0	5.17	54.9	51.7	3.20	34.7	32.8	1.94
Probability Of A	At Least 0			1.0000			1.0000			1.0000
Disruption Of:	At Least 10			0.0100			0.0146			0.0203
	At Least 15			0.0028			0.0041			0.0057
	At Least 20			0.0005			0.0007			0.0010
Cumulative Benefit	0			0.0000			0.0000			0.0000
(Billions Of 1988 \$	10			1.7712			2.1381			2.3906
Discounted and	15			2.2548			2.7176			3.0481
Probability Weighted)	20			2.4534			2.9538			3.3161

Notes: The World Oil Prices are averages over the quarters of the disruption.

The Costs and Benefits are accumulated over six quarters beginning with the start of the disruption.

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